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International Yearbook of Soil Law and Policy 2022

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International Yearbook of Soil Law and Policy

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The *International Yearbook of Soil Law and Policy* is a book series that discusses the central questions of law and policy with regard to the protection and sustainable management of soil and land. The Yearbook series analyzes developments in international law and new approaches at the regional level as well as in a wide range of national jurisdictions. In addition, it addresses cross-disciplinary issues concerning the protection and sustainable management of soil, including tenure rights, compliance, food security, human rights, poverty eradication and migration. Each volume contains articles and studies based on specific overarching topics and combines perspectives from both lawyers and natural scientists to ensure an interdisciplinary discourse.

The *International Yearbook of Soil Law and Policy* offers a valuable resource for lawyers, legislators, scholars and policymakers dealing with soil and land issues from a regulatory perspective. Further, it provides an essential platform for the discussion of new conceptual approaches at the international, national and regional level.

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International Yearbook of Soil Law and Policy 2022

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Foreword

The recently published Sixth Assessment Report (AR6) of the Intergovernmental Panel on Climate Change (IPCC) laid out the stark challenge humanity is facing. Working Group II's contribution "Climate Impacts, Adaptation and Vulnerability" stated with very high confidence that climate change has by now altered marine, terrestrial, and freshwater ecosystems all around the world. Unique and already threatened ecosystems are expected to be at considerable risk in the very near term at 1.2 °C of global warming levels—significantly below 1.5 °C or even the 2 °C target of the Paris Agreement. The report concludes that effective conservation on approximately 30% to 50% of Earth's land will help to build ecosystem resilience and protect biodiversity. The window for effective action is closing rapidly.

At the same time, the Working Group III report "Mitigation of Climate Change" finds that average annual greenhouse gas (GHG) emissions during 2010–2019 were higher than in any previous decade, while the rate of growth has in fact slowed. All modelled mitigation strategies that may still land at global warming below 2 °C integrate the deployment of Carbon Dioxide Removal (CDR) technologies to counterbalance residual GHG emissions. These technologies are land-use intensive—as is the wide-scale deployment of renewable energy sources. As a result, ambitious climate policy within that closing window will render land a scarce resource and likely result in user conflicts.

The scarcity of the twenty-first century then is not determined by limited fossil resources, but by the limited absorption capacity of central sinks, such as the atmosphere, oceans, forests, and land. It is critical for sustainable development that the functioning of these sinks be maintained. The task of international climate policy is to transform these transnational common pool resources, which everyone can use free of charge, into global commons that are defined by sustainable user rights.

Thus, the role of soil in climate change cannot and must not be underestimated. It plays a key role both in mitigation and in adaptation scenarios. It offers solutions and challenges, and barely have we understood either. This book is a manifesto to the significance of soil, and the role both policy architecture and law making can play in guiding its sustainable use. It contributes to the understanding needed to define user rights and regulate resource access in a binding manner to mediate potential conflicts.

The chapters in the International Yearbook of Soil Law and Policy reflect this crucial role land-use plays, and the field of tension in which it is embedded.

The book highlights the intricate interdependencies that arise from the pivotal role of soil. It focusses on negative emissions and current regulatory concepts and challenges, as well as the role that soil ecosystem services play in meeting the objectives of the Convention on Biological Diversity, and what this means for a global policy architecture. At the intersection of both topics lies the critical issue of food security to achieve sustainable soil management—and the legal implications of migration due to soil degradation.

The development in soil legislation and policy architecture is considered on both the international and national levels. From the topic of soil at the global UNFCCC COP negotiations to a wide array of country-specific studies on soil legislation, the book offers knowledge on the legal protection of soil at multiple levels and in a very diverse set of localities.

The book provides a unique perspective tying together aspects that can help elucidate policy options to keep open this crucial window for action. The scarcity of the twenty-first century may be turned into a wealth of the commons, in which humanity manages its scarce resources and sinks sustainably. The appropriation of the global commons is risky in terms of distributional policy and thus also in terms of power—but it also holds the promise of achieving a fair and just sustainable transformation.

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Preface

The sixth volume of the International Yearbook of Soil Law and Policy can almost be viewed as a signal of hope in times of global tension, turmoil, and despair. On 24 February 2022, Russia has started its war against the Ukraine. The world is again facing a global crises—primarily—but by no means uniquely—with disastrous effects for the Ukrainian society due to ongoing armed conflict. The negative effects are already encountered throughout the world. Supply chain issues for energy and food, funding of military equipment, and disruption of efforts for cooperation are prevalent among other things.

In addition to these more or less immediate effects, the desperately needed transformation to climate neutrality and sustainability in the interest of all seems to be at risk to be again slowed down and given a backseat priority. In any case, the crisis dramatically aggravates transformation.

The global crises caused by the Russian invasion into Ukraine has thus similar effects on transformation efforts as the various global crises before in the last two decades. To mention just a few of them: 9/11, the war against Iraq, the food crisis, the finance crisis, the wars in Syria and Yemen, the migration crisis in 2015, and lastly the corona-pandemic, which still prevails. In addition, the world has seen continuously global crisis, due to an insufficient and under-ambitious global sustainability policy.

For volume 6 of the "International Yearbook of Soil Law and Policy" we have chosen as the theme "sustainable soil management and climate mitigation and adaptation". The increase of average global temperature due to the continuous emissions of greenhouse gases worldwide is one of the fundamental challenges of our age. The World Meteorological Organization (WMO) in Geneva has indicated in May 2022 that the crucial limit of 1.5 degree plus to pre-industrial level will already be reached in 4 years' time—with a 50% probability.

Soils are of eminent importance to deal with climate change and to implement measures for climate adaptation in particular in urban areas. Furthermore, the sustainable management of soils is also an enabler to make societies more resilient against ongoing and upcoming crises. Resilience of societies and systems such as food supply, health, or welfare is what we urgently need as well as to understand that due to the lack of sufficient sustainability policy humanity will most probably face further global crises in the next years. To cope with these resilience is needed.

Thus, the promotion of sustainable soil management and good governance to this end is very important. Insofar, volume 6 again provides important information and insight on how to achieve sustainable soil management from a governance perspective—in particular with regard to improved climate mitigation and adaptation. The structure of the volume conforms to all previous volumes—four main parts provide relevant and recent information on soil governance topics for academics, legislators, and policymakers:

- Part I: The Theme
- Part II: Recent Developments of Soil Regulation at International Level
- Part III: National and Regional Soil Legislation
- Part IV: Cross-Cutting Topics

As said, Part I—the theme compiles several chapters on the interface of sustainable soil management and climate change as well as climate adaptation, ranging from a fundamental analysis on governance instruments on carbon uptake in soils, over reports on ground-breaking court decisions in Germany and Australia to de-sealing instruments, the governance of negative emission, and effective contractual arrangements for soil-related climate change instruments.

Part II addresses latest developments at the international level, whereas part III consists of chapters on soil law in Japan and in Thailand.

Part IV deals with cross-cutting topics including a chapter on the management of per and polyfluorinated alkyl substances (PFAS), a newly detected contaminant, and a chapter on the cultural and religious perceptions of soils in African communities.

Given the large variety of topics and an esteemed authorship from all over the world, this volume is expected to be again of high value for all—working in the field of soil governance. Moreover, it is meant to be an instrument to connect people in order to work together—fairly and cooperatively—towards a good goal. We would like to thank all who have made this possible, primarily the authors and member of the Advisory Board. Our special thanks go to Laura Hofmann of the Springer Publishing House for her ongoing operational support and technical assistance.

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Part I
The Theme: Sustainable Soil Management and Climate Mitigation and Adaptation

Sustainable Soil Management and Soil Carbon Sequestration

Ian Hannam

Abstract Globally, food systems are associated with many unsustainable land use practices that lead to environmental damage such as greenhouse gas emissions, land degradation and biodiversity loss. Social issues, such as poor labour conditions, receive ever greater attention as farming has often been associated with practices that harm humans and society. From an economic standpoint, food systems need to be viable and resilient in order to allow operators in the food chain to make a living from their work. The importance of a global shift towards sustainable land use and food production has been commonly accepted for some time and there is an increasing interest by enterprises in the food and agriculture sector in assessing their sustainability performance. As the world has become increasingly vulnerable to the impacts of changing climate so too has the urgency to establish national and international guidelines and rules to acknowledge carbon management in agricultural supply chains and to improve the policy, strategic and legislative systems to manage soil carbon sequestration. An essential aspect of improved carbon management is legislation which has the ability to enable the development and implementation of soil organic carbon land management practices as sustainable soil standards.

1 Introduction

The importance of a global shift towards sustainable food production is commonly accepted and there is an increasing interest in the food and agriculture sector in assessing their sustainability performance, which may include social, ecological and economic aspects.[1] As sustainability within food systems increases in importance

[1] UNCTAD (2019) see pp. 51–52; https://unctad.org/system/files/official-document/tdr2019_en.pdf (Last access: 22 June 2022).

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the different approaches that are used to assess sustainability should adopt a common definition of the notion of "sustainability," along with a description of the methodological approach, indicators and assumptions.[2] Sustainability has become a guiding principle for the assessment of food systems.[3] Most recently, the COVID-19 pandemic has added new pressure to global land use. The global nature of this crisis sheds new light on how our ability to ensure food security and provide key ecosystem services inherent to soils, such as climate regulation and increased carbon sequestration, will increasingly depend on sustainable use of soil.

The term "carbon sequestration" is used to describe both natural and deliberate processes by which carbon dioxide ($CO_{2)}$ is either removed from the atmosphere or diverted from emission sources and stored in the terrestrial environment (vegetation, soils, and sediments).[4] Before human-caused CO_2 emissions began, the natural processes that make up the global "carbon cycle" maintained a near balance between the uptake of CO_2 and its release back to the atmosphere. However, existing CO_2 uptake mechanisms, sometimes called CO_2 or carbon "sinks", are insufficient to offset the accelerating pace of emissions related to human activities. It is argued that successful adaptation to climate change impacts will include advances in international and national environmental law, particularly in the areas of institutional, technological, education, research, and regulatory practices that encourage soil carbon sequestration (SCS).[5]

1.1 Sustainability Tools and Indicators

Sustainability assessment is an evaluation exercise that directs decision-making to ensure ongoing feasibility of the production system. Indicator-based sustainability assessment tools and frameworks can either guide or conduct sustainability

[2] Schader et al. (2014), p. 1, https://www.ecologyandsociety.org/vol19/iss3/art42/ (Last access: 22 June 2022).

[3] Ibid. Schader et al. (2014), p. 2, state that the primary purposes of a sustainability assessment approach can vary considerably and include the following: purely science-oriented approaches for research; monitoring and certification schemes intended to provide proof, such as to consumers, of the sustainability performance of companies; landscape planning tools that focus on the regional level and consider, for example, the environmental and socioeconomic surroundings of a number of farms and assess the impacts on sustainability; farm advisory tools to didactically assess the strengths and weaknesses of a farm and serve as a basis for management improvement or strategy development; and self-assessment tools that serve a similar purpose, but without the support of an adviser.

[4] United States Geological Survey (2008), p. 2, "Terrestrial sequestration (sometimes termed 'biological sequestration') is typically accomplished through forest and soil conservation practices that enhance the storage of carbon (such as restoring and establishing new forests, wetlands, and grasslands) or reduce CO2 emissions (such as reducing agricultural tillage and suppressing wildfires)"; https://pubs.usgs.gov/fs/2008/3097/pdf/CarbonFS.pdf (Last access: 22 June 2022).

[5] Hannam (2019), p. 399.

assessments[6] and they vary widely in whom they target (e.g. farmers or policy makers), selection of indicators, aggregation and weighting method and time required.[7] Scientific evidence on farm sustainability assessments, as well as the sustainability assessment tools available to support decision-making, are ever-expanding. However, these assessment tools can vary enormously in their scope and approach.[8] It is argued that the most pressing need is for the development of an agenda that includes, for example: (i) information on region-specific soil distribution and degradation status, (ii) matching of sustainable management practices to respective soil groups and their degradation status, and (iii) stopping the carbon loss from specific soils that have the potential to significantly affect the global C balance, e.g., peatlands under drainage.[9]

Different terms are used in the literature to describe sustainability assessments, such as methods, methodological approaches, frameworks, and tools. Sustainability assessments that assess the sustainability performance of farms using indicators are called indicator-based sustainability assessment tools.[10] Zaralis et al. provide a list of 103 sustainability tools,[11] many of which were selected and prioritised based on their coverage of the 2014 FAO Sustainability Assessment of Food and Agriculture systems (SAFA) framework guidelines. The SAFA Guidelines provide a hierarchal structure of dimensions, themes and subthemes. An objective for each sub-theme describes the target state of sustainability. In addition to the economic, social and environmental dimensions, the SAFA Guidelines include governance as a fourth dimension that relates to the other three. Governance assesses the ability of an operator, a farm, a processor or a retailer, to deliver adequate sustainability performance.[12]

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[6] Gasparatos and Scolobig (2012), p. 1; www.gasparatos-lab.org/uploads/7/6/6/1/76614589/gasparatos_and_scolobig_2012_ecological_economic.pdf (Last access: 22 June 2022).

[7] Ibid. Schader et al. (2014), p. 1.

[8] Ibid. Gasparatos and Scolobig (2012), p. 3, Table 1.

[9] Amelung et al. (2020), p. 3.

[10] Zaralis et al. (2017), p. 635, identify scientific papers on sustainability assessments relevant to agricultural systems.

[11] Ibid p. 635; these tools were in turn categorized based on the following criteria: i. the quantification of sustainability used (functional units; e.g. currency, carbon footprint, standardised units etc.), ii. farm, product or sector level (spatial scale), iii. whether the tool was designed for a specific country or region or is more widely applicable (transferability), iv. Whether it is sector specific (i.e. specific to dairy/crops/etc. or covers a range of farm types), v. time taken to complete the assessment and vi. software or platform used.

[12] FAO (2014), p. 80.

1.2 Carbon Sequestration

One of the essential aspects of sustainability of agricultural systems is the maintenance or improvement of soil organic carbon (SOC). Currently, 33% of the global soils have been degraded and have lost much of their SOC through the historical expansion of agriculture and pastoralism and subsequent land-use conversion from native ecosystems (e.g., peatlands, forests, grasslands) to arable land.[13] This has resulted in a decline in soil structural stability, increased erosion risks, and reduced water storage and nutrient supplies. Soil degradation has thus become a major threat to food security, especially in developing countries. Soil degradation can be stopped with the maintenance of SOC stocks with good agricultural practice. The related soil health benefits from sequestering carbon may then help to close yield gaps in arable soils due to associated improvements in nutrient supplies, water-holding capacity, and soil structural stability. Priority for the transformation of agricultural systems to increase SOC sequestration should also be considered for regions with low SOC contents caused by large historic SOC losses. Unfortunately, the total area of degraded soil, ranging from 1000 to 6000 M ha^{-1}, is not well-defined globally, thus impairing a global agenda that can target land restoration and thereby support climate mitigation.[14]

1.3 Climate Change

Of significance to the sustainability of soil resources, and of food production in agricultural systems, is the impact of agricultural land use on climate change. Present-day global concentrations of atmospheric CO_2 are higher and rising faster than at any time in at least the past two million years. The speed at which atmospheric CO_2 has increased since the industrial revolution (1750) is at least ten times faster than at any other time during the last 800,000 years, and between four and five times faster than during the last 56 million years. About 15% of CO_2 is generated from land use change, in particular agriculture, and usually results in land degradation.[15] The Intergovernmental Panel on Climate Change (IPCC) warn that the Earth's surface temperature will increase until at least 2050 under all emission scenarios presented in the 6th Assessment Report of 2021 (AR6). The AR6 shows Earth could well exceed 1.5 °C warming limit by the early 2030s. If emissions are reduced sufficiently, there is only a 50% chance global temperature rise will stay around 1.5 °C. To get Earth back to below 1.5 °C warming, CO_2 would need to be removed from the atmosphere using negative emissions technologies or

[13] Ibid Amelung et al. (2020), p. 2.

[14] Ibid Amelung et al. (2020), pp. 2–3.

[15] 85% is from burning fossil fuels.

nature-based solutions including increasing SCS in agricultural systems.[16] Therefore, achieving sustainable soil management (SSM) has never been more important as it relies on practices that improve soil functions. Moreover, SOC-centred SSM practices improve soil health, enhance food security and farm incomes and also help mitigate climate change.[17] Agriculture can provide solid data on the emissions output per unit of production as a way to meet consumer demand for sustainable products and investor requirements for substantiated evidence of on-farm sustainability. In addition, to lower emissions and enhanced production, sustainable farming offers a range of economic benefits, which can deliver important long-term financial gains to agricultural producers.[18]

In this regard, an investigation into countries' commitments to SOC under the Nationally Determined Contributions (NDCs) prepared in response to the 2015 Paris Agreement,[19] found that twenty-eight countries referred to SOC in their NDCs, citing quantified or unquantified mitigation targets, national policies or programs, and actions and measures to be implemented in agricultural lands (14 countries), peatlands (6 countries) or wetlands (14 countries).[20] It also found that countries' reasons for not including SOC in NDCs included the need to prioritize goals of sustainable development and food security above climate mitigation, a lack of incentives for farmers to improve management practices, and the difficulty of accurately monitoring changes in SOC. Other highlights of the investigation included: many NDCs specify practices known to have the potential to achieve SOC sequestration or protection without explicitly mentioning SOC; NDCs are not presently a good indicator of countries' interest or commitment to SOC action at the national level; and increased collaboration between countries with experience managing SOC and countries needing support to develop SOC-related targets, policies, measures and incentives for land users and farmers would facilitate the provision of such needed support.[21]

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[16] IPCC (2019), pp. 17–18.

[17] FAO (2019) www.fao.org/global-soil-partnership/areas-of-work/recarbonization-of-global-soils/en/ (Last access: 22 June 2022).

[18] CEFC (2008), p. 1; https://www.cefc.com.au/media/v5klidlc/cefc_investmentinsight_farmprint_aug2021_web.pdf (Last access: 4 September 2021).

[19] Paris Agreement, available at: http://unfccc.int/paris_agreement/items/9485.php; adopted by consensus on 12 December 2015; Nationally Determined Contributions (NDCs) are at the heart of the Paris Agreement and the achievement of these long-term goals. NDCs embody efforts by each country to reduce national emissions and adapt to the impacts of climate change. The Paris Agreement (Art 4, para 2) requires each Party to prepare, communicate and maintain successive nationally determined contributions (NDCs) that it intends to achieve. Parties shall pursue domestic mitigation measures, with the aim of achieving the objectives of such contributions—https://unfccc.int/process-and-meetings/the-paris-agreement/nationally-determined-contributions-ndcs/national (Last access: 4 September 2021).

[20] Wiese et al. (2021), p. 1 and Table 3 p. 7; https://www.tandfonline.com/doi/full/10.1080/14693062.2021.1969883?scroll=top&needAccess=true (Last access: 22 June 2022).

[21] Ibid p. 1.

2 Sustainability

Sustainable development has become one of the most frequently used frameworks for analyzing the agricultural and food sector in a comprehensive way.[22] The objective of sustainable development is to improve people's quality of life without exploiting natural resources beyond the capacities provided by the natural environment. Sustainable development was defined by the FAO in 1989 as "the management and conservation of the natural resource base, and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable development (in the agriculture, forestry and fisheries sectors) conserves land, water, plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable and socially acceptable".[23] The farm level is one of the main levers for designing sustainable food systems, as many decisions related to farming practices with the most severe social and environmental impacts are made at this level.[24] To enable farmers to make sound decisions, all dimensions of sustainability need to be considered in particular increasing the sequestration of carbon in the soil.

2.1 Sustainable Soil Management

The FAO Global Soil Partnership (GSP), which commenced in 2012, is a key organization in achieving the goal of SSM. The GSP was created to fill a global gap in soil governance where its purpose was to reverse the growing trend of soil degradation through the promotion of SSM. The GSP adopted three different but interrelated approaches to address global soil issues: policy advocacy; development of technical tools; and programmatic actions focused on the implementation of SSM practices at field level.[25] Under its SSM guidelines, the GSP furthers it role in addressing global challenges, and meeting international commitments, in particular, "the commitment to combat desertification and mitigate effects of drought, especially the strive to achieve a land degradation neutral world, taking note of the

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[22] Ibid. Schader et al. (2014), p. 1.

[23] FAO (1989), p. 5, para 6; www.fao.org/3/z4920en/z4920en.pdf (Last access: 22 June 2022).

[24] E.g., see Future Food Systems at https://www.futurefoodsystems.com.au/about/ (Last access: 22 June 2022) The Future Food Systems Cooperative Research Centre (CRC) was created to support innovation and growth across the value chain. The CRC works to advance the development of sustainable food systems across three overlapping areas, including renewable energy, new equipment, tools, technology and systems for high-tech protected cropping, solutions for adding value to produce.

[25] http://www.fao.org/global-soil-partnership/areas-of-work/soil-governance/en/# (Last access: 22 June 2022).

potential benefits for all as per the last UNCCD COP12."[26] Achieving SSM is now highly dependent upon the world reaching the goal of land degradation neutrality (LDN).[27] In this regard, Keesstra et al. point out that "There is an increasing pressure on land, and due to improper use, land resources are quickly degrading, which will create even greater pressure on the remaining land. This calls for a new sustainable approach to land use and land management. There is a sense of urgency; the deadline for LDN (2030) is pressing, especially when it comes to environmental issues. Healthy soils and healthy land are essential to achieving many of the societal goals in the framework of the SDGs [Sustainable Development Goals]".[28]

Developing and implementing an integrated approach to the analysis of different sustainability dimensions, for SSM in particular, and integrating them in agricultural land use strategies, remains a major challenge. To this extent, SSM requires balancing the needs for human purposes with those for environmental conservation and soil quality and soil health is reduced through human-induced degradation processes such as soil erosion, nutrient mining, compaction, acidification, and pollution. FAO specifies that "Soil management is sustainable if the supporting, provisioning, regulating, and cultural services provided by soil are maintained or enhanced without significantly impairing either the soil functions that enable those services or biodiversity. The balance between the supporting and provisioning services for plant production and the regulating services the soil provides for water quality and availability and for atmospheric greenhouse gas composition is a particular concern".[29]

In addition to soil degradation and climate change, globally, agriculture faces many challenges including ability for free trade, and the continuing development of new technologies.[30] Moreover, new strategies are emerging that pursue sustainable

[26] FAO (2017), p. 5.

[27] The concept of LDN was officially recognised by UNCCD in October 2015 by a decision of the twelfth session of the UNCCD Conference of the Parties (COP12). Under Decision 3/COP.12, LDN is defined as "A state whereby the amount and quality of land resources, necessary to support ecosystem functions and services and enhance food security, remains stable or increases within specified temporal and spatial scales and ecosystems"; to date, many countries have identified various land management programs that include SSM practices to manage soil carbon sequestration under the Target Setting Program—https://knowledge.unccd.int/ldn/ldn-target-setting/ldn-country-information (Last access: 22 June 2022).

[28] Keesstra et al. (2018), p. 15.

[29] Ibid. FAO (2017), p. 3.

[30] European Commission (2021) Study on the possibility to set up a carbon border adjustment mechanism on selected sectors, Final Report, p. 223; on 14 July 2021 the European Commission adopted a proposal for a new Carbon Border Adjustment Mechanism which will put a carbon price on imports of a targeted selection of products so that ambitious climate action in Europe does not lead to 'carbon leakage'. This will ensure that European emission reductions contribute to a global emissions decline, instead of pushing carbon-intensive production outside Europe. It also aims to encourage industry outside the EU and our international partners to take steps in the same direction; See Carbon Border Adjustment Mechanism—https:ec.europa.eu/taxation_customs/green-taxation-0/carbon-border-adjustment-mechanism_en.

development of agricultural production with improved environmental practices. In order for agriculture to be sustainable, it must be sufficiently productive, economically viable, culturally and socially acceptable and ecologically adequate; that is, it needs to conserve natural resources and preserve ecological diversity and the capacity of agroecosystems to self-maintain. To this end, increasing the sequestration of carbon as a feature of sustainable agriculture preserves diversity, improves soil biology, provides healthy food, reduces the producer's dependence on external sources, and grants a reliable source of income for farmers.[31] Indicators are useful for assessing the degree of achievement of the sustainability of an agroecosystem. The sustainability indicators make perceivable a phenomenon that is not immediately and easily detectable, and allow us to understand the sustainability status of an agroecosystem or the critical aspects that endanger it. In this regard, various aspects of the FAO SAFA guidelines can be applied to develop and implement an integrated approach to analyzing different sustainability dimensions for SSM. Applying them in agricultural management does however pose some challenges. Sustainable soil management requires balancing the needs for human purposes with those for environmental conservation and functioning.

2.2 Sustainable Development Goal 15

In 2015 sustainability became the fundamental theme of society in constituting the cornerstone of the United Nations Sustainable Development Goals 2030 (SDGs). The 17 SDGs are an urgent call for action by all countries in a global partnership that applies strategies to improve health and education, reduce inequalities, and stimulate economic growth, while tackling climate change and working to preserve land, oceans and forests.[32] Moreover, what is of significance to this chapter derives from paragraph 206 of the Rio+20 Outcome Document which states "We recognize the need for urgent action to reverse land degradation. In view of this, we will strive to achieve a land-degradation neutral world in the context of sustainable development". The SDGs were adopted by the UN General Assembly in September 2015 and include SDG 15.3 as a target on land degradation neutrality (LDN) where "by 2030, combat desertification, and restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land-degradation neutral world".[33] Managing soil carbon is a key component to achieving

[31] Technological advances in agriculture have allowed farmers to cultivate more land with less labour, and one of the main consequences of the increase in the mechanization of the agricultural system is that there are fewer job opportunities on farms, pushing many families to move to urban centres, leaving rural communities to decline, which are the custodians of agricultural traditions and natural resources.

[32] Sustainable Development Goals available online at: https://sustainabledevelopment.un.org/content/documents/4538pressowg13.pdf (Last access: 22 June 2022).

[33] Resolution adopted by the General Assembly on 27 July 2012, 66/288, The Future We Want.

LDN. Boer and Hannam (2021)[34] outline the problems of land degradation worldwide and ways in which LDN can be promoted through international legal mechanisms, as well as at the national level.

3 Soil Organic Carbon

3.1 Linking Soil Carbon Sequestration to Food Security

An adequate supply of SOC and nutrients is essential to maintain crop yields and the nutritional values of the agri-food system. The global agri-food system needs to be reshaped to meet population needs, and become more productive, more inclusive of poor and marginalized populations while remaining environmentally sustainable and resilient.[35] Healthy, productive soils are the key to delivering wholesome and nutritious diets to all humans, and to avoid compromising food security and nutrition for future generations. In this regard, an integrated understanding of carbon cycling in the soil-plant-atmosphere continuum is crucial to adapt to current and future changes and challenges including sustainable production of food, feed, fuel, and fiber in a climate change scenario.[36] Achieving SSM has never been more important as it relies on the establishment of practices that foster improved soil functions that enable ecosystem services and biodiversity.[37] Soil Organic Carbon-centred SSM practices are essential not only to improve soil health and enhance food security, but also to mitigate climate change,[38] but efforts to increase SOC content through SSM practices may be subject to the antagonistic effects of nitrous oxide (N_2O) emissions from unsustainable nitrogen (N) fertilizer management. To ensure that croplands become a sink of atmospheric CO_2 with the implementation of re-carbonization programmes, SSM should be an important part of the solution to N_2O emissions, soil degradation, and water contamination, through practices and tools to improve N use

[34] Boer and Hannam (2021), pp. 392–404.

[35] FAO (2018), p. 4, see Fig. 2; www.fao.org/3/ca2079en/CA2079EN.pdf (Last access: 22 June 2022).

[36] FAO (2020), p. 2; www.fao.org/3/cb0509en/cb0509en.pdf (Last access: 22 June 2022).

[37] FAO (2017), p. 5; www.fao.org/3/bl813e/bl813e.pdf (Last access: 22 June 2022).

[38] Ibid. FAO (2020), p. 1, outlines that the adoption of site-specific Sustainable Soil Management (SSM) practices in agricultural lands can harness a large C sink capacity at a global scale, and it has been highlighted as a significant greenhouse gas (GHG) removal strategy. It has been estimated that the global technical potential of terrestrial C sequestration is between 1.7 and 4.6 Pg C/ year. Sequestration rates due to management practices in agricultural lands are usually in the range of 0.2 to 0.8 t C/ha/ yea. The magnitude and rate of carbon sequestration in soils can vary greatly, depending on the different land uses and practices, soil characteristics, vegetation, topography and climate, among other soil forming factors and processes, which add to the many challenges for quantifying SOC stocks and changes.

efficiency.[39] To this extent, an integrated and joint N management framework, in conjunction with re-carbonization programmes would contribute to unlocking the potential of cropped soils to mitigate and adapt to climate change. The role of SOC in the climate system, and especially in climate change adaptation and mitigation, has been widely recognized and scientifically validated.[40]

The Paris Agreement,[41] the Koronivia Joint Work in Agriculture[42] and the recent Intergovernmental Panel on Climate Change (IPCC) Special Report on Climate and Land,[43] have also led to the development of an enabling political-institutional environment that will allow the support and adoption of sustainable management practices based on SOC maintenance and/or sequestration. In addition, in the context of the SDGs, a sustainable global food system must foster a sustainable environment in which agriculture, biodiversity conservation and climate change adaptation and mitigation can thrive, but also co-exist and complement each other. The Monitoring, Reporting and Verification (MRV) voluntary protocol established by FAO could support the adoption of SSM practices for healthy soils and help protocol users to reliably measure their success in sequestering carbon in the fight against climate change and in the provision of other key ecosystem services. This would also make a great contribution to achieving the SDGs.[44]

Any CO_2 that is sequestered in soil has been removed directly from the atmosphere and will thus help to mitigate climate change.[45] The science of CO_2 sequestration in soils is currently advanced enough to support policy and incentive programs despite some uncertainty in the absolute sequestration rates of particular practices in specific parts of the world.[46] To be successfully implemented at a global scale, appropriate SOC sequestration management strategies are likely to be adopted faster if SOC is considered not only as a means for mitigating climate change but also as a contributor to soil health, food security, and sustainable development goals. The potential to sequester C in soil varies substantially from one region to another, even under similar types of management, due to variations and gaps in current and potential SOC levels.[47] Variations in C sequestration potentials increase with differences in climate, soil groups, cropping systems, and available technologies as

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[39] Ibid. Amelung et al. (2020), pp. 2–3.

[40] Ibid. FAO (2020), p. XVI.

[41] Ibid.

[42] The Koronivia Joint Work on Agriculture (KJWA), a landmark decision under the United Nations Framework Convention on Climate Change, recognizes the potential of agriculture in tackling climate change; www.fao.org/koronivia (Last access: 22 June 2022).

[43] Ibid.

[44] Ibid. FAO (2020), p. XX comments that the GSOC-MRV Protocol "A protocol for measurement, monitoring, reporting and verification of soil organic carbon in agricultural landscapes" is the result of a very inclusive and collaborative work of scientists from many countries around the world, international organizations, panels, initiatives and institutions.

[45] Ibid. FAO (2020), p. 4.

[46] Ibid. Amelung et al. (2020) Box 1, p. 4.

[47] Ibid. Amelung et al. (2020), p. 3.

well as with different yield gaps [48] and soil-specific, historical C losses. This situation can be a barrier to the global implementation of a soil carbon climate-mitigation initiative, which will thus need a coordinated effort at regional scales adapted to these variations. Amelung et al. specify that "the most pressing need is the development of an agenda that includes: (i) information on region-specific soil distribution and degradation status; (ii) matching of sustainable management practices to soil group and its degradation status; and (iii) stopping the C loss from specific soils that have the potential to significantly affect the global C balance, e.g., peatlands under drainage. Currently, only a few countries have robust monitoring, reporting, and verification systems, but there are ongoing research efforts to expand these capabilities."[49]

4 Legislation

An outline of the global legislative framework to manage SCS was presented in 2019.[50] It was argued that an understanding of the physical and human related land use issues associated with SCS provide a guide as to the most appropriate legislative system needed to manage the soil environment. These issues involve how to adapt to climate change impacts, the problems associated with agricultural land use and food security, maintaining and restoring biological and ecosystem diversity and the control and prevention of land degradation. A comprehensive understanding of these issues points towards the actual legislative and institutional elements essential within a national legal and institutional system to effectively manage soil carbon, as well as the appropriate land management practices to improve soil carbon levels. A legal framework provides law and policy-makers with a practical method and guideline for identifying, developing, or strengthening a legal and institutional system that is concerned with aspects of the environment.

At the national level, there are many ways to frame legislation to control the impacts of land use on soil carbon levels. However, the ability of legislation to achieve effective soil carbon management will depend on the legal and institutional elements that protect physical processes associated with SCS and the establishment, maintenance and protection of carbon sinks and reservoirs. Such elements should be incorporated within procedures that regulate and manage the land use activities that

[48] See Global Yield Gap Atlas at https://www.yieldgap.org (Last access: 2 October 2021)—the world's leading database on high-quality agronomic data with local to global relevance that covers 70 countries across six continents and 13 major food crops with the following data: actual and potential yield and yield gap; actual and potential water productivity; actual and potential nutrient requirement; underlying data on weather, soil and cropping systems; climate zones and technology extrapolation domains (TEDs).The data serves research, strategic decision making and local-global actions that aim to improve yield and resource use efficiency by public and private sectors.

[49] Ibid. Amelung et al. (2020), p. 3.

[50] Hannam (2019), pp. 399–433.

cause the loss of soil carbon, lead to land degradation and contribute to the atmospheric CO_2 and global warming. Legislation and policy reform should be approached from a sound conceptual basis, preferably with an overall societal goal of sink management and enhancement. Importantly, a change in attitude to create legislation for SCS management depends on the willingness of society to accept new values in a legal system for land management. Some of the important conceptual and ethical elements for land management include the concept of natural rights for soil, to provide for the public interest, to apply the precautionary principle, and to conserve biological diversity.[51]

There is a variety of ways to design a legal and institutional system to manage soil carbon. Two principal approaches have been suggested, depending on the respective national physical, sociological and economic conditions.[52] However, individual laws could practically use a mix of each of these two broad approaches.

Non-Regulatory Strategy—characterised by elements that focus on:

- Extension, education, and awareness programs for soil carbon management
- Financial support to research soil carbon processes and sink protection.
- Extensive use of community participatory facilities in sink education.
- Development of land use practices that minimise the loss of soil carbon.
- Development of soil carbon management, protection, and incentive-based programs.

Regulatory Strategy—characterised by elements that focus on:

- Development of statutory land use plans that prescribe legal limits and targets of soil and land use to reduce the loss of soil carbon (e.g., cultivation practices, vegetation retention levels and water quality levels).
- Issue of licenses or permits to control soil use. These would prescribe use entitlements relating to soil restoration, management of sinks, habitat protection, organic matter level etc.
- Land use agreements between the State and individuals that set binding land use standards.
- The use of restraining notices where sustainable use limits are exceeded.
- Prosecution for failure to follow prescribed standards for managing soil carbon sinks and reservoirs

4.1 Global Picture of National Soil Carbon Legislation

The FAO GSP soil legislation database, "SoiLEX", has gathered and classified national legislation on soil protection, conservation, and restoration. It provides

[51] Ibid. Hannam (2019), p. 403.
[52] Ibid. Hannam (2019), p. 430.

access to information on the existing legal instruments in force.[53] All instruments in the portal have been validated by national experts and each instrument can be searched by country profile or by soil-related keywords. It includes a ranking system based on the relevance of the document to the selected keyword, the scope of the legislation, its nature and year.[54] The fourteen keywords in SoiLEX comprise recognized soil problems and characteristics associated with soil and land degradation processes. One of the fourteen keywords is legislation for "soil organic carbon loss." Boer and Hannam (2021) note that "as states implement LDN through legislation, SoiLEX could likely become a source for measuring the rate of legally backed uptake of LDN."[55] The same understanding could also apply for "soil organic carbon loss" legislation. At this point SoiLEX identifies 92 laws, regulations, decrees, ordinances and strategies under the soil organic carbon loss keyword, spread between 48 countries.[56] However, none of these instruments have been developed specifically to manage SCS, certainly not along the lines as advanced by Hannam (2019 at 401), for example.

Given the picture from the SoiLEX data, one of the opportunities available is for individual countries to use a combination of laws and instruments to manage SCS. In this situation, however, it would be appropriate to have a principal coordinating instrument which establishes the basic principles, objectives and legal elements for managing SOC.

4.2 Coordinating Legislative Approach: People's Republic of China

In 2012, a study carried out in the People's Republic of China (PRC) presents the results of the analysis of three PRC laws to determine their capacity to manage carbon associated with agricultural land use.[57] The study analysed the capability of the Agriculture Law 2003,[58] the Grassland Law 2002 and the Desertification Law 2001, from an integrated perspective, to manage soil organic carbon (SOC) in PRC's

[53] www.fao.org/soils-portal/soilex/en/ (Last access: 22 June 2022).

[54] www.fao.org/soils-portal/soilex/country-profiles/ (Last access: 22 June 2022).

[55] Boer and Hannam (2021), p. 401.

[56] www.fao.org/soils-portal/soilex/soil-keywords/soil-organic-carbon-loss/en/ (Last access: 22 June 2022).

[57] Ibid. Hannam (2012).

[58] The purpose of this law is to consolidate and strengthen the position of agriculture in the national economy, enable rural reform, develop agricultural productivity, modernize agriculture, protect the lawful interests of farmers and agricultural business organizations, improve farmers' incomes and their knowledge of science and culture, and promote the sustainable, stable and sound development of agriculture and the rural economy, so as to achieve the goal of comfortable social conditions (extracted from Article 1).

grasslands.[59] It also provided an indication of the potential for carbon management in the grasslands to contribute to a national carbon market. These three laws comprise numerous legal elements that are identified with specific individual soil organic carbon land management activities (SOCLMs). Previous PRC studies provide details of the general capabilities of these laws to manage land and ecosystems.[60] Given the duplication of key land management functions between the three laws, it was suggested that PRC could benefit from the introduction of a separate instrument to coordinate key SOCLM functions between these laws in the interest of managing soil carbon more efficiently in the grasslands.[61] The report by Wang et al.[62] provided substantial information on agricultural activities in the grasslands and was used as a major authority on SOCLMs for the study. If not carried out effectively, various agricultural activities can lead to the development of and/or exacerbate problems in the management of carbon. These impacts have potentially severe consequences for people living in PRC in terms of loss of valuable agricultural land and livestock productivity, thus resulting in the more serious issues of human food security, livestock food security and loss of livelihood. Studies in PRC find that overgrazing and conversion of freely grazed grassland (FGG) to cropland lead to an annual average decline of 2.3–2.8% in SOC, and have caused a loss of 30–35% of total grassland SOC in PRC.[63] On the other hand, improved land management activities can reverse the loss of SOC by using practices that retain or increase SOC i.e., "soil organic carbon land management activities". The two key areas examined in the study included:[64]

- Identification of the SOCLMs in each of the three laws;
- Identification of legal procedures in the three laws that enable management of SOC.

[59] In PRC, the term "grasslands" includes rangelands, grazing lands, agro-silvo pastoral systems (a combination of trees or shrubs with crops and animal husbandry), and cultivated pastures.

[60] See Du and Hannam (2011); Chapter 6 (pp. 85–110) of this publication outlines the specific areas where the legislation and policy for prevention and control of LD can be improved, including: integrating key environmental concepts and principles from international environmental conventions into domestic legislation and policy; enacting and improving laws and rules, including new national laws for water and soil conservation, wetland conservation, and soil pollution control; revision of provincial regulations and rules; improving land-use planning administration, ecological compensation and the natural reserve system; closing forests for restoration; improving the EIA procedure and practical water and soil conservation systems; improving policy for LD control, including an increased role of science in policy development; strengthening policy coordination and continuity, policy objectives and market mechanisms.

[61] Ibid. Hannam (2012), pp. 4–5, indicates that various PRC studies document the key climate change impacts on agricultural activity in the grasslands, including land degradation (particularly wind and water erosion), the loss of ecological integrity of grassland, collapsing interconnected ecosystems, and the increasing frequency of dust storms.

[62] Ibid. Wang et al. (2011), pp. 329–340.

[63] Ibid. Wang et al. (2011), pp. 332–335.

[64] Ibid. Hannam (2012), p. 5.

4.2.1 Results

The analysis of the PRC Agricultural Law, Grassland Law and Desertification Law in 2012 indicated that this framework of law has significant potential to manage SOC in the grasslands. In particular, the analysis showed that the existing body of law provides for key SOCLMs that have been identified by various PRC studies. The legislation includes many legal elements that identify with specific SOCLMs. However, there is substantial duplication of key carbon management functions between the three laws. In this regard it was suggested that PRC would benefit from introducing an instrument to coordinate key SOCLM functions between the laws in the interest of managing soil carbon more efficiently in the grasslands.[65]

Significantly, the analysis showed that between the three laws there are many legal procedures to manage SOC, to retain existing levels of SOC or to increase the level of SOC, including procedures:[66]

- That define responsibilities between government, farmers and the community in grassland, livestock, and carbon management;
- That establish mechanisms and obligations for financial management, transfer, allocation, taxation, monitoring and stipulations for on-going funding for grassland and livestock management;
- For making contracts, renewing and revising contracts;
- To transfer carbon benefits and credits between parties;
- Concerning rights and title to revenues from the sale of carbon credits;
- Concerning rights, conditions or restrictions with respect to the grassland on which carbon sequestration activities operate;
- For environmental approvals under particular grassland uses;
- To pay farmers for implementing land management activities according to prescribed standards;
- That enable governments, farmers, and community to share responsibility in carbon management, including provision for the community to participate in grassland decision-making processes;
- For policy development, guidelines and ecological standards to manage carbon, including procedures for implementation, development of special codes of practice, land management indicators and the physical and ecological limits of land use;
- To achieve carbon management in grasslands through a mix of regulatory, part-regulatory, and non-regulatory means, including pastureland management incentives, support programs, and advisory groups;
- To correct unsustainable land use and where sinks are damaged;
- To manage carbon on all classes of grassland (sinks);

[65] Ibid. Hannam (2012), p. 61.

[66] Ibid. Hannam (2012)—for individual articles from the respective laws that provide some support to each of the carbon elements see Table 2, pp. 38–39, and for the legal procedures to manage soil carbon see pp. 40–60.

- To develop grassland management plans based on sustainable land management criteria, sustainable grassland management standards and codes of practice specifically aimed at carbon management in grassland;
- To protect biodiversity and conservation values of grassland and traditional lifestyles;
- To apply a geographic perspective to grassland management, including provisions to develop State and local grassland management plans;

4.2.2 A Coordinating Legal Instrument

The parameters of a legal instrument for the coordinated management of SOC are outlined in the PRC study.[67] It is regarded that a similar approach could be adopted by other countries to frame a coordinating law that would draw on the key elements of existing laws and establish new procedures to improve the coordination of the existing laws in the management of SOC.

- ***Objective***—*The objective of the regulation is to use the procedures of the Agriculture Law, Grassland Law and Desertification Law to manage soil organic carbon, and to assist in the removal of carbon dioxide from the atmosphere and to avoid emissions of greenhouse gases in the grassland region through the implementation of Soil Organic Land Management activities (SOCLMs).*

  The regulation should make reference to the United Nations Framework Convention on Climate Change and the Kyoto Protocol and PRC's obligations under these instruments. The objectives should refer to incentives for PRC farmers to implement SOCLMs and to implement specified offsets projects. There should also be provision to increase carbon abatement in a manner that is consistent with the protection of PRC's natural environment and to improve resilience to the effects of climate change.[68]
- ***Administration***—*The regulation could be administered by an "Administrator for SOCLMs" established under the Agricultural Law with the power to use procedures in the Agricultural Law, Grassland Law and Desertification Law for the purpose of implementing SOCLMs.*
- ***Soil organic carbon land management activities***—*Activities that count towards a PRC national carbon management target include:*[69]

[67] Ibid. Hannam (2012), pp. 62–64.

[68] The regulation could support the development of a scheme for the issue of PRC carbon credit units in relation to SOCLMs and eligible offsets projects. A point to consider is whether a PRC carbon credit unit is personal property and is generally transferable, including the eligibility requirements for eligible offsets projects (e.g., project must be carried out in PRC; the project must be covered by a methodology determination made under the regulation). It may be appropriate that methodology determination must comply with the offsets standards that could also be established under a regulation.

[69] Ibid. Wang et al. (2011) Table 1, p. 330.

  - *Exclusion from grazing*
  - *Sustainable grazing*
  - *Conversion of FGG to cultivated pasture*
  - *Conversion of FGG to cropland*
  - *Conversion of FGG to shrubland*
  - *Conversion of cropland to abandoned field*
  - *Conversion of cropland to cultivated pasture*
  - *Conversion of cropland to shrubland*
  - *Conversion of bare sand to vegetation*
  - *Using fertilizer to improve grassland ecology*
  - *Controlling burning*
  - *Controlling mowing*

- ***Prevention of natural disturbance****—It is proposed that farmers who apply accredited SOCLMs take steps to prevent the effects of natural disturbance factors on the SOCLM activities, including, poor drainage, bushfire, drought, pest attack, disease, or any other event specified in the regulation.*
- ***Approval****—An approval under the regulation means regulatory approval to undertake a SOCLM activity and this could be provided under a contract or agreement within the three laws. In some circumstances a licence or permit may be required in relation to a specific land management activity or land use or development.*
- ***Relevant carbon pool****—In relation to a SOCLM, a "relevant carbon pool" relates to the extent to which the SOCLM activity would remove carbon dioxide from the atmosphere by sequestering carbon in living biomass; or the extent to which the activity would remove carbon dioxide from the atmosphere by sequestering carbon in dead organic matter, or the extent to which the activity would remove carbon dioxide from the atmosphere by sequestering carbon in the soil.*

  PRC carbon credit units could be issued in relation to an eligible SOCLM activity. The number of carbon credit units issued could be determined by reference to a relevant abatement amount calculated under an applicable methodology; or if the SOCLM activity is a forest protection project—the relevant sequestration amount could be calculated under the applicable methodology.

  The Administrator could declare an offsets project to be an eligible offsets project under the regulation. The Administrator could vary or revoke a declaration of an eligible offsets project.
- ***Certificate of entitlement*** *– This could be applied through a land use contract or agreement system.*
- ***Land use rights****—Occupier rights and responsibilities could be applied through a land use contract or agreement system.*
- ***SOCLM maintenance obligation****—This could be applied through a land use contract or agreement system.*
- ***SOCLM crediting period****—The SOCLM period should be specified and could be up to 20 years, particularly if forestry is involved. The Administrator could*

determine a subsequent crediting period for an eligible SOCLM that is not a forest protection project.

- ***Reporting and notification****—The farmer or occupier should provide a report on the SOCLM activity within a period prescribed under a use right contract.*
- ***Relinquishing****—The benefits from SOCLM activity may be required to be relinquished if the land user fails to comply with the standards set for the prescribed SOCLM activity.*
- ***Soil organic carbon maintenance****—A carbon maintenance obligation could be imposed in relation to an area or areas of land if a prescribed land use activity has not been complied with.*
- ***Methodology****—The State Council or its representative should make or vary a methodology that applies to specified SOCLM activities. Factors to consider include the variation of a methodology and the duration of application of a methodology.*
- ***Multiple SOCLMs****—Provision can apply for more than one SOCLM activity in a land use contract or agreement.*
- ***Issue of carbon credit units****—The State Council or its administrative representative may issue carbon credit units (or a carbon exchange). Entries may be made in a registry of accounts for PRC carbon credit units.*
- ***Transfer of carbon credits****—The State Council or its administrative representative may provide for transfer of carbon credit units (or through a carbon market). Entries may be made in a registry of accounts for PRC carbon credit units.*
- ***Publication of information****—The Administrator must publish information about the operation of SOCLM activities, including the different types of SOCLMs available under the three laws, the prescribed standards for implementation, and the obligations of farmers or occupiers to SOCLM implementation.*
- ***Relinquish carbon credits****—If a person is the registered holder of one or more PRC carbon credit units for applying SOCLMs, provision should be made for the person to relinquish any or all of the units.*
- ***Information gathering power****—The Administrator may obtain any information or documents in relation to the operation of SOCLMs.*
- ***Keeping records and monitoring****—The SOCLM regulation may require a person to make a record of information; and retain the record. It should also provide for the person to record-keeping requirements in relation to the preparation of a SOCLM report. A SOCLM proponent should comply with record-keeping and project monitoring requirements that are established under the regulation.*
- ***Monitoring power*** *– Provision should be made for an inspector to enter a land contract area to determine whether the regulation relating to a SOCLM has been complied with; or to substantiate information provided under the regulation. Entry should be with the consent of the occupier of the land contract area. The occupier of the land has rights and responsibilities.*
- ***Audits****—The Administrator may require audits of one or more aspects of a person's compliance with the regulation.*
- ***Enforceable undertakings*** *– These can be applied through the compliance provisions of the Agricultural Law, Grassland Law or Desertification Law.*

- ***Review of decisions****—These can be applied through the compliance provisions of the Agricultural Law, Grassland Law or Desertification Law.*
- ***Civil penalty orders****—These can be applied through the compliance provisions of the Agricultural Law, Grassland Law or Desertification Law.*

4.3 Carbon Laws and Strategies[70]

The enactment of carbon rights legislation to recognize rights associated with carbon sequestration by vegetation and soil has been around for some time. Carbon rights law enables acquisition and trading in such rights through a covenant that gives access to or the maintenance of land, trees or forest of any sequestered carbon. The main purpose of the legislation is to encourage investment in carbon sinks, a legal concept that must be applied readily to sequester soil carbon. A carbon sequestration right in relation to land may mean a right that is conferred on a person by a legal agreement, to the legal, commercial or other benefit of carbon sequestration by any existing or future use of the land. This area of law opens the way for a market in stored carbon and ultimately the future creation of carbon credit schemes for soil carbon.[71] A number of existing laws and strategies serve as useful examples and approaches to frame different types of instruments to address the management of SCS. The following is a selection.

4.3.1 Commonwealth of Australia Carbon Credits (Carbon Farming Initiative) Act 2011[72]

The Carbon Farming Initiative (CFI) is a carbon offsets scheme that provides economic opportunities for farmers, forest growers and landholders to help the Australian environment by reducing carbon pollution.[73] Farmers and land managers are able to generate credits that can then be sold to other businesses who want to offset their carbon pollution. In particular, the CFI enables land managers to earn credits for various land management actions including: reforestation and

[70] For a discussion on the history of legislative aspects of carbon in Australia see Guglyuvatyy and Stoianoff (2016) http://www5.austlii.edu.au/au/journals/UTSLRS/2016/25.html (Last access: 22 June 2022), the article in particular observes several interesting and significant aspects of Australian climate law highlighting governmental approaches and processes leading to the introduction of those laws. The historical perspective identifies common features of the climate law implementation procedures and identifies what political factors influence these processes in Australia.

[71] Ibid. Hannam (2019), p. 421.

[72] https://www.legislation.gov.au/Details/C2017C00076 (Last access: 22 June 2022), Ibid. Hannam (2019), pp. 421–422.

[73] Power (2011), p. 59; Macintosh (2012), p. 28.

revegetation; reduced methane emissions from livestock digestion; reduced fertilizer pollution; reduced pollution or increased carbon storage in agricultural soils (soil carbon); savannah fire management; native forest protection; forest management; reduced pollution from rice cultivation; reduced pollution from legacy landfill waste.

Under s 3 of the Act the first object is "to remove greenhouse gases from the atmosphere, and avoid emissions of greenhouse gases, in order to meet Australia's obligations under the Climate Change Convention, the Kyoto Protocol and an international agreement (if any) that is the successor (whether immediate or otherwise) to the Kyoto Protocol". The second object of the Act is "to create incentives for people to carry on certain offsets projects". The third object of the Act is "to increase carbon abatement[74] in a manner that is consistent with the protection of Australia's natural environment, and improves resilience to the effects of climate change". The fourth object of the Act is "to authorize the purchase by the Commonwealth of units that represent carbon abatement".

Under s 5 "eligible carbon abatement" from an offsets project means "carbon abatement that: (a) results from the carrying out of the project; and (b) is able to be used to meet Australia's climate change targets under: (i) the Kyoto Protocol; or (ii) an international agreement (if any) that is the successor (whether immediate or otherwise) to the Kyoto Protocol". An "Offsets project" means: "(a) a sequestration offsets project; (b) an emissions avoidance offsets project". Under s 54 "a project is a sequestration offsets project if it is a project: (a) to remove carbon dioxide from the atmosphere by sequestering carbon in one or more of the following—(i) living biomass; (ii) dead organic matter; (iii) soil; or (b) to remove carbon dioxide from the atmosphere by sequestering carbon in, and to avoid emissions of greenhouses gases from, one or more of the following: (i) living biomass; (ii) dead organic matter; (iii) soil".

4.3.2 Victoria, Australia: Climate Change Act 2017

The purpose of the Climate Change Act[75] is to establish a long-term greenhouse gas emissions reduction target and set 5-yearly interim greenhouse gas emissions reduction targets in order to reach a long-term greenhouse gas emissions reduction target. It facilitates the development of climate change issues and establishes policy objectives, guiding principles, government policy and provides for a strategic response to climate change through a climate change strategy, adaptation action plans and emissions reduction pledges. Significantly, this Act facilitates the State's

[74] Carbon Credits (Carbon Farming Initiative) Act 2011, Section 5, "carbon abatement" means: (a) the removal of one or more greenhouse gases from the atmosphere; or (b) the avoidance of emissions of one or more greenhouse gases.

[75] Ibid. Hannam (2019), pp. 422–423; Art. 3 "climate change" means a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.

contribution to national and international carbon sequestration efforts and provides for the creation of forestry rights, carbon sequestration rights and soil carbon rights, Forestry and Carbon Management Agreements[76] in relation to private land and Carbon Sequestration Agreements in relation to Crown land.

4.3.3 Brazil: Law Establishing the National Policy on Climate Change

The law that establishes the Sectorial Mitigation and Adaptation Plans for Climate Change aims at the Consolidation of a Low Carbon Emission in several land use sectors including agriculture.[77] During the 15th UNFCCC Conference of the Parties the Brazilian government confirmed its voluntary commitment to reduce greenhouse gas emissions for 2020, between 36.1% and 38.9%, estimating a reduction of these emissions around one billion tons of CO_2 equivalent. For this purpose, different actions were proposed under the Law establishing the National Policy on Climate Change,[78] including: reducing the rate of deforestation in the Amazon by 80%, and by 40% in the Cerrado; recover degraded pastures in agriculture; promote land-use integration; increase the use of the Direct Planting System and the Biological Fixation of Nitrogen; and increase energy efficiency, the use of biofuels, the supply of hydroelectric and alternative sources of biomass, wind energy and small hydropower plants, and increase the use of coal from plantation forests in the steel industry.

4.3.4 Brazil: Decree No. 10.431: The National Executive Committee of the Sectorial Plan for the Consolidation of a Low Carbon Emission in Agriculture

This Decree creates the National Executive Committee of the Sectorial Plan for the Consolidation of a Low Carbon Emission in Agriculture.[79] It establishes the composition, duties and responsibilities of the Committee, to perform many activities: monitor the implementation of the Sectorial Plan for Mitigation and Adaptation to Climate Change for the Consolidation of a Low Carbon Emission in Agriculture (ABC Plan); monitor and evaluate the results achieved and promote resilient, productive, and competitive agricultural production systems adapted to climate change; support the Ministry of Agriculture, Livestock and Supply (MALS) and

[76] Art. 59 (1) The purpose of a Forestry and Carbon Management Agreement is to provide for the imposition of management obligations in relation to any of the following—(a) carbon sequestration by vegetation; (b) carbon sequestration underground; (c) the management of vegetation.

[77] Law 12.187 of 29 December 2009.

[78] Decree No. 7390, consisting of 12 articles and 1 Annex, regulates Law No. 12.187, which institutes the National Policy on Climate Change; www.fao.org/faolex/results/details/en/c/LEX-FAOC093834 (Last access: 22 June 2022).

[79] www.fao.org/faolex/results/details/en/c/LEX-FAOC196838 (Last access: 22 June 2022).

the bodies and institutions involved in the implementation of the ABC Plan; analyze the reports of the monitoring systems established by the ABC Plan and evaluate the results, guide the implementation, strengthening and prioritization of actions to be taken by the MALS; identify and propose studies to support the implementation and review of the ABC Plan; and to support the MALS on the fight against climate change by the Brazilian agricultural sector.

4.3.5 USA: United States Mid-Century Strategy for Deep Decarbonization

The Mid-Century Strategy (MCS) aims to reduce emissions while maintaining economic growth.[80] The MCS sets out policies and strategic measures to ensure global action on climate change, with the vision to achieve greenhouse gas emissions reductions of at least 80 percent below 2005 levels by 2050. In particular, the MCS defines three policy priorities: transform to a low-carbon energy system; sequester carbon through forests, soils and CO_2 removal technologies; reduce non-CO_2 emissions.

The MCS recognizes that sequestering carbon through forests and soil will encompass actions to accelerate private land carbon incentives to support forest carbon enhancing activities and SCS, underpinned by science based carbon accounting protocols and policy frameworks.[81] It also provides for a reduction of land use competition and land use change through research and policies with the objective to increase land productivity.[82] Special attention is given to afforestation and reforestation and minimizing carbon loss due to natural disturbances. The MCS provides for the transition to a low-GHG pathway that guides the process of decarbonisation. This includes maintaining and enhancing the land carbon sink, ensuring that US landscapes continue to sequester substantial amounts of carbon and developing CO_2 removal technologies that sequester and store carbon.[83]

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[80] The White House Washington (2016) United States Mid-Century Strategy for Deep Decarbonization p. 111; see—extwprlegs1.fao.org/docs/pdf/usa181125.pdf (accessed 21 September 2021).

[81] Ibid p. 69, Fig. 1 indicates that the MCS analysis estimates 2050 land sector and CO_2 removal technologies could sequester 30 to 50 percent of economy-wide GHG emissions.

[82] Ibid p. 71, says that "finding efficient ways to structure carbon-based incentives in the land sector will be important. For example, carbon-based payments to farmers, ranchers, and forest owners would incentivize many of the activities described below. Funding these incentives will be an important consideration for future climate action, as well as putting in place the appropriate institutions to administer such incentives to ensure they are efficiently supporting our long-term climate goals."

[83] Ibid p. 77 specifies that "Increasing uptake of key soil carbon-enhancing practices to more than 70 percent of U.S. cropland and ensuring that the practices are implemented to maximize carbon storage benefits could result in an increased soil carbon sink of over 270 million metric tons CO2e per year by 2050."

4.3.6 Australia, New South Wales De-carbonization Hub

The New South Wales Decarbonisation Innovation Study (DIS) investigated opportunities for meeting emissions targets and adapting to climate change while generating economic development for the state.[84] In regard to land and sustainable agriculture, it specifies the promotion of best practice sustainable land management, and expanding sustainability markets and ecosystem services to provide decarbonised income sources for landholders, including Indigenous landholders, where sustainable land management includes carbon farming and regenerative agriculture. The DIS provides for the improvement of agricultural productivity and resilience through technologies including horticulture, renewables, bioenergy, and water efficiency and recycling, gene technologies and synthetic biology. In particular, it emphasises the growth of local demand and supply chains in agricultural goods.[85]

The DIS recognizes that sustainability markets that encompass both carbon and biodiversity can provide greater economic and environmental benefits than separate markets. These markets can also decrease the risk of unintended consequences such as monoculture environments and land use conflicts, and provide greater capacity for protecting the land.[86] Improving decarbonisation and climate resilience will require landholders to build skills in assessing the risks and opportunities of climate change for their land. Landholders would also be required to build skills to adopt carbon sequestration technologies and services that improve productivity and resilience while reducing emissions, as well as building skills to implement sustainable land management practices. Building these skills is a particular challenge in the New South Wales land sector with its diverse range of land uses and geography.[87] Sustainable certification protects the value of sustainable products, encouraging businesses to make investments to improve their sustainability. Certification is particularly important in providing transparency and education to consumers, including through justifying price premiums on sustainable products, and avoiding perceptions of 'greenwashing.'[88]

[84] NSW Government Chief Scientist and Engineer (2020); a major outcome of the Study will be the establishment of a Decarbonisation Innovation Hub under the NSW Government Net Zero Industry and Innovation Program. The Hub will support researchers, industry and government stakeholders in critical sectors to collaborate, and increase the uptake of new technologies in decarbonising NSW, see https://www.chiefscientist.nsw.gov.au/science-in-nsw/nsw-networks/decarbonisation-innovation-hub (Last access: 22 June 2022).

[85] Ibid p. 4.

[86] Ibid p. 90.

[87] Ibid p. 92.

[88] Ibid p. 93; Greenwashing is a process where false or misleading claims are made about the sustainability of a product or service.

5 FAO Guidelines for Sustainability Assessment of Food and Agriculture Systems

The FAO Sustainability Assessment of Food and Agriculture systems (SAFA) Guidelines were derived to assess the impact of food and agriculture operations on the environment and people.[89] It is one of the most comprehensive assessment procedures available to consider the capability of an agricultural land use to sequester carbon and to ensure its benefits are fully accounted for in the supply chain. The vision of SAFA is that food and agriculture systems worldwide are characterized by four dimensions of sustainability: good governance, environmental integrity, economic resilience and social well-being. In this context, SAFA presents a framework that encompasses aspects of land used for cropping, including postharvest, processing, distribution and marketing. Governance is the process of making and implementing decisions. For SAFA, this includes corporate ethics, accountability, participation, rule of law and holistic management.[90] In a SAFA, environmental sustainability is addressed by accessing atmospheric, water, and land and biodiversity information. Economic activity involves the use of labour, land and capital to produce goods and services to satisfy peoples' needs. The four dimensions of sustainability divide into 21 themes and 58 subthemes, all with sustainability objectives.[91] The relevance of the SAFA guidelines to SCS is that it provides a broad framework in which to consider all aspects of soil carbon management within an agricultural land use system.

5.1 SAFA and Carbon

Theme E3 of the SAFA guidelines covers soil resources,[92] and specifies that "no land is lost due to surface sealing or mismanagement of arable lands and pastures, and soil fertility is preserved and enhanced".[93] The main objective of this theme is that soil characteristics provide the best conditions for plant growth and soil health, while chemical and biological soil contamination is prevented. An important aspect of soil quality is monitoring and managing soil biological quality include the macro and microorganisms present in soils; soil organisms provide a multitude of benefits for soils and ecosystems, including breakdown of organic matter leading to nutrient and carbon release, improving soil structure and water holding capacity, providing a sink for GHG emissions. Content and quality of soil organic matter also affect the

[89] FAO (2014).

[90] Ibid. p. 79.

[91] Ibid. Section 3, pp. 75–208.

[92] Ibid. FAO (2014), pp. 121–125.

[93] Ibid p. 122.

nutrient cycling and gas, including CO_2, exchange in soils, and are related to soil life, soil fertility and the functioning of ecosystems.[94] Examples of positive conditions and practices that fulfil this objective include:[95]

- Soil physical structure is in excellent condition on all land used by the enterprise, with no signs of soil compaction of structural degradation.
- Soil chemical quality is in excellent condition on all land used by the enterprise, with no signs of chemical soil degradation.
- Soil biological quality is in excellent condition on all land used by the enterprise, with no signs of biological soil degradation, i.e. a reduction of soil life.
- Soil organic matter content and quality are in excellent condition on all land used by the enterprise, with no signs of quantitative or qualitative losses.
- Adopting soil improvement practices to improve the physical, chemical and biological properties of the soils used by an enterprise and tackling all problematic aspects for soil quality by effective measures on all areas concerned.

5.2 International Reference

One of the benefits of the SAFA guidelines is that they can be applied to assess sustainability along food and agriculture value chains. It establishes an international reference for assessing trade-offs and synergies between the different dimensions of sustainability and has been prepared so that enterprises involved with the production, processing, distribution and marketing of agricultural goods have a clear understanding of the respective components of sustainability. SAFA creates opportunities for enterprises to use existing data and combine it with other tools and sustainability initiatives. It was developed as an international reference document, a benchmark that defines the elements of sustainability and a framework for assessing trade-offs and synergies between all aspects of sustainability.[96] Global trade and the governance of inter-state externalities on public goods (e.g. climate, biodiversity, food safety), compounded by the proliferation of sustainability schemes, call for a multiparty cooperation that must be supported by "common rules" in order to reduce fragmentation, prevent conflicts, mitigate uncertainty and build capacities for effective sustainability. More accurate data and sound guiding principles to establish a common basis for assessing sustainability is needed. While there is now a wide awareness of the sustainability concept, there is also wide interpretation of the definitions and components of sustainability based on different disciplines and political beliefs and values. By providing a transparent and aggregated framework

[94] Ibid p. 122.

[95] Ibid p. 123.

[96] Ibid pp. 1–2.

for assessing sustainability, SAFA seeks to harmonize sustainability approaches within the food value chain, as well as furthering good practices.

5.3 General Application

The SAFA system is constructed so that different users with different purposes can enter at different levels of the SAFA Framework;[97] the themes comprise 21 universal sustainability goals; sub-themes comprise 58 sustainability objectives specific to supply chains; and there is 116 indicators for crops, livestock, forestry, fisheries and aquaculture enterprises. These themes can be implemented at any level, national, supply chain or operational unit and thus, provide a common understanding of what "sustainability" means in a practical context. Each of the 21 sustainability themes is detailed into sub-themes, or individual issues within SAFA themes, with associated explicit sustainability objectives. This level, which comprises 58 sub-themes, is relevant for supply chain actors doing an analysis which identifies risk, as well as gaps in existing sustainability efforts. The SAFA guidelines aim at rendering approaches and results of sustainability assessments in the food sector more transparent and comparable. This is in line with the call for disclosing the values and assumptions behind sustainability.[98] They establish a comprehensive, widely accepted language for sustainability in agriculture and food; facilitating comparisons of the sustainability performance of companies; and emphasizing the need to take the varying scope of influence of enterprises into account, which may stretch beyond the physical borders of a production site and even include suppliers and stakeholders outside the supply chain. Although the guidelines provide a standard set of sustainability themes and goals that all enterprises in the sector should pursue, they allow for flexibility in selecting indicators for measuring sustainability performance.

However, although the SAFA guidelines aim for being globally applicable for all food, their practical applicability must be evaluated under a diversity of environmental conditions.[99] While they define a hierarchically structured and sound set of sustainability topics, and corresponding objectives, which allow the assessment of enterprises against an objective and transparent set of criteria, pilot applications of the tool have shown that sustainability assessments according to the guidelines can provide a detailed picture of the sustainability performance of an enterprise. Jawtusch says that applying the SAFA guidelines to get meaningful, valid and communicable answers requires both a large amount of resources in terms of time and data needs and a profound expertise of the analysts in a wide range of thematic

[97] Ibid p. 3, Fig. 1.

[98] Gasparatos (2010) explores the implications that arise with the selection of specific sustainability evaluation tools and says that in most cases the choice of the evaluation tool is made by the analyst (s) without taking into consideration the values of the affected stakeholders.

[99] FAO (2014).

areas.[100] The examples described below apply different approaches but each would have the ability to provide information on land management practices that provide for improved soil carbon sequestration.

5.3.1 Paraguay

A study in Paraguay[101] analyzed the sustainability of agricultural systems through the use of SAFA indicators, in a comparative way, for identifying critical issues and improvement strategies for enhancing rural sustainability. As regards the evaluation of the sustainability level within Paraguayan agricultural systems, peasant family farming, as well as agro-ecological, conventional, neo-rural, and indigenous agriculture proved to be substantially similar at the time of the sustainability assessment, exhibiting excellent results in the four dimensions of SAFA.

5.3.2 Europe

A livestock sustainability assessment in Europe[102] advocates an approach for the selection of indicators and sustainability tools that lead to the creation of a rapid, but effective, assessment tool. It consolidated information and data collected through an industry partner survey, workshop discussions and literature review and the most appropriate indicators in all dimensions (i.e. social, economic, environmental, governance) were identified in addition to the best tool for assessing sustainability of sheep and goat farms ensuring adaptability to a range of farm types. The assessment concluded that the Public Goods Tool (PG Tool)[103] was the most appropriate framework for adaptation as it was the first to fulfil all the key selection criteria (i.e. ease of tool use; the coverage of a range of sustainability criteria as defined within the SAFA framework and; the possibility and ease of adapting the tool to include new indicators).

[100] Jawtusch et al. (2013), p. 5.

[101] Soldi et al. (2019), p. 26, as regards the evaluation of the sustainability level within Paraguayan agricultural systems, peasant family farming, as well as agro-ecological, conventional, neo-rural, and indigenous agriculture proved to be substantially similar at the time of the sustainability assessment, exhibiting excellent results in the four dimensions. The levels of sustainability achieved by agribusiness, on the other hand, deviate from those of other agricultural systems, resulting in moderate scores in the dimensions of good governance and environmental integrity, and good scores in the economic and social dimensions. Agribusiness represents the most widespread model in terms of cultivated area, thanks to its profitability and orientation to the market.

[102] Ibid. Zaralis et al. (2017), p. 633.

[103] Ibid p. 638.

5.3.3 Brazil

Commercial integrated crop-livestock-forest systems (ICLF) using beef cattle, eucalyptus and cash crops like soybeans and maize are increasing in Brazil, especially in the central part of the country, and broad ranging sustainability assessments of such systems is crucial for local development policies.[104] The Brazil study emphasises that the SAFA framework can be applied to address local ICLF systems but a prior evaluation of the framework is important for checking its suitability for the local context. It concludes that even though the indicators might be considered relevant in a sustainability assessment, many proposed indicators would be difficult to acquire in a given situation. It cautions that users of SAFA for ICLF systems should carefully evaluate each indicator when designing the scope of a study in order to produce good quality results.

6 Conclusion

This chapter has considered that sustainable land use including practices that maintain or improve the sequestration of carbon in the soil of agricultural land is critical for ongoing surety of the production of safe and healthy food. One of the essential aspects of sustainability of agricultural systems is the maintenance or improvement of SOC. The role of SCS in the management of climate change within the safe levels advocated by the IPCC is a key aspect of this objective. The most pressing need is the development of an agenda that includes information on soil distribution and degradation status, matching of sustainable management practices to each soil group and its degradation status, and stopping the carbon loss from specific soils that have the potential to significantly affect the global carbon balance. However, developing and implementing an integrated approach for the analysis of different sustainability dimensions, for SSM in particular, and integrating it in agricultural land use strategies that provides for SCS, remains a major challenge.

There are various ways to frame legislation to control the impacts of agricultural land use on soil carbon levels. However, the ability of legislation to achieve effective soil carbon management will depend on the legal and institutional elements that protect physical processes associated with SCS and the establishment, maintenance and protection of carbon sinks and reservoirs. Such elements should be incorporated within procedures that regulate and manage the land use activities that cause the loss of soil carbon, lead to land degradation and contribute to the atmospheric CO_2 and global warming. In this regard, while the SAFA methodology represents a useful

[104] Bungenstab et al. (2015) show that even though they might be considered relevant in a sustainability assessment, many proposed indicators should be difficult to acquire in a given situation. Therefore, users of SAFA for ICLF systems should carefully evaluate the inclusion of each indicator when designing the scope of their studies in order to have good quality results.

tool to support policy makers in designing and evaluating policies that include the management of SOC, the SAFA guidelines can be applied for comparing different types of agricultural systems and identifying the critical issues for preparing effective intervention policies to achieve sustainable soil management.

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The Climate Decision of the German Constitutional Court and Its Implications on Soil Management

Caroline Douhaire

Abstract On 24 March 2021, Germany's highest court found the German Climate Change Act to be partly unconstitutional because it did not sufficiently mitigate the burden put on the future exercise of freedom rights by the emissions allowed until 2030. The ruling represents a milestone for climate protection in Germany and also deserves attention beyond Germany's borders. In this ruling, the Constitutional Court sets a strong signal for more climate change, making clear that the protection of the climate is a constitutional obligation. Because of the close interactions between soil and climate change, the decision also recalls the importance of a better soil protection. This chapter summarizes the essential statements of the Court and analyses the consequences for soil protection.

1 The Climate Decision of the German Constitutional Court of 24 March 2021

In a groundbreaking decision, the German Federal Constitutional Court (hereinafter referred to as the "Constitutional Court" or "Court") held that Germany's legislation on climate protection was partly unconstitutional because it was insufficient to protect future generations.[1] It is not only this result that explains why this ruling has received so much attention; the court's statements on the existence and scope of a constitutional duty to protect the climate also deserve to be noticed. In the following, the procedural background of the decision is explained first (Sect. 1.1). The chapter then summarizes the most important core statements (Sect. 1.2) and

[1]German Constitutional Court decision of 24 March 2021, 1 BvR 2656/18. The English version is available under https://www.bundesverfassungsgericht.de/SharedDocs/Entscheidungen/EN/2021/03/rs20210324_1bvr265618en.html (Last access: 22 June 2022).

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outlines the amendment of the German Climate Change Act that was passed in response to the ruling (Sect. 1.3).

1.1 Background

The decision of the Court was based on four constitutional complaints: The first complaint was filed in 2018 by eleven people living in Germany aged between 18 months and 86 years and two environmental associations. In 2020, another complaint was added by people living in Bangladesh and Nepal and two further complaints by predominantly adolescents and young adults from Germany; each of the complaints was supported by environmental NGOs.[2] In all four constitutional complaints the core question was whether or not Germany had taken sufficient measures to protect the climate. This aimed at the German Climate Change Act, which was enacted in December 2019 to set out greenhouse gas reduction targets.[3] The Climate Change Act stipulated that greenhouse gas emissions were to be reduced by at least 55% by 2030 compared to 1990.[4] This target was to be ensured by complying with sectoral annual emission ceilings set out in Annex Two until the year 2030.[5] For the period after 2030, the Climate Change Act did not provide for any reduction targets, but merely stipulated that the German government was to set annual emission levels by statutory order in 2025 for further periods after 2030.[6]

1.2 Key Findings

In its decision of March 24, 2021, the Court declared the constitutional complaints to be partially well-founded. The judges from Karlsruhe found that the Climate Change Act places an excessive burden on future generations because it does not sufficiently reduce emissions until 2030 and does not make specific provisions for greenhouse gas emission reductions after 2030. But it is not only this result that has contributed to the description of the decision as "historical" or "revolutionary".[7] It also contains numerous important clarifications on the existence and scope of constitutional

[2]The law firm Geulen & Klinger represented the complainants in two of the proceedings.

[3]Federal Climate Change Act of 12 December 2019 (Klimaschutzgesetz – KSG), Federal Law Gazette I, p. 2513.

[4]Section 3 (1) KSG.

[5]Section 4 (1) 3 KSG.

[6]Section 4 (6) KSG.

[7]See for example Markus et al. (2021), p. 577; Callies (2021), p. 355.

obligations to protect the climate. The most relevant statements are summarized below:

1.2.1 Admissibility

Where the complainants were natural persons, the constitutional complaints were found to be admissible. The Constitutional Court also confirmed standing for the complainants who live in Bangladesh and in Nepal as the validity of German fundamental rights vis-à-vis these complainants did not appear to be ruled out from the outset.[8] However, the constitutional complaint of the two environmental associations were rejected by the Court as inadmissible as the German Constitution (Grundgesetz—GG) and constitutional procedural law did not give them standing for a constitutional complaint.[9]

1.2.2 Climate Change Related Duty to Protect

It is established in German constitutional law for a long time, that the state must not only refrain from violating basic rights but must also actively protect people's fundamental rights from certain risks and dangers.[10] In its decision from 24 March 2021, the Federal Constitutional Court for the first time confirms that such a duty to protect also exists with regard to the risks of climate change.

1.2.2.1 Existence of a Climate Change Related Duty to Protect

The Court confirms that the fundamental right to life and physical integrity in Art. 2 (2) of the German Constitution imposes on the state an obligation to actively protect against risks posed by climate change.[11] This obligation lies on the state not only with regard to people living now, but also with regard to future generations[12] and possibly also with regard to people living abroad.[13] The Court clarifies that the duty to protect against the risks of climate change obliges the state on the one hand to take steps that contribute to stopping global warming. On the other hand, the state must take positive measures aimed at alleviating the consequences of climate change ("adaptation measures"), where climate change is not preventable or has already

[8]Para. 101, 173 ff.

[9]Para. 136.

[10]German Constitutional Court decision of 25 February 1975, 1 BvF 1/74.

[11]Para 147.

[12]Para. 146.

[13]Para. 174.

taken place.[14] The Constitutional Court also confirms that the state has a duty to protect property against the risks of climate change arising from the fundamental right to property in Art. 14(1) of the German Constitution.[15]

1.2.2.2 No Violation of the Duty to Protect

However, after having affirmed the existence of a climate-related duty to protect the Court in the end denies a violation of this duty by the German state. In line with its established case law, the Constitutional Court grants the state a large margin of discretion when fulfilling its duty to protect. A violation of a duty to protect could only be established if the regulations and measures taken were obviously unsuitable or completely inadequate to achieve the required protection goal, or if they would fall considerably short of the protection goal.[16] The Court clarified that such an evident breach of the duty to protect could for example be affirmed if the state “failed to pursue the goal of climate neutrality”[17] or if it “allowed climate change to simply run its course”.[18] Not striving for climate neutrality and doing nothing would thus be unconstitutional. Since the German Climate Change Act aimed according to its Section 1 at climate neutrality and at limiting global warming at “well below 2 °C and if possible 1.5 °C”—as a reference to the temperature target in Art. 2 (1) a Paris Agreement—the Court denied such an evident disrespect of the duty to protect. However, the Court indicated that new scientific evidence, especially in view of the danger of exceeding tipping points, might make it necessary to aim at a more ambitious temperature target such as limiting global warming to 1.5 °C above pre-industrial levels.[19] In view of the findings of the IPCC’s Sixth Assessment Report published after the judgement in August 2021, that climate change is occurring faster and with greater consequences than previously assumed,[20] the question arises as to whether this necessity has now already been confirmed.

1.2.3 Obligation to Protect the Climate from Art. 20a

The Constitutional Court derives a constitutional obligation for the state to protect the climate not only from fundamental rights buts also from Article 20a of the

[14] Para. 144, 155, 157.

[15] Para. 171.

[16] Para. 152.

[17] Para. 155.

[18] Para. 157.

[19] The so-called objective right refers to legal norms that does not entail—unlike, for example, fundamental rights—a subjective right and thus cannot be invoked in court, see Para. 112.

[20] IPCC (2021).

German Constitution. This provision on the "Protection of the natural foundations of life and animals" states:

> Mindful also of its responsibility towards future generations, the state shall protect the natural foundations of life and animals by legislation and, in accordance with law and justice, by executive and judicial action, all within the framework of the constitutional order.

1.2.3.1 Justiciable Obligation to Achieve Climate Neutrality

Art. 20a of the German Constitution has so far played only a minor role as a so-called state objective provision. It does not entail subjective rights and thus cannot be invoked by individuals directly.[21] In its decision from 24 March 2021, the Constitutional Court however attaches considerable importance to this norm and declares it to be one of the Basic Law's "elemental precepts", which must necessarily be respected by climate regulation.[22] The Court derives from the provision of Art. 20a German Constitution an obligation to take climate action and—in particular—to achieve climate neutrality.[23] Although this obligation does not take absolute precedence over other interests, it must be accorded increasing weight as climate change intensifies.[24] Important from a legal dogmatic point of view is the clarification by the Court, that Art. 20a is a justiciable legal provision. That means that the respect of Art. 20a is—despite the leeway the legislator has in specifying the climate protection mandate—subject to review by the Constitutional Court.[25]

1.2.3.2 International Dimension of Climate Mandate

Highly relevant is also the statement of the Court, that the climate action mandate enshrined in Art. 20a of the German Constitution possesses a special international dimension: Art. 20a obliges the state to "involve the supranational level in seeking to resolve the climate problem".[26] The state may not "evade its responsibility here by pointing to greenhouse gas emissions in other states". On the contrary, the particular reliance on the international community here gives rise to the "constitutional necessity to actually implement one's own climate action measures at the national level" and "not to create incentives for other states to undermine the required cooperation".[27] This is a clear rejection of the popular excuse that one state alone cannot effectively combat climate change.

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[21] Para. 112.

[22] Para. 184, 188.

[23] Para. 198.

[24] Para. 198.

[25] Para 205, 207.

[26] Para. 199.

[27] Para. 203.

1.2.3.3 Paris-Objective "Currently" Compatible with Art. 20a

The Constitutional Court then deals with the question whether the level of ambition chosen in the German Climate Change Act is compatible with the constitutional obligation to protect the climate. The Court clarifies that Art. 20a GG itself does not contain specific greenhouse gas reduction targets, but rather places the determination of such targets entirely in the hands of the legislator, who has considerable leeway in specifying the climate protection mandate. Parallel to his remarks on the duty to protect, the court states that the legislator has "currently" not exceeded this leeway, when referring in the Climate Change Act to the goal to limit global warming to "well below 2 °C and preferably to 1.5 °C above pre-industrial levels".[28] The Court however highlights, that "new and sufficiently reliable findings on the development of anthropogenic global warming, its consequences and controllability, might make it necessary to set different targets within the framework of Art. 20a GG, even when taking the legislator's decision-making leeway into account."[29] In view of the new findings of the IPCC, it seems questionable whether it would not be necessary to pursue the more ambitious goal of limiting global warming to 1.5 °C (see above under Sect. 1.2.2.2).

1.2.3.4 Budget Approach

Based on the finding, that the temperature target of "well below 2 °C and if possible 1.5 °C" is (at least currently) compatible with Art. 20a GG, the Court analyses in a next step whether the emission targets of the Climate Change Act are compatible with this temperature goal. Here the Constitutional Court resorts to a budget approach. As there is an approximately linear relationship between CO_2 emissions and the global temperature increase, the temperature goal can in principle be converted into a remaining global CO_2 budget, from which Germanys share can be derived.[30] This national CO_2 budget, here 6.7 gigatons, must according to the Constitutional Court in principle be respected: Although it cannot serve "as an exact numerical benchmark" for constitutional review due to scientific uncertainty, the legislator has a "special duty of care", which requires to even take account of mere indications pointing to the possibility of serious or irreversible impairments, as long as these indications are "sufficiently reliable". The law *must* therefore "take into account the IPCC's estimates on the size of the remaining global CO_2 budget and its consequences for remaining national emission budgets".[31] This budget approach is

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[28] Para: 211.

[29] Para. 212.

[30] Para. 216; In another decision from 18 January 2022 (1 BvR 1565/21 u.a.) the Court clarified that there are currently no rules to further distribute the national emission budget on the several states of Germany.

[31] Para. 229.

the crucial basis for the court's central finding that inadequate emissions regulations interfere with future freedom (see below under Sect. 1.2.4).

In the end, the Federal Constitutional Court however shied away from confirming a violation of Art. 20a GG. Although the national emission budget of 6.7 gigatons would already have been exhausted by 2030 with the emission regulation at stake, the Court denied a breach against Art. 20a GG with regard to the uncertainties presently involved in the budget-calculations and the fact that the remaining budget would not actually be "overshot".[32]

1.2.4 Disproportionate Burdens on the Complainants' Future Freedom

Based on an entirely novel rationale, the Constitutional Court nevertheless found the Climate Change Act to be unconstitutional, because it did not sufficiently contain the risk of future infringements of fundamental freedom rights and thus violated the principle of proportionality. This is the most surprising and novel part of the judgement.

1.2.4.1 Advance Interference-Like Effect on Future Freedom

As a starting point, the Court highlights that the decision of the legislator to allow the amounts of CO_2 to be emitted until the year 2030 as specified in the Climate Change Act has an "advance interference-like effect" (so called "*eingriffsähnliche Vorwirkung*") on the freedom of the complainants.[33] This advance effect on future freedom is based on the consideration, that almost any use of freedom is associated with CO_2 emissions. At the same time, global warming must—as the Court derived from the duty to protect and Art. 20a GG—be imperatively be limited to at least "well below under 2 °C and if possible 1.5 °C", what requires climate neutrality and compliance with a remaining CO_2 budget. And here is the dilemma since, the more CO_2 emissions are allowed until 2030, the less may be emitted in the future and the more drastic the future restriction of freedom will be. Provisions that allow for CO_2 emissions in the present thus constitute an "irreversible legal threat to future freedom".[34] In the words of the Constitutional Court, "the restrictions on freedom that will be necessary in the future are thus already built into the generosity of the current climate change legislation. Climate action measures that are presently being avoided out of respect for current freedom will have to be taken in future – under possibly even more unfavourable conditions – and would then curtail the exact same needs

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[32] Para. 236, 237.

[33] Para. 183.

[34] BVerfG, Press Release No. 31/2021 of 29 April 2021, available under https://www.bundesverfassungsgericht.de/SharedDocs/Pressemitteilungen/EN/2021/bvg21-031.html (Last access: 22 June 2022).

and freedoms but with far greater severity."[35] The Court highlights that the amount of time remaining is a key factor in determining how far future freedom will have to be restricted.[36] If much of the CO_2 budget were already depleted by 2030, there would be a "heightened risk of serious losses of freedom because there would then be a shorter timeframe for the technological and social developments required to enable today's still heavily CO_2-oriented lifestyle to make the transition to climate-neutral behaviour in a way that respects freedom".[37]

1.2.4.2 Necessity of Precautionary Measures That Respect Fundamental Rights

In order for this risk of future losses of freedom to be justified under constitutional law, emission provisions must firstly be compatible with Art. 20a as one of Basic Law's elemental precepts (which was narrowly confirmed, see above under Sect. 1.2.3). Secondly, the provisions must not place disproportionate burdens on the future freedom of the complainants.[38] With regard to the second requirement of proportionality, the Court clarifies that it follows from the principle of proportionality that one generation "must not be allowed to consume large portions of the CO_2 budget while bearing a relatively minor share of the reduction effort, if this would involve leaving subsequent generations with a drastic reduction burden and expose their lives to serious losses of freedom"—something the complainants called an "emergency stop".[39] The Court states that based on Climate Change Act, which allowed nearly an exhaustion of the remaining CO_2-budget by 2030, the efforts required under Art. 20a GG to reduce greenhouse gas emissions after 2030 will be "considerable", which is why the state must take "precautionary steps [...] to manage the reduction efforts anticipated after 2030 in ways that respect fundamental rights".[40] This requires that the transition to climate neutrality is initiated "in good time" for the post-2030 period, extending "sufficiently far into the future".[41] The state must formulate "transparent guidelines for the further structuring of greenhouse gas reduction" at an early stage, providing orientation for the required development and implementation processes and conveying a "sufficient degree of developmental urgency and planning certainty".[42] In addition, the Court clarifies that "further

[35] Para. 120.
[36] Para. 121.
[37] Para. 186.
[38] Para. 188.
[39] Para. 188, 192.
[40] Para. 245.
[41] Para. 253.
[42] Para. 249.

annual emission amounts and reduction measures must be defined in such detail that sufficiently specific orientation is provided".[43]

1.2.4.3 Lack of Precautionary Measures to Contain Risk of Disproportionate Burden

With this reasoning, the Constitutional Court declared Section 3 (1) 2 of Climate Change Act from 2019 and its Section 4 (1) 3 in conjunction with Annex 2 to be incompatible with the German Constitution to the extent that they do not contain a provision on the updating of reduction targets for periods from 2031 onwards that satisfies the requirements of constitutional law.[44] The German legislator was obliged to regulate the updating of the reduction targets from 2031 onwards by December 31, 2022 at the latest, in accordance with the grounds of the ruling.

1.3 Amendment of Climate Change Act

In response to the decision of the Constitutional Court, the German Bundestag passed an amendment of the German Climate Change Act on 24 June 2021.[45] With this amendment, the target year for achieving national greenhouse gas greenhouse gas neutrality was moved forward from 2050 to 2045.[46] After the year 2050, negative greenhouse gas emissions are to be achieved.[47] This means that from this year on, Germany should sequester more greenhouse gases in natural sinks than it emits. The interim reduction target for 2030 compared to 1990 was raised from 55% to 65%, and the emissions budgets for the sectors from 2024 were partially adjusted accordingly.[48] By the year 2040, emissions are supposed to be reduced by at least 88% compared to 1990.[49] The amended Climate Change Act defines a reduction path for 2031–2040 in the form of annual overall reduction targets.[50] The involvement of the legislator for the definition of the of the individual sector budgets from

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[43] Para. 254.

[44] Para. 256 ff.

[45] Federal Climate Change Act of 12 December 2019 (Federal Law Gazette I, p. 2513), as last amended by Article 1 of the Act of 18 August 2021 (Federal Law Gazette I, p. 3905), the English version is available under https://www.gesetze-im-internet.de/englisch_ksg/englisch_ksg.html#p0013 (Last access: 22 June 2022).

[46] Section 3 (2) 1 KSG 2021.

[47] Section 3 (2) 2 KSG 2021.

[48] Section 3 (1) No. 1, 4 (1) 3, Annex 2 KSG 2021.

[49] Section 3 (1) No. 2 KSG 2021.

[50] Section 4 (1) 6, Annex 3 KSG 2021.

2031 and from 2041 onwards is regulated in more detail.[51] The amended Climate Change Act also contains a new provision on the "Contribution of the land use, land-use change and forestry sector",[52] which sets out that negative-emission-goals for the land use, land-use change and forestry sector (LULUCF-sector). The mean of the annual emissions balances is to be improved to at least minus 25 million tonnes of CO_{2e} by the year 2030, to at least minus 35 million CO_{2e} by the year 2040 and to minus 40 million tonnes of CO_{2e} by the year 2045.

It is questionable whether these new provisions meet the constitutional requirements pointed out by the Constitutional Court. In January 2022, a group of young people backed by the German environmental NGO Deutsche Umwelthilfe e.V. ("DUH") already submitted another constitutional complaint, claiming that also the new Climate Change Act is insufficient.[53] They argue that the amount of emissions permitted in the period 2021–2030 exceeds the CO_2 budget remaining for limiting warming to "well below 2 °C and, if possible, 1.5 °C". Also, the new complaint argues that the situation has "decisively changed" with the latest IPCC report, which provides further evidence that global warming must be limited by 1.5 ° C. A decision on this complaint was still pending at the time of writing this chapter.

2 Consequences for Soil Protection and Soil Law

In the aftermath of the Court's decision, a question frequently asked was what could be the implications for other planetary boundaries such as biodiversity,[54] or fossil phosphorus resources.[55] Against attempts of a direct transfer of the Court's core statement on the advance interference effect on future freedom, it was pointed out, that in contrast to climate change, other environmental challenges often lack binding targets and a quantifiable emission budget.[56] This is also the case for the highly diverse soil protection problems, which cannot be broken down to one emission quantity. It thus seems hardly possible to derive a threat for future freedom from a currently insufficient soil protection—at least, if soil protection is regarded as a separate problem area independent from climate change.

The judgement of the Constitutional Court is nevertheless highly relevant due to the close interactions between soil and climate: On the one hand, soil has an

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[51] Section 4 (6) KSG 2021.

[52] Section 3a KSG 2021.

[53] The complainants are represented by the law firm Geulen & Klinger. See for more information https://www.duh.de/vbklima/ (Last access: 22 June 2022), the entire constitutional complaint is available under https://www.duh.de/fileadmin/user_upload/download/Pressemitteilungen/Umweltpolitik/Klimaschutz/Verfassungsbeschwerde_II_KSG_Bund_geschw%C3%A4rzt.pdf (Last access: 22 June 2022).

[54] Ekardt et al. (2021), pp. 6 f.; Schlacke (2021), p. 917.

[55] Stubenrauch (2021), pp. 617 ff.

[56] Breuer (2021); Schlacke (2021), p. 917; Stubenrauch (2021), pp. 621 f.

important climate protection function due to its carbon storage capacity; on the other hand, adaptation to climate change requires increased soil protection.[57] The decision thus enhances the importance of soil protection in its function for climate protection (Sect. 2.1) and for adaptation to climate change (Sect. 2.2):

2.1 Strengthening Soil Protection as Climate Protection

2.1.1 Soil Protection Is Climate Protection

Soils, especially peatlands, store carbon in their organic content and are therefore important CO_2 stores and, in the long term, CO_2 sinks. Worldwide, soils store about five times as much carbon as above-ground biomass.[58] In addition, most ecosystems that can absorb carbon dioxide from the atmosphere also depend on healthy soils.[59] However, land-use changes, such as the drainage of peatlands, the conversion of forest and grassland soils into arable land, deforestation for building land and/or inappropriate soil management, are turning soils into significant sources of greenhouse gases.[60] Most recently, about 53 million tonnes of CO_2 emissions, and thus about 6.7 per cent of Germany's greenhouse gas emissions, came from drained organic soils and peat extraction.[61] Soil is thus currently an important source of emissions in Germany and far from acting as a sink.

2.1.2 Importance of Sinks to Achieve Climate Neutrality

The Federal Constitutional Court has clarified that the constitution obliges the German state to achieve greenhouse gas neutrality or climate neutrality.[62] To this end, it is essential that GHG emissions from soils are reduced and that, in parallel, the function of soils as carbon reservoirs is maintained and expanded. A reduction of GHG emissions to zero will hardly be possible in some sectors, such as agriculture. Therefore, in order to achieve at least net-zero emissions, sufficient greenhouse gas sinks must be available to remove greenhouse gas emissions from the atmosphere and store them. In order to achieve greenhouse gas neutrality, it is thus strictly necessary to achieve a negative emissions balance in the LULUCF sector, which is why the legislator introduced a new Article 3 (2) sentence 2 in the new Climate

[57] See for a detailed description of the interactions between soil and climate LABO (2010).

[58] LABO (2010), p. 5; Federal Government (2021), p. 33.

[59] Federal Government (2021), pp. 32 f.

[60] Federal Government (2021), p. 32.

[61] Federal Environmental Agency (2021).

[62] Para. 32, 155.

Change Act from 2021.[63] Maintaining, restoring and improving the function of soils as carbon reservoirs as far as possible is particularly important in view of the Court's finding that the Constitution obliges the state to comply with the temperature threshold of the Paris Agreement in a way which does not put a disproportionate burden on fundamental rights. The faster and stronger the greenhouse gas sinks grow, the less emission-relevant freedom activities must be restricted. Particularly in areas that are difficult to transform, the expansion of sinks can enable a slower and thus more fundamental-rights-friendly phase-out of emissions-relevant processes. The measures required to reduce emissions and increase the sink function include, for example:[64]

– Protection and rewatering and renaturation of peatland,
– Reducing the use of peat in growing and rewetting peat extraction areas,
– Preservation of permanent grassland,
– Humus preservation and build-up in arable land,
– Reduction of land consumption for settlement and transport purposes or unsealing.

2.1.3 Initiate Activation of Sinks in Good Time

In its decision, the Constitutional Court emphasised that the necessary development and implementation processes must be initiated as early as possible.[65] The legislator must define a transparent reduction path to greenhouse gas neutrality that provides a sufficient degree of development pressure and planning certainty. The necessary developments must begin soon so that future freedom does not have to be suddenly and radically curtailed.[66]

In view of these findings, it seems necessary to strengthen sinks—just like the necessary reduction in emissions—in good time and to regulate them in a differentiated manner. Just as emission reduction, increasing the sink function, especially raising water levels, requires great technical, economic and social efforts and changes.[67] Soils currently still function as a source of greenhouse gases. In order to reduce greenhouse gas emissions from peatlands in Germany as far as possible, at least by 2050, 50,000 ha would have to be rewetted annually.[68] Rewatering of peatland is a complex process that takes several years. Preparations for large-scale rewetting would have to begin immediately in order to avoid major impacts until the middle of the century and to enable social and economic adaptation. Therefore,

[63] BT-Drs. 19/30230, page 19.

[64] Vgl. Repenning et al. (2021), pp. 303 f.; LABO (2010), pp. 9 ff.; Federal Government (2021), pp. 34 ff.

[65] Para. 249.

[66] Para. 252 f.

[67] Abel et al. (2019), p. 8.

[68] Abel et al. (2019), p. 9.

transparent specifications for the further design of the sink increase would have to be formulated as early as possible.[69] The specifications must be sufficiently concrete and detailed to fulfil the necessary orientation function.[70]

The amended Climate Protection Act does not meet these requirements, as it contains in section 3a only selective targets for the years 2030, 2040 and 2045, without specifying further interim targets or annual storage quantities. This provision thus does not provide sufficient planning certainty and orientation as to the extent and the time in which significant land use changes and land transformations will be required. Particularly in view of the fact that soils in Germany currently act as a source of greenhouse gases, more detailed specifications would be necessary to cope with the necessary increase in sinks.

2.2 Strengthening Soil Protection for the Necessary Adaptation to Climate Change

The decision strengthens soil protection not only in its importance for climate protection, but also in its importance for adaptation to climate change. The Constitutional Court has made it clear that the state is obliged by the fundamental right to the protection of life and health under Article 2 (2) sentence 1 of the German Constitution to take adaptation measures to mitigate the consequences of climate change.[71]

Climate change is already having a significant impact on the state of soils.[72] Changes in temperatures, precipitation, and the intensity and frequency of extreme weather events can exacerbate existing soil protection problems such as erosion, compaction or loss of humus, and subsequently also make adaptation to climate change more difficult.[73]

The Constitutional Court highlighted as a particular challenge for Germany the increase in dryness and drought, which has a considerable impact on agriculture due to the dehydration of the soil.[74] Also, soils play an important role in preventing flooding, especially when adapting to the expected increase in heavy rainfall events.[75] The Constitutional Court states in its decision with reference to the Federal Government's national adaptation strategy that protection against the increasing flood risk in river basins should be strengthened above all by preserving non-built areas and that efforts should be made on restoring, desealing, renaturing and

[69] See already Abel et al. (2019), p. 8.

[70] Para. 252–253.

[71] Para. 144.

[72] Federal Government (2021), p. 32; Sanden (2010), p. 226.

[73] See on the individual climate impacts in the field of soil Kahlenborn et al. (2021), pp. 44–48.

[74] Para. 27.

[75] LABO (2010), p. 5; Federal Government (2021), p. 32; Möckel (2012), p. 408.

reforesting suitable land.[76] In addition, soil plays a key role in reducing increasing heat stress in cities.[77]

Important objectives with regard to adaptation to climate change are therefore amongst others the maintenance or increase of water absorption and storage capacity, the prevention of soil erosion and the maintenance and expansion of soil biodiversity as well as the desealing of soil.[78]

3 Conclusion and Outlook

In its landmark decision, the German Federal Constitutional Court has significantly strengthened climate protection. The Court has firmly shown that climate protection and adaptation to climate change are not a political option, but constitutional obligations. Due to the close interactions between soil and climate, the ruling is also a reminder for increased soil protection. It is essential to better protect our soils, both to be able to make a sustainable contribution to climate protection as well as to mitigate the effects of climate change.[79] The current German soil protection law, which focuses on contaminated sites and substance-related hazards to the soil, cannot make a sufficient contribution to this, as has been repeatedly stated.[80] The instruments of soil protection law therefore urgently need to be improved. The German federal government now takes up this concern and announced an adaptation of the Federal Soil Protection Act to the challenges of climate protection.[81] Also the EU Commission has recognised the need for action and announced in its new EU Soil Strategy a special legislative proposal on soil health by 2023.[82] It has to be hoped that these expected legislative changes will help soil to fulfil its important function in climate processes.

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[76] Para. 164.

[77] Pannicke-Prochnow et al. (2021), p. 85.

[78] Federal Government (2021), pp. 36 f.

[79] Federal Government (2021), p. 34.

[80] LABO (2017), pp. 1 ff.; Willand et al. (2014), pp. 22 ff., Part C; Sanden (2010), pp. 225 ff.; Möckel (2012), pp. 409 ff.

[81] SPD/Bündnis 90/Die Grünen/FDP (2021), pp. 41 f.

[82] EU Commission (2021), pp. 4 ff.

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Legislative Protection for the Soil Environment and Climate Change

Ian Hannam

Abstract Recent court decisions in Australia and in overseas jurisdictions have made important progress in society's acceptance of the significance of climate change in the long-term protection of the environment. The term 'climate litigation' is now generally used to refer to legal proceedings initiated to establish responsibility for a failure to prevent or reduce the rate of climate change and/or mitigate its negative consequences. Such legal proceedings are being initiated in courts, tribunals and other rule compliance monitoring bodies, operating around the world, at the domestic, regional, or global level. One decision, in the New South Wales Land and Environment Court on 26 August 2021, orders the New South Wales Environment Protection Authority to develop environmental quality objectives, guidelines and policies to ensure protection of the environment from climate change with regard to its duties under the Protection of the Environment Administration Act 1991. This decision is regarded as a landmark decision in New South Wales in that it orders a statutory authority to exercise its duty and legal responsibilities under the Protection of the Environment Administration Act with regard to the level of seriousness that climate change impacts have reached for the New South Wales environment. The case is also significant because the definition of "environment" under the Protection of the Environment Administration Act encapsulates a broad range of ecological elements, including the "soil". In this context, this chapter argues that the decision is important for a number of reasons including: by interpretation "soil" is a component of the "environment" and it should be protected from climate change under the Protection of the Environment Administration Act; the way the decision is made provides a guiding framework which can used to examine existing environmental laws for protection of the soil environment against climate change; and it provides a guiding framework to prepare new soil legislation with the requisite procedures to develop environmental quality objectives, guidelines and policies to protect the soil environment from climate change. Having regard to these various aspects of the decision, they provide a guiding structure in which to assess the protection of the soil

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environment in New South Wales, but also a procedure which might be beneficial to other countries to assess the legal protection of the soil environment. The way soil is being used in Australia and around the world is directly contributing to global warming by releasing carbon dioxide and other greenhouse gases to the atmosphere. Soil degradation from agricultural land use, vegetation clearing and urban and infrastructure projects and pollution of soil from industrial works require closer attention from legislative and policy structures. Therefore, it is appropriate that increasing attention must be placed on the protection of the soil environment through the adoption of legislative, policy and mitigation responses which prevent the use of soil in a manner that makes it a significant contributor to climate change.

1 Introduction

On 9 August 2021 the United Nations Secretary General, António Guterres stated that the latest report of the Intergovernmental Panel on Climate Change (hereafter, IPCC) is a "code red for humanity". He said "The alarm bells are deafening, and the evidence is irrefutable: greenhouse-gas emissions from fossil-fuel burning and deforestation are choking our planet and putting billions of people at immediate risk. Global heating is affecting every region on Earth, with many of the changes becoming irreversible".[1] He went on to say that "The viability of our societies depends on leaders from government, business and civil society uniting behind policies, actions and investments that will limit temperature rise to 1.5 °C." In this regard, a number of recent legal decisions in Australia and in overseas jurisdictions have made important progress in society's acceptance of the significance of climate change in the long term protection of the environment. The term 'climate litigation' is now generally used to refer to legal proceedings initiated to establish responsibility for a failure to prevent or reduce the rate of climate change and/or mitigate its negative consequences. Such legal proceedings are being initiated in courts, tribunals and other rule compliance monitoring bodies, operating around the world, at the domestic, regional, or global level.[2] In one case in particular, *Bushfire Survivors for Climate Action Incorporated v Environment Protection Authority* (hereafter, BSCA v EPA),[3] in New South Wales (hereafter, NSW), Australia, a climate action group sought an order in the New South Wales Land and Environment Court (hereafter, LEC), in the nature of mandamus[4] to compel the New South Wales Environment Protection Authority (hereafter, EPA), to perform a statutory duty to

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[1] https://www.un.org/press/en/2021/sgsm20847.doc.htm (Last access: 22 June 2022).

[2] Preston (2018), p. 132.

[3] https://www.caselaw.nsw.gov.au/decision/17b7569b9b3625518b58fd99 (Last access: 22 June 2022, hereafter, [2021] NSWLEC 92); and https://www.lexology.com/library/detail.aspx?g=8280d79f-ef5b-491c-83df-da7086acc60f (Last access: 22 June 2022).

[4] A writ or order that is issued from a court of superior jurisdiction that commands an inferior tribunal, corporation, Municipal Corporation, or individual to perform, or refrain from performing,

develop environmental quality objectives, guidelines and policies to ensure the protection of the environment from climate change.[5] This decision, together with other cases discussed below, highlight numerous legal and human-related issues related to climate change including: harm to the natural and ecological environment, intergenerational harm to children of the current generation who are affected by decisions made today that affect the climate; obligation of statutory authorities to invoke the duty that they have to climate management under respective statutes; the importance of clarity of meaning of key words and phrases in environmental statutes; the need to take into account the latest scientific information of the IPCC in decision-making; the effect of climate change on food supply, loss of territory and habitable areas, endangering health, and the human right to a climate system to sustain human life.

It is essential that increasing attention must be placed on the protection of the soil environment through the adoption of legislative, policy and mitigation responses which prevent the use of the soil environment so that it contributes to climate change. However, the various arguments presented in litigation in Australia and in overseas jurisdictions make important progress in society's acceptance of the significance of climate change in the long term protection of the environment. Most importantly for soil is the role that climate science should play in expert evidence in litigation where climate change is the legal challenge that affects the soil environment in particular. On the basis of the facts presented in BSCA v EPA, and other cases referred to in this chapter, IPCC data is likely to be incontrovertible and accepted by the courts as evidence of the risks and threat of climate change.

Before the following examples of climate litigation are discussed, and the BSCA v EPA case in particular, as regards the preparation of policy, guidelines and standards that protect the environment against climate change and why soil falls within the definition of "environment," it is pertinent to review what soil is ecologically. It is also important to understand what contribution to global warming soil makes from the release of carbon dioxide (hereafter, CO_2) to the atmosphere from unsustainable land use practices. A basic understanding of these relationships further justifies the importance of the BSCA v EPA decision in ensuring that the NSW EPA has a duty to prepare policy, guidelines and standards to protect the soil environment of NSW from climate change.

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a particular act, the performance or omission of which is required by law as an obligation; https://legal-dictionary.thefreedictionary.com/mandamus (Last access: 22 June 2022).

[5] [2021] NSWLEC 92 paras 1,2.

2 Soil and Climate Change

To avoid the most dangerous effects of climate change, the Paris Accord recommends limiting global warming to less than 2 °C above pre-industrial levels.[6] According to the IPCC, one of the critical activities will be the removal CO_2 from the atmosphere, as one of the main greenhouse gases (hereafter, GHG) contributing to global warming.[7] Sequestering carbon in soil, however, is a natural way of removing CO_2 from the atmosphere with fewer impacts on land and water, less need for energy, and lower costs. The term "carbon sequestration" is used to describe both natural and deliberate processes by which CO_2 is either removed from the atmosphere or diverted from emission sources and stored in the terrestrial environment (vegetation, soils, and sediments).[8] Before human-caused CO_2 emissions began, the natural processes that make up the global "carbon cycle" maintained a near balance between the uptake of CO_2 and its release back to the atmosphere. In this regard, with the knowledge that society now has on the impact of released terrestrial carbon on the atmosphere, society should now strive to keep as much natural carbon in the soil and in landscape "sinks" by adopting sustainable land management practices.

Existing CO_2 uptake mechanisms, or carbon "sinks", are insufficient to offset the accelerating pace of emissions related to human activities. Currently, 33% of the global soils have been degraded and have lost much of their soil organic carbon (hereafter, SOC) through the historical expansion of agriculture and pastoralism and subsequent land-use conversion from native ecosystems (e.g., peatlands, forests, grasslands) to arable land.[9] This has resulted in a decline in soil structural stability, increased erosion risks, and reduced water storage and nutrient supplies. Soil degradation has become a major threat to food security, especially in developing countries. Better land management and agricultural practices enhance the ability of soils to store carbon and help combat global warming. The amount of carbon that

[6] At COP 21 in Paris, on 12 December 2015, Parties to the UNFCCC reached a landmark agreement to combat climate change and to accelerate and intensify the actions and investments needed for a sustainable low carbon future. The Paris Agreement's central aim is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius; https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement/key-aspects-of-the-paris-agreement (Last access: 22 June 2022).

[7] IPCC Summary for Policymakers (2021) (hereafter, IPCC SPM (2021)).

[8] United States Geological Survey (2008), p. 2, "Terrestrial sequestration (sometimes termed 'biological sequestration') is typically accomplished through forest and soil conservation practices that enhance the storage of carbon (such as restoring and establishing new forests, wetlands, and grasslands) or reduce CO2 emissions (such as reducing agricultural tillage and suppressing wildfires)"; https://pubs.usgs.gov/fs/2008/3097/pdf/CarbonFS.pdf (Last access: 22 June 2022).

[9] Amelung et al. (2020), p. 2; Hannam (forthcoming).

soils can absorb and how long they can store it varies by location and is effectively determined by how the land is managed.[10]

With regard to NSW, a recent emissions overview specifies that CO_2 and other GHG are produced in NSW by a variety of activities where agriculture, land use and land use change combined account for 21% of emissions.[11] Further, in 2019 around 141 megatonnes (Mt) of CO_2-equivalent was emitted in NSW, and agriculture comprised 12% (16Mt) of the total.[12] Agricultural practices that disturb the soil such as tilling, planting mono-crops, removing crop residue, excessive use of fertilizers and pesticides and over-grazing expose the carbon in the soil to oxygen, allowing it to burn off into the atmosphere. In other parts of the world deforestation, thawing permafrost, and draining peatlands cause soils to release carbon.[13] In Australia, agriculture is the primary source of anthropocentric methane emissions (60.4% of national emissions between 1990 and 2011), and cropping and grazing soils represent Australia's potential terrestrial sink.[14] However, agriculture and land management practices that increase soil carbon also provide other benefits which explain why it is essential that there must be a high focus on soil in the management of climate change.[15] Fertile soil produces more food, biodiversity, has better moisture-holding capacity, and is less susceptible to erosion, nutrient loss, and desertification.

2.1 Why Soil Must Be Protected

Soil has been defined by the Council of Europe as an integral part of the earth's ecosystems and is situated at the interface between the earth's surface and bedrock. It is subdivided into successive horizontal layers with specific physical, chemical and biological characteristics. From the standpoint of the history of soil use, and from an ecological and environmental point of view, the concept of soil also embraces porous sedimentary rocks and other permeable materials together, with the water

[10] Ibid. Amelung et al. (2020), p. 2.

[11] https://climatechange.environment.nsw.gov.au/About-climate-change-in-NSW/Causes-of-climate-change (Last access: 22 June 2022); note that in the United Nations Environment Programme (2021) Emissions Gap Report, Section 2.2 provides an overview of current trends in total global GHG emissions and global carbon dioxide (CO2) emissions from fossil fuel use and industry-related sources.

[12] https://climatechange.environment.nsw.gov.au/About-climate-change-in-NSW/NSW-emissions (Last access: 22 June 2022).

[13] Cho (2018): https://news.climate.columbia.edu/2018/02/21/can-soil-help-combat-climate-change/ (Last access: 22 June 2022).

[14] Finn et al. (2014), p. 1, www.publish.csiro.au/CP/CP14116 (accessed 30 October 2021).

[15] See Farmers for Climate Action (2021) https://farmersforclimateaction.org.au/wp-content/uploads/2021/09/FCA-EY-FINAL-Report-Low-emissions-future (accessed 30 October 2021).

that these contain, and the reserves of underground water.[16] In this context, soil has a fundamental role in the terrestrial ecosystem as a whole, as a three dimensional body performing a wide range of ecological functions.[17] Alteration of soil processes leads to changes in the function of ecosystems, and many environmental problems that become apparent in other media actually originate within the soil. It is essential that the principal functions of soil, which include its ecological functions, cultural functions, and its land-use functions, must strongly influence how the soil environment is managed to remain ecologically sustainable and afford protection against climate change. The ecological functions, in particular, should be qualitatively and quantitatively safeguarded and conserved in the long term to conserve biodiversity and maintain human life.[18] Many changes in the Earth's climate system, which urgently need to be controlled, are significantly changing the soil environment and causing soil degradation. Soil degradation is defined as a process that lowers the current and/or the potential capability of the soil to produce goods or services and six specific processes are recognised as the main contributors to soil degradation: water erosion, wind erosion, waterlogging and excess salts, chemical degradation, physical degradation, and biological degradation.[19] In this regard, the way soil is being used, in NSW and around the world, is directly contributing to global warming by releasing CO_2 to the atmosphere on the one hand, and losing its ability to store carbon on the other hand.[20]

Climate change is already affecting every inhabited region across the globe, with human influence contributing to the many changes in weather and climate extremes. Evidence of observed changes in extremes such as heatwaves, heavy precipitation, droughts, and tropical cyclones, and, in particular, their attribution to human influence, has strengthened with the IPCC's AR6.[21] Human influence has likely increased the chance of compound extreme events since the 1950s and it seems certain that hot extremes, including heatwaves, have become more frequent and more intense across most land regions. Future emissions will cause additional warming, but total warming is compounded by past and ongoing CO_2 emissions.[22] Also, since the 1950s, cold extremes, including cold waves, have become less

[16] Council of Europe (1990).

[17] Sheals (1969).

[18] Protocol on the Implementation of the Convention concerning the Protection of the Alps of 1991 in the area of Soil Protection, Article 1(2) sets out the multifunctional role of soil.

[19] Hannam and Boer (2002), p. 12.

[20] State of NSW and Office of Environment and Heritage (2018), p. 6; https://www.bing.com/search?q=soil+carbon+in+new+south+wales&form=ANNTH1&refig=a2b77a0f2a484987a8b562b82e327a68 (Last access: 22 June 2022).

[21] Ibid. IPCC SPM (2021) -10.

[22] Compound extreme events are the combination of multiple drivers and/or hazards that contribute to societal or environmental risk. Examples are concurrent heatwaves and droughts, compound flooding (e.g., a storm surge in combination with extreme rainfall and/or river flow), compound fire weather conditions (i.e., a combination of hot, dry, and windy conditions), or concurrent extremes at different locations.

frequent and less severe, and that human-induced climate change is the main driver of these changes. Some hot extremes observed over the past decade would have been extremely unlikely to occur without human influence on the climate system.[23]

The frequency and intensity of heavy precipitation events have increased since the 1950s over most land areas for which observational data are sufficient for trend analysis, and human-induced climate change is seen by the IPCC as the main driver.[24] Human-induced climate change has contributed to increases in agricultural and ecological droughts[25] in some regions due to increased land evapotranspiration.[26] Global surface temperature will continue to increase until at least the mid-century under all emissions scenarios considered by IPCC, and global warming of 1.5 °C and 2 °C will be exceeded during the twenty-first century unless deep reductions in CO_2 and other GHG emissions occur in the coming decades.[27] From a regional perspective, some mid-latitude and semi-arid regions, and the South American Monsoon region, are projected to see the highest increase in the temperature of the hottest days, at about 1.5 to 2 times the rate of global warming. It is very likely that heavy precipitation events will intensify and become more frequent in most regions with additional global warming. At the global scale, extreme daily precipitation events are projected to intensify by about 7% for each 1 °C of global warming. The proportion of intense tropical cyclones (categories 4–5) and peak wind speeds of the most intense tropical cyclones are projected to increase at the global scale with increasing global warming. Additional warming is projected to further amplify permafrost thawing, and loss of seasonal snow cover.[28]

2.2 Soil Impacts

The current trend of global warming has a special impact on soil functionality. Climate change alters the drivers of natural climate variability and climate extremes, with subsequent impacts on terrestrial ecosystems and natural land processes. As a significant consequence, the increase in climate variability, extreme climatic

[23] Ibid. IPCC SPM (2021) -10.

[24] Ibid. IPCC SPM (2021) -10.

[25] Agricultural and ecological drought (depending on the affected biome): a period with abnormal soil moisture deficit, which results from combined shortage of precipitation and excess evapotranspiration, and during the growing season impinges on crop production or ecosystem function in general. Observed changes in meteorological droughts (precipitation deficits) and hydrological droughts (streamflow deficits) are distinct from those in agricultural and ecological droughts and addressed in IPCC AR6 (Chapter 11).

[26] Ibid. IPCC SPM (2021) -11, the combined processes through which water is transferred to the atmosphere from open water and ice surfaces, bare soil, and vegetation that make up the Earth's surface.

[27] Ibid. IPCC SPM (2021) -17.

[28] Ibid. IPCC SPM (2021) -20.

phenomena, torrential rains and floods are affecting the stability of soils and their ability to buffer extreme climatic phenomena and maintain productivity and biological diversity over the land. Conversely, soil degradation especially due to non-adjusted land management affects important parameters of climate regulation and the atmospheric chemical composition.[29]

Legislative systems must be capable of adapting to the problems that arise from the changing characteristics of the climate and its impact on the soil environment, in a manner depending on the bioclimatic zone and the intrinsic vulnerability of the soil. As global warming continues, soil will release more carbon than was previously thought.[30] Climate change impacts the soil through changes in both soil erosion and rainfall erosivity. The amount of erosion will, therefore, depend upon the combination of the power of the rain to cause erosion and the ability of the soil to withstand erosion. Thus, soil erosion is a function of the erosivity of the rain and the erodibility of the soil.[31] A change in the rate of soil erosion from natural rates to an accelerated rate, caused by increased intensity of rainfall, can have significant implications for the ecological stability of agricultural land and water quality. While some regions are likely to suffer from more droughts in the future, other regions are expected to face the opposing issues of torrential rains and increased flooding. Projected changes in climate are not limited to increases in temperature and heat waves; large changes in rainfall patterns are also expected to occur and these will have a significant impact on the pattern of soil erosion. Continued global warming is projected to further intensify the global water cycle, including its variability, global monsoon precipitation and the severity of wet and dry events. A warmer climate will intensify very wet and very dry weather and climate events and seasons, with implications for flooding or drought, but the location and frequency of these events depend on projected changes in regional atmospheric circulation, including monsoons and mid-latitude storm tracks.[32]

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[29] Rubio et al. (2021), pp. 3–4.

[30] Studies that have heated soils 5 to 20 cm deep found that the soil would release 9 to12 percent more CO_2 than normal. But deeper levels of soil contain more than 50 percent of global soil carbon and after heating soils to 100 cm depth, scientists have found that 4 °C of warming could result in soil releasing as much as 37 percent more CO_2 than normal; https://news.climate.columbia.edu/2018/02/21/can-soil-help-combat-climate-change/ (Last access: 22 June 2022).

[31] McCool and Williams (2008); https://www.sciencedirect.com/referencework/9780080454054/encyclopedia-of-ecology (Last access: 22 June 2022); Erodibility is defined as the vulnerability or susceptibility of the soil to erosion. It is a function of both the physical characteristics of the soil and the land management practices. For a given rainfall condition, one soil condition can be compared quantitatively with the other.

[32] Ibid. IPCC SPM (2021) -25; Monsoon precipitation is projected to increase in the mid- to long term at global scale, particularly over South and Southeast Asia, East Asia and West Africa apart from the far west Sahel. The monsoon season is projected to have a delayed onset over North and South America and West Africa and a delayed retreat over West Africa.

2.3 Food Security

Agriculture, and the wider food production system, is a major source of the gases which contribute to the greenhouse effect and climate change. However, the changing climate is having far-reaching impacts on soil productivity and agricultural production, which are likely to challenge food security in the future.[33] Climate change will contribute substantially to food insecurity by increasing food prices, and reducing food production. Food may become more expensive as climate change mitigation efforts increase energy prices. Water required for food production may become scarce due to increased crop water use and drought. Competition for land may increase as certain areas become climatically unsuitable for production. The consensus of the IPCC is that substantial climate change has already occurred since the 1950s, and it is likely that the global mean surface air temperature will increase by 0.4 to 2.6 °C in the second half of this century, depending on future GHG emissions. Future intensification of agriculture to compensate for reduced production, partly caused by climate change, alongside an increasing demand for animal products, could further increase these emissions.[34]

While gradual increases in temperature and CO_2 may result in more favourable conditions that could increase the yields of some crops, in some regions, these potential yield increases are likely to be restricted by extreme events. Crop production is projected to decrease in many areas during the twenty-first century because of climatic changes. This is illustrated in an IPCC figure which summarises average crop yield projections across all emission scenarios, regions, and with, or without adaptation by farmers, showing an increasing trend towards widespread yield decreases.[35] Periods of extreme high temperature are likely to become more frequent in the future and represent a major challenge for agriculture and food production. Heat waves can cause heat stress in both animals and plants and have a negative impact on food production. Evidence for an increase in heat waves exists from warming that has already occurred, and greater than expected increases in heat wave frequency and magnitude.[36] The impact of heat waves is expected to be non-uniform, and together with other aspects of climate change such as increased drought incidence, they may exacerbate existing issues around food security.

[33] https://www.futurelearn.com/info/courses/climate-smart-agriculture/0/steps/26565 (Last access: 22 June 2022).

[34] See Farmers for Climate Action (2021) Fig. 1 at 6, "Through the deliberate and coordinated application of high-impact carbon abatement initiatives, we have modelled a pathway to mitigate on-farm emissions from Australian agriculture. The pathway modelled is bound by trajectories that are likely to limit global warming to 1.5°C and 2°C by 2100 and would see agriculture reach the equivalent of net zero emissions by 2040"; https://farmersforclimateaction.org.au/wp-content/uploads/2021/09/FCA-EY-FINAL-Report-Low-emissions-future (accessed 27 October 2021).

[35] See figure Ibid. IPCC SPM (2021) -16.

[36] See figure Ibid. IPCC SPM (2021) -16.

3 Climate Litigation

Recent decisions in Australian and in overseas jurisdictions highlight numerous legal and human-related issues related to climate change, i.e., "climate litigation", including: harm to the natural and ecological environment, intergenerational harm to children of the current generation who are affected by decisions made today that affect the climate; obligation of statutory authorities to invoke the duty that they have to climate management under respective statutes; the importance of clarity of meaning of key words and phrases in environmental statutes; the need to take into account the latest scientific information of the IPCC in decision-making; the effect of climate change on food supply, loss of territory and habitable areas, endangering health, and the human right to a climate system to sustain human life. The term 'climate litigation' is now generally used to refer to legal proceedings initiated to establish responsibility for a failure to prevent or reduce the rate of climate change and/or mitigate its negative consequences.[37] The arguments presented in the litigation make important progress in society's acceptance of the significance of climate change in the long term protection of the soil environment. Most importantly for soil is the role that climate science should play in expert evidence in litigation where climate change is the legal challenge that affects the soil environment in particular.

Five cases are briefly discussed in this chapter that depict various human-related and legal issues related to climate change. However, once case in particular, BSCA v EPA is examined in detail. Although this case concerns climate change in NSW, it contains many legal points, rules and principles that are relevant for assessing and developing legislation to protect the soil environment from climate change in other Australian jurisdictions and in other countries. Other reasons for its examination include: (1) by interpretation, "soil" is a component of the "environment" under the POEA Act[38] and following the argument of BSCA v EPA it should be protected from climate change under the POEA Act; (2) the decision provides a guiding framework which could be used to examine existing environmental laws for protection of the soil environment against climate change; and (3) it provides a guiding framework to help prepare new soil legislation so that it can develop environmental quality objectives, guidelines and policies to ensure protection of the soil environment from climate change. The BSCA v EPA proceedings are the second successful

[37] Ibid. Preston (2018), p. 132.

[38] "Soil" is not defined in the NSW Soil Conservation Act 1938, but s 4C "Powers, duties and authorities of the Commissioner", has the "aim of ensuring the conservation of the soil resources of the State, the mitigation of soil erosion and land degradation and the conservation of water resources . . ."; and a further power under 4C (c) is for "the evaluation of the present condition of the State's soil resources, and the future requirements for the mitigation of soil erosion and land degradation". The POEA Act 1991, more broadly, under s 3(1) defines the "environment" as meaning "components of the earth, including: (a) land, air and water, and (b) any layer of the atmosphere, and (c) any organic or inorganic matter and any living organism, and (d) human-made or modified structures and areas, and includes interacting natural ecosystems that include components referred to in paragraphs (a)–(c)."

action brought in 2021 in NSW (after the Gloucester decision, below) resulting in a finding that a public decision maker has a duty to consider, address and mitigate climate change. In conjunction with the determination in the Sharma case, this case highlights that the NSW and Commonwealth Governments, and public agencies, are likely to continue to be pressed by the courts to step up the policy framework, assessment and consideration of the impacts arising from climate change.

3.1 Gloucester Resources Limited v Minister for Planning *2019 (Gloucester Decision)*

In February 2019 the New South Wales Land and Environment Court refused consent to a development application for a coal mining project for reasons relating to environmental and social harm, but specifically that the project will be a material source of GHG emissions and contribute to climate change.[39] The Gloucester decision stated that acceptability of a proposed development of a natural resource depends not on the location of the natural resource, but on its sustainability. One of the principles of ecologically sustainable development is the principle of sustainable use, the aim of exploiting natural resources in a manner that is "sustainable" or "prudent" or "rational" or "wise" or "appropriate".[40] This principle also has an ecological core: that the use of natural resources must be within ecological limits. It was ruled that "Approval of the project will not assist in achieving the rapid and deep reductions in GHG emissions that are needed now in order to balance emissions by sources with removals by sinks of GHGs in the second half of this century and achieve the generally agreed goal of limiting the increase in global average temperature to well below 2 °C above pre-industrial levels".[41]

[39] Gloucester Resources Limited v Minister for Planning [2019] NSWLEC 7; https://www.caselaw.nsw.gov.au/decision/5c59012ce4b02a5a800be47f (accessed 7 October 2021).

[40] As determined by the NSW LEC in *Telstra Corporation Limited v Hornsby Shire Council* [2006] (2006) 146 LGERA 10); the decision of Justice Preston in Telstra provides a comprehensive analysis of the precautionary principle in a judicial context. It contains clear guidance to decision makers on when and how the precautionary principle is to be applied when there is a statutory obligation to have regard to the principles of Ecologically Sustainable Development (ESD).

[41] Ibid. para 697.

3.2 Sharma by Her Litigation Representative Sister Marie Brigid Arthur v Minister for the Environment 2021 (Sharma Decision)

In May 2021, in the first decision of its kind in Australia, the Federal Court of Australia ruled that the Minister for Environment, and the government, has a duty of care to protect Australia's youth from the climate crisis.[42] In Sharma, the applicants claimed that the Minister owes each of the children a duty to exercise her power under ss 130 and 133 of the Environment Protection and Biodiversity Conservation Act 1991 with reasonable care so as not to cause them harm. That duty of care is said to arise by reason of the existence of a legal relationship between the Minister and the "Children" recognised by the law of negligence.[43] The particular harm relevant to the alleged duty of care is mental or physical injury, including ill-health or death, as well as economic and property loss. The applicants in Sharma assert that the *Children* are likely to suffer those injuries in the future as a consequence of their likely exposure to climatic hazards brought about by increasing global surface temperatures that are driven by the further emission of CO_2 into the Earth's atmosphere. The feared climatic hazards include longer and more intense bushfires, storm surges, coastal flooding, inland flooding, cyclones and other extreme weather events.[44]

The applicants alleged that such harm will occur in the future and mainly towards the end of this century, when global average surface temperatures are forecast to be significantly higher than they are currently. The applicants said that today's children will live on Earth during a period in which, if CO_2 concentration continues to increase, some harm is very probable, serious harm is likely and cataclysmal harm is possible. On this basis, the applicants say that the Children are vulnerable to a known, foreseeable risk of serious harm. The applicants maintained that by the Minister's position in the Commonwealth Executive, the Minister has special responsibilities to Australian children[45] and that if the Minister approves the project, carbon presently stored safely underground at the site of the project will be extracted, combusted and emitted as CO_2 into the Earth's atmosphere and will materially contribute to CO_2 concentration.[46]

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[42] Sharma v Minister for the Environment [2021] FCA 560; https://www.judgments.fedcourt.gov.au/judgments/Judgments/fca/single/2021/2021fca0560 (Last access: 22 June 2022); At the time of writing, the decision in *Sharma* is on appeal to the Full Federal Court.

[43] Ibid. para 9.

[44] Ibid. para 11.

[45] Ibid. para 12.

[46] Ibid. para 13.

3.3 Dutch Climate Case

In December 2019, the Dutch Supreme Court, the highest court in the Netherlands, upheld the previous decisions in the Urgenda Climate Case, finding that the Dutch government has obligations to urgently and significantly reduce emissions in line with its human rights obligations.[47] It was the first case in the world in which citizens established that their government has a legal duty to prevent dangerous climate change. On 24 June 2015, the District Court of The Hague had ruled that the government must cut its greenhouse emissions by at least 25% by the end of 2020 (compared with 1990 levels). The ruling required the government to immediately take more effective action on climate change.[48] The court considered that given the severity of the impact from climate change and the significant chance that unless mitigating measures are taken, dangerous climate change will occur. It was ruled that the State has a duty of care to take mitigating measures. It was also ruled that this duty is not diminished by the fact that the Dutch contribution to the present global greenhouse emissions is currently quite minor. Given that at least the 450 ppm scenario is required to prevent hazardous climate change, the Netherlands should take measures to ensure this scenario can be achieved.[49]

In the appeal case it was stated that:

> The emissions of greenhouse gases, which are the partial result of burning of fossil fuels and the resultant release of the greenhouse gas CO_2, is leading to an ever higher concentration of those gases in the atmosphere. This is warming the planet, which is resulting in a variety of hazardous consequences. This may result in local areas of extreme drought, extreme precipitation, or other extreme weather. It is also causing both glacial ice and the ice in and near the polar regions to melt which is raising the sea level. Some of these consequences are already happening right now. That warming may also result in tipping points, as a result of which the climate on earth or in particular regions of earth changes abruptly and comprehensively. This will result in, among other things, the significant erosion of ecosystems which will, for example, jeopardise the food supply, result in the loss of territory and habitable areas, endanger health, and cost human lives.[50]

3.4 Ireland and Pakistan Cases

These two cases are relevant to the environmental protection of soil as they delineate the basic rights of citizens to a healthy environment in particular as a constitutional right. In *Friends of the Irish Environment CLG v the Government of Ireland, and the Attorney General* [2020] IESCDET 13), the focus was on whether the Irish

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[47] See also Spijkers (2022), p. 239.

[48] ECLI:NL:HR:2019:2007 (English translation); https://www.urgenda.nl/wp-content/uploads/ENG-Dutch-Supreme-Court-Urgenda-v-Netherlands-20-12-2019.pdf (Last access: 22 June 2022).

[49] Ibid. para 2.3.1.

[50] Ibid. para 4.1.

Government had acted unlawfully and in breach of specified rights in the manner in which it has adopted a statutory plan (the National Mitigation Plan (hereafter, NMP)) for tackling climate change. The High Court dismissed Friends of the Irish Environment's (FIE) proceedings and FIE appealed to the Court of Appeal.[51] The FIE contended that the government, in regard to the NMP, had failed adequately to vindicate rights which are said to be guaranteed by either or both of the Constitution and the European Convention on Human Rights.[52] Significantly, both the applicant and the respondents accepted that a degree of urgency existed in respect of the adoption of remedial environmental measures, and there was no dispute between the parties as to the science underpinning the NMP and the likely increase in greenhouse emissions over the lifetime of the NMP.[53] Further, the parties accepted the gravity of the likely effects of climate change.[54] The judge concluded that the NMP falls well short of the level of specificity required to provide that transparency and to comply with the provisions of the Climate Action and Low Carbon Development Act, 2015. On this basis, the NMP should be quashed.[55] On the question of a right of citizens to a healthy environment under the Constitution, the judge did not rule out the possibility that constitutional rights and obligations may well be engaged in the environmental field in an appropriate case. In this case, the judge expressed the view that the asserted right to a healthy environment is either superfluous (if it does not extend beyond the right to life and the right to bodily integrity) or is excessively vague and ill-defined (if it does go beyond those rights). The judge's view was that such a right cannot be derived from the Constitution and reserved the position of whether, and if in what form, constitutional rights and state obligations may be relevant in environmental litigation to a case in which those issues would prove crucial.[56]

In the Pakistan case, *Asghar Leghari v Federation of Pakistan*,[57] the petitioner, who is an agriculturist, approached the Court as a citizen for the enforcement of his fundamental rights. He submitted that the overwhelming majority of scientists, experts, and professional scientific organizations related to earth sciences agree that there is sufficient evidence that climate change is real. He also submitted that no one can deny the devastating impact of the increase in frequency and intensity of climate extremes, and that the view of most of the experts is that the major cause is human activities. These, he submitted, include a complex interaction with the natural

[51] Appeal No 205/19; Friends of the Irish Environment CLG Applicants/Appellants and The Government of Ireland, Ireland and the Attorney General Respondents, Judgment of Mr. Justice Clarke, Chief Justice, delivered the 31st of July 2020.

[52] Ibid. para 1.2.

[53] The National Mitigation Plan was adopted under the provisions of the Climate Action and Low Carbon Development Act 2015.

[54] Ibid. para 2.1; an overview of the climate science is provided in cl. 3, at 4–8.

[55] Ibid. para 9.3.

[56] Ibid. para 9.5.

[57] Stereo. H C J D A 38. Judgment Sheet in the Lahore High Court, Lahore Judicial Department Case No: W.P. No. 25501/2015; (accessed 13 October 2021).

environment coupled with social and economic changes that are increasing the greenhouse gases in the atmosphere, which are resulting in the increase of global temperature and in turn causing climate change.[58] In order to address the threat of climate change, the National Climate Change Policy 2012 and the Framework for Implementation of Climate Change Policy (2014–2030) had been formulated by the Pakistan Ministry of Climate Change, but no implementation had taken place on the ground.[59] The petitioner feared that in the absence of any strategy by the Government to conserve water or to covert to heat-resilient crops, he would not be able to sustain his livelihood, as a result of climate change. He also submitted that inaction on the part of the government in not implementing the Framework offended his fundamental rights, in particular, Articles 9 and 14 of the Constitution, besides the constitutional principles of social and economic justice. He further submitted that international environmental principles like the doctrine of public trust, sustainable development, the precautionary principle and intergenerational equity, form part of the fundamental rights under the Constitution.[60] The court took into consideration the National Climate Change Policy 2010, the Framework for Implementation of Climate Change Policy (2014–2030), the role of the Climate Change Commission (instituted in 2015), the Pakistan Climate Change Act 2017, and the concepts of environmental justice and climate justice. The Climate Change Commission was dissolved by the court and replaced by a Standing Committee on Climate Change to act as a link between the court and the Executive and to render assistance to the government and agencies in order to ensure that the Policy and the Framework continue to be implemented.[61] The judge concluded the proceedings by not disposing of the petition, but instead, consigning it to the record, so that the Standing Committee could approach the Court for an appropriate order for the enforcement of the fundamental rights of the people in the context of climate change, if and when required.[62]

4 *Bushfire Survivors for Climate Action Incorporated v Environment Protection Authority*

In Bushfire Survivors for Climate Action Incorporated v Environment Protection Authority (hereafter, BSCA v EPA) the duty on the Environment Protection Authority (EPA) in relation to climate change is imposed by s 9(1)(a) of the Protection of the Environment Administration Act 1991 (POEA Act). This section requires the EPA to "develop environmental quality objectives, guidelines and policies to ensure

[58] Ibid. para 2.
[59] Ibid. para 3.
[60] Ibid. para 3.
[61] Ibid. para 25.
[62] Ibid. para 27.

environment protection." The BSCA's primary argument was that the purpose of environment protection includes protection of the environment from significant threats. In this case, the most significant threat being an "existential" and "grave" threat—is climate change. The environmental quality objectives, guidelines and policies to ensure environment protection that the EPA is required to develop under s 9(1)(a) should therefore include instruments of this kind to protect the environment in NSW from this threat of climate change - as a specific duty. The case contends that the duty requires developing not only instruments to ensure protection of the environment from climate change as a general proposition, but more particularly to do so in ways that are "consistent with limiting global temperature rise to 1.5 degrees Celsius above pre-industrial levels." The outcome of the case was that the EPA, in accordance with s 9(1)(a), is to develop environmental quality objectives, guidelines and policies to ensure environment protection from climate change.

4.1 EPA Duty with Respect to Soil

Two key aspects to improve the protection of the soil environment from the effects of climate change include authorities properly implementing their duty under environmental legislation, and improving the legislation for soil to ensure it contains the procedures that will protect it.[63] In this regard, the BSCA v EPA decision in the NSW LEC, as well as decisions from other climate change cases, can provide useful guidelines that may lead to improved legislative capability to protect the soil environment of NSW, and possibly other areas of the world, against climate change. The extent to which the soil environment should be considered in statutory action is evident by examining the BFCA v EPA decision. The court ordered that "the Environment Protection Authority in accordance with s 9(1) (a) of the Protection of the Environment Administration Act 1991 (NSW) is to develop environmental quality objectives, guidelines and policies to ensure environment protection from climate change." Significantly for soil, in an analysis of the causes and consequences of climate change, and conclusion concerning the severity of the threat to the environment and people of NSW posed by climate change, these findings were not contested by the EPA. Moreover, the EPA and BSCA agreed on a statement of 46 facts regarding the causes and consequences of climate change.[64] Each agreed fact is synonymous with various climate change impacts and, as argued below, many of these impacts are synonymous with specific impacts on the soil environment.[65]

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[63] Various publications provide direction as to how these objectives can generally be met; Hannam and Boer (2002, 2004) and Boer and Hannam (2015).

[64] Bushfire Survivors for Climate Action Incorporated v Environment Protection Authority [2021] NSWLEC 92 (Preston CJ) the Court ordered on 26 August 2021, para. 76.

[65] The data matrix on specific impact on soil environment of each agreed fact is held by the author.

4.2 POEA Act 1991 and Soil

While the POEA Act 1991 does not explicitly refer to "soil", under the definition of "the environment," the following discussion argues that "soil" would fall within the meaning of "environment" under the Act. In NSW, "soil" generally falls within the jurisdiction of the Soil Conservation Act 1938 (SCA),[66] but it is argued that the definitions of "environment" and "environmental protection" under the POEA Act could be applied, more appropriately, to protect the soil environment of NSW from climate change. This interpretation is made in particular since the BSCA v EPA decision. This view is based on the fact that the SCA has remained relatively unchanged since its introduction in 1938 and does not feature the specific legal procedures to protect soil against such significant environmental issues of this era such as the effect on climate change from soil mismanagement and the role that soil should play in protection of the environment against climate change.[67] In this context, this chapter argues, on the basis of the objects of the POEA Act and the General Responsibilities of the Environment Protection Authority, that the POEA Act is the more appropriate legislation to establish the primary environmental quality objectives, guidelines and policies to ensure protection of the soil environment from climate change than the SCA.

It is argued that the broad scope of the objects of the POEA Act makes it more appropriate than the general provisions of the SCA to protect the soil environment of NSW. The objects of the POEA Act are:[68] (a) to constitute the Environment Protection Authority, (b) to provide integrated administration for environment protection, and (c) to require the Authority to perform particular tasks in relation to the quality of the environment, environmental audit and reports on the state of the environment. The EPA has a General Responsibility for:[69] (a) ensuring that the best practicable measures are taken for environment protection in accordance with the environment protection legislation and other legislation, (b) co-ordinating the activities of all public authorities in respect of those measures, (c) inquiring into and reporting on the efficacy of those measures, (d) reviewing the regulatory framework for environment protection and advising on its rationalisation and simplification, (e) investigating and reporting on alleged non-compliance with environment protection legislation for the purposes of prosecutions or other regulatory action, (f) establishing a database on the state of the environment, (g) advising persons engaged in industry and commerce and other members of the community on

[66] The long title of the Act is "An Act to make provision for the conservation of soil resources and farm water resources and for the mitigation of erosion".

[67] Hannam (1993) argues that the soil conservation policy and law for New South Wales is no longer adequate to manage the environmental issues that affect the ecological aspects of soil; see also Hannam and Boer (2004), p. 5, 1.2 "What is wrong with the national legislation in many jurisdictions?"

[68] Ibid. POEA Act 1991 s 4 (a)–(c).

[69] Ibid. POEA Act 1991 s 7 (2) (a)–(h).

environment protection, and (h) advising the Government on methods to ensure the integration of the Authority's pollution approvals and licensing processes with the development consent process so that the importance of environment protection is recognised.

4.3 Significant Principles from the BSCA v EPA Case

To properly establish the argument that "soil" falls within the purview of the POEA Act, in respect of climate change, firstly requires satisfaction that "soil" falls within the meaning of "environment" under the Act, and secondly that soil should be subject to "protection of the environment," from climate change.

4.3.1 Soil as a Component of "Environment"

With regard to being satisfied that "soil" is a component of the environment, under the POEA Act, this relies on at least three things: an understanding of the meaning of "environment": being satisfied that soil is a component of the meaning of "land" in the definition of environment; and being satisfied that "soil" should be protected within the meaning of the "protection of the environment."

4.3.2 Environment

In s 3(1) of the POEA Act "environment" means "components of the earth, including: (a) land, air and water, and (b) any layer of the atmosphere, and (c) any organic or inorganic matter and any living organism, and (d) human-made or modified structures and areas, and includes interacting natural ecosystems that include components referred to in paragraphs (a)–(c)." With this in light, referring back to the definition of "soil" earlier, where "soil has a fundamental role in the terrestrial ecosystem, as a three dimensional body performing a wide range of ecological functions,"[70] then this would satisfy that soil is a "component of the earth" and is an "interacting natural ecosystem[s]' under s 3(1)(d) of POEA Act.

4.3.3 Land

Although the definition of "environment" in the POEA Act does not specifically mention "soil", the reference to "land" in this definition would satisfy the definition of "land" in the UNCCD where it is taken to "include the terrestrial bio-productive

[70] Ibid. Sheals (1969).

system that comprises soil, vegetation, other biota, and the ecological and hydrological processes that operate within the system".[71] This definition supports the fact that "soil" has a fundamental role in the terrestrial ecosystem, performing a wide range of ecological functions.[72] The alteration of soil processes leads to changes in the function of ecosystems, and many environmental problems that become apparent in other media[73] originate from changes in the physical and chemical processes within soil as a direct result of external actions and disturbances such as, bushfires, bulldozing, over-grazing, and unsustainable cultivation practices, for example.

4.3.4 Environment Protection

Under the POEA Act, "environment protection" is defined as "anything which furthers the objectives of the Authority as set out in section 6," of the POEA Act , where s 6(1) specifies that "the objectives of the Authority are: (a) to protect, restore and enhance the quality of the environment in New South Wales, having regard to the need to maintain ecologically sustainable development, and (b) to reduce the risks to human health and prevent the degradation of the environment". Again, referring back to the definition of "soil", soil would be encapsulated both within s 6(1)(a) in regard to protecting, restoring and enhancing the quality of the environment, including the need to maintain ecologically sustainable development, and in s 6(1)(b) in regard to reducing the risks to health (e.g., a reduction in air quality by wind borne dust particles from degraded land), and preventing the degradation of the environment (e.g., soil erosion causing a loss of valuable top soil, and stream sedimentation from soil erosion).

4.3.5 Ecologically Sustainable Development

The concept of ecologically sustainable development (ESD) is critical for the protection of the soil environment.[74] Given that the definition of ESD encompasses

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[71] Definition of "land" in Article 1(e) of the UN Convention to Combat Desertification (1994).

[72] Ibid. Sheals (1969).

[73] E.g., POEA Act s 3(1)(a) air and water; (b) the atmosphere; (c) loss of soil organic matter, loss of nutrients for plants and micro-organisms.

[74] ESD is a long-standing and internationally recognised concept. The concept has been affirmed by the 2002 World Summit for Sustainable Development and has been included in over 60 pieces of NSW legislation. *Australia's National Strategy for Ecologically Sustainable Development (1992)* defines ecologically sustainable development as: 'using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased.' ESD is also defined in the *Protection of the Environment Administration Act 1991* (NSW) and s 3A of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) sets out the "Principles of ecologically sustainable development"; ESD is referred to in many other environmental laws in Australia.

"using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased,"[75] then the protection of soil is an essential activity for these conditions to be met. And further, as s 6(1)(a) of the POEA Act specifies, the objectives of the EPA are "to protect, restore and enhance the quality of the environment in New South Wales, having regard to the need to maintain ecologically sustainable development," then, under these circumstances, it would seem apparent that the EPA has a primary responsibility to protect the soil environment. The concept of ESD is defined under s 6(2), where, for the purposes of s 6(1), "ecologically sustainable development requires the effective integration of social, economic and environmental considerations in decision-making processes."

The POEA Act specifies that ESD can be achieved through the implementation of three important principles; (a) the precautionary principle;[76] (b) inter-generational equity;[77] and (c) conservation of biological diversity and ecological integrity.[78] In this context, the provision for an ecologically sustainable approach within legislation to protect the soil environment has been extensively argued for some time.[79] Boer and Hannam (2015) specify that in relation to the drafting of law and policy for soil " [I]in current debates, this involves a consideration of the 'environmental rule of law. This means developing robust legal mechanisms that enable an ecosystem-based approach to be applied in all aspects of soil protection. The ecosystem approach takes into account the relationship between soil bodies as living ecological communities and the broader environmental and landscape context. An effective environmental rule of law that promotes soil sustainability will therefore depend on the selection of appropriate ecological concepts and the development of a legal structure with the right elements to implement these concepts."[80]

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[75] *Australia's National Strategy for Ecologically Sustainable Development (1992).*

[76] POEA Act 1991 s 6 (2)—namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, public and private decisions should be guided by: (i) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and (ii) an assessment of the risk-weighted consequences of various options.

[77] POEA Act 1991 s 6 (2)—namely, that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.

[78] POEA Act 1991 s 6 (2)—namely, that conservation of biological diversity and ecological integrity should be a fundamental consideration.

[79] Hannam and Boer (2002), pp. 17–23; Hannam and Boer (2004), pp. 11–12; Boer and Hannam (2015), p. 6.

[80] Boer and Hannam (2015), p. 6.

4.4 Duty Under the Law

In BSCA v EPA it is emphasized that the nature and scope of the duty imposed on the EPA is by s 9(1)(a) of the POEA Act and the decision specified that any discretion to perform the duty, are to be construed by reference to both the context and purpose of s 9(1)(a). It was pointed out that where the Court is undertaking judicial review of administrative action, the task of statutory construction is "to ensure that those possessed of executive and administrative powers exercise them only in accordance with the laws which govern their exercise. The rule of law requires no less".[81] This section requires the EPA to perform two important tasks in relation to the quality of the environment: first, to develop certain instruments to ensure environment protection and, secondly, to monitor the state of the environment for the purpose of assessing trends and the achievement of the instruments it has developed.[82] Specifically, it provides that: "The Authority is required to: (a) develop environmental quality objectives, guidelines and policies to ensure environment protection,[83] and (b) monitor the state of the environment for the purpose of assessing trends and the achievement of environmental quality objectives, guidelines, policies and standards." The judge pointed out that what this implies is that the environmental quality objectives, guidelines and policies developed under s 9(1)(a) must be of a certain character and purpose, i.e., that of relating to "environmental quality". Section 9(2) requires the EPA to develop a comprehensive scheme of environmental audit with respect to industry, commerce and public authorities.[84]

On the basis that "soil" is a component of the "environment" under the POEA Act it logically follows that the EPA has a duty to prepare instruments for the protection of the soil environment in relation to climate change in NSW. The procedural rule here concerning national soil legislation in other countries of the world is to ensure that instruments are drafted in a manner that ensure the accountability of the responsible statutory authority.[85]

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[81] Ibid. [2021] NSWLEC 92 para 20.

[82] Ibid. [2021] NSWLEC 92 para 24.

[83] Ibid. [2021] NSWLEC 92 para 30 specifies that if an objective, a guideline or a policy are not specifically defined, then the ordinary meaning of those terms would apply.

[84] In BSCA v EPA, the rule was made clear in that the administrative function the subject of judicial review is a duty not a power and the focus of the review was on the performance or non-performance of the duty. What came into question were the action that the duty requires to be taken, and the legal effect that is given to that action by the statute. An administrative decision or action only has such force and effect as is given to it by the statute pursuant to which it was made or taken. The action taken in accordance with a statutory provision imposing a duty will have the legal effect given to that action by the statute. But action taken otherwise than in accordance with the statutory provision imposing the duty will not have legal effect or consequence under the statute.

[85] See Hannam and Boer (2004) Part IV, Elements for drafting national soil legislation.

4.5 The Character of Environment Quality

The BSCA v EPA case notes that the objectives, guidelines and policies developed under s 9(1)(a) must be of a certain character, that of relating to "environmental quality".[86] As noted, s 9(1) is the source of the requirement on the EPA to perform the particular tasks stated in the subsection "in relation to the quality of the environment", which is the third object of the POEA Act in s 4. Although the expressions, "environmental quality" or "the quality of the environment" are not defined in the POEA Act, the word "environment" has been defined. As discussed above, although the meaning of environment does not specifically mention "soil", the reference to "land" in s 3(1)(a) is taken to include the terrestrial bio-productive system that comprises soil, vegetation, other biota, and the ecological and hydrological processes that operate within the system.[87] This position is further reinforced in BSCA v EPA where it is stated that "environmental quality or the quality of the environment, therefore, refers to the quality of these components of the earth, including interacting natural ecosystems that include the components referred to in paragraphs (a) to (c) of s 3(1)."[88]

4.6 The Purpose to Ensure Environment Protection

The BSCA v EPA case specifies that a duty under s 9(1)(a) is to develop objectives, guidelines and policies not only of a particular character, being of "environmental quality", but also for a particular purpose, "to ensure environment protection". The decision points out that this phrase, "to ensure environment protection", is normative, in that it establishes an evaluative standard or norm for the objectives, guidelines and policies. There are two components: the action "to ensure", and the object of the action, which is "environment protection".[89] In this regard, the object of the action, "environment protection," is defined in s 3(1) of the POEA Act to include "anything which furthers the objectives of the Authority as set out in s 6 (the Objectives of the EPA)".[90] The first objective of the EPA, therefore, is for the EPA to "take action to protect, restore and enhance the quality of the environment in New South Wales in ways that are consistent with achieving and maintaining ecologically sustainable development". The second objective of the EPA in s 6(1) is "to reduce the risks to human health and prevent the degradation of the environment" by various means.[91]

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[86] Ibid. [2021] NSWLEC 92 para 35.

[87] Supra, definition of "land" in Article 1(e) of the Convention to Combat Desertification.

[88] Ibid. [2021] NSWLEC 92 para 36.

[89] Ibid. [2021] NSWLEC 92 para 38.

[90] Ibid. [2021] NSWLEC 92 para 40.

[91] Ibid. [2021] NSWLEC 92 para 42.

It is argued in this chapter that various aspects of the objective of the EPA in s 6(1)(b), in the context of climate change, are highly relevant to soil protection in NSW by: “adopting the principle of reducing to harmless levels the discharge into the air, water or land of substances likely to cause harm to the environment; adopting minimum environmental standards prescribed by complementary Commonwealth and State legislation and advising the Government to prescribe more stringent standards where appropriate; setting mandatory targets for environmental improvement; promoting community involvement in decisions about environmental matters; and conducting public education and awareness programs about environmental matters.”[92] Whilst these actions would clearly apply to protect “soil” in NSW, they are the types of rules that could apply when any jurisdiction is drafting soil legislation. However, meaning of such activities must be clearly expressed as well as the procedures for statutory authorities and in a manner such that can be successfully and practically applied.[93]

4.7 Discretion in Performing the Duty

There are two other points from BSCA v EPA relating to a duty to the protection of the NSW soil environment. The first point is that there is no discretion as to whether any environmental quality objectives, guidelines and policies to ensure environment protection need to be developed because there is a duty on the EPA to do so. The second point is that there is no discretion as to why environmental quality objectives, guidelines and policies need to be developed because the duty requires such instruments to be developed to ensure environment protection.[94] However, “there are controls on the discretion afforded to the EPA in its performance of the duty” and “[T]thus, a document that does not answer the statutory description of “objectives, guidelines and policies”, with the character of “environmental quality” and for the purpose “to ensure environment protection” will have no legal effect or consequence under s 9(1)(a).”[95] The second point is that “the objectives and functions of the EPA vest it with expert administrative competence in environment protection. Section 9 (1) seeks to employ this expert administrative competence by imposing on the EPA the duty to develop environmental quality objectives, guidelines and policies to ensure environment protection. This requirement for expert administrative competence is a positive control on the discretion to perform the duty in s 9(1)(a). The discernible legislative intention is that the discretion to perform the duty is less likely

[92] Ibid. [2021] NSWLEC 92 para 45.

[93] See Hannam and Boer (2004), Part IV, Elements for drafting national soil legislation.

[94] Ibid. [2021] NSWLEC 92 para 48.

[95] Ibid. [2021] NSWLEC 92 para 51.

to be abused if it is exercised by a public authority who has expertise in environment protection."[96]

4.8 Establishing Protection of the Soil Environment from Climate Change

A key aspect of the BSCA v EPA decision for protecting the soil environment from climate change is the discussion on the appropriateness of instruments to protect the environment and that the type of instruments required will vary over time. The duty under s 9(1)(a) to develop environmental quality objectives, guidelines and policies "to ensure environment protection" includes a duty to develop these instruments to ensure environment protection from climate change.[97] It was submitted by BSCA that "environment protection" necessarily includes protection of the environment in NSW from climate change. This follows from the meaning of "environment protection" in s 3(1) of the POEA Act. Actions to protect the environment in NSW from climate change meet the description of being anything which furthers the objectives of the EPA as set out in s 6(1). Such actions further the first objective "to protect, restore and enhance the quality of the environment in New South Wales, having regard to the need to maintain ecologically sustainable development". The environment is defined to include the "air" and "any layer of the atmosphere", both of which are adversely affected by climate change caused by the anthropogenic emissions of greenhouse gases.[98]

In this regard, the IPCC 2021 AR6 has clearly established that the emission of greenhouse gases is a grave threat to the atmosphere and climate systems.[99] In BSCA v EPA it is stated that "The atmosphere and climate systems interact with, support, and impact on other components of the earth and its natural ecosystems, including land, air and water; organic or inorganic matter and any living organism; and human-made or modified structures and areas. Protection of the environment against the threat of greenhouse gas emissions must entail mitigation of the sources of greenhouse gas emissions; adaptation to climate change is insufficient as it is not directed to protection of the atmosphere. Protection of the environment from climate change implements the principles of ecologically sustainable development, including the precautionary principle, intergenerational equity, conservation of biological

[96] Ibid. [2021] NSWLEC 92 para 53.

[97] Ibid. [2021] NSWLEC 92 para 60.

[98] Ibid. [2021] NSWLEC 92 para 61.

[99] Ibid. SPM-5, A1.1 "Observed increases in well-mixed greenhouse gas (GHG) concentrations since around 1750 are unequivocally caused by human activities. Since 2011 (measurements reported in AR5), concentrations have continued to increase in the atmosphere, reaching annual averages of 410 ppm for carbon dioxide (CO_2), 1866 ppb for methane (CH_4), and 332 ppb for nitrous oxide (N_2O) in 2019".

diversity and ecological integrity, and the polluter pays principle, thereby enabling the achievement and maintenance of ecologically sustainable development: *Gloucester Resources Ltd v Minister for Planning* (2019) 234 LGERA 257; [2019] NSWLEC 7 at [488], [498]."[100]

The role of up-to-date knowledge of climate threats in exercising a duty appear in the BSCA v EPA case where it is stated that actions to protect the environment from climate change also further the second objective of the EPA in s 6(1) "to reduce the risks to human health and prevent the degradation of the environment" by means such as those specified in s 6(1)(b).[101] In this regard, the judge opined that the threats to the environment, against which environmental quality objectives, guidelines and policies need to be developed to protect the environment, will change over time and place and in magnitude and impact. Under the circumstances, the environmental quality objectives, guidelines and policies to ensure environment protection will need to change in response to the threats to the environment that prevail and are pressing at the time.[102] What is required to perform the duty in s 9(1)(a), therefore, will vary over time and place in response to the changes in the threats to the environment. This may make it difficult to describe definitively what the duty requires at any particular time or place, because it requires identification of the current threats to the environment. It was stated that it should always be possible to identify the current threats that are of greater magnitude and greater impact. This means that, at a minimum, the duty under s 9(1)(a) will require progressive development of environmental quality objectives, guidelines and policies to ensure the protection of the soil environment from threats of greater magnitude and greater impact.[103]

The IPCC AR6 report is clear in its summation that, at the current time, the threat to the environment by climate change is of sufficient magnitude and impact that urgent protection is required. Thus, the duty in s 9(1)(a) to develop environmental quality objectives, guidelines and policies to ensure environment protection requires the development of such instruments to ensure environment protection from climate change.[104] In this regard, for Australia, a number of recent individual extreme events have been directly linked to climate change, including for example the 2019–2020 bushfires.[105] Further, a number of elements of "Unabated anthropogenic climate change" referred to in the BSCA v EPA case that are a useful framework in which to consider the climate change impacts resulting from soil mismanagement include:[106]

[100] Ibid. [2021] NSWLEC 92 para 61.

[101] Ibid. [2021] NSWLEC 92 para 62.

[102] Ibid. [2021] NSWLEC 92 para 66.

[103] Ibid. [2021] NSWLEC 92 para 68.

[104] Ibid. [2021] NSWLEC 92 para 69.

[105] See Pickrell (2021), pp. 1–13.

[106] From Summary in Sackett Fourth Report of 10 August 2021, as quoted in [2021] NSWLEC 92 para 75.

a) Fundamental - affecting basic aspects of the physical Earth system, and the ecosystems that depend on it,
b) Global - greenhouse gases emitted anywhere in the world affect the whole globe,
c) Comprehensively Dangerous - with the potential to disrupt/destroy every ecosystem,
d) Rapid - occurring at a speed that precludes many organisms and even whole ecosystems from adapting,
e) Inertial - with a delayed response to emissions that "locks in" some measure of climate change that is greater than that currently experienced,
f) Compounding - the effects of climate change can occur simultaneously, greatly increasing the negative consequences of extreme events,
g) Irreversible - feedbacks in the Earth System have the potential to irreversibly change ecosystems and processes in the Earth system.[107]

4.9 Climate Change Standards

4.9.1 Global Target

Based on the evidence in the statement of facts agreed between BSCA and EPA regarding the causes and consequences of climate change,[108] BSCA argued that it is the duty of the EPA to develop environmental quality objectives, guidelines and policies to ensure environment protection includes a duty to develop instruments to ensure the environment in NSW is protected from climate change, and that a target consistent with a global average temperature rise of 1.5 °C above pre-industrial levels is appropriate,[109] being the long-term temperature goal in the Paris Agreement.[110] Article 2(1)(a) of the Paris Agreement aims to strengthen the global response to the threat of climate change by "holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels". Limiting the increase in global average temperature to 1.5 °C will ensure environment protection to a greater degree than would be possible if the increase in global average temperature were to be higher.

Under the circumstances, the environmental quality objectives, guidelines and policies to ensure environment protection which the EPA is required to develop, need to regulate sources of direct and indirect greenhouse gas emissions consistent with limiting global temperature rise to 1.5 °C above pre-industrial levels.[111] BSCA argued that this outcome or objective is supported by the general responsibility of the EPA of "ensuring that the best practicable measures are taken for environment

[107] At [52] of the Sackett First Report and see further Section 6) as quoted in [2021] NSWLEC 92 para 75.

[108] Ibid. [2021] NSWLEC 92 para 76.

[109] Ibid. [2021] NSWLEC 92 para 77.

[110] Paris Agreement, opened for signature 22 April 2016 [2016] ATS 24 (entered into force 4 November 2016).

[111] Ibid. [2021] NSWLEC 92 para 90.

protection in accordance with the environment protection legislation and other legislation" (s 7(2)(a) of POEA Act). BSCA submitted that the best practicable measures to protect the environment in NSW from climate change is to reduce direct and indirect sources of greenhouse gas emissions consistent with limiting global temperature rise to 1.5 °C above pre-industrial levels.[112] This of course means that there will have to be significant changes to the management practices for the use of soil to substantially reduce the amount of CO_2 released from the soil environment.[113] It is argued here that this action should take place under the POEA Act.

4.9.2 Local Level Standards

Local action alone by the EPA in NSW will not fully address the problem. Its local action must be combined with multiple local actions elsewhere in order for climate change to be effectively addressed. Some of the local actions that should be taken include, for example, banning certain activities, licensing other activities, and using economic instruments or measures to incentivise or dis-incentivise other activities.[114] The judge characterised the aspect of environment protection in respect of which environmental quality objectives, guidelines and policies need to be developed as being simply "climate change", as this term is sufficiently wide to embrace the phenomenon itself, as well as its causes and consequences. The duty imposed on the EPA by s 9(1)(a) in the current circumstances would, therefore, include developing environmental quality objectives, guidelines and policies to ensure environment protection from climate change.[115] Collectively, this could include guidelines and policies to: achieve net-zero emissions; accounting for carbon credits and emissions; measures to remove CO_2 from the atmosphere and store it in vegetation or soil (if the carbon is stored permanently, this should generate a carbon credit for the landholder); provide long-term support for extension programs necessary to deploy new tools and practices; improve the long-term outlook for emissions reduction by supporting new technologies and opportunities; management controls over carbon farming and land clearing.[116]

4.9.3 Documents Must Meet the Standards Prescribed by the Law

In BSCA v EPA, the assessment of the seven documents relied on by the EPA found that none of them met the statutory description of the instruments that the EPA is

[112] Ibid. [2021] NSWLEC 92 para 91.

[113] See Hannam (forthcoming) Sustainable Soil Management and Soil Carbon Sequestration.

[114] Ibid. [2021] NSWLEC 92 para 95.

[115] Ibid. [2021] NSWLEC 92 para 101.

[116] E.g., see Wood et al. (2021) Section 3, pp. 21–30 "What governments should do to help reduce emissions".

required to develop under s 9(1)(a) of being environmental quality objectives, guidelines and policies to ensure environment protection from climate change. It found that to discharge the duty, the EPA must at least develop environmental quality objectives, guidelines and policies to ensure the protection of the environment from threats of great magnitude and impact, where climate change is one such threat to the environment. The development of environmental quality objectives, guidelines and policies directed towards ancillary or insignificant causes or consequences of climate change was determined by the court to be insufficient to discharge the duty in s 9(1)(a) of the POEA Act.[117]

5 Instruments to Protect the Soil Environment

Following the outcome of BSCA v EPA it is argued that, to ensure the protection of the soil environment from climate change, the EPA should now commence the preparation of a specific instrument to address the quality objectives, guidelines and policies. This decision, together with other recent climate change-related court decisions, brings to mind a range of legal and human issues related to climate change which should be taken into account when designing instruments to protect the soil environment, including:[118]

- Harm to the natural and ecological environment;
- Intergenerational-related harm to the children of the current generation by those making the decisions now that affect the climate in the longer term;
- Obligation of statutory authorities to invoke the duty that they have to climate management under respective statutes;
- Loss of productivity of soil and its effect on food production;
- Taking into account the latest scientific information in IPCC reports;
- The effect of climate change on food supply, the loss of territory and habitable areas, endangered health, and cost of human lives.

Based on the BSCA decision, some of the specific matters that should be addressed in instruments to protect soil from climate change include:[119]

- Describe what climate change is and the specific types of soil management practices that cause a loss of SOC and directly contribute to climate change.

[117] Ibid. [2021] NSWLEC 92 para 143.

[118] Ibid. Wood et al. (2021).

[119] Ibid. [2021] NSWLEC 92 paras 106–143; to discharge the duty in s 9(1)(a) of the POEA Act; see Ernst and Young (2021) figure at 6 “the deliberate and coordinated application of high-impact carbon abatement initiatives, we have modelled a pathway to mitigate on-farm emissions from Australian agriculture”.

- The specific land management actions that must be undertaken to reduce loss of SOC and other greenhouse gases from the soil environment to mitigate climate change.
- Set out the objectives and prescribe specific standards and actions to be undertaken to ensure the protection of the soil environment from climate change.
- Specify what approaches, tools or measures will be used to achieve any of the outcomes or objectives implicit in actions described in a regulatory instrument to protect the soil environment from climate change, and outline the criteria against which the outcomes or objectives must be measured.
- Identify the adaptation and mitigation measures to reduce greenhouse gas emissions to ensure protection of the soil environment from climate change.
- Develop environmental quality objectives, guidelines and policies to ensure the protection of the environment from threats of great magnitude and impacts that arise from climate change, e.g., bushfires, intense rainfall, heat stress, cold stress, drought.

6 Conclusions

The BSCA v EPA decision, which orders the NSW EPA to develop environmental quality objectives, guidelines and policies to ensure protection of the environment from climate change, by following its duties under the POEA Act, is a landmark decision in NSW, especially with regard to the level of seriousness that climate change impacts have reached for the NSW environment. This case, and others in Australian and overseas jurisdictions, indicate important progress in society's acceptance of the significance of climate change in the long term protection of the environment in general. This chapter argues that the BSCA v EPA case is particularly significant, however, because the definition of "environment" under the POEA Act clearly encompasses "soil".

The decision is important for a number of reasons. Firstly, given that "soil" is a component of the "environment" it should be protected from climate change under the POEA Act. Secondly, the decision includes many points of law, legal principles and rules that could be useful as a guiding framework to examine existing environmental laws for protection of the soil environment against climate change. While the main objective is to ensure that soil is protected from the impacts of climate change is also critical that "soil" is recognized as a carbon sink and must be protected for this reason. The manner in which soil is used contributes GHGs, and the EPA's policies should be specifically directed to these issues.

Moreover, and of great significance, is the fact that the BSCA v EPA case, and other cases discussed in this chapter, have relied on critical climate science from IPCC reports, and expertly show how it was critical to leading to the decisions in those cases. Most importantly for soil is the role that climate science should play in expert evidence in litigation where climate change is the legal challenge and the soil environment is threatened or harmed by the impacts of climate change. On the basis of the facts presented in BSCA v EPA in particular, and also in the other cases referred to earlier in this chapter, the IPCC data is likely to be incontrovertible and accepted by the courts as evidence of the risks and threat of climate change. The law is not static, and must evolve and adapt to the most authoritative climate science and soil scientific evidence available to protect the soil environment and to ensure that it is managed in the interests of reducing climate change. A further significant aspect of this case is that statutory nomenclature, such as "environment protection" and "environment," as used in the NSW POEA Act, and other key components of the legislation, such as the "objectives" and duties," must be interpreted according to contemporary ecological and legal standards. This means that climate change, as a threat and risk to the soil environment, is one of the matters in which environmental agencies must exercise their statutory duty adequately, by developing and implementing policies for protection of all elements of the environment from climate change. The global context of climate change and the relevant science is a material consideration when applying the public interest test enshrined in Australian environmental legislation and could equally be applicable in other nations. Respective points of law, legal principles and rules argued in the BSCA v EPA case may also be useful as a guiding framework to prepare new legislation in other parts of the world with the requisite procedures to develop environmental quality objectives, guidelines and policies to protect the soil environment from climate change.

Based on the incidence of climate litigation the past few years, it is likely that there will continue to be frequent legal challenges in Australian jurisdictions alleging failure by a decision-making authority to properly take climate change into account when approving a potential GHG-emitting project. Given these important developments, there is likely to be an increased sensitivity to, and awareness of, the materiality of climate change considerations by decision making authorities when making determinations. As a result, it is imperative that any application by a proponent for an approval, licence or funding linked to a GHG emitting project, properly address both the contributions to climate change that may be caused by the project and the impacts of climate on the natural environment, including the soil environment. This includes consideration of the longer term impacts of climate change. Cumulatively, these developments emphasise that the state of play surrounding climate change is rapidly shifting.

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Unsealing: Benefits, Potentials, Legal Provisions and Funding: The German Experience

Nadine Pannicke-Prochnow and Juliane Albrecht

Abstract Soil ecosystem services are unavailable or very limited in urban areas with a high degree of soil sealing, thereby undermining the long-term quality of life of local residents at a time of climate change. To counter this, unsealing measures can contribute to soil protection and the provision of ecosystem services and thus to climate adaptation. In addition, unsealing measures are essential to compensate for new soil sealing and to ensure land degradation neutrality (SDG 15.3). However, the benefits of unsealing are undermined by the low availability of potential sites for unsealing and a number of obstacles to implementation.

In Germany, various legal instruments are available to activate unsealing potentials. Relevant regulations may be found in the fields of building and soil law as well as in water, nature protection and planning law. In practice, however, such regulations are limited in their impact. The paper shows how to better exploit unsealing potentials by a more consistent application of regulatory and planning legislation by authorities and legal revisions on the part of the legislator.

1 Introduction

To ensure sustainable development, it is essential to preserve natural soils and their ecosystem functions. Soils are key prerequisite for, among others, food and drinking water supply, but also assist in climate protection and the maintenance of biodiversity. In a nutshell: soils are crucial for the continued health and well-being of humankind. For instance, soils contribute to the infiltration and retention of

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rainwater, provide water to plants and facilitate evapotranspiration, which greatly helps to cool down the air and to improve the microclimate, especially in urban areas.

In the wake of urbanization, soil ecosystem services are destroyed or curtailed by soil sealing. Clearly, the unsealing of soils can greatly pave the way for the restoration natural soil functions and their associated ecosystem services. In this way, unsealed sites can help meet the goals of climate adaptation, particularly regarding water, soil and nature protection but also in safeguarding human health, for instance by reducing heat stress in cities or supporting flood prevention. Vegetation-covered restored soils may also contribute to climate protection by fixing carbon dioxide within plants and supporting the formation of soil organic matter (provided that there is adequate soil and plant management).

There is no doubt that soil unsealing can make an important contribution to the overarching goals of sustainable development such as land degradation neutrality (Sustainable Development Goal (SDG) 15.3[1]) as well as the reactivation of ecosystem services to support climate adaptation and protection. Consequently, it is vital to implement measures for soil unsealing in order to restore soil functions and ensure better adaptation to the impacts of climate change. Hitherto, however, existing unsealing potentials have been insufficiently exploited to realize the mentioned goals.

In this article, we provide an overview of Germany's experiences in soil unsealing. In Sect. 2 we present some definitions and goals for unsealing before outlining the benefits of unsealing (Sect. 3) and current potentials in Germany (Sect. 4). Then we discuss legal provisions for unsealing under German law (Sect. 5) and conclude with some key messages (Sect. 6).

2 Definitions and Goals of Unsealing

In this section, we define some important concepts around unsealing and outline its objectives.

2.1 *Definitions*

Soil is considered *sealed* if covered with impermeable layers such as asphalt, concrete, paving or buildings or if heavily compacted.[2] All (fully or partially) sealed areas with reduced or lost natural soil functions due to sealing are considered to be sites with *unsealing potential*. This includes plots which have been out of use for a

[1] UN General Assembly (2015).

[2] Blume et al. (2011).

longer period of time and/or will stay out of use in the foreseeable future, or plots whose current use can continue after a (partial) unsealing has taken place.

A *complete unsealing* of an area occurs when the physical barrier/covering layers, foreign materials and resulting soil compaction are completely removed and replaced by a soil type typical for the area with the aim of restoring as many of the natural soil functions as possible and/or creating a soil layer which can be inhabited by the root systems of vegetation. *Partial unsealing* refers to the incomplete removal of the profile layers of a sealed surface. Partial unsealing can take the form of:

1. unsealing of parts of a site,
2. changes in the artificial covering layer, or
3. functional unsealing (decoupling rainwater runoff from the sewer system).

After a partial unsealing measure, a considerable proportion of the original sealing material, substructure and/or anthropogenic influence remains present in the soil, thereby hindering the full restoration of all natural soil functions. However, a series of many small-sized partial unsealing measures located nearby, e.g. in backyards, may (especially in densely populated residential areas) also noticeably improve the local hydrologic balance or reduce heat stress. Partial unsealing is often more compatible when a site is subject to multiple forms of use, e.g. for walking or car parking. Of course, due to the specific features of each site (e.g. its slope, primary use or other practical issues), not every artificial covering is suitable to replace the original sealing layer. The decoupling of rainwater runoff from the sewer system may be realised, for instance, by storing the rainwater in an infiltration trench or pond. In general, *partial unsealing* aims to mitigate the impact of soil sealing, whereas *complete unsealing* provides compensation opportunities for new soil sealing undertaken elsewhere.[3]

2.2 Goals of Unsealing

While not an end in itself, unsealing helps smooth the way towards achieving the following three goals for sustainable development:

1. *Restoration of soil functions and enhancement of ecosystem services*: After unsealing, the uncovered soils can be reactivated and physical, chemical and/or biological functionality of the soils may be restored. This may enhance the supply of ecosystem services. If appropriate soil and plant management is ensured, the resulting carbon dioxide fixation by vegetation and the formation of soil organic matter can also assist in meeting climate protection goals.
2. *Climate adaptation:* The restored ecosystem services following unsealing may contribute to climate adaptation goals, particularly those related to health, water,

[3] Cf. Science for Environment Policy (2016).

soil and nature protection, provided that an appropriate concept for the usage of the unsealed area is implemented, for instance as a tiny forest,[4] a pocket park[5] or a retention area.[6]

3. *Land degradation neutrality (SDG 15.3):* As soil sealing is the most common cause of land degradation in Germany,[7] soil sealing may be reduced or even halted at a certain level in order to maintain or improve the quantity and quality of land resources as a precondition for sustainable development,[8] for instance to maintain food security (SDG 2) or the supply of clean drinking water (SDG 6). Alongside measures to avoid and reduce new land degradation, the goal of land degradation neutrality also demands that degraded soils be restored (for instance in the wake of unsealing).[9] Unsealing of soils may serve as compensatory measures for newly sealed areas.

3 Benefits of Unsealing

The benefits of unsealing measures comprise the improved provision of ecosystem services and the resulting contributions to climate adaptation and sustainable urban development.

3.1 Provision of Ecosystem Services

After soil sealing, no interaction can take place between the pedosphere and the atmosphere or biosphere (which equates to the ecosphere), thereby greatly inhibiting exchange processes such as infiltration and evaporation, gas exchange and biotic processes. In this way, the natural soil functions as defined in Section 2 para. 2 no. 1 of the German Soil Protection Act (BBodSchG 1998) are impaired.

Soil sealing may result in the removal of humus and an input of translocated substrates, soil compaction and changes to the soil profile and land relief. Such impacts can also affect the soil functionality *after* unsealing and restoration, as they are only partly reversible. For this reason, it is essential to prevent the sealing of pristine, well-functioning soils. Although unsealing and recultivation measures are expensive, associated with high opportunity costs and may not completely restore

[4] Steingässer and Scharfe (2020).

[5] Bruce (2017).

[6] NWRM (2015).

[7] German Federal Environment Agency (2018).

[8] Cf. German Federal Environment Agency (2020a).

[9] Cowie et al. (2018).

soil functionality, they nonetheless contribute to the provision of relevant ecosystem services, especially in urban areas with limited supply of ecosystem services.

Regarding restoration measures, the reestablishment of *physical soil functions* such as infiltration and storage of rainwater, groundwater recharge and evapotranspiration requires the least effort. The reactivation of these processes may positively impact the local hydrological balance, leading to higher soil moistures and evaporation from soils, which also bring some cooling and positive microclimatic effects. By contrast, much more effort is required to restore the *chemical soil functions* such as nutrient transformation and storage processes as well as the *biological soil functions* such as decomposition of mulch, soil respiration and mineralisation caused by the biocoenosis of the soil. Yet, chemical and biological soil functions enable long-term stable and self-sustaining habitats, e.g. city forests. In general, the climate protection function of soils arises through the interplay of biological and chemical soil functions, whereby biomass is decayed and fixed in the soil as organic matter and humus.

3.2 Contribution to Climate Adaptation

Clearly, the impacts of climate change such as higher risks of flooding and heat stress are intensified in sealed areas. Soil unsealing can usefully restore ecosystem services and thereby contribute to climate adaptation, e.g. by increasing evaporative cooling (for an overview see Fig. 1). Central to the climate adaptation goals mentioned in this article are the rainwater retention function of soils and groundwater recharge. In many cases, synergy effects can be exploited to achieve different climate adaptation goals.[10] For example, a water-sensitive urban development can recharge groundwater through rainwater infiltration and retention while at the same time reducing both, surface runoff and the likelihood of drought *(water protection-related climate adaptation goals)*. Cooling via evapotranspiration may reduce the intensity of the urban heat island effect, the number of tropical nights and/or the annual hours of heat stress[11] (*health protection-related climate adaptation goals).* Furthermore, a smart design and management of neighbourhoods to ensure a greater volume of urban vegetation can improve both, the attractiveness of the residential environment and the well-being of local people.[12] Simultaneously, the provision of habitats for flora and fauna will improve biodiversity and contribute to the achievement of *nature protection-related climate adaptation goals*. Additionally, greater rainwater infiltration may reduce surface runoff peaks and thus, may reduce the risk of erosion in adjacent areas *(soil protection-related climate adaptation goals).*

[10] Cf. German Federal Environment Agency (2020b).

[11] Cf. e.g. Sieker et al. (2019).

[12] Cf. e.g. Matzinger et al. (2017) and German Federal Environment Agency (2020b).

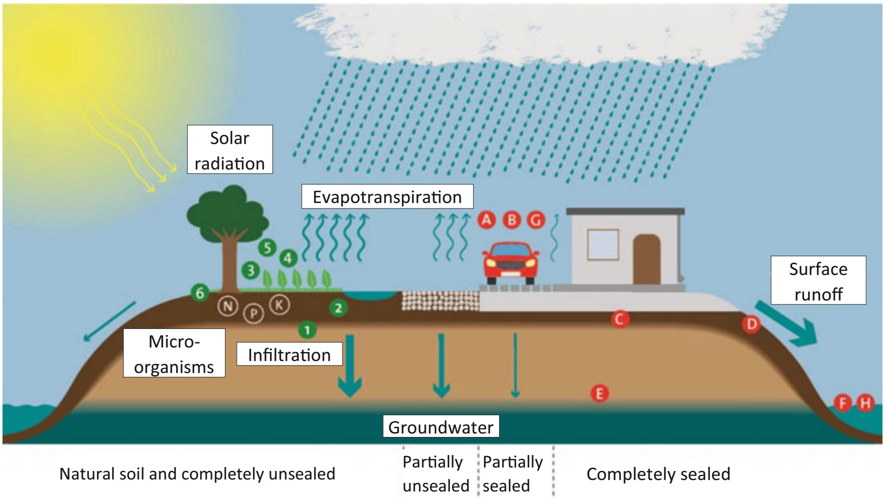

Fig. 1 Intensification of climate change impacts in sealed areas (A–H) and potential contributions of soil functions in unsealed and natural soils to climate adaptation (1–6). (A) heat stress, (B) changes in biodiversity, (C) changes in soil development, (D) erosion, (E) changes in groundwater level, (F) low surface water levels, (G) soil drought and low air humidity, (H) floods; (1) rainwater infiltration, (2) rainwater retention and reduction of surface runoff, (3) evaporative cooling, (4) fresh air production from green open areas, (5) shade from trees and shrubs, (6) increased biodiversity and plant productivity (Own illustration based on Pannicke-Prochnow et al. (2021), p. 85)

Regarding the water protection-related climate adaptation goals, partial and complete unsealing measures may contribute significantly to the realisation of Sustainable Urban Drainage Systems (SUDS) such as in Shanghai, China,[13] Water Sensitive Urban Designs (WSUDs) such as in Australia[14] and Great Britain[15] or "Schwammstadt" ("sponge city") concepts found in Germany.[16] These climate adaptation concepts make use of many scattered, spatially distributed, larger and smaller measures combined with a certain flexibility in application and the exploitation of synergy effects. Unsealing measures and the restoration of soil functions (in connection with appropriate land use concepts) are particularly suited to accomplish climate adaptation goals as they provide a number of synergies and are widely applicable despite the huge range of differences, opportunities and priorities between sites.[17]

[13] Roxburgh (2017).

[14] Wong (2006) and Barton and Argue (2007).

[15] Ashley et al. (2013).

[16] See e.g. Fenner (2018) and Sieker et al. (2019).

[17] German Federal Government (2008), p. 14.

3.3 Contribution to Sustainable Urban Development

Unsealing measures in urban areas may provide additional co-benefits for other municipal development goals, such as increasing the extent of green spaces for recreation, leisure, sports and social interaction, thereby improving the quality of local recreation and the resilience of urban residents by reducing their social and psychological stress.[18] Especially in structurally disadvantaged areas, the creation of open areas as meeting points, playgrounds and sports fields may be key measures for upvaluation.[19] The motivation of local residents to use these areas is largely determined by spatial proximity.[20] The lockdowns imposed in 2020 and 2021 by the coronavirus pandemic highlighted the importance of green and open space provision within each neighbourhood, and was a timely reminder to municipalities of their responsibility to provide such spaces to ensure a good quality of life.

Furthermore, unsealed and renaturated areas may improve the general health and well-being of urban residents by boosting the formation and supply of fresh air, enhancing the local bioclimate (which can reduce the likelihood of stress-related health problems such as heart attacks) and reducing particulate matter in the air.[21] Furthermore, protective measures on unsealed areas, for instance against flooding, may be supported by the retention of rainwater in the restored soil. This helps lower the risks to public safety as well as potential costs for repairing damaged buildings and infrastructure. In addition, concepts for the multifunctional usage of sites may provide benefits for a range of actors. For instance, a park or city forest can be used for recreation, as a retreat or for nature observation or for sports; a short-rotation coppice may link regional value creation to open space design, noise protection, nature and soil protection; an urban garden may serve as a meeting and educational point as well as a source of regional food.

The challenge for sustainable urban development is to maintain a balance between re-densification and the preservation of a sufficient supply of attractive green and open spaces. An important prerequisite for the future viability of settlement and living areas is to ensure a good quality of life within a comparatively cost-efficient climate adaptation path.

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[18] Cf. German Federal Ministry for the Environment, Nature Conservation, Housing and Nuclear Safety (2015).

[19] City of Leipzig (2015).

[20] Palliwoda et al. (2020).

[21] Cf. e.g. Watson et al. (2020) and IÖR (2020).

4 Potentials for Unsealing in Germany

Generally speaking, the availability of unsealing potentials in Germany is mainly limited by technical, economic and political factors creating different *levels* of unsealing potential. Specifically, we can say that: (1) The *theoretical potential* for unsealing comprises all those areas which are not going to be used in the foreseeable future or where changes in use enable a partial or complete unsealing. (2) This potential is decreased to a *technically feasible potential* determined by the current technical options for soil unsealing and restoration, also taking into account possible restrictions due to contamination or architectural features, etc. (3) This is further decreased to an *economically feasible potential* determined by the costs of unsealing and restoration measures while considering all the available implementation and usage options as well as realisation, follow-up and opportunity costs. (4) Finally, this potential may be reduced to a *politically feasible potential* in consideration of the political and social (majority) consent needed to approve unsealing measures, especially against the background of conflicting urban development goals, e.g. more housing vs. open green spaces for maintaining quality of life. This aspect is particularly challenging due to high opportunity costs for municipal authorities facing low municipal budgets.

Economic and political feasibility are the two main obstacles to the implementation of unsealing measures. Typical problems arising in this regard are limited financial capacities, inappropriate legal guidelines on the obligations of municipalities and private landowners, conflicts in land use, a lack of political majorities and poor awareness of the contributions that unsealing can make to climate adaptation and other municipal development goals. And, of course, political decisions may significantly alter the economic, financial and capacity-related framework conditions.

In Germany, the theoretical supply of potential unsealing sites is rather limited and unevenly distributed geographically. A theoretical renaturation potential exists for approximately 1% of the area for buildings and their associated open spaces, even though only about half of this area is actually sealed. A further 1% of the area for buildings and their associated open spaces is considered as building land for short-term use and another 3–5% as reserve sites for inner development.[22] Additional unsealing potentials may be available in the form of small-scale sites in residential areas for partial unsealing measures as well as in traffic areas, especially in car parking spaces, for partial and complete unsealing measures. These potentials may rise in future years due to shifting patterns of mobility.

[22] Pannicke-Prochnow et al. (2021), p. 122.

5 Legal Provisions for Unsealing

Germany's body of environmental and planning law provides several mechanisms that require or at least promote the unsealing of soil. In the following, we analyse these instruments with regard to their prerequisites, substantive scope and significance in practical enforcement before making some practical proposals for refining the legal framework. The results draw on an analysis of relevant literature and case law as well as interviews with experts.

5.1 Unsealing Obligations in Building and Soil Protection Law

The obligation to implement unsealing measures is primarily regulated by Section 179 of the Federal Building Code (BauGB 2017) and Section 5 of the Federal Soil Protection Act (BBodSchG 1998). However, these are rarely if ever applied in practice.

5.1.1 Section 179 BauGB

Section 179 para. 1 BauGB stipulates that, under certain conditions, a municipality can oblige a property owner to tolerate the complete or partial removal of a building. Such work will often necessitate soil unsealing. Para. 1 distinguishes between three circumstances that trigger such an obligation to tolerate: firstly, if the building is in conflict with the designations of the so-called "binding land-use plan" (sent. 1 no. 1); secondly, if the building displays irremediable defects and deficiencies that cannot be rectified (sent. 1 no. 2); and thirdly, if the goal is to rehabilitate a permanently unused area (sent. 2). As in the case of sentence 1 no. 1 (and unlike no. 2), the third variant requires that the building conflicts with the designations of the development plan. This is an "ecological variant" of the demolition requirement under sent. 1 no. 1, which is intended to emphasise the special importance of environmental context.[23]

In practice, the demolition and unsealing requirements of Section 179 BauGB are rarely applied.[24] The few examples that we could identify relate exclusively to cases under Section 179 para. 1 no. 2, i.e. demolition in the case of unsatisfactory urban conditions and defects. The patchy application of these legal instruments can be attributed to a lack of experience on the part of the authorities as well as a reluctance to engage in legal dispute and possibly face litigation. And, of course, the municipality has to bear the costs of unsealing; the owner is only required to "tolerate" the

[23] Stock (2014), § 179 Rn. 35.

[24] Detailed Pannicke-Prochnow et al. (2021), pp. 172 ff. with further references.

measure.[25] The only cases where Section 179 para. 1 no. 2 BauGB has been applied to demolish dilapidated buildings and unseal areas are when municipalities could use earmarked budgets to this end.

5.1.2 Section 5 BBodSchG

Section 5 BBodSchG is a further legal instrument that can be used to unseal soil. This, however, may only be applied subsidiarily to building law (Section 3 para. 1 no. 9 BBodSchG). Section 5 sentence 1 BBodSchG authorises the federal government to adopt a legal ordinance obliging the landowner to unseal soil under certain conditions. In such cases, the land must be permanently unused and its sealing must conflict with planning regulations. The obligation relates to restoring the functional capacity of the soil as far as is reasonable and possible. In the absence of an ordinance under Section 5 sentence 1, the competent authority may also issue an individual unsealing order against the owner based on section 5 sentence 2, provided that the requirements of sentence 1 are met.

In contrast to Section 179 BauGB, which has been applied in several cases, Section 5 BBodSchG has never been enforced.[26] The federal government has neither issued an ordinance on unsealing pursuant to sentence 1 nor have the soil protection authorities ever made use of the individual authorisation in sentence 2, although some efforts have been undertaken in the past to make the regulation easier to enforce. For example, within the framework of a research project commissioned by the Federal Environment Agency, an unsealing ordinance was drafted in accordance with Section 5 BBodSchG, the feasibility of which was tested in a simulation game in 2005.[27] However, the simulation game proved rather unproductive as the participants were generally critical of the regulatory approach of Section 5 BBodSchG.[28]

This criticism included the lack of prerequisites under planning law, the expense of large-scale sealing in outdoor areas, a lack of obligations to cooperate, weak official powers of investigation as well as poor financial incentives for unsealing. All of these factors are needed to ensure a certain willingness to cooperate and thus help enforce the ordinance.[29] The subsidiarity of the regulation vis-à-vis building law and its interpretation also adds to the confusion. Moreover, the relevant authorities have not yet developed any practical system for the regulatory enforcement of unsealing.

[25] Pannicke-Prochnow et al. (2021), p. 173.

[26] Pannicke-Prochnow et al. (2021), p. 217.

[27] Willand/Kanngießer (2005).

[28] Willand/Kanngießer (2005), p. 32.

[29] Willand/Kanngießer (2005), p. 33.

5.1.3 Proposed Amendments

The analysis of Section 179 BauGB and Section 5 BBodSchG shows that their areas of application must be clearly demarcated. In this regard, we propose that Section 179 BauGB should apply to sealing in inner settlement areas (i.e. the responsibility of the municipality) and Section 5 BBodSchG should apply to sealing in outlying areas (i.e. the responsibility of the soil protection authority).[30]

Further, the scope of Section 179 BauGB should be extended to the *entire* inner area of a municipality to increase the effectiveness of the regulation. In addition, municipalities should be *generally* authorised to order unsealing measures to restore natural soil functions, not just when a building conflicts with a development plan or in the case of unsatisfactory conditions and deficiencies. In addition, the owner's duty to "tolerate" unsealing measures by the municipality (cf. Section 179 BauGB) should be converted into an active duty to act.[31] It is difficult to justify the current unequal treatment of property owners depending on whether they are obliged to unseal under building law (Section 179 BauGB) or under soil protection law (Section 5 BBodSchG).

In addition, we recommend that Section 5 BBodSchG be simplified: not only should the general primacy of building law be dropped, but also the requirement that the Federal Government be the relevant authority to issue an unsealing ordinance.[32] Instead, the regulation should be formulated in such a way that it can be enforced on its own. The requirement of contradiction with planning regulations (cf. Section 5 BBodSchG) also does not appear necessary, as the norm could be undermined in the absence of concrete plans. Finally, the proportionality of the official order to unseal should be specified by a provision on the bearing of costs.

With regard to both Section 179 BauGB and Section 5 BBodSchG, we recommend that public bodies be made more responsible for unsealing measures. In this respect, regulations should require that disused, publicly-owned structural facilities should in general be unsealed.[33] For example, Section 179 BauGB could include an obligation for municipalities to set a good example in the unsealing of public spaces, properties and municipal (transport) infrastructure that are no longer needed.

However, the further development of the legal basis *alone* is unlikely to be sufficient to ensure the enforcement of unsealing orders. For the implementation of Section 179 BauGB and Section 5 BBodSchG, it is vital that concrete responsibilities be designated within the authorities and that municipal employees be supported at the working level by formulating procedural standards for the application of regulations. This can be done, for example, through further training, the provision

[30] Pannicke-Prochnow et al. (2021), pp. 221 f.

[31] Pannicke-Prochnow et al. (2021), p. 222.

[32] Pannicke-Prochnow et al. (2021), p. 223.

[33] Pannicke-Prochnow et al. (2021), p. 224.

of working aids, sample certificates, flow charts and standard procedures as well as internal and inter-communal exchange of experience.[34]

At the same time, the obligations to unseal should be supplemented with advice for property owners and the provision of subsidies. Interviews with practitioners have confirmed that financial incentives are the strongest driver for politically desired changes.[35] Section 175 BauGB explicitly provides for consultation and the consideration of grants from public funds when issuing urban development orders. Financial support from the public purse may also be needed to ensure the proportionality of the measure while respecting the property rights of the owners.

5.2 Unsealing Obligations in the Undesignated Outlying Area

Section 35 para. 5 sentence 2 BauGB stipulates a special deconstruction (unsealing) obligation for facilities in the undesignated outlying area after permanent abandonment of the permissible use. These are, for example, buildings (and sealing) for market gardens, for the public supply of electricity, gas, telecommunications, heat and water, and for the use of wind and water energy (e.g. wind farms) or biogas plants.

The expert interviews conducted for the study showed that this legal provision is indeed applied and considered effective: the obligation is stipulated in connection with the granting of the building permit and thus can be secured.[36] However, physical structures in the undesignated outlying areas are exempt from the obligation to deconstruct if they serve some agricultural or forestry activity and only occupy a minor proportion of the total plot (Section 35 para. 1 no. 1 BauGB). This exemption should be removed, as there is in fact no real justification for it.

5.3 Urban Redevelopment and Urban Restructuring

Urban redevelopment measures (Sections 136 ff. BauGB) and urban restructuring measures (Sections 171 ff. BauGB) are area-based instruments that initiate unsealing measures in built-up neighbourhoods.

[34] Pannicke-Prochnow et al. (2021), p. 224.

[35] Pannicke-Prochnow et al. (2021), p. 172.

[36] Pannicke-Prochnow et al., Entsiegelungspotenziale, p. 199 m.w.N.

5.3.1 Urban Redevelopment

Urban redevelopment aims to substantially improve or redesign an area that shows some deficit. Such measures must be initiated by a public authority. Sections 136 ff. BauGB provides a suitable framework for this.

An area can be formally designated as a redevelopment area if the results of preparatory investigations by the municipality reveal urban deficits (Section 142 para. 1 BauGB). Such deficits are when the area does not meet the basic requirements for healthy living and working conditions or for general safety. This can also explicitly be the case with regard to climate-related concerns (i.e. climate protection and adaptation, Section 136 para. 2 no. 1 BauGB).

Section 147 BauGB lists the redevelopment measures that the municipality must implement to comply with the redevelopment statutes. These include unsealing activities such as the complete or partial removal of structures, the clearing of fill or road surfaces, the clearing of storage areas, the removal of soil sealing and the removal of contamination.[37] Urban redevelopment is normally associated with rather small-scale measures such as the unsealing of backyards.

5.3.2 Urban Restructuring

In contrast to urban redevelopment, urban restructuring (Section 171a BauGB) is an instrument for conceptualising and implementing large-scale unsealing measures. It serves to create sustainable urban structures where there is a considerable loss of urban function. The latter is particularly the case if there is a current or projected long-term oversupply of buildings for certain uses, namely for residential purposes. In practice, urban redevelopment is usually associated with the demolition of prefabricated buildings to eliminate vacant housing, the removal of industrial wastelands or former barracks.[38]

One acute reason for urban restructuring is when entire residential neighbourhoods or housing estates have become vacant. However, this is not only about the demolition of individual buildings, but also an area-related conceptual development that should take into account the needs of the residents as well as urban development concerns, including environmental protection and climate adaptation, in a sustainable manner.[39] The basis for restructuring activities is an urban development concept drawn up by the municipality. Basically, we can say that the regulations on urban restructuring offer considerable potential for implementing unsealing measures.

[37] Stemmler (2010), § 147, Rn. 9.

[38] Pannicke-Prochnow et al. (2021), p. 183.

[39] Reidt (2019), § 171a Rn 10.

5.3.3 Implementation and Realisation in Practice

In order to implement the planned urban redevelopment and urban restructuring measures, the municipality can negotiate mutually agreeable arrangements and sign contracts with the property owners concerned (Section 146 para. 3 and Section 171c BauGB). If amicable solutions cannot be found, the municipality can resort to urban development regulations (cf. Section 175 ff. BauGB). In particular, the owner can be obliged to tolerate the removal of a building by means of a demolition order pursuant to Section 179 BauGB.[40] However, the removal of structures can also take place after acquisition or expropriation by the municipality. In practice, financial incentives are mainly provided in the form of urban development grants (cf. Section 164a, 164b BauGB).

From the numerous good examples of urban redevelopment and restructuring cited by the interviewed experts, it can be concluded that these legal instruments function well.[41] In general, it can be stated that even in urban redevelopment areas, no demolition orders are issued in accordance with Section 179 BauGB; instead, unsealing measures are taken voluntarily on the basis of discussions and consultations with the owners, often in combination with financial incentives. If the funding agency requires the municipality to issue a demolition order in accordance with Section 179 BauGB as a prerequisite for funding, the deconstruction order is issued *pro forma*.[42]

5.4 *Urban Land Use Planning*

Unsealing measures can be conceptually prepared by means of urban land use planning. This is the case when existing urban districts are being redesignated. Thus, in addition to areas for building development, areas for unsealing and renaturation can be provided for in the urban land use plans (cf. Sections 5 and 9 BauGB). In principle, the redesignation of land can even be carried out with the exclusive objective of improving the environmental situation in the planning area.[43] This is guided by the requirements formulated in Section 1 and 1a BauGB, which include soil protection and climate adaptation.

However, the protection of existing buildings under building law sets limits to redesignation. For example, the designation of green spaces cannot interfere with existing buildings. If existing buildings are to be demolished, e.g. in order to secure areas needed for the establishment of a public green space by the municipality, this would only be possible by way of expropriation (cf. Section 85 BauGB). However,

[40] See Sect. 5.1 above.

[41] Pannicke-Prochnow et al. (2021), pp. 181, 183.

[42] Pannicke-Prochnow et al. (2021), p. 181.

[43] Köck, Fischer, DVBl. 2016, 1300.

expropriation is a measure of last resort, for which owners have to be compensated.[44]

Inner-city brownfield sites represent an important potential for unsealing. Generally, such brownfield sites should not be designated in development plans solely for the construction of buildings but also for the creation of open spaces and green areas close to residential areas. This idea is expressed in the guiding principle of "double inner development".[45] The planning principle of inner urban development designated in the Federal Building Code (cf. Section 1, 1a and 176a BauGB) should be understood in this dual sense.

5.5 *Building Regulations of the States*

The building laws of the federal states (*Länder*) can also mandate unsealing measures.

5.5.1 Removal Orders for Reasons of Illegality, Hazard Prevention or Forfeiture

The building laws include the obligation to remove buildings which are illegally constructed (e.g. Section 80 Saxon Building Code – SächsBO 2016). Such demolition orders are the last resort against unauthorised physical structures that are formally and materially in breach of building law.[46]

On the basis of hazard prevention, deconstruction orders can also be issued to avert dangers emanating from dilapidated properties.[47] It should be borne in mind, however, that any danger to life and limb is likely to be eliminated if a structure has been physically secured or demolished down to the height of the foundation walls. Generally, therefore, complete unsealing with restoration of the soil functions is not required from the perspective of hazard prevention.

Some building laws also permit a demolition order if a legally erected building that is no longer in use begins to deteriorate (without already being in danger of collapsing) and no interest can be claimed in maintaining the building (cf. Section 80 para. 2 Brandenburg Building Code (BbgBO 2018) and Section 79 para. 2 Bremen Building Code – BremLBO 2018). As part of the demolition, structural foundations that significantly restrict water permeability of the soil must be removed (Section 82 i.V.m. Section 10 Abs. 4 Rhineland-Palatinate Building Code – LBauO RP 1998). Ideally, such regulations should also be introduced to other federal states.

[44] Pannicke-Prochnow et al. (2021), p. 190.

[45] Kühnau et al. (2016).

[46] Pannicke-Prochnow et al. (2021), p. 200.

[47] Schäfer et al. (2009), p. 37.

5.5.2 Greening and Water Infiltration Requirements: In Particular the Prohibition of Gravel Gardens

The requirement to unseal land can also result from greening regulations for unbuilt property areas anchored in the state building codes[48] or independent greening laws.[49] Usually these also stipulate that the water infiltration capacity of sites be untouched or restored. Compliance with these regulations is supposed to be monitored. In the event of non-compliance, the building supervisory authorities must work to ensure that the sealing is removed and the green space (re-)restored. These regulations, however, are not consistently enforced.

A special problem are so-called gravel gardens, which conflict with the goals of soil protection and climate adaptation.[50] Nevertheless, such garden designs are becoming increasingly popular and often tolerated by the authorities. The newly introduced Section 21a in the amended Baden-Württemberg Nature Conservation Act (NatSchG BW ÄndG 2020) stipulates that such gardens violate the greening requirement under building law. This makes it easier for the authorities to issue a removal order due to the illegality of the project.[51] Whether this results in an obligation to remove existing gravel gardens is, however, questionable and requires further legal clarification.[52]

5.6 *Impact Mitigation Regulation*

In practice, most unsealing measures are implemented on the basis of the so-called "impact mitigation regulation" (cf. Sections 13 ff. Federal Nature Conservation Act – BNatSchG 2009). This stipulates that interventions in nature and the landscape (and thus also the use of soils) must be compensated. This can be achieved through various measures such as tree planting, the creation of biotopes or soil unsealing. Unsealing measures are considered "classic" compensatory measures: these restore the functional capacity of the soil, enable the creation of new habitats for plants and animals or natural succession and, if necessary, can help eliminate existing damage to the landscape.[53]

A special obligation to examine possible unsealing measures follows from Sections 15 para. 3 BNatSchG. According to this regulation, land particularly suitable for agricultural activities shall only be used for compensation measures

[48] Such regulations can be found in many state building codes, e.g. Section 8 Para. 1 SächsBO 2016 (Pannicke-Prochnow et al. 2021, p. 202 with further references).

[49] Section 3 Bremen Greening Act – Begrünungsortsgesetz Bremen 2019.

[50] Pannicke-Prochnow et al. (2021), p. 203; Ferber (2021), p. 371.

[51] Detailed Ferber (2021), pp. 370 ff.

[52] Ferber (2021), pp. 370 ff.

[53] Pannicke-Prochnow et al. (2021), p. 230.

where no viable alternatives exist. In order to fulfil this requirement, it must be examined first and foremost whether compensation can be achieved through unsealing measures, i.e. through the removal of existing sealing and the demolition of building structures that are no longer required. This is intended to prevent stocks of agricultural and forestry land being used for compensation measures.[54]

Unsealing measures thus have top priority, at least in regards to preventing the use of agricultural and forestry land for compensation. However, these measures can be rather costly.[55] To provide encouragement, some federal states have developed ideas to promote unsealing measures such as offering discounts on the amount of required compensation.[56] These approaches have been taken up by the Federal Compensation Ordinance (BKompV 2020), which applies to interventions by federal projects: According to Section 8 para. 3 BKompV, unsealing measures are to be given priority for funding over other compensation measures (e.g. upgrading of existing habitats).

In addition to the appropriate methodological considerations of unsealing measures in the assessment of impact compensation, other factors will influence their realisation, e.g. information on the quality and availability of areas to be unsealed, which should be systematically recorded and made available within the framework of unsealing registers.[57] Another challenge is the procurement of land for compensation measures, for which the polluter has only limited options. Here, eco-accounts can offer a solution. By enabling the pooling of compensatory sites, several construction projects can collaborate in order to make an unsealing measure feasible (cf. Section 16 BNatSchG).[58]

It should be noted, however, that unsealing measures within the framework of the impact mitigation regulation at best contribute to maintaining the status quo. This is because they presuppose new sealing elsewhere, which must be compensated for. In addition, the special regulations for urban land use planning (cf. Section 18 BNatSchG and Sections 1a, Section13a and 13b BauGB) restrict the applicability of the impact mitigation regulation in settled areas. We believe this should be changed.[59]

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[54] Lütkes (2018), § 15 Rn. 51.

[55] Pannicke-Prochnow et al. (2021), p. 231.

[56] Albrecht (2021), pp. 35 ff. with further references.

[57] LABO, Statusbericht (2020), p. 51; Blossey et al. (2005), p. 41.

[58] Blossey et al. (2005), p. 41.

[59] Albrecht (2021), p. 44.

5.7 *Water Regulations*

Water law offers a variety of starting points for unsealing measures. These have positive effects not only on the ecological quality of water bodies but also on groundwater recharge, natural flood protection and rainwater management.

5.7.1 Regulations on Water Quality

The EU Water Framework Directive (WFD 2000), which in Germany is implemented within the Federal Water Act (WHG 2009), can promote unsealing by requiring renaturation measures to achieve good water status (cf. Sections 27 ff. WHG). This is because the required good status also applies to ecological factors and is oriented towards a natural status. Examples of this are the renaturation of obstructed river banks or the opening up of piped water bodies. Unsealing measures are part of the programmes of measures specified by Section 82 WHG and which are implemented by the water authorities.[60]

It should be noted, however, that these measures are primarily limited to the watercourse corridor, i.e. they do not impact a broader area.[61] Furthermore, a major challenge for the authorities is to procure the necessary areas for unsealing measures. Implementation also depends on the availability of financial resources. In addition, such conversion measures are considerably delayed by the planning approval procedures that are sometimes required. Generally, municipalities could benefit from additional funding for land acquisition.[62]

5.7.2 Regulations on Flood Risk Management

Unsealing measures can also be triggered by plans to create near-natural flood protection. Soil unsealing promotes water retention, which in turn helps prevent flooding. Such measures can be defined in the flood risk management plans under the EU Floods Directive (FD 2007) (cf. Section 75 WHG).[63] Unsealing measures are also promoted by the provision of Section 77 para. 2 WHG, according to which former floodplains should be restored as far as possible. Further, such measures can provide the necessary compensation for newly sealed areas in floodplains (Section 77 para. 1, Sections 78 ff. WHG).

In the case of designated “flood generation areas” (Hochwasserentstehungsgebiete) under Section 78d WHG, compensation for the loss of retention space due to sealing and changes of use above a certain size is also

[60] Cf. LAWA, BLANO (2020), nos. 21, 22 and 25, 70 and 93.

[61] Pannicke-Prochnow et al. (2021), p. 243.

[62] Pannicke-Prochnow et al. (2021), p. 244.

[63] Cf. LAWA, BLANO (2020), nos. 305, 311, 312, 314.

required in the hinterland (para. 4 to 6). In addition, there is a general unsealing requirement in these areas (para. 3), which, however, is not directly enforceable.[64] The flood generation areas are located in mountainous areas at the headwaters of watercourses, i.e. where the floods originate. Until now, such areas have only been designated in one federal state, namely Saxony. Their implementation should also be extended to other states.

5.7.3 Regulation of Wastewater Management

Rainwater disposal and management is a crucial field of action for climate adaptation, one which has hitherto been insufficiently standardised. Here the aim should be to retain water in areas where unsealed soil can reduce the water load. The principle of Section 55 para. 2 WHG points in this direction, according to which rainwater should be infiltrated close to the site where it falls, trickled away or discharged directly or via a sewer system into a body of water without being mixed with wastewater.

However, Section 55 para. 2 WHG is not directly enforceable; instead, it requires further specification, which is not provided in the WHG. In particular, a clear responsibility for stormwater management should be named in the law and the responsible institution (e.g. urban drainage) given funding to fulfil this task.[65] Following the example of some water regulations in Germany's federal states, provisions should be included that standardise the authorisation of property owners to manage their own rainwater.[66] Conceptually, a drainage plan is required that is oriented towards decentralised rainwater management and coordinated with the urban development uses.[67]

The obligation to charge property owners for rainwater disposal provides a financial incentive for them to disconnect unsealed areas (for which rainwater infiltration is guaranteed) from the sewage system. This allows the owner to save on wastewater fees. A calculation of fees according to the "split wastewater fee" also provides a financial incentive for unsealing.[68] Accordingly, wastewater charges are not based on water consumption but rather on the size of the built-up or artificially paved area of the property from which rainwater runs off. Unsealing can thus help reduce charges for wastewater disposal.

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[64] Pannicke-Prochnow et al. (2021), p. 254.

[65] Pannicke-Prochnow et al. (2021), p. 251.

[66] Cf. Section 36a BWG 2005.

[67] Reese (2020), pp. 49 f.

[68] Hennebrüder (2003), pp. 11 f.

5.8 Climate Laws

Unsealing measures are also necessary for reasons of climate protection and adaptation: intact soils are carbon reservoirs and thus help counteract global warming. These facts should be stated more clearly in the description of soil functions in Section 2 para. 2 BBodSchG.[69] The evaporation, infiltration and cooling effects of the soil also contribute to climate adaptation.[70] The legal framework for climate-impacting measures is provided by the Federal Climate Protection Act (KSG 2019) and the climate (protection) laws of the federal states (as far as available).[71] Climate targets are implemented through climate protection plans and adaptation strategies. These should also address the issue of unsealing and list appropriate measures.

It is particularly important to improve soil functions in those urban areas susceptible to overheating.[72] In theory, the climate (protection) laws of the states (*Länder*) can promote appropriate measures, especially by including them in municipal climate (protection) concepts. It would be better if there were an obligation rather than just a recommendation to draw up such concepts.[73] A further improvement would be regulate the interlinking of municipal climate concepts with urban land use planning, thereby boosting the likely implementation of measures.[74] In addition, the law should make clear that climate adaptation and protection are municipal tasks, and that local authorities are obliged to ensure climate-adapted urban development.

6 Key Messages and Recommendations

Our investigation has revealed a discrepancy between the various benefits of unsealing, on the one hand, and the scarce availability of unsealing potentials and various obstacles for the realisation of unsealing measures, on the other. This suggests a need for inventories of prerequisites and opportunities as well as their appropriate combination: For this, c*limate adaptation requirements* in residential areas have to be investigated at district level to identify the specific prerequisites. Simultaneously, *unsealing potentials* have to be identified and characterised to determine the specific opportunities to contribute to climate adaptation goals. Finally, *consistent and balanced concepts for inner development* at municipal or district level have to be created and implemented to address the identified climate adaptation requirements by the use of the identified opportunities for unsealing,

[69] Pannicke-Prochnow (2021), p. 224.

[70] See Sect. 3.2 above.

[71] An overview of the existing climate laws of the individual states can be found in Pannicke-Prochnow (2021), p. 262.

[72] See Sect. 3.2 above.

[73] Ginzky et al. (2021), pp. 449 f.

[74] Cf. § 13 para. 1 sent. 2 BremEKG 2015.

while closely interlinking these with further measures. As unsealing measures can be expensive, it could be useful to rank these in terms of their benefit for climate adaptation along with their costs.

Unsealing must not be seen as an end in itself but rather as one element in an overall development approach that encompasses the creation of green spaces and encouragement of social urban development as well as decontamination of sites. These goals may be facilitated by incentives. To boost the implementation of unsealing measures, a sufficient supply of good information and advice is important, not least in order to include a large number of different actors, such as lessors and tenants of housing or commercial areas. As key players in unsealing, Germany's municipalities need to be empowered in terms of financial and personnel resources to be able initiate unsealing measures amongst local residents as well as to set a good example themselves.

The various legal instruments currently available to promote unsealing are rather inefficient and impractical. In particular, the unsealing obligations specified in Section 179 BauGB and Section 5 BauGB should be clearly distinguished, simplified and expanded in order to reduce the existing enforcement deficit. Their application should be supported by dedicated funds. The contribution of unsealed soils to climate protection and climate adaptation should be more strongly expressed in soil protection law. In addition, the climate protection laws of the federal states should require mandatory climate adaptation planning by the municipalities.

The impact mitigation regulation already plays an important role in the implementation of unsealing measures. Its legal provisions should be strengthened to ensure that newly sealed areas are compensated by the unsealing of other sites. Last but not least, water law can promote the implementation of unsealing measures in various ways. In view of the challenges of climate change, it is essential that we create an integrated system of urban water management, one which does not just consider wastewater disposal but also coordinates all water-related measures (i.e. water quality, flood protection, groundwater recharge). Here legal prerequisites should be created, aimed at optimising the system for the greatest possible ecological effect.

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Land-Use Implications of Carbon Dioxide Removal: An Emerging Legal Issue?

Till Markus and Romina Schaller

Abstract Science has expressed concerns that carbon dioxide removal (CDR) as a means to fight climate change could potentially increase competition for land and contribute to soil degradation. This paper aims to map out the potential land-use and soil implications of CDR to identify possible lines of political and legal conflicts. To this end, we will briefly introduce the most promising removal approaches, highlight existing preliminary estimates about their removal potential, give some basic assumptions about their effects on competition over land and the environment, and discuss the demand for political and legal action (Sect. 5).

1 Introduction

Parties to the Paris Agreement aim to hold the increase in the global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the global temperature increase to 1.5 °C above pre-industrial levels. To achieve this, many scientists and governments agree that climate neutrality must be realized by 2050, i.e. there must be a balance between greenhouse gases emitted and the absorption of greenhouse gas emissions by sinks.[1] This objective reflects a broad consensus in the scientific community about what is necessary to avoid dangerous anthropogenic interference in the climate system.[2] Attaining climate neutrality, however, requires, drastic measures. Most importantly, the use of fossil fuels for energy production must be phased out and emissions from activities that are difficult to avoid have to be reduced as far as possible.

[1] Art. 4 Para. 1 of the Paris Agreement (adopted 12 December 2015, entered into force 4 November 2016) 55 ILM 740.

[2] Masson-Delmotte et al. (2018), p. 17; Rogelj et al. (2018), p. 325.

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Several factors, however, not only make the goal of less than a 1.5 °C temperature increase very challenging, but in fact make an emission overshoot likely. First, the states' current greenhouse gas reduction commitments under the Paris Agreement—the so-called Nationally Determined Contributions—are projected to only limit temperature increase to 2.4 °C.[3] Second, even if states would undertake all necessary actions to achieve these (insufficient) goals, there is no guarantee that they will succeed in due time. Success in sufficiently reducing GHG-emissions depends on a myriad of social, political, and environmental factors and developments, some of which are difficult to generate or predict. Third, based on our current technical understanding, it is difficult to decarbonize some important sectors, such agriculture and transport.

Against this background, the IPCC in its 1.5 °C Report from 2018 has included so called "negative emissions" in most of its climate scenarios, implying that they will be necessary to some extent if less than a 1.5 °C or even 2.0 °C temperature increase is to be achieved.[4] Negative emissions have broadly been defined as the "removal of greenhouse gases (GHGs) from the atmosphere by deliberate human activities (. . .)."[5] *T*he process of carbon dioxide removal (CDR), in turn, *comprises* different methods and techniques *deployed* to reduce the atmospheric CO_2 concentration (see below).[6] In addition, the IPCC's Sixth Assessment Report of 2022 also highlights the importance of CDR.[7] It emphasizes that the quantity of removal activities required will depend on both the ambition and the success of mitigation efforts. Accordingly, projected extraction ranges from 100 $GtCO_2$ to 1000 $GtCO_2$ by 2100. The IPCC's statement on negative emissions has sparked a lively debate in climate sciences and politics about appropriate actions to create negative emissions, and several industrialized countries such as Japan, Sweden, Germany, Canada, the USA, and the European Union have included CDR measures in their national climate policies.

Relying on the prospects of CDR, however, could bear several risks.[8] Uncertainties regarding political, economic, and technical aspects may lead to the overestimation of removal potentials, which could eventually end up leaving too much CO_2 in the atmosphere and creating so-called lock-in effects regarding the newly developed technologies.[9] Second, there is a widely spread fear that the emerging option to retrieve CO_2 from the atmosphere may in fact reduce efforts to avoid CO_2 generation. This mitigation deterrence effect, as it is called, is fueled by a strong economic incentive to fully exploit the remaining fossil energy carriers and not loose

[3] See Climate Action Tracker at https://climateactiontracker.org/ (Last access: 22 June 2022).

[4] IPCC 2022, Climate Change 2022, Box TS.10, Chapter 12; Luderer et al. Residual fossil CO_2 emissions in 1.5–2 °C pathways, Nat. Clim. Ch. 8 (2018), p. 626–633.

[5] See Definition in IPCC, Global Warming of 1.5°C (2018), Glossary, p554.

[6] See Definition in IPCC, Global Warming of 1.5 °C (2018), Glossary, p. 544.

[7] IPCC, WG II Contribution to the Sixth Assessment Report (2022), pp. 94 ff.

[8] See, e.g., Anderson and Peters (2016), pp. 182–183.

[9] IPCC Climate Change 2022, Chapter 12, p. 1247–1322.

former investments (stranded assets). Finally, different removal activities may potentially create various negative side effects, both on people and the environment.[10]

One reoccurring critique is that several of the removal options may require a lot of space, thus increasing local, regional and even global competition for non-degraded, agriculturally productive, or biodiverse land, which has globally become an increasingly scarce resource.[11] The chapter aims to map out the potential land-use and soil implications of CDR to identify possible lines of political and legal conflicts. To this end, we will briefly introduce the most promising removal approaches (Sect. 2), highlight existing preliminary estimates about their removal potential (Sect. 3), give some basic assumptions about their effects on competition over land and the environment (Sect. 4), and finally discuss the demand for political and legal action (Sect. 5).

2 CDR Methods

At present, a variety of different methods for the deliberate removal of greenhouse gases from the atmosphere are being discussed.[12] Discussion mainly focuses on the removal of CO_2 as the biggest contributor to the greenhouse effect.[13] For removal activities to be effective in the long term, gases must be stored or sequestered in the ground, in the ocean or seabed, or in artificial reservoirs.[14]

CDR methods may be classified according to different characteristics.[15] While some measures accelerate or expand the *natural carbon sequestration processes*,

[10] Markus et al. (2021), p. 90.

[11] See, e.g., United Nations Convention to Combat Desertification, Global Land Outlook (2017); Creutzig (2017), pp. 28–29; IPCC, Climate Change and Land: An IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems – Technical Summary (2019).

[12] Hanna et al. (2021), p. 368; National Academies of Sciences, Engineering, and Medicine, 'Negative Emissions Technologies and Reliable Sequestration' (The National Academies Press 2019); European Academies Science Advisory Council, 'Negative Emission Technologies: What Role in Meeting Paris Agreement Targets?' (European Academies' Science Advisory Council 2018); Minx et al. (2018), p. 13; Fuss et al. (2018), Part 2, 063002; Minx et al. (2018), Part 1, 063001.

[13] The IPCC 1.5 °C-Report focused mainly on CDR, see IPCC (2022), sec. C. 3 f. Regarding methane see, e.g., Stolaroff et al. (2012), p. 6455; Secretariat of the Convention on Biological Diversity (2016), p. 68.

[14] Removed greenhouse gases may also be recycled and put to (re-)use. At present, most *re-use options*, however, will release CO_2 back into the atmosphere at some point. See Schaller et al. (2022).

[15] Pires (2019), pp. 502 ff.; McGlashan et al. (2012), p. 2; de Richter et al. (2019), pp. 593 f.; Psarras et al. (2017), pp. 5 f.

others are *technology-based*.[16] Some methods store greenhouse gases *terrestrially* (e.g., in soil or in deeper ground-layers), others in the *oceans* or under the *seafloor*. Some techniques use biological processes for removal (esp. photosynthesis), while others use chemical or geochemical processes.

Of all *terrestrial removal approaches*, the "Bioenergy with Carbon Capture and Storage" (BECCS) is probably receiving the most attention.[17] For BECCS, large-amounts of biomass are used to generate energy, then the resulting CO_2 is captured and stored underground.[18] The biomass would stem either from energy crops, or from forestry or agricultural sources which may or may not be specifically planted for this purpose.[19] Two other nature-based terrestrial CDR approaches include afforestation and reforestation, i.e. the planting of trees for creating new forests or re-planting trees in areas where there used to be forests.[20] Growing trees extracts CO_2 from the atmosphere, thus creating a carbon reservoir.[21] Another discussed CDR option in this category would be the insertion of biochar into the ground. This involves "carbonizing" biomass (through thermochemical conversion or hydrothermal carbonization) and injecting the char into soils for storage.[22] There is also the "enhanced weathering approach"—a process by which the natural decaying-process of certain rocks is artificially accelerated and CO_2 is chemically or physically bound. Enhanced weathering can be achieved, for example, by crushing silicate rocks that contain calcium and magnesium and then spreading particles over large areas of arable land. Finally, another nature-based terrestrial strategy to remove carbon from the atmosphere is to improve soil management practices to increase carbon sequestration.[23] On one side this involves strengthening utilization practices that expand the input of CO_2 into soils, e.g., through the rewetting and sustainable management and use of peatlands (i.e. paludiculture[24]), generally improved agricultural practices,

[16] IPCC, Technical Summary, in: Climate Change 2021 – The Physical Science Basis: Working Group I Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, p. 99; IPCC, Climate Change 2022, Cross-Chapter Box 8. In the discourse, the term "negative emission technology" also includes nature-based approaches, although these do not represent a technology in the narrower sense, see Minx et al. (2018), p. 5.

[17] BECCS takes a central role in the mitigation scenarios of the IPCC, see IPCC, Global Warming of 1.5 °C (2018), section C. (pp. 17 f.). See also Creutzig et al. (2019), p. 1807; The Royal Society/Royal Academy of Engineering (2018), p. 39; Kemper (2015), p. 401.

[18] IPCC, Global Warming of 1.5 °C (2018), p. 543.

[19] The Royal Society/Royal Academy of Engineering (2018), p. 39.

[20] United Nations Framework Convention on Climate Change (UNFCCC), Report of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol on its first session, held at Montreal from 28 November to 10 December 2005 (FCCC/KP/CMP/2005/8/Add.3), Decision 16/CMP.1, Annex; UNFCCC, CDM Methodology Booklet (2019), p. 39.

[21] See, e.g., Dixon et al. (1994), pp. 185, 188; Pan et al. (2011), pp. 988–989.

[22] Fuss et al. (2018), Part 2, 063002, p. 30.

[23] The Royal Society/Royal Academy of Engineering (2018), p. 32.

[24] Tannenberger et al. (2020), pp. 2309 ff.

or systematic fire management in forests, and, on the other side, avoiding activities that promote the discharge of CO_2 from soils (e.g., the conversion of grasslands).[25]

In addition to modifying or accelerating the terrestrial natural carbon cycle processes, technology-based approaches are being developed by which greenhouse gases are filtered out of the atmosphere ("Direct Air Capture" or DAC).[26] DAC approaches capture CO_2 from the ambient air, compress it, and then either store it underground (Direct Air Carbon Capture and Storage or DACCS), or put it to further use (Direct Air Carbon Capture and Utilization or DACCU), primarily using chemical binders.[27] Further use, however, results in negative emissions only if the removed carbon remains stored in the product. Accordingly, the duration of sequestration essentially depends on the lifetime of the products. DACCU approaches are climate-neutral at best, which is why they are also referred to as "circular carbon" approaches.[28]

Here, carbon capture and storage (CCS), is of particular interest.[29] CCS does not aim at avoiding the formation of CO_2, but merely prevents its release into the atmosphere.[30] The CO_2 is captured during power generation or in the course of industrial production processes and then stored underground. CCS thus shares with DACCS and BECCS the storage element, since none of these approaches would be climate effective without storage.[31] At the global level, CCS came into discussion as early as 2005 in international climate politics, including in a publication by the IPCC specifically dedicated to CCS.[32] Discussions have recently been re-ignited and are expected to intensify due to the debate around CO_2 removal.[33]

Terrestrial nature-based and terrestrial technology-based CDR methods are potentially complemented by ocean-based methods. While these methods will not directly impact land-use and soils, they will do so indirectly. They may possibly serve both as an alternative or a supplemental approach and may thus influence the scale of land-based methods. Different options are referred to as blue carbon, ocean alkalinization, ocean fertilization, and marine CCS. While marine CCS basically resembles land-based CCS in that it uses subsurface storage sites (under the seafloor), blue carbon includes techniques which store CO_2 in marine and coastal ecosystems, particularly through seagrass beds, salt marshes, and mangrove forests. The protection and expansion of these areas can contribute to carbon removal and

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[25] See, e.g. the study of Fargione et al. (2018), p. 1869.

[26] Beuttler et al. (2019), p. 4.

[27] NAS (2015), p. 196; The Royal Society/Royal Academy of Engineering (2018), p. 59.

[28] Hepburn et al. (2019), pp. 87, 88 f.; Beuttler et al. (2019), p. 4; Breyer et al. (2019), p. 2053.

[29] See IPCC, Global Warming of 1.5 °C (2018), section C., pp. 17 f.

[30] Markus et al. (2021), p. 90.

[31] Haszeldine et al. (2018), p. 3.

[32] IPCC, Carbon dioxide capture and storage (2005).

[33] See, e.g., International Energy Agency (2019); Wennerstein et al. (2015), p. 724; EASAC (2013).

storage.[34] Ocean alkalinization, in turn, aims to expand the sea's capacities to absorb CO_2 by increasing its alkalinity, e.g. through the placement of $Ca(OH)_2$.[35] Finally, ocean fertilization aims to supply "fertilizers" (e.g. iron) to certain nutrient-poor ocean regions (usually far offshore) to stimulate algal growth, binding atmospheric CO_2. When the algae die, they sink to the bottom of the sea and store removed CO_2.[36]

3 Removal Potential

Estimated removal quantities still vary widely for different CDR methods, for different countries, and for the global level.[37] The vast majority of scientists agree, however, that removal methods will not serve as an alternative to ambitious mitigation strategies.[38] Most importantly, if CDR methods were to effectively contribute to reducing CO_2 levels in the atmosphere, they would have to be applied at a large scale. Successfully scaling-up existing or currently tested approaches and rendering them effective, however, depends on multiple social (particularly economic, political, and legal), technical, and natural factors, many of which are difficult to predict or provide. For example, political commitment to ramp up removal techniques would strongly depend on emission reduction ambitions and gaps, consumer behaviour and interests (for example, with a view to consuming meat, flying, cars, etc.), and existing incentives for industries to make CDR a business case, etc. In addition, most removal methods will require huge commitments to research, development, and implementation regarding CDR methods.[39] Furthermore, large-scale afforestation, reforestation, soil management and BECCS would require successful long-term and *sustainable* management of forests or the cultivation of bioenergy crops. The duration of CO_2 storage by these means, however, can be -reversed by natural or human-caused factors, e.g., droughts, fires, and plant diseases). In the case of BECCS, again, CO_2 stored in geological reservoirs is less prone to this reversion.[40] Finally, the implementation of DACS-infrastructures may face acceptance problems.

[34] IPCC, Global Warming of 1.5 °C (2018), p. 543; Herr and Landis (2016), pp. 8 f.; Vierros (2017), p. 89; Macreadie et al. (2019), p. 1.

[35] Fuss et al. (2018), p. 30.

[36] Smetacek and Naqvi (2008); Boyd et al. (2007), p. 612; Buesseler et al. (2008), p. 162; see also Güssow et al. (2010), p. 911.

[37] The removal potential for Germany in 2030, for example, is estimated to possibly lie between 32–42 MtCO2/pa, possibly ramping up to 103,116 MtCO2/pa for 2045, see Ariadne-Study, pp. 223–224.

[38] See EASAC (2013), pp. 1 f.; Smith et al. (2016), p. 6.

[39] IPCC (2022), Summary for Policymakers. In: Climate Change 2022: Mitigation of Climate Change. C. 11.3.

[40] See, e.g., Wiliamson (2016), pp. 153–154; IPCC, WG II Contribution to the Sixth Assessment Report (2022), C.11.3.

Table 1 Estimated removal potential of different CDR-methods by 2050[a]

CDR-method	Removal potential
BECCS	0.4–11.3 $GtCO_2\ yr^{-1}$[b]
Afforestation/Reforestation	0.5–10.1 $GtCO_2\ yr^{-1}$[c]
Soil carbon sequestration	0.6–9.4 $GtCO_2\ yr^{-1}$[d]
Peatland and coastal wetland restoration	0.5–2.1 $GtCO_2\ yr^{-1}$[e]
Biochar	0.2–6.6 $GtCO_2\ yr^{-1}$[f]
Enhanced wheathering	2–4 $GtCO_2\ yr^{-1}$[g]
DACCS	5–40 $GtCO_2\ yr^{-1}$[h]
Blue carbon	0.02–0.08 $GtCO_2\ yr^{-1}$[i]
Ocean fertilization	0.2–3.7 $GtCO_2\ yr^{-1}$[j]
Ocean alkalinization	1–100 $GtCO_2\ yr^{-1}$[k]

[a] The data used for the range of mitigation potential in 2050 comes from studies and reports from: IPCC AR6 WGIII (2022), Table 12.6; Fuss et al. (2018), IPCC, Global Warming of 1.5 °C (2018); NAS (2015); EASAC (2013); Minx et al. (2018); The Royal Society/Royal Academy of Engineering (2018); Friends of the Earth (2011)
[b] IPCC, AR6 WGIII (2022), Table 12.6; Fuss et al. (2018), p. 31; NAS (2015), p. 7; IPCC, Global warming of 1.5 °C: Summary for policymakers (2018), p. 17; Friends of the Earth (2011), p. 17
[c] IPCC, AR6 WGIII (2022), Table 12.6; Fuss et al. (2018), p. 14, IPCC, Global Warming of 1.5 °C (2018), p. 17; Minx et al. (2018), p. 8; NAS (2015), p. 6
[d] IPCC, AR6 WGIII (2022), Table 12.6; Fuss et al. (2018), p. 32; The IPCC 2018 report also references the study by Fuss et al. (2018). See IPCC, WG II Contribution to the Sixth Assessment Report (2022), p. 345; NAS (2015), S. 6, Friends of the Earth (2011), p. 21
[e] IPCC, AR6 WGIII (2022), Table 12.6
[f] IPCC, AR6 WGIII (2022), Table 12.6; Fuss et al. (2018), p. 32; Pires (2019), p. 511; The Royal Society/Royal Academy of Engineering (2018), p. 35
[g] IPCC, AR6 WGIII (2022), Table 12.6; Fuss et al. (2018), p. 32; Friends of the Earth (2011), p. 12. Minx et al. also refers to the reports of the Friends of the Earth (2011), Minx et al. (2018)
[h] IPCC, AR6 WGIII (2022), Table 12.6; Fuss et al. (2018), p. 30
[i] IPCC, AR6 WGIII (2022), Table 12.6; NAS (2015), p. 62
[j] IPCC, AR6 WGIII (2022), Table 12.6; NAS (2015), pp. 60 f.; Minx et al. (2018), p. 9; EASAC (2013), p. 27; Friends of the Earth (2011), p. 19
[k] IPCC, AR6 WGIII (2022), Table 12.6; Includes date by Minx et al. for ocean liming, Minx et al. (2018). See also Caserini et al. (2019), pp. 1231, 1234

The subsurface storage of CO_2 in particular is unpopular in large parts of Europe (Table 1).[41]

Against this backdrop, two points become evident. First, CDR does not offer a quick fix to the climate problem. Second, at this point, assessing and estimating the structure, the size, and the removal potential, as well as the resource and spatial demands of future removal measures is extremely difficult, not only at national levels but particularly at a global level.[42]

[41] For example, the states of Mecklenburg-Vorpommern, Lower Saxony and Schleswig-Holstein have completely excluded carbon dioxide storage for their territories. See: BT-Drs. 19/6891, p. 49; Miranda-Barbosa et al. (2017), p. 6668. See also Kern et al. (2016), p. 250.

[42] Johannes Förster et al. (2022), p. 758628; Terese Thoni et al. (2020), p. 590305.

4 Land-Use Implications and Environmental and Economic Effects

Several authors have expressed concern that CDR measures could have major land-use implications. In particular, replacing ongoing uses for the purpose of CO_2 removal might increase competition over land. In our context, competition over land means that the use of land for CO_2 removal by one actor rules out, reduces, or makes more expensive the use of land by others. It is especially feared that food production and environmental conservation might be negatively affected.[43] Such effects are still difficult to predict as they will depend on the CDR activities to be deployed and other factors such as local context, management, previous land use and the scale to be applied.[44] Hypothetically, however, were CDR approaches to be developed at large scale, some specific basic effects seem likely.

First, terrestrial removal methods will have land-use impacts. They will introduce a new demand for land, i.e. surface or subsurface spaces are required for an additional purpose. The impact level would depend on the scale of the respective removal activity, which, in turn, would be determined by the amount of CO_2 that it is meant to remove from the atmosphere.[45] Where BECCS, afforestation, reforestation, and biochar would be carried out they would use terrestrial surface space and replace or reduce land-use opportunities for other uses (e.g. regular agriculture, forestry).[46] The rewetting of peatlands and increasing soil-carbon would also reduce opportunities to carry out conventional agriculture. In addition, scaling up technical approaches such as BECCS, DACS and CCS requires (a) the construction (or refurbishing) of large facilities for capturing and storing CO_2 and (b) reserving spaces suitable for removal and storage (i.e. using land which is geographically close to renewable energy sources and storage sites).[47] Finally, sub-surface storage of CO_2 may prevent the use of the respective areas for other sub-surface activities (e.g., storing different gases, or maintaining drinking water sources, and possibly geothermal energy exploitation[48]).

Second, the land-use could have different economic effects that could be determined by many other factors, including, for example, the land's past and future alternative uses.[49] At a basic level, nevertheless, adding another land-use practice would reduce the overall availability of land on the market and raise demand. Increasing demand for land could, in turn, make food production more expensive.[50]

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[43] IPCC, Summary for Policymakers (2021), In: Climate Change 2021, p. 183.

[44] Smith et al. (2016), pp. 43 f.; IPCC, Summary for Policymakers (2021), p. 29.

[45] Smith et al. (2016), pp. 43 f.

[46] Boysen et al. (2017), pp. 4303–4317; Creutzig et al. (2019), p. 1807.

[47] Smith et al. (2016), p. 46; Fuss et al. (2018), p. 063002.

[48] Wu and Li (2020), pp. 1–28; Miranda-Barbosa et al. (2017), pp. 6666–6676.

[49] Popp et al. (2017), pp. 331–345.

[50] Fujimori et al. (2022), pp. 110–121; Fuss et al. (2018), pp. 13 f.

In addition, changed use practices could also reduce net gains from certain land-use practices (e.g. changing from regular agro-industrial production to paludiculture).[51] It is important to point out, however, that although all CDR methods require a certain amount of surface or subsurface space, they may not necessarily create or increase competition over land. For example, spreading crushed silicate to enhance weathering over vast areas of arable land will not necessarily exclude, reduce or make more expensive agricultural practice and may even have a number of positive effects on soils (and possibly some negative).[52] In addition, where negative side effects can be avoided, subsurface storage of CO_2 may have little effect on surface activities.

According to our understanding, competition over land would most likely increase where the overall availability of land for other purposes is reduced. This would also be the case where CDR methods would degrade land's environmental status and reduce its potential for providing different ecosystem-services, such as providing clean drinking water or hosting ecosystems rich in biodiversity. The environmental impacts, particularly those on soils, water, and biodiversity, will vary depending on the removal activity, how it will be carried out, and most of all its scale.[53] To render CDR methods climate-effective, i.e. in order to remove significant quantities of CO_2 from the atmosphere, most approaches would have to be carried out at a large scale.[54] Large-scale removal, however, carries the risk of creating significant environmental harm.[55] For example, the introduction of biochar into soils over vast areas of land, though adding nutrients to soils, may also change the microbial composition of the soil if the addition of biochar is at high rates. This could lead to the reduction of genes related to plant immunity and defense.[56] Similarly sized enhanced weathering activities may have significant physical and chemical impacts on soils as well as on ground and surface water.[57] Building large-scale BECCS, DACS and CCS infrastructures will require substantial amounts of material (e.g. metals and chemicals) and the process of filtering carbon out of the air would demand large amounts of energy (in the form of heat and/or electrical energy).[58] Providing both materials and energy may also have significant environmental effects. With regard to the CCS technology, it is feared that the sequestered CO_2 could escape and that the storing process might set free chemicals or salty water

[51] For example, while recognizing the potential of paludiculture, the importance of economic viability is also emphasized. See: Tannenberger et al. (2020), p. 2311.

[52] Beerling et al. (2020), pp. 246–247.

[53] IPCC, Summary for Policymakers (2021), p. 29; Yamagata et al. (2018), pp. 301–313.

[54] Masson-Delmotte et al. (2018), p. 33.

[55] Ibidem.

[56] Jiang et al. (2016), pp. 1–14; Viger et al. (2015), pp. 658–672.

[57] Fuss et al. (2018), p. 22.

[58] The Royal Society/Royal Academy of Engineering (2018), p. 59; Daggash et al. (2019), pp. 181, 184; Fuss et al. (2018), p. 17; Here it is certainly necessary to differentiate regarding different plants, see Dittmeyer et al. (2019), p. 1818.

from deeper ground layers and push them to the surface, where they could salinize and spoil soils as well as ground and surface water.[59]

5 Preliminary Conclusions, Discussion, Outlook

Substantial uncertainties remain with regards to the potential impacts of the development of CDR. While it appears relatively easy to calculate the required scale and space for the different CDR approaches to remove certain quantities of atmospheric CO_2, it is much more difficult to predict (a) if, how, and when CDR can be scaled up in different countries or regions and (b) what effect that would have on competition over land, whether locally, at country-level, across borders, or at a global level.[60] Such effects may vary in different places and circumstances and will depend on many variables. Despite all these uncertainties it is clear that all large-scale CDR methods would require substantial amounts of surface or subsurface space, and that this can lead to changes in land-use practice, negatively affect the environment, increase competition over land, and possibly increase costs for food production.

The potential scale of CDR projects justifies worrying about these possible effects. Two aspects regarding land use and food security are of particular concern.

First, it becomes clear though that the potential for severe conflicts are globally unevenly distributed. Increasing land or food prices, for example, would predominantly affect food insecure regions.[61] According to the FAO, "moderate to high rates of hunger and/or child undernourishment still affect 53 countries."[62] The number of people who are insufficiently nourished was recently estimated to lie between 690 million and 820 million people.[63]

Second, land for food production is not necessarily scarce at a global level; it is scarce in some regions and often inefficiently, unsustainably, and—arguably—unethically used. The production of animal-based food, for example, is one of the most important factors in this regard. While the consumption of meat products are estimated to have tripled since the 1960s (due to population growth, increasing affluence, urbanization, and globalization),[64] its negative effects on human health

[59] Rothkirch and Ejderyan (2021), p. 9.

[60] Förster et al. (2022), p. 758628; Thoni et al. (2020), p. 590305.

[61] Hasegawa et al. (2018), pp. 699–703.

[62] FAO, Progress towards ending hunger and malnutrition – A cross-country cluster analysis (2020a), p. ix.

[63] See, e.g., FAO, The State of Food Security and Nutrition in the World 2020 (2020b); Willett et al. (2019), pp. 447 ff.

[64] FAO, Animal Production and Health Division, Shaping the Future of Livestock – Sustainably, Responsibly, Efficiently, The 10th Global Forum for Food Agriculture (2018), p. 1; Kirchhelle (2018).

and the environment are well understood.[65] Industrial meat production is particularly demanding of space. For example, according to the FAO, approximately 26% of the ice-free terrestrial surface is used for animal grazing and 33% of arable land is used for growing crops for animal feed.[66] In some countries, the share of land used for growing fodder for animals is much higher and often fodder is also imported from third countries. In Germany, for example, 60 to 70% of agricultural land is used for growing plants for animal feed. It has also been estimated recently that if humans would choose a vegan diet, agriculture would eventually need only a quarter of the land it uses today. If meat from cattle and sheep were avoided, agricultural land use could be cut in half.[67] Still, CDR leading to changes in land use practices, degrading land, increasing competition over land, and possibly raising costs for food production and consumption could create social, ethical, environmental or legal conflicts, some of which are local, some of which are global.[68] It may particularly affect poor consumers in both rich and low-income countries. For those who live under food insecure conditions, rising costs for food can be life-threatening.

Against this background, developing and deploying CDR measures at large scale will require political and legal action. At present, a large-scale development and deployment of CDR would basically be unregulated (maybe with the exception of ocean fertilization[69]), including those approaches which may lead to competition over land (and have negative effects on the environment or food production). Considering their potential transboundary or possibly even global effects thus calls for an internationally coordinated governance approach. This will be particularly important with a view to integrating CDR-measures into the international climate regime (e.g. clarifying how the removed carbon can be counted with regards to achieving nations' *Nationally Determined Contributions* under the Paris Agreement), to guarantee their effective and non-collusive implementation (e.g. adopting transparent accounting systems to prevent green-washing practices), and ultimately

[65] At the same time, "moderate to high overweight among adults has become the most important nutrition concern in more than half of all countries in the world." According to the World Health Organization (WHO), "in 2016, more than 1.9 billion adults, 18 years and older, were overweight. Of these over 650 million were obese, see FAO, Progress towards ending hunger and malnutrition – A cross-country cluster analysis (2020a), p. ix, available at: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight (Last access: 22 June 2022). See also Polly Walker et al. (2005); Machovina et al. (2015); Banhazi et al. (2018); Malik et al. (2015). See also IPCC, Climate Change and Land: An IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems – Technical Summary (2019), p. 22.

[66] See FAO, Livestock's Long Shadow: Environmental Issues and Options (2006), p. 271.

[67] Poore and Nemecek (2018), pp. 987–992; see also The Economist, If everyone were vegan, only a quarter of current farmland would be needed, Jan 28th (2022).

[68] This make a global perspective on justice issues arising out of CDR important. For a conceptual approach to global justice see, e.g., Risse, On Global Justice (2012).

[69] Ginzky and Frost (2014), pp. 82–96.

avoiding negative side effects, including those investigated here as well as mitigation deterrence.[70]

At present, there is, however, a range of international policy and legal instruments that aim to protect land and soil from degradation. Since human induced factors contributing to land and soil degradation are so manifold these days (e.g. urbanization, deforestation, unsustainable agricultural practices, unsustainable use of water etc.), so are policies and laws aiming to keep land in good condition.[71] Some of them are binding, some of them are not. In the event that removal activities would steeply increase, these different political and legal requirements would have to be taken into consideration, and land degradation would have to be avoided in order to comply with them. At a fundamental level, future regulations need to be guided by some basic objectives and principles. First, the UN's "Sustainable Development Goal 15 (Target 3)" lays down the following political goal: "By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world."[72] Particularly with a view to avoiding transboundary effects, protecting the climate through CDR must neither lead to transforming one environmental problem into another nor transferring hazards from one region to another. In this light, would be called upon to remove CO_2 by mainly using their own territory. Where removal or storage activities would be carried out abroad, operators are to be required to ensure that their activities, including their investments in land, would not negatively affect food security and the environment in the destination area. Activities and investments would have to comply with safeguards and standards, for example, similar to those developed for transboundary investments in farmland.[73]

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[70] See Markus et al. (2021); McLaren (2020), pp. 2411–2428.

[71] Boer et al. (2016), pp. 49 ff; Bodle and Stockhaus (2020).

[72] See, e.g., Huck (2022), pp. 554 f.

[73] See, e.g., overview from Markus (2020/2021), pp. 360–382.

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What Place for Contractual Commitments in the Protection of European Agricultural Soils? The Example of Carbon Sequestration

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Abstract The contractual formula is becoming increasingly attractive to stakeholders, especially when it is associated with a booming market, as is the case for carbon sequestration in agricultural soils. Contracts have developed in tandem with the interest of this natural sequestration by agricultural soils to achieve climate neutrality by 2050. The parallel arrival of draft legislation with binding targets does not oppose two modes of legal intervention. On the contrary, it actually tends to strengthen the legitimacy of each of them in favour of increased protection of agricultural soils, although many questions remain unanswered.

1 Introduction

Although European law has an EU Water Framework directive[1] and a framework directive on air,[2] soil has long been considered the poor relation of legal protection of environmental components. However, efforts in this direction have not been spared.

A part of this work was carried out under two research contracts: project H2020 CONSOLE "*Contract solutions for effective and lasting delivery of agri-environmental climate public goods by EU agriculture and forestry*", call H2020 RUR-O3-2018 for Contract for effective and lasting delivery of agri-environmental public goods, see in this research report "legal aspects" by A. Langlais, M. Cardwell and T. Runge, 102 p., available at https://console-project.eu (Last access: 22 June 2022); The second project is a national MITI-CNRS-France, "Interrogating the role of carbon capture and storage to meet the challenge of climate neutrality" (translated title).

[1] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, OJ L 327, 22.12.2000.

[2] Directive 2008/50/CE du Parlement européen et du Conseil du 21 mai 2008 concernant la qualité de l'air ambiant et un air pur pour l'Europe, OJ L 152, 11.6.2008 (changed in 2015).

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In 2002, a thematic strategy on soil stated the need to provide a legal framework for soil.[3] Legal recognition of the preciousness of soils and the need to protect them goes back further than this, if we look at the European Soil Charter of 1972.[4] At the international level, a first version of the world soil charter was adopted in 1981 by the FAO.[5] Although these efforts led to a draft EU framework directive on soil in 2006, the withdrawal of this draft marks a halt to a coherent and binding legal framework for soil protection.

The contributions and reasons for the failure of this draft directive are, however, a source of particularly useful lessons for analysing the place of contractual commitments in the protection of European agricultural soils. Defining what is a contract is not as straightforward as one might think, since the form of contract varies from state to state. In particular, there is a divergence in the rules of law governing contracts as between the civil law and the common law. These divergences, which reflect cultural diversity, can affect the ways in which the contract is drawn up and implemented. However, over and above the often specific and technical rules, there are nevertheless major principles such as “pacta sunt servanda” (Latin for “agreements must be kept”, or the principle of good faith), which guide most legal systems. In general, a contract can be defined as an agreement which creates or purports to create a binding legal relationship, or which purports to produce some other legal effect. It is a bilateral or multilateral act.

Because of their very strong connection with the land and the soil, the latter form a particularly rich field of observation. The nature of this link was recently made clear in the European Commission’s Communication, ‘The Future of Food and Farming’ in 2017.[6] This preparatory document for the 2023 CAP, placed particular emphasis on soils, indicating the importance of ‘increase resilience and soil health’.[7] The mention of resilience was only made for soils, underlining the specific importance of soils for agriculture.

Despite its failure, the draft EU Soil Framework Directive explicitly stated a new angle of legal protection for soils. In fact, the draft directive has clearly focused the purpose of its protection on soil functions and services. The new European soil strategy of 21 November 2021[8] confirms and strengthens the choice of this functions

[3] Communication from the Commission to the Council and the European Parliament, the European Economic and Social Committee and the Committee of the Regions: Towards a thematic strategy for soil protection, COM (2002) 179 final.

[4] “**Soil** is a living and dynamic medium which supports plant and animal life. It is vital to man’s existence as a source of food and raw materials”. This charter was revised in 2002.

[5] In 2015, a revised version was written.

[6] Communication from the Commission to the European Parliament, the Council, the European Economic and social commitee and the Comitee of the Regions, The Future of Food and Farming, COM (2017) 713 final, 29.11.2017.

[7] Ibid, p. 12.

[8] Communication from the Commission to the European Parliament, the Council, the European Economic and social commitee and the Comitee of the Regions, EU Soil Strategy for 2030 Reaping the benefits of healthy soils for people, food, nature and climate, COM (2021) 699 final.

and services approach to soil protection. It is in line with the aborted draft directive, which also aimed to focus on human activities that compromise the capacity of soil to perform these functions and to identify areas and processes of degradation. The new Soil Strategy 2021 also states that "as part of the Soil Health law, and in the context of an impact assessment, assess requirements for the sustainable use of soil so that its capacity to deliver ecosystem services is not hampered, including the option of setting legal requirements" (pt 4.1) as well as "significant areas of degraded and carbon-rich ecosystems, including soils, are restored" (pt 2).[9] The new European soil strategy therefore again envisages a binding legal framework for soils. The recent proposal for a directive of 5 July 2023 qualifies this ambition (Proposal for a Directive on Soil Monitoring and Resilience, COM (2013) 416 of 5 July 2023) as it now focuses on soil monitoring rather than explicitly on soil restoration. The requirement for legally binding targets to be achieved has disappeared. Furthermore, with regard to sustainable soil management (article 10), the Member States will have to define sustainable soil management practices that will have to be progressively implemented on all managed soils, as well as soil management practices that have a negative impact on soil health and that will have to be avoided by soil managers. However, on the one hand, the obligations on land managers are not direct and, on the other hand, the time required to define these management practices is not immediate. However, the proposed text must now be examined by the European Parliament and the Council.

In addition, one of the main difficulties faced by the draft Soil Framework Directive is that the Member States' conception of soil is not conducive to taking account of its ecological functionality. It is, in fact, a soil-surface where the sovereignty of the states is expressed and private property claims are made. From this point of view, a legal framework on soil is immediately associated with a fear of loss of prerogatives, which a contractual approach can mitigate. However, Member States' views on soils have changed.[10] They are now more receptive to a more holistic view of soil and thus more broadly to a new Soil Framework Directive which may set legal requirements for soil protection which they will have to implement. All soils, especially agricultural soils, are privately owned. Here, too, a shift towards the use of land for environmental purposes is noticeable. Both owners and tenants of agricultural land are increasingly aware of the need to use agricultural land sustainably. This awareness is driven by the Common Agricultural Policy which, through its contractual funding, guides farmers' agricultural practices. Through their competences in the field of land use planning and land policy, the Member States are also at the origin of this change by proposing, in particular, the integration of environmental clauses in rural lease contracts.

[9] Ibid.

[10] In addition, "The proposal for a soil health law answers calls from the European Parliament and the European Committee of the Regions to develop a comprehensive EU legal framework for soil protection and to grant this valuable natural resource the same level of protection as water and air", Proposal for a Directive on protecting, sustainably managing and restoring EU soils - Soil Health Law, Document Ares(2022)1132884, See Call for evidence for an impact assessment.

The purpose of this chapter is to highlight the existence of a particular conjunction of legal instruments for the protection of European soils, and more particularly European agricultural soils, on which we will focus. Both contractual and regulatory tools are currently being developed with the same aim of protecting soil and preserving its functions and services. The announced arrival of a new framework directive on soil containing a new regulatory approach provides an opportunity to consider the link between these two approaches, i.e. between a regulatory approach and a contractual approach. To anchor this analysis, we illustrate our remarks by focusing more specifically on carbon sequestration.

First, we will develop the contribution and the undeniable interest of the contractual approach to preserve and sustainably manage agricultural soils (Sect. 2). The aborted draft Soil Framework Directive put the functions and services of soil in the spotlight. Its withdrawal did not extinguish interest in this aspect of soil protection and in a way left the field open for other interventions than regulatory ones. In this case, the clearly stated recognition of the services provided by soils has opened up prospects to identify a new contractual object. Actions to preserve them are, in fact, at the heart of contractual arrangements that consider specific services provided by the soil, such as carbon sequestration. Protection through the preservation or restoration of these services implies new contractually agreed agricultural practices. The farmers concerned are thus encouraged to change their practices without being hindered in their freedom to use their land as they wish. The potential of the contractual tool appears undeniable to contribute to the preservation and improvement of agricultural land. In particular, in the agricultural field, the contractual tool has been able to renew itself to propose innovative formulas and thus meet specific environmental expectations, including the fight against climate change. The contract will therefore be a privileged vector to encourage agricultural practices favourable to the sustainable management of agricultural soils but also to commit to environmental performance by linking the conclusion of contracts with farmers to the achievement of environmental results.

However, in order to consolidate or even reinforce the changes in practices obtained with the help of contracts, but also to offer a common orientation to ensure the sustainable management of soils, in this case agricultural soils, the regulatory tool appears useful or even necessary. This need may arise from both greater visibility of the capacity of soils to respond to the challenges of global change, leading to a collective awareness and the urgency of the action to be taken. Agricultural soils have a special place among the responses to the reiteration of the urgency to act to curb global change.[11] In particular, they are being considered as negative emission technologies (NETs)[12] to remove and sustainably store CO2 from the atmosphere. The urgency of the action to be taken certainly requires us to think

[11] IPPC (2009).

[12] Fuss et al. (2018); IPPC (2018), pt C. 3.1; Langlais and Lemoine-Schonne (2022); Langlais (2022).

differently about the legal attention given to soils, and more specifically to agricultural soils, with regard to the expectations that are formulated for them.

This is why, in a second step (Sect. 3), we will examine the support that a regulatory approach can give to the contractual one. The new European soil strategy of 2021 allows a start to be made. This strategy proposes that the requirements for sustainable land use should be assessed during the impact assessment so that there is no obstacle to ecosystem services. This announcement is associated with a draft Soil Framework Directive for 2023.

On reading this strategy, we hypothesised that sustainable soil use was based on a high environmental ambition for the European Commission, namely not to alter the ecological integrity of soil. Based on this assumption, we saw this new binding legislative framework as an opportunity to create a synergy with the contractual approach to sustainable soil management, in this case agricultural soil. This potential synergy was tested from a spatial perspective by analyzing the relevance of ecological zoning of agricultural soils for carbon sequestration. This potential was also tested from a temporal perspective by questioning the legally binding objectives for restoring the most carbon-rich degraded ecosystems envisaged in the framework of the 2030 biodiversity strategy, on which the soil strategy also intends to rely. A truly binding legal framework around the setting of legal requirements for sustainable land use is therefore currently being developed. In this last section, the aim is to verify how this new regulatory framework can contribute to strengthening the legitimacy of the contractual tool, but also to specify how the contract can broaden the sometimes limited spectrum of action of the regulatory tool.

2 The Contractual Tool, Ideal Tool for Encouraging Changes in Agricultural Practices That Are Favourable to Agricultural Soils

The ecosystem services approach, i.e. the services provided by ecosystems for human well-being,[13] has the merit of considering agricultural soils not only as a production support but also as an ecosystem.[14] This implies that soils, in this case agricultural soils, as ecosystems, must also respect their own needs to be able to provide the required ecosystem services. Of course, the productive dimension is still present, including in the approach to services, since supply services are currently included in the categorisation developed by the Millennium Ecosystem Assessment (MEA).[15] However, including in this hypothesis, the services approach allows agricultural production to be reconnected to the soil as an ecosystem, a connection that had been undermined for many years.[16]

[13] MEA (2005).

[14] Langlais (2015).

[15] MEA (2005).

Alongside these provisioning services, there are other services such as support, regulation or cultural services according to the categorisation established by the MEA, readapted by the CICES (Common International Classification of Ecosystem Services).[17] Among the ecosystem services that have come to the fore in the agricultural sphere, the climate regulation service of carbon sequestration is particularly promoted. The issue of carbon sequestration in agricultural soils gives visibility to these soils. This highlighting of agricultural soils through carbon sequestration contributes to the development of new contracts.

One of the immediate advantages of contracts is their flexibility, both to adapt to the actors involved and to local requirements. However, precisely, the great diversity of agricultural soils, adapted and differentiated practices may be required. This valuable advantage of contracts is coupled with a recent contractual innovation to integrate the environment into agricultural production. These approaches mark a real turning point in the relationship between agricultural production and the environment, with the latter becoming an opportunity rather than a constraint. Agricultural soils are a privileged witness to this new paradigm, which is reflected in the contracts by the identification and integration of relevant agro-ecological practices for agricultural land use (Sect. 2.1) as well as a search for environmental performance (Sect. 2.2).

2.1 Identification and Integration of Agro-ecological Practices Favourable to Soil Preservation Within Contracts

The identification of agro-ecological practices that are favourable to soil preservation is an essential prerequisite for initiating a change aimed at preserving agricultural soils and their capacity to provide services. Contracts are an important vehicle for this change, as they allow the desire of the person working the land to change their practices to be respected.

The contractual initiative can come from two different initiatives. It can come from the CAP wishing to encourage agro-ecological practices deemed relevant for the environment. In all EU Member States, European agricultural policy undoubtedly shapes the national agricultural policy of individual Member States through its contractual financial instruments. These long-established instruments include agri-environmental and climate change measures (AECMs) under the second pillar of the CAP, as well as the new eco-schemes under the first pillar of the CAP which came

[16]The work of the chemist Liebig contributed to this. He argued that the soil was not the source of all the elements necessary for the plant; his discoveries thus made it possible to get rid of "bad soils"; the soil therefore no longer became an essential resource for the proper development of plants but a "simple support".

[17]https://cices.eu (Last access: 22 June 2022).

into force in 2023. According to Article 31 of the regulation on support for strategic plans:[18] "Member States shall establish, and provide support for, voluntary schemes for the climate, the environment and animal welfare ('eco-schemes') under the conditions set out in this Article and as further specified in their CAP Strategic Plans" (paragraph 1). "Furthermore, the article specifies in its paragraph 3 that: "Member States shall establish the list of agricultural practices beneficial to the climate and the environment and animal welfare and combatting antimicrobial resistance". "In mid-January, the Commission published a list of potential eco-regimes in which a wide range of agricultural practices are suggested such as agroecology (crop rotation, low-intensity grassland farming), agroforestry, precision farming (reduced use of fertilisers) and carbon sequestration (extensive use of permanent grasslands).

The initiative may also come from a landowner wishing to offer his tenant a rural lease with environmental clauses. These land tenure contracts vary from one Member State to another, as land law is a matter for the Member States. For example, French legislation has created a specific category of contracts, the rural lease with environmental clauses, with a specific legal regime.[19] According to Article R.411-9-11-1 of the French Rural and Maritime Fishing Code, sixteen environmental practices, which may consist of practices to be maintained or new practices to be introduced by the tenant, may be at the heart of the contractual commitment. Among these, some directly concern soil protection. Among the practices identified, these include non-tillage of grassland, the creation, maintenance and management of grassland areas, the limitation or prohibition of fertiliser inputs, periodic or permanent plant cover for annual or perennial crops, tillage techniques and techniques combining agriculture and forestry, particularly agroforestry. The purpose of these contracts, which are granted as a derogation from the classic contracts concluded between a landowner and a tenant of agricultural land, is to "green" the contracts for access to land. In fact, this rural lease with environmental clauses has, in this French framework, a limited scope of application insofar as the environmental clauses are pre-identified, and only a lessor who is a legal entity under public law or an approved environmental protection association can envisage their implementation throughout the territory. For a private lessor, only certain designated plots are eligible. These are those that already benefit from environmental protection.

In addition to these lease contracts granting access to the land, in their 'green' version or not, other contracts targeting specific practices, such as those promoting carbon sequestration, may be superimposed. These contracts reflect the emergence of new forms of contractualisation based on the promotion of identified ecosystem

[18] Regulation (EU) 2021/2115 of the European Parliament and of the Council of 2 December 2021 establishing rules on support for strategic plans to be drawn up by Member States under the common agricultural policy (CAP Strategic Plans) and financed by the European Agricultural Guarantee Fund (EAGF) and by the European Agricultural Fund for Rural Development (EAFRD) and repealing Regulations (EU) No 1305/2013 and (EU) No 1307/2013, *OJ L 435, 6.12.2021.*

[19] Bodiguel (2011).

services. However, this contractual overlap on the same agricultural land is not without its difficulties insofar as the two contracts are not necessarily based on the same contractual commitment period.[20] Therefore, if the lessor does not allow the duration of the lease contract to be adapted to other environmental commitments made by the lessee, it will be difficult to carry out certain environmental actions on the agricultural land.

Lease contracts with environmental clauses aim at the respect of particular agro-ecological practices, which have supposed environmental effects. In this contractual hypothesis, if a farmer commits himself to respect a particular practice, he only commits himself to the implementation of this practice and not to the expected effects of the latter. However, a new logic of environmental performance, particularly present in the framework of the CAP reform, tends to modify the paradigm from action-based contracts to result-based contracts.

2.2 The Search for Environmental Performance Within Contracts

This search for environmental performance requiring specific environmental results is expressed explicitly by the establishment of result-based contracts, which would be concluded individually by a farmer. This search for environmental performance is also expressed implicitly by encouraging collective implementation, which is particularly relevant for obtaining results not on a given plot scale but on a landscape scale (Kerr et al. 2014).

These contractual forms meet with strong expectations, particularly on the part of the European institutions. The European Court of Auditors,[21] in particular, has not hidden its interest in this area. Echoing this expectation,[22] the European regulation of 6 December 2021 on national strategic plans states that 'Member states may promote and support collective schemes and result-based payment schemes to encourage farmers or other beneficiaries to deliver a significant enhancement of the quality of environment at a larger scale or in a measurable way' (article 70 paragraph 5).

Result-based contracts are bound to have a significant impact on carbon sequestration in agricultural soils insofar as, from the point of view of climate change mitigation, contracting is only of interest if a certain quantity of carbon is effectively and permanently sequestered. In line with this, the European Commission, in

[20] Bodiguel (2021).

[21] European Court of Auditors, Special Report No. 7/2011, Is Agri-environment Support Well Designed and Managed, paras. 26 and 27 (available at https://www.eca.europa.eu/Lists/ECADocuments/SR11_07/SR11_07_EN.PDF, Last access: 22 June 2022).

[22] In The Future of Food and Farming, it was stated that there should be "a greater focus on high standards and actual results" and, more specifically, that there should be "a result-oriented delivery of environmental and climate public goods, European Commission, The Future of Food and Farming (COM(2017) 713 final), pp. 9 and 20.

launching the European initiative for carbon storage in agricultural soils, relied on a recently published study.[23] In particular, this study examined existing climate change programmes in five promising areas: peatland restoration, agroforestry, soil organic carbon (SOC) maintenance and enhancement on mineral soils, SOC management on grasslands and carbon balance on livestock farms. In addition, the study concluded, above all, that agriculture, if results-oriented, “can potentially make a significant contribution to climate change mitigation in the EU” and offer co-benefits such as increased biodiversity and ecosystem preservation. The same study points out that soil management practices that sequester carbon are already known, effective and low-cost practices.

While the logic of results in terms of carbon sequestered in agricultural soils is justified, it is nonetheless contractually risky because of the difficulties of measurement,[24] a certain volatility of carbon stocks over time and climatic and environmental hazards.[25] Indeed, since the contract is based on environmental results, failure to achieve them is contractually binding on the farmer. The latter, although having implemented all the required environmental practices, could therefore be refused any payment. In addition to a contractual risk, a logic based on environmental results is also likely to put agricultural soils at risk. Indeed, to the extent that payment is associated with tangible environmental results, a quantity of carbon sequestered could unfortunately encourage land degradation before any commitment. Such a process would aim to maximise the opportunity to improve the land and consequently the financial benefit associated with this improvement.

For this reason, it is becoming increasingly relevant to mix outcome-based approaches with practice-based approaches. A collective implementation of these contractual forms also fits well with these hybrid formats. It can indeed make it possible to reconcile a contractually secured approach to the achievement of agro-ecological practices and to finance the result of collective efforts made on a scale that goes beyond the single contracted agricultural plot. In the context of carbon sequestration, the protection of a carbon sink whose contours exceed those of the contracted agricultural plots can usefully benefit from contracts of this nature. Moreover, carbon sinks are not necessarily located on the territory of a single farm and therefore require the potential commitment of several different farmers.

However, the downside of these valuable contributions of contracts to agricultural soil conservation is the temporality of contractual obligations, the relative effect of contracts, but also simply the willingness to commit or not. Indeed, can the efforts made to increase or maintain carbon sequestration in response to a contractual commitment be sustained once the commitment has expired? Furthermore, since the contract only binds the parties to the contract, there is necessarily a risk of fragmentation of the efforts made if no rules are established to set a common measure of carbon sequestration and to ensure monitoring and control outside the

[23] European Commission et al. (2021).

[24] For example, see Schwarz et al. (2008).

[25] Langlais (2022).

contracting parties of the results obtained. Finally, the carbon sequestration potential of certain ecosystems may not be easily subject to the willingness of farmers to contract or not. More generally, the urgency of the climate situation and the need to capture carbon in agricultural soils means that agricultural soils, whether already rich in carbon or capable of increasing the amount of carbon sequestered, must be widely mobilised.

Therefore, the flexibility offered by contracts to boost agricultural actions or practices in favour of agricultural soil protection and to give responsibility to the actors involved should be complemented by a common legal framework with common legal requirements to consolidate and guide the contractual actions undertaken. Although not yet clearly defined, this legal framework for setting legal requirements for sustainable land use is currently under construction.

3 Building a Binding Legal Framework Around the Setting of Legal Requirements for Sustainable Land Use

Setting requirements for sustainable use, to which the phrase "so that there are no obstacles to ecosystem services" has been added, offers a relatively clear orientation of the tone of the legal requirements required, which can be specified by the use of the notion of soil health[26] in the very title of the European soil strategy. Its definition is "Soils are healthy when they are in good chemical, biological and physical condition, and thus able to continuously provide as many of the following ecosystem services as possible: (. . .) act as a carbon reservoir".[27] The definition of "healthy soil" in article 3.4 of the proposed directive of 5 July 2023 is along the same lines. A soil health approach is not insignificant, as it explicitly refers to the ecological functions of the soil. On the basis of its ecological functions, soil must be able to "function as an essential life support system, consisting of biological elements that are key to the proper functioning of the ecosystem within the limits of land use".[28] Therefore, in the light of the new European soil strategy's focus on soil health, not excluding ecosystem services in setting requirements for sustainable soil use allows an ecological, non-utilitarian view of soil use to be emphasised. The ability of land to provide ecosystem services is based on its ecological functioning. It follows that the standard on which legal requirements for sustainable land use should be based should be an ecological standard that protects the soil and is therefore less dependant of current and future land uses. In this respect, legal requirements for sustainable

[26] The notion of quality appeared at the same time as that of soil health. It corresponds to the stability of the soil ecosystem through its resilience to stress, its biological diversity and the level of internal recycling of nutrients (Elliott and Lynch 1994).

[27] European soil strategy, p. 5.

[28] Kinyangi (2007).

land use offer a certain hierarchy of uses, which is often lacking in the concept of sustainability.[29]

Moreover, the reference to the notion of soil health, far from being trivial, can also help to characterise this ecological standard. This is the choice made by the World Soil Charter in its revised version of 2015.[30] Although the notion of soil health does not necessarily enjoy consensus within the scientific community, soil health and soil quality now seem to be synonymous.[31] It is stated that the notion of health is preferred to that of quality "because it maintains a more 'living' vision of soil, more dynamic, involving a holistic approach".[32] Moreover, these same authors emphasise that "recognising that soil has its own health means recognising that its condition can be altered" and that, regarding agricultural soils, "a certain number of practices[33] are now recognised for their contribution to good soil health".[34] However, a holistic vision of the soil whose health can be altered ultimately refers to the preservation of the ecological integrity of the soil as an ecological standard of preservation: "The ecological integrity of the soil- which is the preservation of the ecosystems, including the prevention of loss of their wholeness, so as to prevent the commencement of soil degradation, to control existing soil degradation, and to protect and manage soil for its sustainable use".[35]

Consequently, if respect for the ecological integrity of agricultural soils is the ecological standard for preserving these soils, the legal framework for land use must naturally be consistent with this standard.

Applied to carbon sequestration in agricultural soils, it is therefore appropriate to examine this framework in the light of the conditions of spatial (Sect. 3.1) and temporal (Sect. 3.2) expression of the ecological integrity of agricultural soils.

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[29] Mauerhofer (2016).

[30] In 2015, a revised version of the World Soil Charter, adopted by the FAO in its initial version in 1981, focuses on soil health and especially on soil ecosystem services. Indeed, according to the ninth principle, "All soils – whether actively managed or not - provide ecosystem services relevant to global climate regulation and multi-scale water regulation. Land use conversion can reduce these global, common-good services provided by soils. The impact of local or regional land- use conversions can be reliably evaluated only in the context of global evaluations of the contribution of soils to essential ecosystem services", FAO, Revised World Soil Charter, June 2015, point 9, Retrieved on 9 October 2017 from www.fao.org, p. 5, available at https://www.fao.org/publications/card/fr/c/e60df30b-0269-4247-a15f-db564161fee0 (Last access: 22 June 2022).

[31] Doran (2002).

[32] Chabert and Sarthou (2017), p. 54.

[33] These practices include no tillage, diversification of sales and intermediate crops, the use of plant cover and the use of organic amendments (Larkin 2015), all of which are the subject of contractual commitments (see above).

[34] Chabert and Sarthou (2017), p. 54.

[35] Hannam and Boer (2002), p. 38.

3.1 Respecting the Spatial Dimension of the Ecological Integrity of Agricultural Soils: The Relevance of Ecological Zoning?

Efforts to improve the quality of agricultural soils, using the contractual tool, such as an increase in the quantity of carbon in these soils, are not necessarily secure insofar as changes in land use could ruin the efforts made or even worsen the situation due to a release of the sequestered carbon. In addition to taking into account this logic of additional carbon storage to be promoted and conserved, certain naturally carbon-rich areas also deserve special attention. Many of these areas are already protected. In the case of soils, this legal protection is indirect in that it is not aimed at soils in particular but at sites identified as being of great value. These are, for example, wetlands of international importance protected under the Ramsar Convention of 2 February 1971 or Natura 2000 sites under the Habitats Directive of 21 May 1992.[36] In this case, what about agricultural soils, many of which are "ordinary" and therefore do not benefit from this indirect protection. Would ecological zoning be a relevant mechanism for preserving the integrity of agricultural soils in their spatial dimension and thus ensure the sustainable use of these agricultural soils?

The purpose of zoning is to divide the territory into several zones in order to think about the use of space. This spatial planning makes it possible to establish which uses will have priority or at least to reserve spaces for a particular use. In the environmental field, ecological zoning is a common technique. The motivation behind such zoning is quite diverse. For example, it may be to protect the vulnerability of an area subject to specific sources of pollution, as is the case for vulnerable areas under the directive of 12 December 1991 on water pollution by nitrates from agricultural sources.[37] It may also be a question of protecting threatened habitats and species. This is the purpose of the "Natura" network protection areas provided for by the above-mentioned directive of 21 May 1992. They may also be to protect drinking water catchment areas provided for by Directive of 16 December 2020 on the quality of water intended for human consumption,[38] the objective of which is to prevent risks to water safety. The establishment of these zones is accompanied by a set of rules intended to ensure the prevention and management of the targeted risks, guaranteeing the respect of the objective to be reached. These zones could help to calibrate the contractual tools so that they contribute, in a concerted manner, to the stated objectives of these zones. These may be public contracts or private contracts, as is the case for the Vittel company. This company is emblematic of the use of payments for environmental services[39] developed in drinking water catchment areas.

[36] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora, OJ L 206, 22/07/1992.

[37] Council Directive of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources, OJ L 375, 31.12.1991.

[38] Directive (EU) 2020/2184 of the European Parliament and of the Council of 16 December 2020 on the quality of water intended for human consumption, OJ L 435, 23.12.2020.

Faced with the high cost for water denitrification, the Perrier-Vittel company opted for a new approach by entering into long-term contracts with farmers who live near the water catchment area on land that it had bought. The aim of these contracts is to set up particularly restrictive conditions of agricultural land use for farmers in return for a payment in order to reduce as much as possible the quantity of nitrates in the water to be collected.

With regard to agricultural soils, particularly in terms of their capacity to sequester carbon, on what basis could such zoning be envisaged? Under French legislation, for example, it is possible to reserve sectors for agriculture. Such zoning, established by a public authority, is justified by the agronomic, biological or economic potential of agriculture. Traditionally, it is the agronomic and therefore economic value of the land that is emphasised. However, the agronomic and ecological quality of lands do not necessarily go hand in hand. Some lands that are poor from an agronomic point of view could be 'environmentally-rich land, such as meadows and extensive pasture land".[40] In this case, these soils are precisely carbon-rich.

Doesn't the IPCC's repeated finding of the disastrous consequences for the earth's livability of a temperature rise above 1.5 degrees in average surface temperatures and the call for carbon capture solutions in addition to mitigation measures[41] provide a legitimate basis for establishing such zoning for agricultural soils? More specifically, do the risks associated with land use and land use change for climate change not form a valid basis?

If this is the case, the question of the territorial delimitation of these zones arises. Should we consider the territorial contours of carbon sinks? If so, what criteria should be used, given that a carbon sink is a process by which GHGs are removed from the atmosphere? This process can more easily be based on a territorial anchoring when the extraction process is chemical. However, it is more complex when the carbon sink is natural.

While the legal consequences of these carbon sinks are becoming more and more concrete, particularly in relation to agricultural soils, it is clear that there is no legal definition of these sinks that would clarify their spatial scope. This lack of definition contrasts with the strong interest in carbon sequestration in agricultural soils, particularly at the European Union level. Indeed, this sequestration echoes the 4/1000 initiative, according to which increasing the carbon stock of agricultural soils by 0.4% (or 4 per 1000) each year in the top 40 centimetres of the soil would, in theory, be equivalent to the increase in annual carbon emissions caused by human activities.[42] This initiative launched by the French government at the 21st

[39] For a legal analysis of PES applied to agriculture, see Langlais (2019).

[40] Special Report No 14/2000 on 'Greening the CAP' together with the Commission's replies (OJ C, C/353, 08.12.2000, p. 1, available at, pt 29.

[41] Achieving "carbon neutrality" by 2050, i.e. reaching a balance between the amount of greenhouse gases emitted worldwide and the earth's capacity to capture and store carbon dioxide, requires drastic GHG emission reductions. In its 2018 report (IPCC 2018), the IPCC considers other complementary options for achieving carbon neutrality.

[42] Amelung et al. (2020).

Conference of the Parties to the United Nations Framework Convention on Climate Change as part of the Lima-Paris Action Plan is seen as an additional opportunity to counter the increase in CO2 concentrations in the atmosphere. This 4/1000 initiative is also an integral part of the European Soil Strategy, as it expressly states that it wants to contribute to it. In particular, this strategy is in line with a number of existing objectives, including that of achieving “a climate-neutral Europe and, as a first step, aiming for terrestrial climate neutrality in the EU by 2035”. In particular, it is stated that “Achieving net-zero greenhouse gas emissions by 2050 relies also on carbon removals through the restoration and better management of soils to absorb the emissions that will remain at the end of an ambitious decarbonisation pathway. Targeted and continued sustainable soil management practices can significantly help in achieving climate neutrality by eliminating the anthropogenic emissions from organic soils and by increasing the carbon stocked in mineral soils”.[43]

The strategy focuses on two types of soil relevant to the fight against climate change: organic soils and mineral soils, for which it envisages differentiated measures to ensure that soils play a full part in achieving the climate neutrality objective. For the former, the Commission envisages proposing legally binding objectives in the context of nature restoration law “to limit drainage of wetlands and organic soils and to restore managed and drained peatlands, in order to maintain and increase soil carbon stocks, minimise flooding and drought risks, and enhance biodiversity, taking into account the implications of these objectives for future carbon farming initiatives and agricultural and forestry production systems”.[44] For these soils, it is also to “contribute to the assessment of the state of peatlands in the context of the Global Peatland Initiative, hosted by FAO and the United Nations Environment Programme”.[45] For the second type of soil, mineral soils, several measures are envisaged by the European Commission; in particular, it is planned to “consider measures, possibly in the context of the Nature Restoration Law, to enhance biodiversity in agricultural land that would contribute to conserving and increasing soil organic carbon (SOC)”.[46] It is also planned to “Develop a long-term vision for sustainable carbon cycles (including capture, storage, and use of CO2) in a climate-neutral EU economy. As part of this, the Commission will deliver a communication on restoring sustainable carbon cycles, in 2021[47] and present the EU carbon farming initiative and a legislative proposal on carbon removal certification in 2022 to promote a new green business model rewarding land managers, such as farmers and foresters, for climate–friendly practices”.[48]

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[43] European soil strategy, p. 6.

[44] European soil strategy, Pt 3.1.

[45] Ibid.

[46] Ibid.

[47] Communication from the Commission to the European Parliament and the Council, Sustainable Carbon Cycles, COM (2021) 800 final du 15/12/2021. This initiative aims to support the development of sustainable carbon absorption solutions to achieve climate neutrality by 2050. It includes the development of an action plan to promote carbon storage in agricultural soils and the establishment of a regulatory framework for the certification of carbon removals.

Of course, an easy solution would be to rely on the territorial delimitation of agricultural plots to anchor these carbon sinks. However, such a solution would quickly sweep aside the fact that carbon sequestration is a process and that it is highly dependent on the biological activity of a soil: soil organisms will play a role in both the carbon protection mechanisms and the mineralisation of organic matter. However, soil organisms, by their very nature, move. This characteristic may therefore make ecological zoning as such unsuitable.

Although not defined as such, carbon sinks can nevertheless be qualified as ecosystems, defined by the 1992 Convention on Biological Diversity as "a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit" (art. 2). Although the notion of ecosystem as a functional unit does not necessarily offer an easier territorial anchorage, as this notion is so variable in geometry, it nevertheless opens the doors to legal protection of ecosystems. In particular, this ecosystem-based approach makes it possible to envisage the restoration of degraded and therefore altered ecosystems, which is likely to complete the establishment of a binding legal framework based on the setting of legal requirements for sustainable land use. However, protecting the temporal dimension of ecological integrity of soils in this way can be fraught with difficulties.

3.2 Respecting the Temporal Dimension of Ecological Integrity of Agricultural Soils Through Ecosystem Restoration?

In addition to the legislative proposal on the state of soil to achieve healthy soil, the soil strategy states that the Commission will propose legally binding objectives to limit the drainage of wetlands and organic soils and to restore drained and exploited peatlands. This is based on the 'Biodiversity 2030' strategy,[49] which provides for legislation with binding restoration targets for degraded ecosystems. In particular, it targets those with the greatest potential to capture and store carbon and to prevent and reduce the effects of natural disasters.

By preserving soil as a resource in order to achieve its sustainable use, while considering it as an ecosystem to be restored, the European Commission is in line with the latest IPBES recommendations of 2018 on simultaneous action to combat land degradation and restore it.[50] It is also in line with the spirit of the joint IBPES and IPPC seminar of June 2021,[51] which clearly identified the need to avoid and

[48] European soil strategy, pt 3.1.

[49] Communication from the Commission to the European Parliament, the Council, the European economic and social committee and the Committee of the Regions, Biodiversity Strategy for 2030-Bringing nature back into our lives, COM (2020) 380, 20/05/2020.

[50] IPBES (2018).

reverse the loss and degradation of carbon-rich and species-rich terrestrial and oceanic ecosystems such as wetlands, peatlands, grasslands and savannas. Such a synergy of actions in favour of soils, including agricultural soils, can only be beneficial to agricultural soils. Such binding legal provisions will be likely to condition the contractual terms, and even more so to increase the environmental requirements for soil protection in contracts.

This synergy of binding legal provisions opens up a new framework for soils, including agricultural soils. However, two main points of vigilance need to be clarified with regard to the identification of the ecosystem to be restored. The first point concerns the impact of this identification on the protection of the ecological integrity of agricultural soils. The second point concerns the impact on the agro-ecological transformation of agriculture.

Firstly, concerning the impact of the identification of the ecosystem to be restored and its impact on the protection of the ecological integrity of agricultural soils, the issue is to take into account the storage potential of all agricultural soils. The draft European legislation providing for binding objectives for the restoration of degraded ecosystems targets in particular those that have the best potential to capture and store carbon. This would therefore mainly lead to thinking through the prism of ecosystems identified as the main carbon sinks. In this case, do the issues of agricultural soil protection arise in the same terms depending on the ecosystem chosen? Indeed, insofar as the ecosystem is a variable geometry concept, the ecosystem targeted can be both the agricultural soil as an identified carbon sink and a more targeted ecosystem such as a wetland or a meadow. Therefore, there is a potential risk of fragmentation of the legal protection of agricultural soils, if cultivated soils, with a lower carbon sequestration potential, are neglected.

Secondly, concerning the impact of identifying the ecosystem to be restored and its impact on the agro-ecological transformation of agriculture, the challenge is to fully integrate these ecological soil dynamics into agricultural production. Here again, it is important to consider agricultural soils as a fully-fledged ecosystem on two scales. Firstly, it arises from the now well-known perspective of competition between agriculture and forests, the latter being reputed to have a greater carbon sequestration capacity. Agriculture therefore has a role to play in reconciling food production and carbon sequestration, which is also said to have positive effects on biodiversity. The same question also arises within the farm itself, insofar as carbon stocks are generally found in the maintenance of permanent grasslands, wetlands and forests and less in cultivated soils. Carbon sequestration should be an opportunity for the farmer to change his practices and not to consider it as a new environmental constraint confined to a specific plot. This plot is, moreover, likely to be modified according to new production orientations or new arbitrations of the common agricultural policy. The maintenance or otherwise of carbon-rich permanent grasslands has been a casualty of these choices and orientations. The newly reformed CAP should provide new sources of funding to support sustainable agricultural land use.

[51] Pt 7, Pörtner et al. (2021).

Indeed, because of its direct link with agricultural soils, the CAP is likely to play an important role in the development of carbon sequestration-friendly practices. Under the current CAP, this is already the case. The first pillar of the CAP includes obligatory climate and environmentally beneficial agricultural practices. This mandatory ecological component includes the maintenance of existing permanent grasslands which are identified as high carbon sequestration environments.[52] As for the second pillar of the CAP dedicated to rural development,[53] its flagship measure, agri-environmental measures, are now called agri-environmental and climate measures, a testimony to the CAP's role in the fight against climate change. The promotion of "resource efficiency and (support for) the shift towards a low-carbon and climate-resilient economy in the agricultural, food and forestry sectors" (art. 5.5) is listed as one of the Union's priorities for rural development. More specifically, the promotion of carbon conservation and sequestration in the agricultural and forestry sectors is one of the priority areas for action (art. 5.5 e).

This ambition should be increased tenfold in the new CAP, which came into force in 2023, at the same time as many pieces of legislation that contain legal provisions to promote carbon sequestration in agricultural soils. Certain guarantees to ensure this implementation within the new CAP have been already foreseen. These include a requirement that the ambitions of the Green Pact for Europe,[54] a document in which the issue of carbon sequestration has been clearly reinforced, be taken into account in the texts that shape the new CAP. Even before the adoption of the final texts of this new CAP,[55] a link between it, the Green Pact and its different variations had been the subject of an important working document by the Commission services.[56] The aim of this document was to facilitate the preparation of national strategic plans and was intended to integrate the issues of the Green Pact. This

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[52] Regulation (EU) No 1307/2013 of the European Parliament and of the Council of 17 December 2013 establishing rules for direct payments to farmers under support schemes within the framework of the common agricultural policy and repealing Council Regulation (EC) No 637/2008 and Council Regulation (EC) No 73/2009, *OJ L 347, 20.12.2013, See Recital 42:* "For the sake of the environmental benefits of permanent grassland and in particular carbon sequestration, provision should be made for the maintenance of permanent grassland. This protection should consist of a ban on ploughing and conversion on the environmentally most sensitive areas in "Natura 2000" areas covered by Directives 92/43/EEC and 2009/147/EC, and of a more general safeguard, based on a ratio of permanent grassland, against conversion to other uses".

[53] Regulation (EU) No 1305/2013 of the European Parliament and of the Council of 17 December 2013 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD) and repealing Council Regulation (EC) No 1698/2005, *OJ L 347, 20.12.2013.*

[54] Communication from the Commission to the European Parliament, the Council, the European economic and social committee and the Committee of the Regions, The European Green Deal, COM (2019) 640, 11/12/2019.

[55] The main text for the new CAP: Regulation (EU) 2021/2115 establishing rules on support for strategic plans to be drawn up by Member States under the common agricultural policy (CAP Strategic Plans) and financed by the European Agricultural Guarantee Fund (EAGF) and by the European Agricultural Fund for Rural Development (EAFRD), OJ L 435, 6/12/2021.

[56] Analysis of links between CAP Reform and Green Deal, SWD (2020) 93.

integration is particularly important insofar as these plans are now the nerve centre of the reformed CAP. In addition, more specifically, recommendations on carbon sequestration in agricultural soils were made to Member States for the preparation of their strategic plans. These strategic plans must contain all the tools of the different pillars of the CAP, including the eco-schemes, which have been identified as the ideal tools for accommodating new measures in favour of carbon sequestration.[57] Finally, in order to ensure that these carbon sequestration issues are taken into account at the heart of CAP documents, the European Commission is to monitor the directions taken by these national strategic plans.

The regulatory approach still being developed also potentially has a number of limitations in addressing the issues of carbon sequestration currently largely absorbing soil protection as an ecosystem. These measures are still far from being defined, but it is important to consider in advance the risks that any particular legal requirement affecting agricultural land use could entail for soil protection, i.e. an overly fixed or fragmented approach to protection.

4 Conclusion

Through carbon sequestration in agricultural soils, we have analysed the role of the contractual tool in protecting these soils. Although it appears that contracts alone cannot ensure this protection, it is not a question of depriving ourselves of its incentive dynamic but rather of linking it to a regulatory approach to preserve the ecological integrity of agricultural soils in all their dimensions. Although increasing carbon sequestration in agricultural soils has the virtue of meeting the objectives of combating climate change and preserving biodiversity, as well as preserving food sovereignty, the legal responses, although abundant, are still hesitant and marked by scientific uncertainties about the future of this carbon storage and, more generally, about the legal protection of this storage.

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Part II
Recent International Developments

UNFCCC CoP26: Key Outcomes for Soil Management

Fabiano De Andrade Corrêa, Margret Vidar, and Tejas Rao

Abstract Declining soil health does not often reach the frontpages of newspapers or dominate the news cycle. Yet the importance of soil health cannot be understated. The health of soil everywhere is threatened by climate change. Unsustainable soil policy and use can contribute to the advancing of climate change, whereas sustainable soil management can and should be part of the solution(s). Against this background, this brief paper aims to expand on the value of soil. After establishing this context for the purposes of the climate conversation, the paper expands on the international legal frameworks on soil and its place within the international climate change regime. From this, it discusses key advancements made at the UNFCCC CoP26 held in Glasgow, Scotland in 2021, with a particular focus on the Korovia Joint Work in Agriculture, the Global Methane Targets, and the Glasgow Declaration on Forests and land use. We conclude by looking forward to what might happen at the upcoming UNFCCC CoP27 in Sharm-el-Sheikh, Egypt in 2022.

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1 Introduction: The Value and Importance of Soil in the Climate Change Context

Land provides the basis for human livelihoods and well-being including food supply, freshwater and multiple other ecosystem services, as well as biodiversity. At the same time, human activity has already directly affected more than 70% of the global ice-free land surface. Further, land can be simultaneously a source and a sink of CO2 due to both anthropogenic and natural drivers, making it difficult to separate anthropogenic from natural fluxes. Soils play an important part in this puzzle. The IPCC reports that activities related to ‘Agriculture, Forestry and Other Land Use (AFOLU)’ accounted for around 13% of CO2, 44% of methane (CH4), and 81% of nitrous oxide (N2O) emissions from human activities globally during 2007–2016, representing 23% of total net anthropogenic GHG emissions.[1] Agriculture is amongst the sectors already suffering from the heaviest negative impacts of climate change. Extreme weather events are having a profound effect on agricultural performance worldwide and will likely be both more frequent and more intense in the future. Not only does this influence levels of agricultural production, but it is also expected to alter the present conditions of agriculture in almost all countries worldwide, including risks for other important goals like food security.

At the same time, it is pointed out that the mitigation potential of agriculture is large, equivalent to around 6 billion tons of carbon dioxide per year. Around 90% of this potential lies in increasing carbon sinks, primarily through sequestering carbon in the soil, reducing emissions from inputs (e.g. fertilizers) and livestock management (e.g. manure management), etc. This can be promoted, among other means, through the implementation of practices such as agroforestry, improved grazing land management, crop rotations and fallows, residue management, reduced tillage and the restoration of degraded lands. In addition, considering that CDR technologies are still in their infancy, as mentioned above, so-called ‘nature-based solutions’ are gaining increasing recognition due to their huge potential and easier implementation.[2]

A growing number of States around the world are proposing policies that encourage the building of healthier agricultural soil. Although an expensive and costly investment, research indicates that this can benefit farmers and the environment. The improved health of soil will mean that it can retain water in a better manner.[3] Critically, healthy soil can also store more carbon; absorb water like a sponge before becoming saturated, making it more resilient in a dry year; and improve water quality by retaining more water, which reduces runoff from

[1] IPCC (2019).

[2] de Andrade Correa and Voigt (2021).

[3] Friedrichsen et al. (2021), p. 3.

cropland.[4] Healthy soil goes further in meeting the needs of a growing population and food production.[5]

It is no wonder then that in recent years the attention of the global community has turned toward the question of sustainable soil management.

1.1 The Importance of Soil as a Solution to Climate Change

As already noted above, land and soil where managed and used unsustainably are key causes of climate change. However, as critical climate sinks, they can form a part of the solution to climate change.

Agriculture already suffers the heaviest negative impacts of climate change. Extreme weather events are having a profound effect on agricultural performance worldwide and will likely be both more frequent and more intense in the future. Not only does this influence levels of agricultural production, but it is also expected to alter the present conditions of agriculture in almost all countries worldwide, including risks for other important sustainable development goals including food security.[6]

At the same time, it is pointed out that the mitigation potential of agriculture is large, equivalent to around 6 billion tons of carbon dioxide per year.[7] With respect to the role of the land sector in reaching global net-zero CO2 emissions, the IPCC notes that all modelled pathways that limit global warming to 1.5 °C or below 2 °C require land-based mitigation and land-use change, with most including different combinations of reforestation, afforestation, reduced deforestation, and bioenergy, but their scale depends on the pursued mitigation portfolio.[8] Pathways that limit global warming to 1.5 °C with project up to a 2.5 million km increase of non-pasture agricultural land for food and feed crops.[9]

In this context, it is useful to reflect on the fact that multiple technology solutions are still being researched. These include bioenergy, carbon capture and storage, and increased carbon sequestration in soils. While preliminary research reveals the enormous potential of these solutions, the market for these it yet to ripen. What may be useful in assessing market conditions and where to devote resources for the climate solution is that soils are the second largest carbon sinks in the world after the oceans.[10] It is no wonder then that international law and regulation has turned its attention to the sustainable use and management of soils, and soil conservation.[11]

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[4] *Id.,* 4.

[5] *Id.,* 6.

[6] FAO (2017a), p. 72.

[7] *Id.,* 78.

[8] IPCC (2019).

[9] FAO (2017b), p. 23.

[10] Geden and Schenuit (2020).

[11] Ruppel (2022).

1.2 The International Law Association Guidelines on the Role of International Law in Natural Resources Management for Sustainable Development

In Japan, the International Law Association adopted Guidelines on the Role of International Law in Natural Resources Management for Sustainable Development[12] and emphasized critically the importance of the sustainable management of soil. The accompanying report is especially important for the observations it makes about land use and soil.

In addition to the global relevance in relation to the sustainable management of the atmosphere and a stable climate system, and conservation of biodiversity, as well as any transboundary or regional relevance, land and soils within States still play a significant role in international environmental, societal, cultural and security concerns and are thus subject to international laws and policies as well as national laws and enforcement mechanisms.[13] Furthermore, the report notes that land and soil are increasingly viewed through an international human rights lens, which impacts on their sustainable management.[14]

The report also notes that nearly all States are required to create National Biodiversity Strategies and Action Plans (NBSAPs) for the sustainable use and conservation of biodiversity resources, which should include soil biodiversity. It prioritises that States should take action to restore, conserve and enhance terrestrial and coastal land and soils, including wetlands, peatlands and mangroves. These are especially important because these lands and soils function as greenhouse gas sinks and reservoirs.[15]

It further notes that States should additionally contribute to enhancing adaptive capacity, including in relation to agricultural lands and food security, and seek a high level of ambition in their NDCs under the Paris Agreement in order to minimize the risks and impact to land and soil resulting from the effects of climate change. States shall also combat desertification and mitigate the effects of drought in areas experiencing serious drought and/or desertification through effective National Action Plans as well as through international cooperation and partnerships, including long-term integrated strategies focusing on improved productivity of land, and the rehabilitation, conservation and sustainable management of land and water resources, leading to improved living conditions. States shall strive to achieve a land degradation neutral world through setting land degradation neutrality targets and collaboration. Further, States should designate wetlands of international

[12] ILA (2020).

[13] *Id.,* 13.

[14] *Id.*

[15] *Id.*

significance within their territories, adopting an ecosystem approach, and identify areas of relevance under the World Heritage Convention.[16]

The ILA Guidelines also recognise that States have a duty to prevent pollution of land and soils, including by chemical and other types of pollutants such as pesticides and fertilizers, or resulting from mining, and take appropriate measures to avoid the risks presented by such products or activities to human health and the environment, including through adequate legal and institutional measures at national level. It calls on them to implement regional conventions with provisions directed towards the sustainable management of soils, as well as sectorial treaties, dealing for example with water, air, protected areas and species, hazardous substances, pollution and waste, which implicitly have the objective of protecting land and soil.[17] This inclusion is important because it recognises implicitly the soil as part of what is regulated by States' obligations within international environmental law.[18]

The ILA further emphasises the importance of commitments that States have made already. It indicates that States should cooperate to implement the Revised World Soil Charter, as further elaborated in the Voluntary Guidelines for Sustainable Soil Management (VGSSM).[19] In particular, States should pursue the overarching goal to ensure that soils are managed sustainably and that degraded soils are rehabilitated or restored, and that actions at all levels are informed by the principles of sustainable land and soil management and contribute to the achievement of a land-degradation neutral world in the context of sustainable development. States should promote sustainable soil management and strive to create socio-economic and institutional conditions favourable to sustainable soil management by removal of obstacles, in particular those associated with land tenure, the rights of users, access to financial services and educational programmes, taking into account the Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security (VGGT).

The ILA calls on States to participate in the development of multi-level, interdisciplinary educational and capacity-building initiatives that promote the adoption of sustainable soil management by land users; support research programs that will provide sound scientific backing for development and implementation of sustainable soil management relevant to end-users; and incorporate the principles and practices of sustainable soil management into policy guidance and legislation at all levels of government.[20]

It further says that States should incorporate sustainable use and management of land and soil to promote food security and human nutrition as part of their agricultural, planning, and land management laws, policies and practices. States and non-state actors should promote responsible investments in land, agriculture and

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[16] *Id.*

[17] *Id.*

[18] *Id.*

[19] *Id.;* also see, Blanco and Razzaque (2011), p. 72.

[20] ILA (2020), p. 15.

food systems, including through promoting the conservation and sustainable management of land and natural resources.[21]

2 Soils and the International Climate Change Regime

The purpose of this section is not to provide a holistic overview of international law related to soil management and protection. This includes regimes on many policy areas, such as the United Nations Convention to Combat Desertification (UNCCD), the Convention on Biological Diversity (CBD) as well as the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement, which will be particularly relevant due to the emphasis on the climate aspects of soil management.

2.1 The United Nations Framework Convention on Climate Change

The 1992 United Nations Framework Convention on Climate Change (UNFCCC) was adopted to regulate greenhouse gas concentration in the atmosphere, so as to, *inter alia*, avoid the occurrence of climate change on a level that would compromise initiatives in food production. Article 2 of the UNFCCC defines the object of the Parties as the stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.[22] Agriculture, forestry and land use (AFOLU) have been key targeted areas of the climate change regime from the onset. Further, over time increasing attention has also been place on regulation that aims to preserve and enhance emission sinks to remove carbon dioxide from the atmosphere.[23]

2.1.1 The Kyoto Protocol

The Kyoto Protocol was adopted on 11 December 1997 and came into force on 16 February 2005. In short, the Kyoto Protocol operationalizes the UNFCCC by committing industrialized countries and economies in transition to limit and reduce greenhouse gases emissions in accordance with agreed individual targets. The Convention itself only asks those countries to adopt policies and measures on

[21] *Id.*
[22] Article 2, United Nations Framework Convention on Climate Change.
[23] Feaver and Durrant (2008).

mitigation and to report periodically. The Kyoto Protocol is based on the principles and provisions of the Convention and follows its annex-based structure. It only binds developed countries and places a heavier burden on them under the principle of "common but differentiated responsibility and respective capabilities", because it recognizes that they are largely responsible for the current high levels of GHG emissions in the atmosphere.

The Kyoto Protocol set quantitative targets for countries to reduce their emissions of greenhouse gases to the atmosphere, but it recognized that the same goal can be achieved by removing greenhouse gases from the atmosphere. There were opportunities to reduce the rate of build-up of atmospheric carbon dioxide (CO2) through land management activities, referred to as Land Use, Land-Use Change, and Forestry (LULUCF) activities. These opportunities include slowing the loss of carbon from plants and soils—e.g., through reduced rates of deforestation—and encouraging the return of carbon from the atmosphere to plants and soils—e.g., by planting trees (afforestation and reforestation) or improving management of forests or agricultural soils.[24]

The Kyoto Protocol provided opportunities for enhanced soil conservation activities. These opportunities would have realised the benefits of both carbon sequestration and soil conservation. Although in the past this would have implied simply mobilizing technologies for soil conservation, probably supported by public financing, the Kyoto Protocol identified carbon as a commodity that can be traded on the international market, and identified that sequestering carbon in the soil constitutes a global environmental benefit suitable for payment. This was a major shift in the focus of how soil could be conserved and managed in the fight against climate change and presented a new opportunity for promotion of soil conservation.

The list below is a summary of the most important articles within the Kyoto Protocol that related to soil conservation:

Article 3.1: Emission Reduction: Annex 1 (developed) countries agreed to reduce their overall emissions (assigned amounts) by at least 5% during the first commitment period, 2008–2012. This required monitoring and assessment of soil carbon (Article 5) and reporting (Article 3.7).

Article 3.3: Forestry Sinks: The net changes (difference between emissions at source and sequestration in sinks) in GHGs resulting from direct human induced land use change and forestry are limited to afforestation, reforestation, and deforestation since 1990, measured as changes in carbon stocks. Forestry accounting is on a 'gross–net accounting' basis, i.e., the net change in carbon stocks over the commitment period for activities begun after 1990.

Article 3.4: Agriculture and Forestry Sinks: The net changes (difference between emissions at source and sequestration in sinks) in GHGs resulting from direct human induced land use change and forestry, including cropland management,

[24] Schlamadingerm and Marland (2000).

grazing land management, re-vegetation, and forest management. Reporting on agricultural activities is based on 'net-net accounting', i.e., additions from sources and removals by sinks from all management practices on all areas registered for reporting. Most soil conservation activities would be reported under Articles 3.3 (forestry) and 3.4 (agriculture).

Article 3.7: Reporting: The countries shall report the change in carbon stocks (carbon dioxide equivalents) over the first reporting period (2008–2012) compared to the base year 1990. Based on these GHG inventories, it will be determined whether emissions have been reduced according to the amounts assigned to each country.

Article 6: Joint Implementation (Carbon Trading): Any Annex 1 party may acquire or transfer to another party 'Emission Reduction Units (ERU)' resulting from projects aimed at reducing anthropogenic emissions in any sector of the economy, providing that these are additional to any that would occur otherwise. This implies trading of carbon credits between and within developed countries.

Article 12: Clean Development Mechanism: A Clean Development Mechanism (CDM) shall be developed to assist Annex 1 countries to achieve compliance with their quantified reduction commitments, and to assist Annex 2 countries in contributing to the objectives of the Convention. This requires development of 'Certified Emission Credits (CER)', which are measurable and verified by an independent environmental audit team, and which are long term (relatively permanent) and additional to any that would have occurred in the absence of the certified project. Sinks in the CDM were initially limited to afforestation and reforestation projects for the first commitment period, but increased far more to include agricultural sinks.[25] This implies trading of carbon credits between developed and developing countries.

2.1.2 The Paris Agreement

The Paris Agreement is an international treaty on climate change. It was adopted by 196 Parties at COP 21 in Paris, on 12 December 2015 and entered into force on 4 November 2016. Its goal is to limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels. To achieve this long-term temperature goal, countries aim to reach global peaking of greenhouse gas emissions as soon as possible to achieve a climate neutral world by mid-century. The Paris Agreement is a landmark in the multilateral climate change process because, for the first time, a binding agreement brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects.

In its Preamble, the Paris Agreement includes the explicit acknowledgement "that climate change is a common concern of humankind" and that "Parties should, when taking action to address climate change, respect, promote and consider their

[25] Cabello (2011).

respective obligations on human rights".[26] As such the agreement binds its parties regarding activities on their respective territories and under their control.

The Paris Agreement supplements the UNFCCC and the Kyoto Protocol by incorporating existing elements of this regime. Both the UNFCCC and Kyoto Protocol adopted rules on reporting and accounting for emissions from land use, land use change and forestry (LULUCF). These rules determine how parties have to report LULUCF in their regular emission inventories, which under the Kyoto Protocol is also relevant for accounting whether parties meet their emission reduction targets.[27]

Through the sustainable development mechanism in Article 6, the Paris Agreement allows the space to harness the lowest cost mitigation options worldwide. This may incentivise policymakers to enhance mitigation ambition by speeding up climate action. This implies that global climate policy development and the future of the carbon market also relate to mechanisms which support and encourage sustainable climate policies in host countries as production-based accounting does not necessarily reflect a country's contribution to global emissions because globalisation and consumption can prompt emissions beyond borders.[28]

In addition, the parties to the Paris Agreement explicitly recognise—

> [. . .] the fundamental priority of safeguarding food security and ending hunger, and the particular vulnerabilities of food production systems to the adverse impacts of climate change;

while Article 2(1)(b) of the Paris Agreement provides for—

> [*in*]creasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production [. . .].

The Paris Agreement further requires parties to engage in adaptation planning and implementation that takes into account "vulnerable people, places and ecosystems"[29] and builds "the resilience of socio-economic and ecological systems, including through economic diversification and sustainable management of natural resources".[30]

Soil as well as land use and sustainable land management are closely linked to climate change in terms of carbon capture and storage and the emissions from deforestation and agriculture. This is underlined by Article 4 of the Paris Agreement, which explicitly includes the target "to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century". Although the Paris Agreement fails to explicitly mention 'soil', 'land' or 'agriculture', it does so indirectly. Article 5(1) of the Paris Agreement

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[26] Preamble, Paris Agreement (2016).

[27] Bodle et al. (2016).

[28] Tanzler et al. (2011).

[29] Paris Agreement, Article 9(c).

[30] Paris Agreement, Article 9(e).

obliges parties to take action to conserve and enhance, as appropriate, sinks and reservoirs of greenhouse gases as referred to in Article 4(1)(d) of the Convention.

In 2018, the Paris Agreement adopted a transparency framework which, inter alia, included rules for reporting on and accounting for land use and land-use change, which is expected to eventually replace the existing UNFCCC framework. This may open opportunities also to shape new rules complementing the UNFCCC's Koronivia joint work on agriculture (KJWA).

2.2 *The Koronivia Joint Work on Agriculture*

Agriculture first appeared in the ongoing climate negotiations under the Koronivia Joint Work on Agriculture (KJWA) at CoP23 in 2017:[31]

> The decision officially acknowledges the significance of the agriculture sectors in adapting to and mitigating climate change. Countries agreed to work together to make sure that agricultural development ensures both increased food security in the face of climate change and a reduction in emissions. The joint work is expected to address six topics related to soils, nutrient use, water, livestock, methods for assessing adaptation, and the socio-economic and food security dimensions of climate change across the agricultural sectors.
>
> To achieve the aforementioned, countries should take all appropriate measures according to their capabilities to progressively achieve the protection of the interests of all concerned. And when speaking of 'all concerned' in the context of global food security, this phrase is by no means an exaggeration. Much of the work to translate the Paris Agreement and the NDCs into concrete climate interventions in agriculture is in progress.
>
> Food systems are responsible for 21–37% of global greenhouse gas emissions and a major driver of deforestation and land degradation, yet there is still widespread food insecurity and malnutrition. Managing the land sector (agriculture, forestry, wetlands bioenergy) sustainably and holistically could contribute up to 30% of the global climate mitigation effort.

As can be seen, the KJWA is a landmark Decision recognizing the unique potential of agriculture in tackling climate change. The KJWA was established at the 23rd COP in Fiji in 2017 as a new process to advance discussions on agriculture in the United Nations Framework Convention on Climate Change (UNFCCC).

Under the leadership of the UNFCCC Subsidiary Body for Scientific and Technological Advice (SBSTA) and Subsidiary Body for Implementation (SBI), and in conjunction with ten Constituted Bodies of the Convention, countries agreed to work together to make sure that agricultural development ensures both increased food security in the face of climate change and a reduction in emissions. The joint work is addressing six topics related to soils, nutrient use, water, livestock, methods for assessing adaptation, and the socio-economic and food security dimensions of climate change across the agricultural sectors.

[31] FAO (2021).

The implementation and success of the KJWA depends on combined efforts from Subsidiary Bodies, Constituted Bodies as well as operating entities of the Financial Mechanism under the UNFCCC, Parties and observers, and other relevant stakeholders. Such a setup brings with it many opportunities, as it strengthens science-policy-practice linkages, with the potential to catalyze concrete action when it comes to addressing approaches to food security, the vulnerability of agriculture to climate change, and how to mitigate agriculture's contribution to climate change.

As the Decision[32] elaborates, States were especially invited to consider and share their views on:

a) Modalities for implementation of the outcomes of the five in-session workshops on issues related to agriculture and other future topics that may arise from this work;
b) Methods and approaches for assessing adaptation, adaptation co-benefits and resilience;
c) Improved soil carbon, soil health and soil fertility under grassland and cropland as well as integrated systems, including water management;
d) Improved nutrient use and manure management towards sustainable and resilient agricultural systems;
e) Improved livestock management systems;
f) Socioeconomic and food security dimensions of climate change in the agricultural sector.

The above focus indicates the KJWA's prominence in providing a platform for discussions on soil use and management. The SBSTA and the SBI initiated their joint consideration of the KJWA at their 48th sessions in Bonn, Germany. Based on Parties' and observers' views, a roadmap to guide the KJWA was adopted, with the KJWA due to report back to the plenary at CoP26.

3 UNFCCC CoP26: Specific Results for Soils

3.1 Developments Under the Koronivia Joint Work on Agriculture

At CoP26 in 2021, Governments recognized that soil and nutrient management practices and the optimal use of nutrients lie at the core of climate-resilient, sustainable food production systems and can contribute to global food security. It was also recognized that while livestock management systems are vulnerable to climate change, improving sustainable production and animal health can contribute to reducing greenhouse gas emissions while enhancing sinks on pasture and grazing lands.[33]

[32] Koronivia Joint Work on Agriculture, Decision 4/CP.23, Report of the UNFCCC Conference of the Parties on its twenty-third session, held in Bonn from 6 to 18 November 2017, FCCC/CP/2017/11/Add.1, 8 February.

[33] Loeb (2021).

Governments agreed on the need to continue working on Agriculture under the UNFCCC process with a view to adopting a decision at CoP27 in 2022. They recognized that the KJWA has an impact on financing entities and can help to better align international organizations and processes in their work on agriculture and climate change. Furthermore, there was acknowledgement of how the working mode of the KJWA promotes inclusivity through knowledge sharing between decisions makers, farmers, indigenous peoples, women and youth.[34]

At CoP26, Governments found significant agreement on the last three topics of the initial KJWA roadmap, which complement the conclusions already adopted on the previous three CoP Conferences. The conclusions relative to each of the topics are the result of a process combining views from Parties and observers submitted to the UNFCCC, KJWA workshops, and the corresponding UNFCCC Secretariat workshop reports. Key conclusions include:[35]

TOPIC 2(a) Modalities for implementation of the outcomes of the five in-session workshops on issues related to agriculture and other future topics that may arise from this work[36]

> The SBI and the SBSTA welcomed the report on the first Koronivia road map in-session workshop, on topic 2(a) (modalities for implementation of the outcomes of the five in-session workshops on issues related to agriculture and other future topics that may arise from this work), which was held in conjunction with SB 49. The SBSTA and the SBI considered the workshop report and agreed to:
>
> a) Recognize that information provided during the workshop and in the workshop report and other information provide a mapping of activities and mandates of constituted bodies;
> b) Encourage the continued involvement of constituted bodies and financing entities in the KJWA, highlighting the potential of creating interlinkages that lead to enhanced action and improvements in implementation;
> c) Recognize that some modalities for implementation already exist and invite Parties to scale up implementation;
> d) Recognize the importance of the continued involvement of scientific and technical knowledge in transforming the agriculture sector, enabling conditions, the crucial role of farmers, youth, local communities and Indigenous Peoples, including gender considerations, and of meeting the needs of farmers and the food systems;
> e) Welcome the presentation made by the Green Climate Fund (GCF) on its work on issues relating to agriculture, and welcome the subsequent clarification from the secretariat on the process for Parties to submit their views to the Standing Committee on Finance, in line with existing procedures, on elements to be taken into account in developing guidance to the operating entities of the Financial Mechanism.

TOPIC 2(b) Methods and approaches for assessing adaptation, adaptation co-benefits and resilience[37]

[34] UNFCCC (2021).

[35] *Id.*

[36] FCCC/SB/2019/L.2.

[37] FCCC/SB/2019/L.5.

Having considered the workshop report on topic 2(b), the SBSTA and the SBI recognized that various tools are available for assessing and monitoring adaptation and its co-benefits, but existing tools could benefit from further adjustment and new tools could be developed for country-specific circumstances, while taking into consideration the importance of sharing best practices among countries and other stakeholders and the important role of science, technology and capacity-building in facilitating data collection and adaptation assessment.

TOPIC 2(c) Improved soil carbon, soil health and soil fertility under grassland and cropland as well as integrated systems, including water management[38]

Having considered the workshop report on topic 2(c), the SBSTA and the SBI also recognized that issues relating to soil carbon, soil health and soil fertility as well as sustainable soil and integrated water management are context-specific and, taking into account countries' circumstances, should be dealt with in a holistic and inclusive manner to realize the full potential of increased productivity in contributing to food security, adaptation and adaptation co-benefits as well as enhancing carbon sinks.

TOPIC 2(d) Improved nutrient use and manure management towards sustainable and resilient agricultural Systems[39]

Having considered the report on the workshop on topic 2(d), the SBSTA and the SBI recognized that soil and nutrient management practices and the optimal use of nutrients, including organic fertilizer and enhanced manure management, lie at the core of climate-resilient, sustainable food production systems and can contribute to global food security.

TOPIC 2(e) Improved livestock management systems, including agropastoral production systems and other systems[40]

Having considered the report on the workshop on topic 2(e) of the Koronivia road map, the SBSTA and the SBI also recognized that livestock management systems are very vulnerable to the impacts of climate change, and that sustainably managed livestock systems have high adaptive capacity and resilience to climate change while playing broad roles in safeguarding food and nutrition security, livelihoods, sustainability, nutrient cycling and carbon management. They noted that improving sustainable production and animal health, aiming to reduce greenhouse gas emissions in the livestock sector while enhancing sinks on pasture and grazing lands, can contribute to achieving long-term climate objectives, taking into account different systems and national circumstances.

TOPIC 2(f) Socioeconomic and food security dimensions of climate change in the agricultural sector[41]

Having considered the report on the workshop on topic 2(f) of the Koronivia road map, the SBSTA and the SBI recognized that socioeconomic and food security dimensions are critical when dealing with climate change in agriculture and food systems. They also recognized the fundamental priority of safeguarding food security and ending hunger by designing sustainable and climate-resilient agricultural systems applying a systemic approach in line with the long-term global climate objectives, further recognizing the importance of long-term investments in agriculture focused on this objective.

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[38] FCCC/SB/2019/L.5.

[39] FCCC/SB/2021/L.1.

[40] FCCC/SB/2021/L.1.

[41] FCCC/SB/2021/L.1.

3.2 Global Methane Pledge

At CoP26, for the first time in history, the CoP decision included an invitation for Parties to “consider further actions to reduce by 2030” other greenhouse gases, including methane. Further, the EU and the US launched the Global Methane Pledge—a collective goal of reducing man-made methane emissions by at least 30% from 2020 levels by 2030.[42] Although the 30% target is insufficient to limit global warming to 1.5 °C, according to the IPCC a 40–45% by 2030 is required, increasing the chances of keeping the 1.5 °C target within reach. Countries joining GMP also commit to improving inventory methodologies to quantify methane emissions, particularly from high emission sources. It is a significant development given the uncertainty of current methane emissions estimates.[43]

This is of interest for soil management and use especially as recent studies have revealed that the amount of methane absorbed by soils has reduced by 77% over the past 30 years.[44] Given that soils also produce methane, the GMP provides an opportunity for greater partnerships and investment into soil research moving forward.

3.3 Glasgow Leaders’ Declaration on Forests and Land Use

Launched on 2 November, 134 countries covering 91% of the world’s forests (including Brazil, China, Russia and Indonesia) have now endorsed the Glasgow Leaders’ Declaration on Forests and Land Use, committing to halt and reverse forest loss and land degradation by 2030. The full package of commitments and action includes a range of fresh partnerships and new commitments.

The Policy Action Agenda for the Transition to Sustainable Agriculture sets out pathways and actions that countries can take to repurpose public policies and support to food and agriculture, to deliver these outcomes and enable a just rural transition.[45] It also sets out actions and opportunities for other stakeholders (international organisations, food producers, financial entities, researchers, civil society and others) to channel their expertise, knowledge and resources in support of this agenda. Leaders were also able to secure funding of £38.5m over 2 years to the CGIAR, the world’s leading agricultural science and innovation organisation, which will create and scale new crops and technologies yielding climate, nature, health, gender and economic impact. Funding will support the development and deployment of

[42] Olczak and Pieblags (2021).
[43] Mountford et al. (2021).
[44] Ni and Groffman (2018).
[45] UNFCCC (2021).

- crop varieties that are climate-resilient (more resistant to heat, drought and flooding) and more nutritious (with elevated levels of essential micronutrients).
- agricultural practices that are more productive, sustainable and climate-resilient;
- new livestock varieties, diagnostics and management practices, which reduce the risks faced by pastoralists and livestock keepers.
- foresight and trade off tools for risk management of, and resilience to, major threats emerging from the food system, including anti-microbial resistance and emerging zoonotic diseases.
- evidence on better policies to help poor farmers use new technology to access markets, reduce risks and increase incomes.[46]

Finally, as a final component of the Glasgow Leaders Declaration, it also led to the launch of the Gilbert Initiative, which will coordinate investments in evidence generation, technology development and delivery to support a food system that by 2030 feeds 9 billion people with nutritious, safe foods; uses environmental resources sustainably; enhances resilience and adaptation to climate change; and generates inclusive growth and jobs.[47]

Taken together, this funding and these partnerships are especially critical for the way that research and policies for soil are mobilised moving forward.

4 Concluding Remarks

Given its relevance, soils could still receive further attention in the climate agenda and outcomes of international processes. At the same time, the efforts outlined above already provide a solid basis for soils to be better protected through the recognition of their role as carbon sinks, in addition to all the other environmental services they provide, through different mechanisms under the climate regime. There is enough reason to look with hope toward UNFCCC CoP27 in Sharm-el-Sheikh, especially with agreement still needed on three topics as part of the Koronivia Joint Work on Agriculture.

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[46] *Id.*

[47] Department for Environment, Food & Rural Affairs & Department for Business, Energy & Industrial Strategy, Government of the United Kingdom (2021).

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The Mainstreaming Agenda of the Convention on Biological Diversity and Its Value to Protecting and Enhancing Soil Ecosystem Services

Cairo Robb

Abstract This chapter highlights the importance of soil biodiversity in the provision of ecosystem services, and its relevance in the context of the Convention on Biological Diversity 'mainstreaming' agenda, and Convention architecture. It provides case studies relating to the mainstreaming of soil biodiversity, as well as a 'Soil Biodiversity Perception Checklist', to help integrate soil biodiversity, soil health and soil ecosystem services into decision making at all levels and across all sectors, including in policy, and land use and management strategy and practice.

1 Introduction

The mainstreaming agenda of the Convention on Biological Diversity (CBD)[1] has, to date, focused chiefly on mainstreaming above-ground biodiversity. Yet it is widely acknowledged that a considerable—if largely undocumented—proportion of global biodiversity can be found below-ground. Decaëns (2006) suggested that the majority of animals in terrestrial habitats are soil inhabitants for at least one stage of their life cycle, and estimated that at least 25% of described living species are strictly soil or litter dwellers.[2] A recent review by Anthony et al. (2023) suggests that soil is likely home to 59 [+ or − sign] 15% of the species on Earth.[3]

Moreover, these hidden creatures are critical actors in vital soil functions that contribute to invaluable ecosystem services and nature's contributions to people—

[1] Convention on Biological Diversity (1992).

[2] Decaëns et al. (2006).

[3] Anthony et al. (2023).

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including food provisioning, nutrient cycling, water filtration and storage, climate regulation, flood defences, recycling, buffering pollution, and to such an extent that there could be no terrestrial life as we know it, ourselves included, without them.

The description of life **in** earth being "*A Truly Epic Production*", as so beautifully expressed by Karl Ritz, is no overstatement. Ritz points out:

> Soil is alive. Very alive. The total mass of living material in a typical arable soil is about 5 tonnes per hectare – in grasslands and forests it can be 20 times this, such that the biomass belowground always equals and sometimes exceeds that aboveground. In a handful of such arable soil, there will be 10 billion bacteria, scores of kilometers of fungal hyphae, tens of thousands of protozoa, thousands of nematodes, and hundreds of worms, insects, mites and other fauna. Life in soil is diverse. Very diverse. The genetic diversity of the soil biota always exceeds that found aboveground and by orders of magnitude – in our handful of soil, there will typically be 10 thousand "species" of bacteria and hundreds of species of the other forms.[4]

According to Ritz "*soil biota are … essentially the biological engine of the earth, driving and governing many of the key processes that underpin the functioning of terrestrial ecosystems*"[5] and, of course, all the life, including our own, that depends on them. However, as he points out, "*most of this life and biodiversity is invisible to humans*". While this can be taken literally in two senses—firstly because soil biomass is predominantly 'microbial in scale' and therefore cannot be seen by the naked eye, and secondly because soil is 'opaque' and cannot be looked into as can, for example, air or water[6]—it also, certainly among many people upon this earth, belies a more fundamental perception gap. And the consequence of all this results in the relative invisibility of soil biodiversity in policy, assessment processes and procedure. With this comes a failure to take the critical importance of soil biodiversity into account in decision-making.

At the same time, it almost goes without saying that above-ground biodiversity relies on the myriad of below-ground organisms for many of the same reasons that humans do. It relies on the ecosystem services facilitated by soils, including provisioning of primary production, water management, filtration and storage, and climate regulation. Indeed, the *Status of the World's Soil Resources Report 2015* (SWSR 2015) points out that

> Essential services provided by soil biota include: regulating nutrient cycles; controlling the dynamics of soil organic matter; supporting soil carbon sequestration; regulating greenhouse gas emissions; modifying soil physical structure and soil water regimes; enhancing the amount and efficiency of nutrient acquisition by vegetation through symbiotic associations and nitrogen fixation by bacteria; and influencing plant and animal health through the interaction of pathogens and pests with their natural predators and parasites.[7]

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[4] Ritz (2014), pp. 379–380.

[5] Ritz (2014), p. 380.

[6] Ritz (2014), p. 380.

[7] FAO and ITPS (2015).

This chapter considers how the CBD's 'mainstreaming' agenda can be harnessed to promote soil health and to protect and enhance soil functions and the ecosystem services soils provide, and proposes a checklist to help integrate soil biodiversity, soil health and soil ecosystem services into policy, and into land use and management strategy, practice and decision-making.

2 Soil Biodiversity Mediated Ecosystem Services

2.1 Soil Ecosystem Services (SES)

The 2005 Millennium Ecosystem Assessment (MEA) defined 'ecosystem services' as "the capacity of natural processes and components to provide goods and services that satisfy human needs, directly or indirectly",[8] and grouped them into four categories: (i) provisioning services, (ii) regulating services, (iii) cultural services, and (iv) supporting services. Some more recent classifications combine 'regulating' and 'supporting' services to identify three broad categories, namely 'provisioning', 'regulation and maintenance', and 'cultural' services.[9]

While clearly a valuable concept, there have been criticisms of the largely 'scientific' and 'economic' focus encapsulated by the concept of 'ecosystem services'. In response, the broader concept of Nature's Contributions to People (NCP) has been developed. The NCP approach emphasises 'culture' as being important in the links between people and nature, and calls attention to the need to value the social, cultural, spiritual and religious significance of nature, and recognise wider knowledge systems, including those of local communities and indigenous peoples.[10]

Soil 'functions' and 'processes' may be distinguished from soil 'ecosystem services', in the sense that soil ecosystem 'services', are considered to derive from the underlying biological, physical and chemical soil functions and processes, which themselves derive largely from soil properties, and against the background of human activity. Sometimes, however, these terms are used interchangeably, or combined in different ways, such as for example 'soil ecosystem functions'.[11] As can be seen in the MEA definition above, ecosystem 'services' also encompasses ecosystem 'goods'. Attempts have been made to try to clarify or stimulate coherence in relation to these concepts.[12] Lilburne et al. (2020) provide a useful recent summary of the literature on the relationship between soil functions and ecosystem services.[13]

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[8] MAB (2005), pp. v–vi.

[9] Lilburne et al. (2020), p. 2; TNFD (2022).

[10] Díaz et al. (2018). See further on the relationship between ES and NCP Kadykalo et al. (2019), and on soils specifically Smith et al. (2021).

[11] FAO et al. (2020), p. 118, Table 3.1.

[12] Adhikari and Hartemink (2016), Baveye et al. (2016).

[13] Lilburne et al. (2020).

In their seminal work on ecosystem services, Daily et al. (1997) described, and considered the value of, the ecosystem services supplied by soils.[14] They concluded that "Soil provides an array of ecosystem services that are so fundamental to life that their total value could only be expressed as infinite."[15] Daily et al. (1997) did, at the same time, attempt to highlight the value of soil ecosystem services in monetary terms, and others have since presented frameworks or case studies for doing so,[16] as interest in this subject increases.[17] In their global review linking soils to ecosystem services, Adhikari and Hartemink (2016) have stressed the need to appreciate the contribution of soils to human welfare beyond food production, and make the point that "Soil ecosystem services depend on soil properties and their interaction, and are mostly influenced by its use and management."[18]

Today's heightened understanding of the 'global' nature of 'wicked' and interrelated problems requires us to acknowledge that soil ecosystem services are influenced and impacted by activities far beyond the use and management of the land whose services we may be interested in. And also that the soil ecosystem services provided by an area of soil can extend and have impacts well beyond the area of land, or the state, in which the soil sits.

2.2 *Importance of SES for Above-Ground Biodiversity*

Above-ground biodiversity is dependent on soil ecosystem services. Daily et al. (1997) observed that "The total value of soil is incalculable, as it includes the existence value of human society and of millions of other species."[19]

In modern international policy, the importance of 'soil' to what we now term 'ecosystem services' (ES) and 'nature's contributions to people' (NCP), has long been known.

The first line of the 1972 *European Soil Charter*, some fifty years ago, stated:

> Soil is one of humanity's most precious assets. It allows plants, animals and man to live on the earth's surface." It continued: "Soil is a living and dynamic medium" that is "vital to man's existence as a source of food and raw materials", and constitutes "a fundamental part of the biosphere and, together with vegetation and climate, helps to regulate the circulation and affects the quality of water.[20]

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[14] Daily et al. (1997), Chapter 7.

[15] Daily et al. (1997), p. 128.

[16] Dominati et al. (2010), Dominati et al. (2014), Pascual et al. (2015); Jónsson and Davíðsdóttir (2016), Pereira et al. (2018), Plaas et al. (2019).

[17] FAO et al. (2020), pp. 182–189, Dasgupta (2021), e.g. Chapter 2, Box 2.5, Chapter 4, Boxes 4.3 and 4.7, and pp. 314, 318–321.

[18] Adhikari and Hartemink (2016), p. 103.

[19] Daily et al. (1997), p. 126.

[20] European Soil Charter 1972.

During the fifty years since 1972, the scientific community has been developing its knowledge of soils and soil biodiversity and understanding of the links and feedbacks between soils, climate regulation, nutrient and water cycles, above and belowground biodiversity, including vegetation, and the provision of ecosystem services. Considerable progress has been made, yet we are still only scratching the surface, with gaps and research needs in many areas.[21]

Nevertheless, a fundamental point is that we know enough to be sure that it is imperative to take transformative action. The outcomes of numerous national, regional and global assessments, along with advances in scientific understanding, are making it increasingly clear how urgent that need to take action is.[22]

2.3 Role of Soil Organisms in SES Provision

The description of the fragile nature of soil given in the *European Soil Charter* spoke to the relevance of soil biology. It highlighted that "Soil is a limited resource which is easily destroyed", and continued:

> Soil is a thin layer covering part of the earth's surface. Its use is limited by climate and topography. It forms slowly by physical, physico-chemical, and biological processes but it can be quickly destroyed by careless action. Its productive capacity can be improved by careful management over years or decades but once it is diminished or destroyed reconstitution of the soil may take centuries.

Between 1972 and the present day the role of soil and its biological aspects in the provision of ecosystem services has been increasingly acknowledged, with exponential interest in the last few years.[23]

The Preamble to the *Revised World Soil Charter 2015* recognises the significance of careful soil management to safeguarding ecosystem services and biodiversity. It states:

> Soils are fundamental to life on Earth but human pressures on soil resources are reaching critical limits. Careful soil management is one essential element of sustainable agriculture and also provides a valuable lever for climate regulation and a pathway for safeguarding ecosystem services and biodiversity.

Principles 7 and 8 of the Revised Charter highlight the significance of soil biota:

> 7. The specific functions provided by a soil are governed, in large part, by the suite of chemical, biological, and physical properties present in that soil. Knowledge of the actual state of those properties, their role in soil functions, and the effect of change – both natural and human-induced—on them is essential to achieve sustainability.

[21] FAO et al. (2020), FAO (2021a).

[22] FAO and ITPS (2015), IPBES (2018, 2019), IPCC (2019), FAO (2020a), IPCC (2021).

[23] Kibblewhite et al. (2008), Powlson et al. (2011), Wall et al. (2012), Adhikari and Hartemink (2016), FAO (2020a), Smith et al. (2021), FAO (2021a).

> 8. Soils are a key reservoir of global biodiversity, which ranges from micro-organisms to flora and fauna. This biodiversity has a fundamental role in supporting soil functions and therefore ecosystem goods and services associated with soils. Therefore it is necessary to maintain soil biodiversity to safeguard these functions.

Our scientific knowledge concerning the existence, diversity and functional roles of soil organisms has increased manyfold. Still, our comprehension of them as principal actors in the 'epic production' of 'Life on Earth' is only in its infancy, and is possibly so overwhelming and awe-inspiring that the reality of this situation, and implications for our future, have not yet fully 'landed'—even in the 'science' community, to say nothing of broader policy and civil society.

Soil biodiversity contributes to the provisioning of food, clean water, medicines,[24] and raw materials including fibres and timber; to soil formation, nutrient cycling, erosion prevention, regulation of water flows, water storage and flood management, carbon sequestration and storage and climate regulation, waste processing and detoxification of contaminants, genetic diversity, and regulation of pests and pathogens; as well as to spiritual experience and sense of place, recreation and mental and physical health, cultural heritage, knowledge and education, and aesthetic appreciation and inspiration for culture, art and design.[25] Below-ground biodiversity also represents one of the largest reservoirs of biodiversity on earth,[26] the vast majority of which has yet to be described.[27]

3 Loss of Soil Biodiversity

3.1 What Is Soil Biodiversity?

We might begin by asking ourselves, 'What is soil biodiversity?' The response to this question usually relates the definition of biodiversity provided in CBD, Art 2, to soil, such that it encompasses

> the variability of life belowground, from genes and species to the communities they form, as well as the ecological complexes to which they contribute and to which they belong, from soil-micro habitats to landscapes.[28]

The term 'soil biodiversity' is also often used to refer to soil organisms more generally.

[24] Beach et al. (2019), p. 141.

[25] FAO (2020a), pp. 115–185.

[26] Bardgett and van der Putten (2014).

[27] Anthony et al. (2023).

[28] FAO (2020a), p. 7.

3.1.1 Categorising and Describing Soil Organisms

Soil organisms are often considered in terms of their 'size' class, usually measured by body width (not length), and some groups span different size classes (e.g. earthworms).[29] The main size classes are shown in Table 1 below, along with examples of relevant taxa, their location in the soil, and their activities.

Different soil organisms will be found in different parts of the soil. For example micro-organisms are particularly abundant in the hot-spots of nutrients and other resources around plant roots (the area known as the rhizosphere, where roots exude 'root exudates'), and in earthworm castings; aquatic micro-organisms (such as bacteria, nematodes, tardigrades and protists) inhabit the thin waterfilm around soil particles; mesofauna (such as springtails and mites) inhabit the air filled pore spaces; and macrofauna (such as earthworms) and megafauna (such as moles) may live throughout the soil. Some earthworms, for example, inhabit the litter layer, others travel horizontally through the upper soil layers, and deep burrowing earthworms can make their vertical burrows down to over 1m belowground and feed from the litter layer, although there may in some cases be less clear distinctions in these respects than previously thought.[30]

Diversity and abundance of soil organisms is therefore influenced by the above and below ground environment in which they live.[31] Below-ground this will depend on relationships between soil 'type';[32] soil texture; soil structure; soil organic matter (SOM) content; soil air and moisture content; temperature; pH and a range of other factors, including C:N ratio; predation; species, structure, depth and characteristics of plant roots; frequency, intensity and extent of soil disturbance; application and incorporation of natural or synthetic materials—such as leaf litter, crop residues, manure, slurry, fertilizers, and other chemicals, spanning a range of natural and human induced conditions.

3.1.2 Further Notes on the Question 'What Is Soil Biodiversity?'

For those interested in delving further, the simple question 'What is soil biodiversity?' unearths a multitude of more complex aspects one might consider. We might, for example question 'What is soil?', 'What is diversity?' and 'How do these relate in a conservation context?'

For example, to what extent does the substrate on green roofs count as 'soil'? Rare beetles and other faunistically interesting invertebrates have been identified on green roofs,[33] and a recent study has shown greater Shannon diversity on green roofs

[29] Orgiazzi et al. (2016), p. 31, FAO (2020a), p. 11.
[30] Bottinelli et al. (2020).
[31] Briones (2018).
[32] IUSS Working Group WRB (2022).
[33] Brenneisen (2006).

Table 1 Showing main soil biodiversity size classes, taxa, location and activities, adapted from FAO et al. (2020), Box 2.2, p. 9 and supplemented from Orgiazzi et al. (2016), pp. 31, 107 (which acknowledge Swift et al. (1979) and Gilyarov (1949)) and Turbé et al. (2010), pp. 3–7

	Size (width)	Examples of taxa	Location	Activities
Microbes	20 nm–10 µm	Virus Bacteria Archaea Fungi	Mostly live in soil solutions in gravitational, capillary and hygroscopic soil water	Participating in decomposition of plant material, formation and decomposition of soil organic matter, nutrient cycling and chemical exchange, and weathering of soil minerals; some predation; water purification; bioremediating pollutants
Microfauna	10 µm–0.1 mm	Nematodes Tardigrades Protists		
Mesofauna	0.1 mm–2 mm	Microarthropods including acari (mites) and collembola (springtails) Enchytraeids (potworms) Apterygota Small insect larvae	Mostly live in air-filled soil pore spaces	Forming microaggregates; increasing surface of active biochemical interactions; participating in formation and transformation of soil organic matter; some predation
Macrofauna	2–20 mm	Large soil invertebrates including earthworms, woodlice, ants, termites, beetles, arachnids, myriapods, gastropods, insect larvae		Variously, participating in transformation of litter, formation and transformation of soil organic matter, soil aggregate formation; predation; herbivory; ecosystem engineering, bioturbation, increasing water infiltration and influencing water distribution; influencing aeration and gaseous exchange; creating hotspots for microbial activity; bioremediating pollutants
Megafauna	>20 mm	Vertebrates e.g. moles, gophers, worm lizards		Creating spatial heterogeneity on soil surface and throughout soil profile through their movement; increasing

(continued)

Table 1 (continued)

	Size (width)	Examples of taxa	Location	Activities
				water infiltration and influencing water distribution; influencing aeration and gaseous exchange

than at nearby ground level sites.[34] Is there a relevant gradient between technosols (anthropogenic/manmade) and natural soils? What about the accumulated matter under vegetation on green walls, or trees, which can be substantial? Decaëns et al. (2006) also raised the question, "Where does soil begin and end? What about vertebrate dung, decaying wood, rocks, hollow trees and other "epiphytic" soils...", adopting a broad definition encompassing these.[35]

There are also many different ways to consider and measure biodiversity. It is usually used in a taxonomic sense, to refer to the number of distinct species, but it can also refer to genetic, phenotypic, functional, structural or trophic diversity.[36] 'Species diversity' can relate to a local site (alpha diversity), to the differentiation between sites (beta diversity), and in terms of overall species diversity within a landscape (gamma diversity). There are also numerous different diversity indices, based single or groups of organisms. Along with taxonomic diversity, soil biodiversity is most often considered in terms of 'functional' or 'trophic' diversity.

Given the potential microscale of the soil habitat it may be difficult to decide when we are dealing with in situ or ex situ conservation. We might also consider whether it is the nature of the taxa that determines its inclusion, or its habitat? And what of the relevance of the increasing recognition of the importance of microbial 'necromass' which can result from very time-limited soil organisms (aka 'sticky dead microbes')[37]? We might also ask to what extent the answers to these questions matter? Different answers could arise in different contexts. Orgiazzi has helpfully begun this conversation in a recent paper, and emphasises the significance for policy and regulation.[38] Anthony et al (2023) have also recently highlighted the challenges involved in enumerating soil biodiversity.[39] Still, for the most part at least, we know an earthworm when we see one, and must proceed accordingly.

[34] Gonsalves et al. (2022).

[35] Decaëns et al. (2006).

[36] FAO (2020a), p. 7, Geisen et al. (2019b).

[37] Buckeridge et al. (2020); Wang et al. (2021).

[38] Orgiazzi (2022); Byrne (2022).

[39] Anthony et al. (2023).

3.2 *Loss of Soil Biodiversity Highlighted in the* Status of the World's Soil Resources Report 2015

3.2.1 Loss of Soil Biodiversity Among ITPS Ten Soil Threats

The Intergovernmental Technical Panel on Soils (ITPS) and FAO produced the *Status of the World's Soil Resources Report 2015*, to coincide with the United Nations International Year of Soils in 2015. The report discussed the global status and trends of the major soil processes threatening ecosystem services, and identified ten key threats including soil biodiversity loss. The other threats identified were soil erosion, soil organic carbon loss, soil contamination, soil acidification, soil salinization, soil surface effects, soil nutrient status, soil compaction and soil moisture conditions. These threats are interrelated, and can also feed into soil biodiversity loss.

The Report drew attention to a European study in 2013 by Gardi, Jeffery and Saltelli, based on a survey of 20 experts, which found that:

> the main anthropogenic pressures on soil biodiversity were (in order of importance): (1) intensive human exploitation; (2) reduced soil organic matter; (3) habitat disturbance; (4) soil sealing; (5) soil pollution; (6) land-use change; (7) soil compaction; (8) soil erosion; (9) habitat fragmentation; (10) climate change; (11) invasive species; and (12) GMO pollution.[40]

Many of the available studies of soil biodiversity have focused on soil biodiversity in an agricultural context, showing, for example, that agricultural intensification can reduce soil biodiversity, and lead to decreased food-web complexity and fewer functional groups.[41] Such reductions in soil biodiversity can result from land use change and management practices, such as conversion of natural lands to agriculture, practice of monoculture, intensive tillage, use of heavy machinery, and chemical inputs. These alter the chemical, physical and biological properties of soils, and hence the availability and suitability of habitat and substrate for a diversity of soil organisms, and can cause disruption of the delicate balance between soil pests and their natural enemies. In conventional agricultural tillage systems, for example, organisms adapted to high levels of physical disturbance become dominant, thereby reducing species richness and diversity.[42]

The consequences of anthropogenically induced global warming also has the potential to affect soil biodiversity. A global study of soil fungi in natural ecosystems found that distance from the equator and annual precipitation influenced fungal species richness,[43] and underscores the relevance of climate change to the provision of soil biodiversity mediated ecosystem services.[44]

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[40] FAO and ITPS (2015), Chapters 6 and 7.

[41] Tsiafouli et al. (2015).

[42] Paoletti et al. (1993), Labouyrie et al. (2023), Köninger et al. (2023).

[43] Tedersoo et al. (2014).

[44] Guerra et al. (2022), Tedersoo et al. (2022), Bardgett and van der Putten (2014).

Global ecoregion / **Main threats to soil biodiversity**	Agricultural Intensification	Climate change	Deforestation	Erosion and landslides	Fire	Invasive species	Land degradation	Loss of SOM and SOC	Salinization and sodification	Soil compaction and soil sealing	Urbanization
Tropical and subtropical forest	X		X								
Tropical and subtropical grassland			X	X	X			X		X	
Mediterranean forest, woodland and shrubland					X	X	X				X
Montane grassland and shrubland	X							X			
Desert and dry shrubland		X		X	X		X	X	X		
Temperate broadleaf and mixed forest	X		X			X		X			X
Temperate grassland	X										
Temperate and boreal coniferous forest					X	X					
Tundra		X				X		X			
Boreal forests/Taiga			X								

Fig. 1 Threats to soil biodiversity in global Ecoregions, adapted from FAO (2021a), Table 1, p. 14

The outcome document of the recent Global Symposium on Soil Biodiversity,[45] suggests that globally the most widespread threats to soil biodiversity are the loss of soil organic matter(SOM) and soil organic carbon (SOC), deforestation and agricultural intensification, and identifies the 'main threats' to soil biodiversity by 'ecoregion' as shown in Fig. 1 below. It can be seen that 'deserts and dry shrublands', 'tropical and subtropical grasslands' and 'temperate broadleaf and mixed forests' face multiple threats, though this does not necessarily relate to overall magnitude of threat, or of potential consequences. For example, the threats of climate change and SOM/SOC loss to the tundra ecoregion could have extremely significant effects on the global climate and overall biodiversity, resulting from positive feedback loops.

The threats to soil biodiversity are often interlinked, with, for example, many of the other nine SWSR identified threats feeding into loss of soil biodiversity. Likewise, threats identified (eg deforestation) can relate to broader threats (e.g. land use change), or can serve as an umbrella terminology (e.g. land degradation) for more specific types of threat, such as air, water and soil 'pollution', all of which must be addressed. Tibbett et al. (2020) provide a useful review of literature regarding potential threats to soil biodiversity, and compare the threats identified to research

[45] FAO (2021a).

being undertaken, concluding that there is a disparity between research actions and perceived threats.[46]

3.2.2 Effect of Loss of Soil Biodiversity on Ecosystem Services

Reductions in soil biodiversity have been shown to affect multiple ecosystem functions and services including decomposition, nutrient retention and nutrient cycling, erosion control, water management and food nutrition.[47] It has also been shown that where threats to soil biodiversity co-occur, there can be additive or synergistic effects, reducing soil biodiversity even further.[48]

Most threats to soil biodiversity and ecosystem functions and services result from human activity associated with choice of land cover, land management and land-use change.[49] Land cover choices, such as monocultures, or non-native or inappropriate tree species, can negatively impact soil organisms and the ecosystem services associated with them, including natural pest and disease regulation and climate regulation through soil carbon storage and sequestration. Land management choices involving high input agriculture, the overuse of chemicals and fertilizers, high soil disturbance regimes, bare fallow, land clearance, overstocking livestock, removal of hedgerows, use of heavy machinery and working on wet soil, can all upset the delicate soil food web and result in negative consequences for ecosystem services.

Wolters (2001) has warned that "functionally important soil biota might be among the first to be affected by large-scale changes in land use", and contends that loss of even 'redundant' species for a particular function could still have an effect on the function and services associated with it.[50] This is of particular importance given Wu et al. (2011)'s suggestion that endemism is prevalent in soil faunal communities.[51] While many gaps in knowledge remain, it is generally presumed that increased diversity of soil systems increases resilience to perturbation since, if some elements are removed or compromised, others will be available to compensate.[52]

Soil sealing provides an extreme example of land use change resulting in loss of soil biodiversity and impact on ecosystem services at multiple scales. Urbanisation, including soil sealing, and residential building and associated public infrastructure construction, affects the provision of ecosystem services at local, regional and potentially global scales. This occurs through direct and indirect consumption of agricultural, and natural land, and the associated urban resource demands, including

[46] Tibbett et al. (2020).

[47] Wagg et al. (2014), Bender et al. (2016), Soliveres et al. (2016), Orgiazzi and Panagos (2018), El Mujtar et al. (2019), Hallam and Hodson (2020).

[48] Thakur et al. (2018), Rillig et al. (2019).

[49] FAO (2020a), p. 191.

[50] Wolters (2001).

[51] Wu et al. (2011), Tedersoo et al. (2022), Guerra et al. (2022).

[52] Kibblewhite et al. (2008).

building materials, that link to habitat loss all round the world.[53] Land consumption impacts the, now urban, soil directly by sealing, reducing the soils' multifunctional ability to provide a range of ecosystem services to simply supporting infrastructure. It can affect the soil elsewhere, such as where displaced agriculture encroaches on forest or grassland soils, in the process also reducing their carbon storage and future sequestration potential, or resulting in more chemically intensive agriculture, elsewhere; and it can cause local and distant soil erosion resulting from poorly managed run off from sealed areas. Urbanization is also often accompanied by local soil pollution, for example from road, roof and driveway run off, from sports pitches, in the form of nutrient and herbicide leaching or other toxins from artificial pitches, and compaction of open areas that are used as pedestrian thoroughfares, or for car parking.

Consumption of land for urban development can impact hydrological cycles. Prevention of rainwater infiltration reduces groundwater filtering and replenishment, and unmitigated soil sealing channels stormwater at pace increasing the risk of local flash flooding and flooding further afield. Drainage and consumption of coastal wetlands can also reduce buffering capacity against storm surges, exacerbating the effects on remaining coastal wetlands and their above and below-ground biodiversity. Degradation of non-sealed soil resulting from urbanization, including poor soil management practice during construction, can also impact soils' water storing capacity, with additional consequences for water management and soil biodiversity supported vegetation, and the related potential for associated ecosystem service provision of urban cooling though evapotranspiration, surface albedo and shading.[54]

Biodiversity loss results from habitats consumed by urbanization, ecosystem fragmentation in the urban environment, and from losses of natural habitat elsewhere due to agricultural displacement. Urbanization involves changes in species abundance and community assemblages. Land use intensity generally correlates negatively with native species richness, and urbanization correlates positively with proportion of invasive species

There is a growing interest in urban soil ecosystem services,[55] including for urban agriculture and responses to disturbances and global change, and in the role soil biodiversity plays in the urban environment. Bray and colleagues (2019) for example, point to the high variability observed in microbial community composition between different urban soil fragments, and to recent work showing that increased microbial diversity is partly driven by soil invertebrate functional diversity.[56] They suggest that targeted approaches investigating invertebrate-microbe interactions may increase our ability to manage urban soil microbiomes and the ecosystem services they provide.[57]

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[53] Simkin et al. (2022)

[54] Spronken-Smith and Oke (1998); Rakoto et al. (2021).

[55] O'Riordan et al. (2021), Fan et al. (2023).

[56] Bray et al. (2019).

[57] Bray and Wickings (2019).

The encroachment of urban sprawl on both natural and prime agricultural lands, and the costs of infrastructure provision, can be reduced where local authorities impose stringent density requirements on new residential developments and prioritize infill sites, reuse of brownfield sites and rejuvenation and/or densification of existing schemes.

Local and regional authorities, in combination with water authorities, can minimize the environmental risks and impacts of urbanization by mandating or incentivising appropriate urban greening measures, such as installation of green roofs and walls, and can target subsidy schemes towards lower income areas,[58] to address social and environmental justice inequalities.

Soil biodiversity is relevant across all these issues: from protecting and nurturing well-functioning agricultural soil food webs for food provisioning; through the important role soil biodiversity plays in the health of urban vegetation and green spaces, and the ecosystem services that flow therefrom, not least in relation to water management, urban cooling and air quality; to the contribution of urban and surrounding green space as repositories of and habitat for conservation of common and rare soil organisms; as well as regulating the threats and risks arising from soil borne pathogens. Approaching these issues from the point of view of a global, national and local commitment to the conservation and sustainable use of soil biodiversity could provide additional policy drivers to support transformative action in relation to the challenges posed by urbanization.

3.2.3 Measuring and Monitoring Soil Biodiversity

It has been suggested that links between above and below-ground communities make it likely that factors affecting above-ground extinction may also be affecting soil organisms.[59] At the same time, while there are fundamental connections between above and below-ground biodiversity, levels of species richness and abundance above and below ground do not necessarily correlate, and protecting above-ground biodiversity may not sufficiently reduce threats to soil biodiversity. Managing soil biodiversity can implicate different hotspots and coldspots, and raise different challenges to aboveground biodiversity.[60]

Guerra et al. (2021) have pointed out that we know little about the conservation status of most soil organisms, or about the effects of nature conservation policies on soil systems. As have others,[61] they suggest that "[s]oil biodiversity and its ecosystem functions thus require explicit considerations when establishing nature protection priorities and policies and when designing new conservation areas."[62]

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[58] UN-Habitat (2020).

[59] FAO and ITPS (2015), p. 128.

[60] Cameron et al. (2019).

[61] Phillips et al. (2019).

[62] Guerra et al. (2021), p. 239.

To inform such policy consideration, and the associated need for a holistic approach and standardised international monitoring system to track the state and dynamics of global soil biodiversity and ecosystem functioning over time, the global Soil Biodiversity Observation Network—SoilBON—has been established under the umbrella of the Group on Earth Observations Biodiversity Observation Network (GEOBON). This aims to use standard protocols to systematically assess soil biodiversity and soil ecosystem functions using observational data worldwide from protected and non-protected areas, to feed into decision and policy-making.[63] It will provide a global soil biodiversity and ecosystem function monitoring framework, to assess a suite of soil ecological indicators based on 'essential biodiversity vairables' (EBVs), that directly link to targets under the CBD, SDGs and Paris Agreement.[64]

Soil BON will help to address the point made in SWSR 2015 that no benchmark values for soil biodiversity exist on a global scale, making it difficult "to quantify changes or future losses that may result from natural or anthropogenic-induced changes."[65] In addition, the Soil BON Foodweb Team, focusing on soil fauna, has also been established (Potapov et al. 2022), and van den Hoogen et al. (2019) have documented global soil nematode abundance and functional group composition using over six thousand georeferenced samples, Phillips et al. (2019) have compiled a global dataset of earthworm communities from samples at nearly seven thousand sites,[66] and Lavelle et al. (2022) have carried out a world-wide assessment of soil macroinvertebrate communities from over three thousand five hundred sites, also contributing to global benchmarking.

A number of states, sub-national authorities and regions have collected and/or regularly collect soil biodiversity data,[67] such as for example the EU's Land Use/Cover Area Frame Statistical Survey Soil (LUCAS Soil), which is an extensive and regular topsoil survey that is carried out across the European Union to derive policy-relevant statistics on the effect of land management on soil characteristics. From 2018 it added additional properties, including bulk density, soil biodiversity, and specific measurements for organic-rich soil and soil erosion. The soil biodiversity component is being further developed to harmonise with national soil biodiversity monitoring and provide indicators relevant to the European Green Deal and EU Soil Strategy for 2030.[68] The European Commission Proposal for a Directive on Soil Monitoring and Resilieance (Soil Monitoring Law) (EC 2023) (previously referred to as the proposed Soil Health Law)[69] makes reference to loss of soil biodiversity, but currently leaves soil descriptors for biodiversity optional (providing a few examples) beyond specifying 'soil basal respiration', which itself is arguably not a

[63] Guerra et al. (2021).

[64] Guerra et al. (2021), p. 239.

[65] FAO and ITPS (2015).

[66] Phillips et al. (2019).

[67] FAO (2020a), Annex I.

[68] JRC (2022), Labouyrie et al. (2023), Köninger et al. (2023).

[69] EC (2021, 2023), European Parliament. Committee on the Environment, Public Health and Food Safety (2023).

'diversity' indicator at all. The text may change as the proposal progresses, and it may nevertheless stimulate national action, both within the EU and beyond.

And at a local, and farm-scale level, more use is being made of biological indicators of soil health, such as earthworm counts (for example as part of the new UK Soil Health Scorecard),[70] and the use of the QBS-ar (Soil Biological Quality index using microarthropods) is increasing.[71] The Soil BON Foodweb Protocol and manuals have been published, and can be followed.[72] The Global Soil Partnership (GSP) Soil Doctors farmer-to-farmer training programme *Soil Testing Methods* manual includes earthworm density as one of a few simple biological tests,[73] and the FAO Protocol for the Assessment of Sustainable Soil Management refers to extraction, counting and identifying soil meso and macrofauna, or genomic analysis for the microbial level, as indicators of soil biodiversity, to complement other soil biological measurement such as soil respiration.[74]

Given the heterogeneity of soils and the extent of differing local circumstances, the topic of standard soil biological indicators has proved challenging. Tensions exist not least between the choice of use of expensive genetic sequencing equipment or more accessible and lower cost methods for standard indicators, and in relation to the organisms, communities or other proxies used. This lack of common agreement has hindered progress in securing soil commitments in global policy forums, including in the development of the post-2020 Global Biodiversity Framework (see Sect. 5.1.2.2 below), where policy-makers have been reluctant to set soil biodiversity targets in the absence of agreed standard indicators.[75]

3.3 State of Knowledge of Soil Biodiversity: Status, Challenges and Potentialities, Report 2020

Over the past two decades, there has been a notable increase in interest in research and understanding of soil biodiversity. Milestone events outside the direct CBD context include a 2010 EC meeting on soil biodiversity and report for policy makers,[76] as well as publication of the European Atlas of Soil Biodiversity,[77] the establishment of the Global Soil Biodiversity Initiative (GSBI),[78] publication of the

[70] Allison (2021).

[71] Menta et al. (2018).

[72] Soil BON Foodweb website.

[73] FAO (2020b), pp. 52–63, 79.

[74] FAO-ITPS (2020), p. 5.

[75] GSBI webinar (2022).

[76] Turbé et al. (2010).

[77] Jeffrey et al. (2010).

[78] GSBI website.

Status of the World's Soil Resrouces Report 2015, and in 2016 of the Global Atlas of Soil Biodiversity.[79]

As a result of significant growth in the methods and instrumentation available to study soil organisms, including computer aided tomography, and genetic sampling, there has also been an increasingly greater appreciation of the physical, chemical and biological properties of soil. This has brought a growing awareness of soils' critical role as the dynamic interface between water, land and atmosphere, as the foundation for food, water and energy provision; and of soil biodiversity, soil health and the ecosystem services they provide being fundamental to the success of the objectives of multiple international policy frameworks.

This growing awareness and interest led the fourteenth CBD Conference of the Parties (CBD COP14) to invite FAO, in collaboration with other organizations, to consider the preparation of a report on the state of knowledge of soil biodiversity covering its status, challenges and potentialities.[80] The resulting report, produced together by the FAO, ITPS, GSBI, CBD and EC was launched in December 2020,[81] to coincide with World Soil Day, held on 5 December each year.

That report provides a wealth of information on the current state of knowledge of soil biodiversity, and is an invaluable and timely resource. Following an introduction it contains chapters devoted to global diversity and distribution of soil biodiversity, contributions of soil biodiversity to ecosystem functions and services, threats to soil biodiversity—global and regional trends, responses and opportunities, state of soil biodiversity at national level, ending with conclusions and suggestions for the way forward. It also contains a useful annex of country responses to a soil biodiversity survey, which includes, often short, but nevertheless interesting, responses on the topic of 'mainstreaming: policies, programmes, regulations and governmental frameworks' provided by a variety of stakeholders.

3.4 *Global Symposium on Soil Biodiversity 2021 and* Keep Soil Alive, Protect Soil Biodiversity: Outcome Document and Proceedings

The FAO, GSP, ITPS, CBD, UNCCD-SPI and GSBI together co-organized the Global Symposium on Soil Biodiversity, which, after postponement due to the Covid19 pandemic, eventually took place virtually from 19–22 April 2021. It was attended by over 5000 participants, from more than 160 countries. Participants included representatives of FAO Members, organizing institutions, academia, research institutions, the private sector, civil society, farmers and land users working on soil biodiversity and related fields.[82]

[79] Orgiazzi et al. (2016).

[80] CBD/COP/DEC/14/30.23 (30 November 2018).

[81] FAO et al. (2020).

[82] FAO (2021a), p. 1.

The Symposium was convened in anticipation of the adoption of the Post-2020 Global Biodiversity Framework, and in response to the "urgent need for a more integrated and coherent policy framework, where soil biodiversity protection is incorporated into other sectoral policies," acknowledging the different components and challenges involved in managing soil biodiversity compared to aboveground biodiversity.[83]

The overall aim of the symposium was to gather updated scientific knowledge on soil biodiversity, review the role of soil biodiversity and ecosystem services in tackling environmental problems and to drive actions towards the implementation of the Revised World Soil Charter 2015, the Voluntary Guidelines for Sustainable Soil Management (VGSSM),[84] and the Protocol for the Assessment of Sustainable Soil Management.[85,86] It aimed to fill critical knowledge gaps, and to promote discussion among policy-makers, food producers, scientists, practitioners and other stakeholders on solutions to live in harmony with nature, and ultimately, achieve the SDGs through the conservation and sustainable use of soil biodiversity. More specifically, the symposium aimed to:

I. Examine the current scientific, technical, indigenous and traditional knowledge on the role of soil biodiversity on food production, human health and on sustaining biodiversity aboveground.
II. Identify knowledge gaps and explore opportunities for collaborative research, capacity building and technical cooperation.
III. Identify limitations and opportunities to promote the sustainable use of soil biodiversity, knowledge sharing and capacity building.
IV. Present effective and replicable methodologies, techniques, technologies and practices that promote sustainability, with a view to upscale those sustainable approaches to promote soil biodiversity conservation, the sustainable use of its resources and equitable participation in productive landscapes.
V. Identify policy options to protect soil biodiversity and encourage the adoption of practices that enhance it.
VI. Present national, regional and global initiatives that support the effective design, planning, implementation, monitoring and reporting of solutions and their contribution to the achievement of the SDGs.
VII. Helping build a broader appreciation of soil biodiversity and our dependence on the many benefits it provides.[87]

The Symposium *Outcome Document*, provides a summary of some of the main points raised during the Symposium. It also includes recommendations to support the development of policies and actions to encourage the full use of soil biodiversity. The Symposium outcomes were intended to contribute to advocating for the endorsement of the updated plan of action 2020-2030 for the implementation of the CBD cross-cutting International Initiative for the Conservation and Sustainable

[83] FAO (2021a), pp. 4–5.
[84] FAO (2017).
[85] FAO-ITPS (2020).
[86] FAO (2021a), p. 1.
[87] FAO (2021a), p. 5.

Use of Soil Biodiversity (see Sect. 4.2 below), and to the development of the post-2020 Global Biodiversity Framework.[88] The Symposium *Proceedings*, running to approximately 900 pages of topical soil biodiversity research and practice, have also been published.[89]

4 The Relevance of Soil Biodiversity Within the CBD

4.1 Convention Text

The relevance of soil biodiversity to the CBD cannot be doubted. We may ask ourselves why it not been more prominent in Convention activity to date? More importantly, given the advances in scientific understanding, and what we now know about the critical importance of soil biodiversity to all aspects of ecosystem functioning, we must now ask what impact this should have in terms of Convention implementation in the future?

To situate soil biodiversity within the 'letter' of the Convention process, we can observe that 'soil biodiversity' is not mentioned expressly in the Convention text. Neither, however, are any other specific groups of biodiversity, so there is no surprise there. Article 1 sets out the objectives of the Convention, which are threefold:

1. the conservation of biological diversity
2. the sustainable use of its components and
3. the fair and equitable sharing of the benefits arising out of the utilization of genetic resources.

Article 2 defines 'biological diversity':

> "Biological diversity" means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

Article 2 also provides the following definitions, which are particularly relevant to the conservation and sustainable use of soil and its biodiversity under the Convention:

> "Biological resources" includes genetic resources, organisms or parts thereof, populations, or any other biotic component of ecosystems with actual or potential use or value for humanity.
>
> "Ecosystem" means a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.

[88] FAO (2021a).

[89] FAO (2021b).

> "Habitat" means the place or type of site where an organism or population naturally occurs.
>
> "In-situ conditions" means conditions where genetic resources exist within ecosystems and natural habitats, and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties.
>
> "In-situ conservation" means the conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties.
>
> "Sustainable use" means the use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations.

There are, therefore, a number of ways to consider soil and its biodiversity within the framework of the CBD.

First, 'biodiversity' includes 'soil biodiversity', and so soil biodiversity is already implicitly captured in the CBD and its mainstreaming agenda. The challenge remains to make it explicit, and of consequence in practice.

Second, 'soil' including and going beyond its biotic factors, forms a 'habitat' for soil biodiversity, and so for that reason also forms part of biodiversity.

Third, the diversity of 'soil' and the vegetation that relies upon it, form part of the 'ecological complex' upon which above ground biodiversity depends, and so again must be considered part of biodiversity.

Fourth, in many circumstances, 'healthy soils', which support effective soil functioning and soil processes, will generally support more diversity of species, and so promoting healthy soils provides a means of implementing the objective of the Convention.

In addition, the ecosystem approach, endorsed at COPV[90] provides for the integrated management of land, water and living resources, as the primary framework for action under the Convention.

Whichever way we look at it, there is scope for much more attention to be paid to soil and its biodiversity within the implementation of the Convention, through the cross-cutting International Initiative for the Conservation and Sustainable Use of Soil Biodiversity, mentioned below, and more generally.

Likewise, there is scope for much more attention to be paid to soil and its biodiversity when considering conservation and sustainable use of above-ground biodiversity.

[90] CBD COP V/6.

4.2 Cross-Cutting International Initiative for the Conservation and Sustainable Use of Soil Biodiversity

Following on from earlier case studies of 'soil-microorganisms in agriculture',[91] and the identification of components of agricultural biodiversity that provide ecological services, including a diverse range of organisms that contribute to nutrient cycling, decomposition of organic matter and maintenance of soil fertility; pest and disease regulation; pollination; maintenance and enhancement of local wildlife and habitats; maintenance of the hydrological cycle; erosion control; and climate regulation and carbon sequestration,[92] the CBD cross-cutting International Initiative for the Conservation and Sustainable Use of Soil Biodiversity was established in 2002, within the Programme of Work on Agricultural Biological Diversity.[93] FAO and other relevant organizations were invited to facilitate and coordinate the Initiative.

A Framework for Action for the Initiative was endorsed by the COP in 2006.[94] This lays out strategic principles, including a 'focus on integrated holistic solutions and technical adaptation to local contexts within a clear framework that builds on the principles for application of the ecosystem approach' and developing partnerships and alliances that demonstrate multidisciplinarity and foster synergies and ensure multi-stakeholder participation. Implementation is to be appropriately linked to other thematic programmes, particularly on dry and sub-humid lands, mountain and forest biological diversity, and with relevant cross-cutting issues, particularly the Global Taxonomy Initiative and work on technology transfer and cooperation.

The Framework sets out three overall objectives relating to (1) the sharing of knowledge, information and awareness raising; (2) capacity building for the development and transfer of knowledge of soil biodiversity and ecosystem management into land use and soil management practices; and (3) strengthening collaboration among actors and institutions and mainstreaming soil biodiversity and biological management into agricultural and land management and rehabilitation programmes, to be achieved through a number of specific goals and activities.

Though the Framework is implemented through the agricultural biodiversity programme, the COP has noted that the conservation and sustainable use of soil biodiversity is an important issue beyond agricultural biodiversity and is relevant to most terrestrial ecosystems, and that soil biodiversity is impacted by human activities beyond agriculture as well as natural influences.[95] It has called upon Parties and other Governments to integrate soil biodiversity conservation and sustainable use into their national strategies and action plans and to put in place multisectoral

[91] CBD COP III/11, Annex III.

[92] CBD COP V/5.

[93] CBD COP VI/5.

[94] CBD COP VIII/23.

[95] COP VIII/23.B.2 and 3.

programmes and initiatives for the conservation and sustainable use of soil biodiversity, at national and subnational levels. It has also invited Parties, other Governments, international organizations, non-governmental organizations and other interested stakeholders to support and, where appropriate, implement the Initiative and to supply further case-studies on soil biodiversity in order to further strengthen it, and urged Parties and relevant organizations to identify research activities to address knowledge gaps on soil biodiversity and their implications for land use practices.[96]

Following on from previous review, COP 14 requested the CBD Executive Secretary to review the implementation of the Initiative, in consultation with FAO under the framework of the Global Soil Partnership (GSP) as well as other interested partners, and present an updated draft action plan for consideration by the CBD Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) prior to COP15.[97]

The Executive Secretary's resulting document[98] provided a review of the three objectives of the Initiative as well as an analysis of soil biodiversity in national reports and national biodiversity strategies and action plans (NBSAPs), highlighted the contributions of soil biodiversity to the sustainable development goals (SDGs) and opportunities for the post-2020 Global Biodiversity Framework, and included suggested recommendations and a draft Plan of Action (2020-2030) for the Initiative, which, as subsequently amended, was adopted in Decision COP15/28 at COP 15.[99]

The Plan of Action (2020-2030) describes its purpose and objective as follows:

> The *purpose* of this plan of action is to provide ways to encourage conservation, restoration and sustainable use of soil biodiversity and to support Parties, other Governments, subnational and local governments, indigenous peoples and local communities, women and youth, relevant organizations and initiatives, in accelerating and upscaling efforts towards the conservation, restoration and sustainable use of soil biodiversity, and towards the assessment and monitoring at the corresponding level of soil organisms to promote their conservation, sustainable use and/or restoration, and to respond to challenges that threaten soil biodiversity.
>
> . . .The *overall objective* of this plan of action is to mainstream soil biodiversity science, knowledge, and understanding into public policies, at all levels, and to foster coordinated action to invest in soil biodiversity assessments at the global level to safeguard and promote the conservation, restoration and sustainable use of soil biodiversity and its ecosystem functions and services, which are essential for sustaining life on Earth, while acknowledging that economic, environmental, cultural and social factors contribute to sustainable soil management, and to promote investment in soil biodiversity research, monitoring and assessment at the corresponding level. Achieving this objective will ensure that soil biodiversity recovers and continues to provide a full range of functions. It will also formally promote sustainable soil management practices, including artisanal forms of food

[96] CBD COP III/11; COP VIII/23.

[97] CBD/COP/DEC/14/30.24(b).

[98] CBD/SBSTTA/24/7/REV.1 (4 December 2020),

[99] CBD/COP/DEC/15/28 (19 December 2022).

production, which can enhance soil biodiversity while maintaining the productivity of managed ecosystems.

It comprises four main elements, the first of which is entitled ‘policy coherence and mainstreaming’, under which it lists 12 activities, the first three of which are:

1.1 Promote the importance of mainstreaming soil biodiversity, including the conservation, restoration, sustainable use and management of soil biodiversity into policies aimed at the sustainability of agriculture, and other relevant sectors and support the development and implementation of coherent and comprehensive policies for the conservation, sustainable use and restoration of soil biodiversity at the local, subnational, national, regional and global levels;

1.2 Foster activities to safeguard and promote the importance as well as the practical application of soil biodiversity, and integrate them into broader policy agendas for food security, ecosystem and landscape restoration, climate change adaptation and mitigation, urban planning and sustainable development, including the Kunming-Montreal Global Biodiversity Framework, UNCCD 2018-2030 Strategic Framework and the Sustainable Development Goals;

1.3 Promote the implementation of good practices of sustainable soil management [100] as a vehicle to promote integrated and holistic solutions that recognize the key role of above-ground/below-ground biodiversity interactions and of indigenous peoples and local communities and their traditional knowledge and practices, and that consider local contexts and integrated land-use planning, in a participatory manner.

Further activities listed include promotion of “integrated ecosystem approaches” and “policies that protect or help increase soil biodiversity”. Also included is the development of “policies and actions based on the recognition that soil biodiversity is central for sustaining all ecosystems and a key asset in restoring soil multi-functionality in degraded and degrading ecosystems”; the strengthening of “synergies between scientific evidence, conservation, restoration and sustainable practices, farmer-researcher community practices, agricultural advisory services and traditional knowledge of indigenous peoples and local communities to better support policies and actions”; as well as addressing linkages between soil biodiversity and “human health, nutritious and healthy diets and pollutants exposure. Likewise, there is a focus on promoting “ways and means to overcome obstacles to the adoption of good practices in sustainable soil management associated with land tenure, the rights of users of land and water, in particular women, the rights of indigenous peoples and local communities, and the rights of peasants and other people working in rural areas” and “recognizing their important contributions through their knowledge and practices, gender equality, access to financial services, agricultural advisory services and educational programmes”. Attention is also drawn to the existing tools and guidance available to actors at all levels such as the FAO agroecology knowledge hub, the FAO Voluntary Guidelines for Sustainable Soil Management (VGSSM),[101] the FAO’s Revised World Soil Charter,[102] the Code of Conduct on Pesticide

[100] FAO (2017).

[101] FAO (2017).

[102] Revised World Soil Charter 2015.

Management,[103] the International Code of Conduct for the Sustainable Use and Management of Fertilizers;[104] and the Committee on World Food Security's recently revised and reissued Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forest in the Context of National Food Security (VGGT).[105] The 'policy coherence and mainstreaming' activities list ends with "Encourage Parties to include soil biodiversity in national reports and national biodiversity strategies and action plans, and coordinate at the national and subnational levels, in order to increase and improve public and private actions that improve soil biodiversity"; and "Promote coordinated spatial planning and other approaches to reduce the loss of soil and soil biodiversity and implement adequate monitoring of soil sealing."[106]

These activities are what one might expect from a CBD Party's concerted effort to implement the mainstreaming agenda of the CBD in any event, especially in the light of recent greater understanding of the critical role of soil biodiversity in terrestrial ecosystem function since the Convention was concluded. They are set against the background of a number of 'global actions' that have been identified as supporting the implementation of coherent and comprehensive policies for the conservation, restoration and sustainable use of soil biodiversity at all levels. Among the 'global actions' to be considered by Parties is "Include soil biodiversity as an important component of soil description surveys using a large range of tools, including state-of-the-art methods and technology, and the development of bioindicators".[107]

Including one or a number of groups of soil organisms in soil description surveys as a matter of course by public and private actors at all levels would be an obvious, straightforward, important and (subject to relevant ability and expertise) achievable, first step. Efforts should be made now to ensure sufficient and appropriate training, expertise and facilities among soil stakeholders, including farmers, other professionals and researchers. Guerra et al. (2020) have drawn attention to the lack of globally distributed expertise, research funding and infrastructure for research on a macroecological scale.[108] Potential bottlenecks can be anticipated also at smaller scales, and at a local level, highlighting the need for investment in soil biodiversity capacity building.

FAO is invited to facilitate the implementation of the Plan of Action (2020-2030), which:

> is intended to align activities on soil biodiversity more closely with other FAO-related activities including the International Network on Soil Biodiversity and the Global Soil Biodiversity Observatory, to monitor and forecast the conditions of soil biodiversity and soil health as well as with regional and country offices in order to create synergies and

[103] FAO and WHO (2014).

[104] FAO (2019).

[105] Previously FAO (2012), now FAO (2022).

[106] CBD/COP/DEC/15/28 Annex, Part V.

[107] CBD/COP/DEC/15/28 Annex, Part IV.

[108] Guerra et al. (2020).

provide broader support. The full implementation of the plan of action at the national and subnational levels will depend on the availability of resources.[109]

5 CBD Mainstreaming Agenda

5.1 Mainstreaming in Context

Section 4.2 above draws attention to the areas of focus on 'soil biodiversity' within the CBD framework. However, as also recognised above, 'soil biodiversity' forms part of 'biodiversity' more generally, so CBD objectives, strategies, programmes etc. inherently encompass soil biodiversity.

The CBD 'mainstreaming' agenda seeks to ensure that ***biodiversity and the ecosystem services it provides*** are ***valued, and that this value*** *and other* ***biodiversity issues,***[110] are ***taken into account*** in policies and practices that ***depend*** and/or ***impact*** on it.[111]

Mainstreaming and awareness raising go hand in hand, as it is difficult to value and take into account what you do not know. It is also difficult to conceive of any policy sphere that does not, in one way or another, depend and/or impact on biodiversity and its ecosystem services. Nevertheless, mainstreaming attention has been focused on those sectors that most obviously or directly depend and/or impact on biodiversity, namely agriculture, forestry, fisheries, tourism, energy and mining, infrastructure, manufacturing and processing, and health. It is also now being focused on certain topics such as pollution and invasive species, and on certain mechanisms such as incentives and subsidies, as well as on the business, investment and finance sector more generally.

Valuing the important role in conserving and sustainably using the land, and the rights, including to fair and equitable sharing of the benefits arising out of the utilization of genetic resources, of indigenous peoples and local communities, and gender equality, are also fundamental aspects of the mainstreaming agenda.

In terms of 'valuing', one may consider the intrinsic, ecological, genetic, social economic, scientific, educational, cultural, recreational and aesthetic values of biological diversity and its components.[112]

Biodiversity mainstreaming therefore, can take place in many contexts, and in many ways[113]. It is mandated, promoted and encouraged through the following CBD Convention articles (Table 2), and in Strategies (Table 3), thematic Programmes of

[109] CBD/COP/DEC/15/28 Annex, Part III.

[110] CBD COP X/2, Strategic Plan for Biodiversity 2011–2020, III. Mission of the Strategic Plan refers to mainstreaming of 'biodiversity issues and values'.

[111] CBD website: Mainstreaming Biodiversity: concept and work under the Convention.

[112] CBD COP X/3, paragraph 9(b)(ii).

[113] CBD website: Mainstreaming Biodiversity: concept and work under the Convention.

Table 2 A selection of CBD articles particularly relevant to mainstreaming

Article	Convention Text
1 under Objectives	The objectives of this Convention. . . are the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources. . .
6(b) under General Measures for Conservation and Sustainable Use	Each Contracting Party shall, in accordance with its particular conditions and capabilities: Integrate, as far as possible and appropriate, the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plans, programmes and policies
7(c) under Identification and Monitoring	Each Contracting Party shall, as far as possible and as appropriate, in particular for the purposes of Articles 8 to 10: Identify processes and categories of activities which have or are likely to have significant adverse impacts on the conservation and sustainable use of biological diversity, and monitor their effects through sampling and other techniques
8(l) under In-situ Conservation	Each Contracting Party shall, as far as possible and as appropriate: Where a significant adverse effect on biological diversity has been determined pursuant to Article 7, regulate or manage the relevant processes and categories of activities
10(a) under Sustainable Use of Components of Biological Diversity	Each Contracting Party shall, as far as possible and appropriate: Integrate consideration of the conservation and sustainable use of biological resources into national decision-making
10(c)	Protect and encourage customary use of biological resources in accordance with traditional cultural practices that are compatible with conservation or sustainable use requirements
11 under Incentive Measures	Each Contracting Party shall, as far as possible and as appropriate, adopt economically and socially sound measures that act as incentives for the conservation and sustainable use of components of biological diversity
14 (a) under Impact Assessment and Minimizing Adverse Impacts	Each Contracting Party, as far as possible and appropriate, shall: Introduce appropriate procedures requiring environmental impact assessment of its proposed projects that are likely to have significant adverse effects on biological diversity with a view to avoiding or minimizing such effects and, where appropriate, allow for public participation in such procedures
14 (b)	Introduce appropriate arrangements to ensure that the environmental consequences of its programmes and policies that are likely to have significant adverse impacts on biological diversity are duly taken into account
20(1) under Financial Resources	Each Contracting Party undertakes to provide, in accordance with its capabilities, financial support and incentives in respect of those national activities which are intended to achieve the objectives of this Convention, in accordance with its national plans, priorities and programmes

Table 3 A selection of the CBD Strategic Plan for Biodiversity 2011–2020 provisions particularly relevant to mainstreaming

Strategic Goal A (Aichi Targets 1-4)	Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society
1	. . . people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.
2	. . . biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.
3	. . . incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimize or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio economic conditions.
4	. . . Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.

Work and cross-cutting Issues and Initiatives, COP decisions and a proposed new long-term strategic approach to mainstreaming biodiversity (LTAM), described below.

5.1.1 Mainstreaming in CBD Convention Articles

The following are a selection of Convention articles with particular relevance to mainstreaming.

5.1.2 Mainstreaming in CBD Strategic Plans

5.1.2.1 Strategic Plan for Biodiversity 2011–2020

The CBD Strategic Plan for Biodiversity 2011–2020[114] included Aichi Targets 1-4, which were expressly focused on the strategic goal (Goal A) of "address[ing] the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society". Strategic Goal A and Targets 1-4 are set out in Table 3 below. Other Aichi targets focused on specific sectors (such as fisheries, agriculture, aquaculture and forestry) and issues (such as pollution, invasive species, ecosystem

[114] CBD COP X/2, Annex.

restoration, sustainable consumption and production and resource mobilization), which are the subject, object or means of implementing the mainstreaming agenda.

As is well known, there has been a failure to achieve any of the Aichi Targets, with only six of the twenty targets (not including 1–4) being partially achieved by the 2020 deadline.[115]

5.1.2.2 Post-2020, now Kunming-Montreal Global Biodiversity Framework (GBF)

In CBD COP Decision 14/34, the Conference of the Parties set out the process for developing a post-2020 Global Biodiversity Framework, which has now been adopted pursuant to COP Decision 15/4 as the Kunming-Montreal Global Biodiversity Framework (GBF), as annexed to Decision 15/4, which also decided that the GBF "should be used as a strategic plan for the implementation for the Conention and its Protocols, its bodies and its Secretariat, over the period 2022-2030. Decision 15/4 notes that the implementation of the GBF is to be supported by other decisions adopted at COP15, including Decision 15/5 on the monitoring framework for the Kunming-Montreal Global Biodiversity Framework, Decision 15/6 on planning, monitoring, reporting and review, Decision 15/7 on resource mobilisation, Decision 15/8 on capacity-building and development and technical and scientific cooperation, Decision 15/9 on digital sequence information on genetic resources and Decision 15/13 on cooperation with other Conventions and international organizations. Decision 15/4 also requests the CBD Executive Secretary to conduct a strategic review and analysis of the Programmes of Work of the Convention in the context of the GBF to facilitate its implementation, and, on the basis of such analysis, to prepare draft updates of those Programmes of Work for consideration by the SBSTTA before COP16, and to report on this work to COP16.

The GBF "aims to catalyze, enable and galvanize urgent and transformative action by Governments, and subnational and local authorities, with the involvement of all of society, to halt and reverse biodiversity loss, to achieve the outcomes it sets out in its Vision, Mission, Goals and Targets," and thereby contribute to the objectives of the Convention and its Protocols.[116]

The '**2050 vision**' is a world of living in harmony with nature where: "by 2050, biodiversity is valued, conserved, restored and wisely used, maintaining ecosystem services, sustaining a healthy planet and delivering benefits essential for all people."[117] The **mission for the period up to 2030**, moving towards the 2050 vision, is: "To take urgent action to halt and reverse biodiversity loss to put nature on a path to recovery for the benefit of people and planet by conserving and sustainably using biodiversity and by ensuring the fair and equitable sharing of benefits from the

[115] Zhongming et al. (2020); CBD/SBI/3/2/Add.2 (16 March 2020).

[116] CBD/COP/DEC/15/4, Annex 1, Section B.

[117] CBD/COP/DEC/15/4, Section F.

use of genetic resources, while providing the necessary means of implementation”. The Framework is to be “understood, acted upon, implemented, reported and evaluated consistent with a ... [w]hole-of-government and whole-of-society approach”, and notes that it’s success “requires political will and recognition at the highest level of government and relies on action and cooperation by all levels of government and by all actors of society”.[118]

The GBF sets out four long-term goals, A-D, related to the 2050 vision, and twenty-three global targets for 2030. 'Mainstreaming is highly relevant throughout the goals and targets,[119] and is epressly referenced, in Target 12, and in the overarching heading for Targets 14-23. Target 12 addresses the need to "Significantly increase the area and quality, and connectivity of, access to, and benefits from green and blue spaces in urban and densely populated areas sustainably, by mainstreaming the conservation and sustainable use of biodiversity, and ensure biodiversity-inclusive urban planning. Targets 14-23 are headed "Tools and solutions for implementation and mainstreaming", and include Target 14 on full integration of biodiversity and its multiple values into policies; Target 15 to encourage and enable business, and in particular large transnational companies and financial institutions, to monitor, assess and disclose their risks, dependencies and impacts on biodiversity, including along their operations, supply and value chains, and portfolios; Target 16 on encouraging and enabling sustainable consumption choices and equitably reducing the global footprint of consumption; Target 17 on strengthening capacity for and implementation of biosafety measures; Target 18 on identifying, eliminating, phasing out or reforming harmful incentives, including subsidies; Target 19 on effectively mobilising financial resources from all sources; Target 20 on strengthening capacity building, transfer of technology and research; Target 21 on data, information and knowledge availability and sharing, and the strengthening of communication, awareness raising, education, monigoring, research and knowledge management, while ensuring that traditional knowledge, innovations, practices and technologies of indigenous peoples and local communities are only accessed with their free, prior and informed consent, in accordance with national legislation; Target 22 on ensuring the full, equitable, inclusie, effective and gender-responsive representation and participation in decision-making, and access to justice and information related to biodiversity by indigenous peoples and local communities, respecting their cultures and rights over lands, territories, resources, and traditional knowledge, as well as by women and girls, children and youth, and persons with disabilities and ensure the full protection of environmental human rights defenders; and Target 23 on ensuring gender equality in the implementation of the Framework, including by recognizing their equal rights and access to land and natural resources and their full, equitable, meaningful and informed participation and leadership at all levels of action, engagement, policy and decision-making related to biodiversity.

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[118] CBD/COP/DEC/15/4, Section C.

[119] CBD/COP/DEC/15/4.

The importance of sustainable soil management is implicit throughout the goals and targets, and 'soil health' is explicitly mentioned in Target 11, which provides "Restore, maintainand enhance nature's contributions to people, including ecosystem functions and services, such as teh regulation of air, water and climate, soil health, pollination and reduction of disease risk, as well as protection from natural hazards and disasters, through nature-based solutions and/or ecosystem-based approaches for the benefit of all people and nature".[120] The GBF includes an important section on "Responsibility and transparency", which refers to the need for national targets communicated in a standardized format as part of national biodiversity strategies and action plans, along with effective mechanisms for planning, monitoring, reporting and review, forming an agreed, synchronized and cyclical system,[121] which itself aims for collaboration and enhanced synergies with other multilateral conventions and processes, including the SDGs.[122] The GBF concludes with a section on "Communication, education, awareness and uptake", which includes, as "essential" to effective implementation, key aspects of mainstreaming, including "Increasing awareness, understanding and appreciation of the knowledge systems, diverse values of biodiversity and nature's contributions to people, including ecosystem functions and services and traditional knowledge and worldview of indigenous peoples and local communities as well as of biodiversity's contribution to sustainable development" and "Integrating transformative education on biodiversity into formal, non-formal and informal educational programmes, promoting curriculum on biodiversity conservation and sustainable use in educational institutions, and promoting knowledge, attitudes, values, behaviours and lifestyles that are consistent with living in harmony with nature."[123]

5.1.3 Mainstreaming in CBD Thematic Programmes of Work and Cross-Cutting Issues and Initiatives

The Thematic Programmes of Work established by the Conference of the Parties, "contain provisions closely related to the mainstreaming of biodiversity", and work on specific Cross-cutting Issues addressing implementation of substantive provisions in Articles 6-20, and providing bridges and links between the thematic programmes, also "have direct relevance to mainstreaming".[124] Likewise, cross-cutting Initiatives, such as the International Initiative for the Conservation and Sustainable Use of Soil Biodiversity under the thematic Programme of Work on Agricultural Biodiversity, as well as another on pollinators. also have provisions

[120] CBD/COP/DEC/15/4, Annex 1, Section H.

[121] CBD/COP/DEC/15/4, Annex 1, Section J.

[122] CBD/COP/DEC/15/6.

[123] CBD/COP/DEC/15/4, Annex 1, Section K.

[124] CBD website, Related documents, CBD Secretariat 'Mainstreaming Biodiversity: concept and work under the Convention'.

relating to mainstreaming, as mentioned above. The CBD COP has previously pointed out that the Thematic Programmes of work, and work on Cross-cutting Issues, together provide detailed guidance on implementation of the Strategic Plan, and are key tools to be considered in the updating of national biodiversity strategies and action plans.[125]

5.1.4 Mainstreaming in CBD COP Decisions

Several CBD COP decisions have focused on mainstreaming. These include COP Decision X/2 to which the Strategic Plan for Biodiversity 2011–2020 was annexed. The Decision highlighted that the Strategic Plan would be implemented primarily through activities at the national or sub-national level, and that NBSAPs are key instruments for translating the Strategic Plan to national circumstances, including through national targets, and integration of biodiversity across all sectors of government and society.

Against the background of the high-level ministerial Cancun Declaration on Mainstreaming the Conservation and Sustainable Use of Biodiversity for Well-being,[126] the thirteenth CBD Conference of the Parties adopted COP Decisions XIII/1 and XIII/3. Decision XIII/1, on progress in the implementation of the Convention and the Strategic Plan, encourages parties to mainstream biodiversity targets into NBSAPs and policies of other sectors or processes when they are being reviewed, and to ensure that NBSAPs are adopted as policy instruments. Decision XIII/3, on strategic actions, provides sectoral and cross-sectoral approaches to mainstreaming biodiversity in the agriculture, forestry, fisheries and tourism sectors, including integrated landscape management and recognition and integration of traditional knowledge, customary sustainable use and diverse approaches undertaken by indigenous peoples and local communities in efforts to maintain genetic diversity and reduce habitat and biodiversity loss. It also highlights the need for enhanced monitoring of the use of natural resources, including soil, in all sectors. On agriculture, for example, it encourages Parties to: develop land use policy frameworks to promote sustainable increases in the productivity and diversification of production of existing agricultural land and rangeland while enhancing ecosystem services and functions, including pollination, pest control, water provision and erosion control, acknowledging the importance of agro-ecological approaches, diversification, ecological rotation, agroforestry, organic farming, and of pollinators, pest-control organisms and soil organisms that promote nutrient recycling, thereby reducing the need for or replacing chemical inputs; contribute to the integrated, efficient and sustainable management of energy, water and soil resources; and to use an appropriate mix of regulatory and incentive measures aligned with national

[125] CBD COP X/2.

[126] CBD Cancun Declaration on mainstreaming the conservation and sustainable use of biodiversity for well-being, 3 December 2016, UNEP/CBD/COP/13/24.

biodiversity objectives, including the elimination, phasing out and reform of incentives harmful to biodiversity in order, inter alia, to reduce habitat loss, degradation and fragmentation and to increase the efficiency of use of water, fertilizer and pesticides and to avoid their inappropriate use.

At the fourteenth CBD Conference of the Parties, COP Decision 14/3 was adopted on mainstreaming biodiversity in the energy and mining, infrastructure, manufacturing and processing sectors. Notable features include the recognition of: opportunities to mainstream biodiversity in those sectors, including in relation to integrated spatial and strategic planning, project design, decision-making and economy-wide and sector-wide policies, including incentive measures; the critical role that multilateral development banks, insurance companies, the business sector, financial institutions and other sources of financial investment can play in mainstreaming environmental and social safeguards and best practices to avoid irreparable damage to biodiversity and ecological infrastructure; the existence of opportunities for the wider application of biodiversity-inclusive impact assessments and the integration of biodiversity considerations in feasibility studies and risk assessments and risk communication, in particular strategic environmental assessment of policies, plans and programmes and the use of spatial planning at the national and regional levels, as well as adjusting regulatory frameworks to encourage the assessment and disclosure of financial risks from biodiversity loss related to investors and businesses.

The decision encourages Parties, and invites other Governments and relevant stakeholders, notably public and private entities engaged in the energy and mining, infrastructure, manufacturing and processing sectors to identify opportunities for mainstreaming biodiversity; conserve, enhance and sustainably use biodiversity and ecosystem functions and services in upstream decisions on investments, through such available tools as strategic environmental assessments and integrated spatial planning, **including the evaluation of alternatives to such investments**; apply best practices on environmental impact assessments and biodiversity mainstreaming to decisions, including those of public and private financial institutions, related to the approval of projects and investments in these sectors; apply the mitigation hierarchy when planning and designing new projects and plans; review and update legal frameworks, policies and practices to promote the mainstreaming of biological diversity including through safeguard, monitoring and oversight measures, and promote the full and effective participation of relevant sectors, indigenous peoples and local communities, academia, women, youth and other relevant stakeholders, including in relation to free, prior and informed consent; provide, as appropriate, effective incentives and appropriate governance mechanisms that strengthen best practices and best available and innovative techniques; review and use existing tools to shift markets towards more sustainable consumption and production; and review and update legal frameworks, policies and practices, to foster the mainstreaming of biodiversity conservation and sustainable use in socio-economic and business policies and planning, including through incentives for best practices in supply chains, sustainable production and consumption and measures at the scale of sites or production plants, requiring reporting by businesses on biodiversity dependencies and impacts, strengthening voluntary disclosures, and adopting or updating laws on sustainable procurement, and similar policies to shift markets towards more sustainable products and technologies. It also invites intensification of work to improve the internalization by businesses of the importance and values of biodiversity; and develop and improve metrics, indicators, baselines and other tools to measure the biodiversity dependencies of businesses in these sectors and their impacts on biological diversity, in order to provide business managers and investors with trusted, credible and actionable information for improved decision-making and the promotion of environmental, social and governance investments.

COP Decision 14/4 was also adopted by the fourteenth Conference of the Parties, addressesing mainstreaming biodiversity in the health sector. Among its provisions, it invites "Parties and other Governments, and relevant organizations to further develop communication, education and public awareness tools on the importance for public health of the conservation and sustainable use of biodiversity and ecosystem-based approaches, with a view to mainstreaming biodiversity and developing biodiversity-inclusive One Health policies, plans and programmes, among other holistic approaches, in line with the objectives of the 2030 Agenda for Sustainable Development", and encourages "Parties, and other Governments and relevant stakeholders, in accordance with their national capacities and circumstances, priorities and regulations ...[t]o provide, where appropriate, effective incentives to mainstream biodiversity in the health sector.[127]

The CBD Secretariat has identified a non-exhaustive list of decisions and work streams with particular relevance to promoting mainstreaming, or providing tools for it: these include impact assessment (COP Decisions VIII/28 and 14/3), incentive measures (COP Decisions X/44, XI/30, XIII/3 and 14/22), business engagement (COP Decisions X/21, XI/7, XII/10 and XIII/3) and resource mobilisation (COP Decisions XIII/3 and 14/15), alongside the sectoral approaches to mainstreaming detailed in COP Decisions XIII/3, 14/3 and 14/4, mentioned above.[128]

5.1.5 Long-Term Strategic Approach to Mainstreaming

CBD COP Decision 14/3 also provides for the establishment of a long-term strategic approach for mainstreaming biodiversity, and an Informal Advisory Group on Mainstreaming of Biodiversity (IAG), to advise, taking into account consultation with stakeholders, on the development of a proposal for a long-term approach to mainstreaming biodiversity, including ways to integrate mainstreaming into the post-2020 Global Biodiversity Framework.[129,130]

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[127] CBD COP 14/4.

[128] CBD website, Related documents, CBD Secretariat 'Mainstreaming Biodiversity: concept and work under the Convention'.

[129] CBD/SBI/3/13 (31 August 2020).

[130] CBD/SBI/3/13/Add.1 (28 August 2020).

According to Annex I of Decision 14/3, the goal of the long-term strategic approach to mainstreaming should be to establish priorities for action, based on scientific evidence of likely impacts and benefits in accordance with national capacities and circumstances, and identify key actors and appropriate mechanisms to implement such action. It should first focus on implementation of previous COP Decisions relevant to mainstreaming, and furthermore facilitate assessment and monitoring of gaps and progress. The long-term strategic appoach should be kept under review by the Conference of the Parties, and be flexible enough to respond to relevant changes.[131]

In COP Decision 15/17, the Conference of the Parties welcomed the work of the IAG, which was reflected in the progress report of the Executive Secretary to the third meeting of the Subidiary Body on Implementation (SBI),[132] and later submissions,[133] and requested Parties and other relevant stakeholders to submit their views on the 'draft long-term approach' (also referred to as 'draft LTAM') and an associated 'action plan', that resulted from the work of the IAG, and to identify ways forward to support implementation of the Kunming-Montreal Global Biodiversity Framework. It also requested the Executive Secretary to organize an open-ended online forum to facilitate further views on the relvant reports and submissions. In its decision, the Conference of the Parties emphasised "the importance of intensified mainstreaming actionto achieve the transformational change needed in order to attain the 2050 vision, while acknowledging the specific challenges faced by developing countries in supporting mainstreaming policies and the need for adequate means of implementation and enhanced international cooperation.[134]

The draft LTAM presented to the third meeting of the SBI[135], as updated for inclusion in SBI Recommendation 3/15[136] identifies the three actor-oriented strategy areas and five headline actions, set out in Table 5 below.

Section III of the document presented at the third meeting of the SBI highlights that the financial sector has “unique leverage”, and also makes the point that

> the long-term approach action plan proposes that each player prioritize those sectors with the highest impact and opportunity for progress in a given national or thematic context, as a precondition for more targeted, and hence likely more effective, mainstreaming action in the coming decade. Some of the post-2020 global biodiversity framework’s action targets, such as those on threats and people’s needs, can provide useful pointers for such a prioritization exercise at the national level. For instance, the references to agricultural and other managed ecosystems, to nature-based solutions contributing to clean water provision, or to the benefits of green spaces for health and well-being, especially for urban dwellers, provide useful entry points for mainstreaming action.[137]

[131] CBD COP14/3, Annex I.

[132] CBD/SBI/3/13, 31 August 2020.

[133] CBD/COP/15/INF/10, 11 and 12, 11 November 2022.

[134] CBD COP 15/17.

[135] CBD/SBI/3/13, 31 August 2020.

[136] CBD/SBI/REC/3/15, 28 March 2022.

[137] CBD/SBI/3/13 (31 August 2020), para. 15.

5.2 Reciprocal Mainstreaming

'Reciprocal mainstreaming,' or recognizing priorities at both local and national or global levels, is a critical approach to mainstreaming. As has been pointed out in the context of urban-rural linkages, a one-size-fits-all approach at the national level may not address the needs of local communities. "Solutions should start from the priorities, knowledge and experience of local and subnational actors and Indigenous Peoples."[138]

Being smaller and closer to the ground than national governments, local authorities may be able to transform their governance practices faster than national governments. It is also being recognised that "Subnational and local approaches to systemic transformative change are gaining increased attention as actors at these levels demonstrate the ability to manage complexity and to adapt quickly to changing conditions". COP Decision 15/12 addressed engagement with subnational governments, cities and other local authorities to enhance implementation of the Kunming-Montreal Global Biodiversity Framework, endorsed an updated Plan of Action on Subnational Governments, Cities and other Local Authorities for Biodiversity (2023-2030).[139]

5.3 Sustainable Soil Management and Soil Biodiversity as Front and Centre of Terrestrial Biodiversity Mainstreaming

Looking from this perspective, one can see that the case for sustainable soil management [140]—understood in the broadest sense—and the concomitant protection of soil ecosystem services, ought clearly to be a cornerstone of national implementation of the CBD—and front and centre of mainstreaming for terrestrial biodiversity.

Implementation of the mainstreaming agenda of the CBD must incorporate mainstreaming of soil biodiversity. The International Initiative for the Conservation and Sustainable Use of Soil Biodiversity can today be seen as simply emphasising this, and providing a potential framework for action, alongside explaining why.

In many instances threats to terrestrial biodiversity and the impacts of drivers of terrestrial biodiversity loss may first be played out in the soil—with the consequences of land use change, soil sealing and intensive agricultural production producing their first casualties in the soil. As Guerra et al. (2019) suggest, soil organisms are like the 'canaries in the coal mine'.[141] And, it is becoming

[138] Forster et al. (2021), p. v.

[139] Forster et al. (2021), p. 3.

[140] FAO (2017).

[141] Guerra et al. (2021), p. 239.

increasingly clear that the human species is also suffering from loss of soil biodiversity—and without transformative action, we can be expected to suffer more so in the future.

6 Topical Issues and Case Studies

In this section topical issues in relation to mainstreaming soil biodiversity, soil health and sustainable soil management are presented, using case studies drawn largely from the UK, along with comparative examples from Switzerland and India.

6.1 Citizens/Stakeholders: Raising Awareness, Monitoring and Education

On raising awareness, a recent Freedom of Information request by the Sustainable Soils Alliance (SSA) revealed that only a tiny proportion (0.41%) of England's spending on environmental monitoring went to soil monitoring. SSA found that while £60.5 million was spent on water quality monitoring and £7.65 million on air, only £283,780 was spent on soil monitoring during 2017/18. The SSA Press Release, which received broad press coverage, stated: "This figure… reflects the widespread underinvestment in soil health compared to air and water, despite soil's significant environmental importance—not least as a determinant of the health of these other two factors".[142] The Sustainable Soils Alliance has been actively raising the profile of soils in the UK since its launch in 2017.

Following on from its recent successful 'Science Note on Soil Carbon',[143] which was produced in both a short and detailed version, accessible to the public, policy makers and specialists alike, the British Society of Soil Science (BSSS) is currently working on a 'Science Note on Soils and Biodiversity'.[144]

The BSSS, the SSA and new initiatives, such as uksoils,[145] are becoming increasingly involved in education and awareness raising for soils. Launched on 4 December 2020 as a contribution to World Soil Day, uksoils is "an ambitious new initiative that aims to kickstart a nationwide appreciation and understanding of the economic, societal and ecological importance of soil health to support action and research… enable better access to robust, independent information, and provide a space for new proactive communities to share their knowledge and experiences of actions to improve soil health."

[142] SSA (2019).

[143] BSSS (2021a, b).

[144] BSSS (2022).

[145] Uksoils website 'About Us'.

It is notable that existing resources tend especially to be aimed at younger schoolchildren and current professionals. In the near term, further work needs to be done to embed soil literacy and the importance of soil biodiversity among new and existing, university and college undergraduates, postgraduates and researchers in all disciplines, who will become the professionals and policy makers during the current critical decade. This includes ensuring that both the physical and the academic learning environment demonstrate care for the value of soil and its biodiversity, and imbue an 'intrinsic' perspective.[146]

6.2 *Local Authorities and Partners: Parks and Open Spaces, the Pull of Pollinators and Construction Soils*

Hågvar has pointed out that "Local authorities responsible for long-term area planning probably represent key bodies for preservation of soil biodiversity".[147] The importance of subnationalgovernment for biodiversity is being increasingly acknowledged, as is evidenced in the decision on 'Engagement with subnational governments, cities and other local authorities to enhance implementation of the Kunming-Montreal Global Biodiversity Framework' adopted at COP15.[148]

6.2.1 Cambridge: *Parks and Open Spaces Biodiversity Toolkit* and Happy Bee Street

In the UK, Cambridge City Council is one of a rising number of local authorities to have declared a "Biodiversity Emergency".[149] In its management of parks and green spaces (including 12 local nature reserves, over 80 parks and recreation grounds, large commons, allotment sites, community gardens and orchards, burial grounds, and extensive green roadside planting) the Council is promoting measures to enhance biodiversity, including "the amazing soil ecosystem".[150] Its *Parks and Open Spaces Biodiversity Toolkit* documents measures that are being taken by the City Council that encompass conservation and sustainable use of soil biodiversity, without expressly referring to 'soil biodiversity' as such. These include replacing formal annual bedding schemes that used intensively produced plants and bulbs, and were associated with the use of long-acting pesticides, with perennial flowering meadows, including native species, that are drought tolerant and require no or very little watering during establishment, reducing water being drawn from the chalk

[146] Xylander (2020).

[147] Hågvar (1998).

[148] CBD COP Decision 15/12.

[149] Cambridge City Council (2019).

[150] Cambridge City Council (2021), p. 7.

aquifer that supplies the City's drinking water and local globally rare chalk streams.[151] It also mentions that some areas of green spaces and verges that have traditionally been maintained by regular cutting by petrol driven lawnmowers and strimmers are being left as long grass to flower and provide food, cover and habitat for insects and other invertebrates and their predators. Since 2019, adopting a precautionary approach, short and long-acting herbicide use has been ceased in Council run parks and open spaces, except in exceptional circumstances (such as to treat Japanese Knotweed).[152] Areas of brambles and nettles are being managed on rotation to support biodiversity, and Local Nature Reserve staff and volunteers are using traditional scythes instead of petrol strimmers to cut flower meadows. Tree stock is managed to ensure a diverse range of species and age groups, with deadwood retained standing where safe to do so, and where felling is necessary large sections are being retained as both natural play features, and as a habitat for fungi and beetles.[153] The Council has extended a trial of using no herbicides in all public areas, including streets and council estates, to four areas in the city, with the hope of extending it across the city in the future.[154] They have also set up a volunteer scheme in which residents can 'adopt' their street to improve biodiversity, including for herbicide free maintenance. To become a 'Happy Bee Street' the street must fulfil certain criteria, relating to safety, and if adopted participants will be expected to manage unwanted vegetation growth without using herbicides. In return the Council will stop spraying chemicals to control weeds in that street, and provide equipment to help remove and dispose of weeds; provide relevant health and safety training; specialist advice on biodiversity improvements and wildlife habitat creation; public liability insurance for the street's 'Happy Bee Street' activities (subject to completion of a health and safety session); and a single point of contact and regular communications about the initiative.[155]

6.2.2 *Monmouthshire:* 'Nature Isn't Neat' Project and *Training Manual*

In support of their "legal obligations and duties as a public authority to manage the environment sustainably",[156] Monmouthshire County Council have piloted, and since expanded, an alternative grassland cutting regime on verges, open spaces and parks to benefit pollinators, as part of its Nature Isn't Neat project.[157] In their *Nature Isn't Neat Training Manual*, they listed "increase habitat for pollinators –

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[151] Hawksley and Mungoran (2020).

[152] Cambridge City Council (2021), Cambridge City Council website 'Reduced use of herbicides'.

[153] Cambridge City Council (2021).

[154] Cambridge City Council website 'Reduced use of herbicides' and 'Cambridge herbicide free ward trial extended' (which was accessed on 16 August 2023).

[155] Cambridge City Council website 'Adopt your street to help improve biodiversity'.

[156] Monmouthshire County Council website 'Nature Isn't Neat Training Manual', second last page.

[157] Monmouthshire County Council website 'Nature Isn't Neat'.

more food, shelter, hibernation sites and opportunities to reproduce to increase populations; connect isolated habitats allowing pollinators to move around, find resources and repopulate areas; [and] increase the source population of pollinators to spread into wider countryside and support food production; increase diversity of pollinator species", as "primary objectives".[158] The Training Manual, nevertheless, recognises expressly and implicitly soil related "complimentary co-benefits", including "improve general health of other wildlife and the natural environment both above and below ground"; increase resilience of the natural environment to pests and diseases; increase resilience of the natural environment to drought and flooding; "open soil structure", "no pan", "more belowground activity", and "improved root development and less soil compaction [which] improves resilience to drought and flooding". The text is illustrated with diagrams showing increased numbers of soil organisms (represented by what appear to be earthworms), more extensive and deeper plant roots, increased carbon in vegetation and soil, and increased water infiltration, compared to business as usual. It also mentions the additional benefits to people of supporting farm yields, and improving absorption of pollutants, and the impact on mental and physical health. The Council point out that "[t]his is not a cost cutting exercise, we are working differently, not less", and that "[t]here are lots of unseen benefits to people".[159]

6.2.3 The Pull of Pollinators

As is often the case, 'pollinators' provide the 'pull' and soil biodiversity comes along for the ride. This is the case not only for citizen, stakeholder and policy-maker engagement, but also in practice. Many pollinators, including ground nesting bees, are also soil dwelling creatures, during at least part of their life cycle. And pollinator dependent flowering plants (and their roots), making up 87% of flowering plant species,[160] are key to healthy soils, soil biodiversity and the provision of soil ecosystem services. In particular erosion prevention, flood prevention and maintenance of soil fertility rely on ground cover and on plants with extensive root systems, some of which will depend on pollinators. As Christmann (2019) has noted, many nitrogen fixing legumes and other soil fertility enhancing plants depend on specific wild bee pollinators, which can be ground dwelling. They also point out that while (invasive) pollinator-independent plants may be able to address soil erosion, or flood prevention to some extent, they aggravate the local lack of pollen and nectar, and pose a risk of exacerbating pollinator decline, and result in 'pollinator-loss syndrome' as a potential driver of global change. Christmann points to the lack so far, and importance going forward, of synergies between initiatives for pollinators and for soil biodiversity, including the importance of acknowledging ground dwelling pollinators as part of

[158] Monmouthshire County Council website 'Nature Isn't Neat Training Manual', second page.
[159] Monmouthshire County Council website 'Nature Isn't Neat Training Manual', second last page.
[160] Christmann (2019).

soil biodiversity. Orgiazzi and Panagos have suggested "Soil biodiversity and soil erosion. It is time to get married."[161] Let's ensure that wild pollinators are at the wedding, and that they all remain life-long companions thereafter.

6.2.4 Cambridge and Peterborough: Developing with Nature Toolkit and Construction Soils

In contrast to the Nature Isn't Neat Training Manual described above, a Cambridge and Peterborough Combined Authority approved *Developing with Nature Toolkit*,[162] although including many excellent and helpful recommendations - such as involvement of ecologists at an early stage in development planning, and a focus on important aspects of above-ground biodiversity and on green infrastructure - demonstrates a familiar lack of positive express attention to 'soils' or 'soil biodiversity'. It does, though, mention the potential of nutrient poor soils for flower rich grasslands; and implicitly values soil in the context of the promotion of 'green infrastructure' and 'biodiverse green roofs', which, increasingly, may use local soil substrates. However, if the ecologists engaged are above-ground focused, and contractors, as is often the case, are not focused on handling soil in accordance with soil conservation and sustainable use, it is likely that soil and its biodiversity will be compromised, not to mention wasted.[163] The opportunity has, so far, been missed to refer to existing 2009 government guidance on soil handling in construction projects, the DEFRA Construction Code of Practice for the Sustainable Use of Soils on Construction Sites,[164] which seeks to support sustainable soil management, including for the benefit of "soil organisms", "biodiversity" and "soil fauna". [165] The 2009 Code of Practice is currently subject to review,[166] and efforts are being made towards securing its update, and for more targeted activity on urban soils.[167] A first effort at guidelines on soils and EIA has recently been produced by IEMA.[168] For comparison, the presentation by Prof. Fabienne Faure Boivin, of the Haute école d'ingénierie et d'architecture de Fribourg at Eurosoil 2021,[169] provided a valuable example of mainstreaming sustainable soil management in the construction industry in Switzerland through the longstanding requirement for a pedological

[161] Orgiazzi and Panagos (2018).

[162] Natural Cambridgeshire (2018).

[163] Simon (2021).

[164] DEFRA (2009).

[165] DEFRA (2009) pp. 4, 48.

[166] CL:AIRE website 'DEFRA Construction Code of Practice for the Sustainable Use of Soils on Construction Sites—survey extended'.

[167] SUSHI (2020).

[168] IEMA (2022).

[169] HES.SO People website 'Fabienne Faure Boivin'.

consultant for large projects,[170] as well as the provision of awareness raising across a range of stakeholders in relation to construction soils.[171] While this has been reported to benefit soil physical and chemical properties,[172] it can also be expected to have benefits for soil biological properties too.

6.3 Devolved Authorities and Subnational States: Strategic Environmental Assessment (SEA) Guidelines, Prime Farmland Protection, Sustainable Farming Incentive, State-Wide Organic and Other Forms of Sustainable Farming

Environmental protection and agriculture are devolved matters in the UK, and the approaches adopted by the devolved authorities illustrate differing ways in which soil biodiversity, soil health and sustainable soil management can be mainstreamed.

6.3.1 Scotland: SEA Soil Guidance and Soil Biodiversity

In Scotland, the Scottish Environment Protection Agency (SEPA) *Guidance on consideration of soil in Strategic Environmental Assessment*,[173] expressly includes "changes in soil biodiversity"[174] among the processes that can result in damage to the wider environment, society and the economy. It highlights that soil biodiversity is essential to most soil functions, specifically referring to the fact that soil biodiversity affects the sustainability of species and habitats that rely on soil, and to the role soil organisms play in the carbon and nitrogen cycles and GHG exchanges, and in breaking down potential contaminants.

The Guidance identifies changes in land management practices affecting the structure, stability, biological, physical and chemical characteristics of soil as among the causes of changes in soil biodiversity, and lists the following as possible "typical effects of a [plan, programme or strategy] on soil biodiversity":

- Major positive ++ action very likely to lead to full conservation of current biodiversity status in most affected / vulnerable areas, particularly sensitive and designated areas; measures put in place to promote enhancement of soil biodiversity, especially in sensitive / designated areas.
- Minor positive + action very likely to lead to some conservation of current biodiversity status in some areas

[170] Neuner and Schaber (2020).

[171] BAMU website 'Bodenschutz beim Bauen'; Havlicek and Staehli (2022), p. 26.

[172] Neuner and Schaber (2020).

[173] SEPA (2019).

[174] SEPA (2019), 2.1.

- Minor negative – action very likely to lead to an overall moderate increase, or a series of smaller increases, to rates of loss of soil biodiversity in some areas.
- Major negative - - action very likely to lead to an overall large increase, or a series of smaller increases, to rates of loss of soil biodiversity in large areas and is likely to affect sensitive and designated areas.[175]

The Guidance does acknowledge that "Relatively little is known about the state and trend of Scotland's soil biodiversity except for a few protected soil-dwelling species,"[176] and it is not known to what extent this aspect of the Guidance has been applied in practice. It is notable that later in the Guidance, under the SEA Headline Objective 'To maintain or improve soil quality and prevent any further degradation of soils', the sub-objectives given do not refer specifically to soil biodiversity. Nevertheless, the existence of the Guidelines, and the inclusion of express reference to "changes in soil biodiversity" among the "Existing environmental problems relating to soil, their potential causes and examples of likely significant effects", and acknowledgment of its connection with species and habitats generally, is evidence of some express effort to mainstream soil quality and soil biodiversity, alongside biodiversity more generally, in Scottish environmental policy.

6.3.2 Wales: Prime Farmland Protection, 'Very High Sensitivity' Receptor And Global Responsibility

Laws can be enacted to protect prime farmland from soil sealing and development, as in Switzerland, where sufficient farmland to provide for national food security in an emergency has been protected.[177] In the UK, Wales goes further than other devolved nations in providing an example of how a devolved authority can make a difference in addressing local development threats to agricultural soils and the ecosystem services they provide, by strengthening protection for prime farmland from sealing and development, through actively prioritising 'agricultural land use' for the 'best and most versatile land' (BMV), according to the Agricultural Land Classification system, in national planning policy,[178] and adopting a broad range of agricultural land classification bands that are deemed to be receptors of 'Very High Sensitivity' for assessment purposes.[179] The Welsh Minister for Climate Change recently wrote to Chief Planning Officers emphasising that "in accordance with Welsh Government policy . . . where BMV land is identified within a proposed solar PV array development, considerable weight should be given to protecting such land from development, because of its special importance, and unless other significant material considerations indicate otherwise it will be necessary to refuse

[175] SEPA (2019), 2.3.
[176] SEPA (2019), 2.3.
[177] Tobias and Price (2020), p. 3.
[178] Welsh Government (2021), 3.58–9.
[179] IEMA (2022), pp. 47–49.

permission."[180] Wales is also notable for its progressive Well-Being of Future Generations (Wales) Act (2015), which includes 'A Globally Responsible Wales' among the country's seven key 'well-being goals',[181] promoting consideration of the implications of Welsh policies on global well-being, including, for example, the potential for loss of Welsh arable land to result in shifting production to 'less environmentally sensitive systems' overseas.[182] The Act also provides for national indicators of progress, which include 'concentration of carbon and organic matter in soil'.[183]

6.3.3 England: Sustainable Farming Incentive and Soils Data as a Public Good

In England the Common Agricultural Policy is being replaced by the new Environmental Land Management schemes (ELMs), incorporating the new Sustainable Farming Incentive (SFI), which aims to pay farmers public money for delivering environment and climate goods and services, including by encouraging actions that improve soil health.[184] This comes against the background of a Government pledge to manage soils sustainably by 2030,[185] as set out in the 25 Year Environment Plan,[186] which has, however, not fully been reflected in the followup Environmental Improvement Plan.[187] Under the SFI land managers will be paid to protect and restore soil health by carrying out SFI 'actions'. After discontinuing an initial pilot of an 'arable and horticultural soil standard' and an 'improved grassland standard', the 'soil actions' now rewarded under the Sustainable Farming Incentive, as of September 2023, are *SAM1 Assess Soil, Produce a Soil Management Plan and Test Soil Organic Matter*, which will provide £5.80 per hectare, and £95 per SFI agreement, per year; *SAM 2 Multispecies Winter Cover Crop*, which will provide £129 per hectare per year; and *SAM3 Herbal Leys* which will provide £382 per hectare. These SFI actions can be combined with other SFI actions and other environmental land management options including under an improved Countryside Stewardship scheme.[188] Take up, and impact on soils, remain to be seen. It is notable that, although they have since been replaced with 'soil actions', 'soil standards' were the first SFI measures to be introduced. An introduction to the current

[180] Welsh Government (2022).

[181] Section 4.

[182] Welsh Government (2019), pp. 140–141.

[183] Section 10, Gov.wales website 'Wellbeing of Wales: national indicators'.

[184] Gov.uk website Environmental Land Mangement (ELM) update: how government will pay for land-based environment and climate goods and services. Updated 21 June 2023.

[185] DEFRA (2009), p. 10.

[186] HM Government (2023), p. 165.

[187] HM Government (2023), p. 165.

[188] DEFRA (2023).

SFI soils actions states "The SFI actions for soils are focused on improving soil health, structure, organic matter and biology ... These actions can help with the long-term productivity and resilience of the soil to benefit food production. They can also provide environmental benefits, such as better water quality, improved climate resilience and increased biodiversity."[189] Interestingly, the SFI Handbook makes it explicit that the data from the soil assessment and soil organic matter test results "is one of the public goods that this action is paying for and part of wider government measures in relation to our soils policy and strategy."[190] Additional SFI actions relating to moorlands, hedgerows, integrated pest management, nutrient management, farmland wildlife, buffer strips and low impact grasslands are also available.[191]

6.3.4 Sikkim: 100% Organic Agriculture, and Wider Adoption of 'Natural' Farming

From a political commitment made in 2003, the Indian state Sikkim has successfully adopted organic farming as state policy across the entire state, with a view to preserving the state's fragile ecosystem and the health of its citizens. Sikkim has phased out chemical fertilizers and pesticides, and implemented a total ban on sale and use of chemical pesticides, with the transition benefitting more than 66,000 farming families. Socio-economic objectives of the policy also include helping young people stay on the land, attracting local and foreign sustainable tourism, and taking advantage of premium organic markets.[192]

In a 2021 horizon scan, Sutherland et al. (2021) highlighted that globally, uptake in sustainable farming is going through a step change increase.[193] They point to Sikkim and other entire states in India adopting forms of sustainable farming that promote the use of non-synthetic, locally sourced, inputs, which reduces costs while boosting yields and farmer health. Soil health and biodiversity can be expected to benefit too. States, such as Andhra Pradesh, Himachal Pradesh, Bihar, Kerala, Maharashtra and Rajasthan have announced or are working towards statewide uptake of 'natural' farming. The horizon scan suggests that with policy support, such as the state-led programme of training, extension and social capital development in Andhra Pradesh, which has let to adoption by over a quarter of a million farmers to date, including many who have transitioned from high input farming practices, uptake could be rapid and could induce similar changes in other regions of the world. An impact assessment of the system in Andhra Pradesh addresses soil quality and reports that an overwhelming majority of the farmers have reported that

[189] DEFRA (2023), p. 18.
[190] DEFRA (2023), p. 21.
[191] DEFRA (2023).
[192] Heindorf (2019).
[193] Sutherland et al. (2021).

"the quality of the soils and crops have improved" due to Andhra Pradesh Community Managed Natural Farming (APCNF), and that "soil improvements are not just the farmers' perceptions, they have manifested into higher and resilient crop yields and quality crop outputs which in turn resulted in higher gross and net returns". The majority of farmers reported improvement in their own and their families health, and "in their financial position; their outlook towards agriculture and their happiness."[194] In terms of soil quality farmers were questioned about whether they had noticed an increase in the 'softening of the soil', which was confirmed by almost all farmers in 2019–2020 (97%), up from 87% in 2018–2019, and also whether they had seen an increase in numbers of visible earthworms, which was the case for the great majority of farmers, although slightly fewer in 2019–2020 (80%) than in 2018–2019 (85%).[195]

These examples demonstrate a range of actors, and contexts, in which soil biodiversity can be explicitly or implicitly mainstreamed, across urban and rural landscapes. They also emphasise the difference that individuals, who are willing to 'propose' and 'do' things 'differently' can make. Even small actions initiated by individuals will build upon, and stimulate, each other. This underscores the importance of soil biodiversity awareness raising among the next, imminent, cohort of policy makers and decision makers currently in tertiary education today. We need them to be ready and motivated to value soil biodiversity, and the ecosystem functions and services that depend on it, and to implement a transformative agenda across a broad spectrum of disciplines.

7 The Economics of Biodiversity and Nature-Based Financial Disclosure

Implementation of a transformative agenda includes, and requires, a supportive 'economic' system that is fit for purpose. CBD COP Decision X/2 invited Parties "to make use of the findings of the study on The Economics of Ecosystems and Biodiversity[196] and other relevant studies, to make the case for investment for biodiversity and ecosystem services and to strengthen policy commitment to biodiversity at the highest level."[197] More recently, work on the long-term strategic approach to mainstreaming, has noted that the financial sector has 'unique leverage' in mainstreaming biodiversity as all economic sectors rely on financial services.[198]

[194] Galab et al. (2021), p. 74.

[195] Galab et al. (2021), pp. 39–40.

[196] TEEB website.

[197] CBD COP X/2.7.

[198] CBD/SBI/3/L/17 (28 March 2022).

If it still needed saying,[199] the recent Dasgupta Review of the Economics of Biodiversity has highlighted that 'economics' is 'embedded within' and dependent on nature.[200] Measures of economics and cost-effectiveness cannot be considered independently of, but must be nested within, the natural resource base upon which all of humanity relies. 'Flows' of ecosystem services are dependent on 'stocks' of 'natural capital', including healthy soils. Dasgupta, along with others,[201] calls for transformative changes in our understanding and accounting of 'wealth'. He acknowledges the significance of 'planetary boundaries', as indications of safe operating spaces for humanity, and draws attention to the fact that planetary boundaries in relation to N and P cycles, and biodiversity are already exceeded.[202]

The Dasgupta Review highlights three properties of nature that make the economics of nature a challenge: 'mobile', 'silent' and 'invisible', and points out that "The soils are a seat of a bewildering number of processes with all three attributes."[203] 'Soil' is mentioned 84 times throughout the Review. The Review also devotes a box to 'The Soils (which makes frequent mention of soil biodiversity)'[204] and another to 'Soil Biodiversity Loss',[205] the text of which is reproduced below, which alludes to the links between soil biodiversity loss and soil erosion, and highlights the negative impacts of agrochemicals on soil biodiversity and biological processes occurring in soil. Peatlands also feature prominently in the Review. While there is a slight sense of disconnectedness in the soil narrative throughout the Review, there can be no doubt that the intention is to highlight, and showcase, the essential need to take soil and its biodiversity into account in economic decision-making to ensure a sustainable future for a growing global population (Fig. 2).

Over the past two decades there has been a steady trickle of corporate social responsibility (CSR)/environmental, social, governance (ESG) and investment guidance and standards, which have incorporated biodiversity concerns to a greater or lesser degree. The trickle is turning into a stream, [206] with associated literature. Some use soil degradation, and related issues such as overfertilization, chemical inputs and land/soil restoration as 'case' or 'use' studies.[207] The relevance of soil biodiversity is not always made explicit, but is key.

The recent Taskforce on Nature-related Financial Disclosures (TNFD) has taken inspiration, and aims to build on, the success of the Task Force on Climate-related Financial Disclosures (TCFD). The TCFD and TNFD provide opportunities to

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[199] Waring and Steinem (1988), Raworth (2017).

[200] Dasgupta (2021), p. 47.

[201] Bennett Institute for Public Policy website 'The Wealth Economy'.

[202] Dasgupta (2021), p. 107, Steffen (2015).

[203] Dasgupta (2021), p. 6.

[204] Dasgupta (2021), pp. 62–63, Box 2.5.

[205] Dasgupta (2021), p. 112, Box 4.3.

[206] Finance and Biodiversity Foundation et al. (2022).

[207] Robeco and CISL (2022), CISL and UBP (2022), CISL and NatWest Group (2022).

"Soil Biodiversity Loss

Soil erosion is usually slow in stable ecosystems but accelerates with the removal of vegetation; for example, deforestation.[131] According to a 1998 estimate, we obtain more than 99% of our food calories from land-based products, even while loss of soil organic carbon through conversion to agriculture is significant (Pimentel, 2006; Sanderman, Hengl, and Fiske, 2017).[132] Studies suggest that some 80% of the globe's farmland has moderate to severe erosion, first (surprisingly, to the uninitiated) from water and second from wind. Wetlands hold specific types of soil, rich in carbon and nutrients (as in peatlands; Box 4.7). Nearly 90% of wetlands have been lost over the past 300 years; about 35% since 1970 (IPBES, 2018). Collating data on soil erosion, WWF (2017) reported that some half of all top soils have eroded in the past 150 years. A typical estimate is that 75 billion tonnes of soil erode annually at a rate 13 to 40 times the background rates of erosion that prevailed before the acceleration caused by human dominance of the biosphere (Pimentel and Kounang, 1998). The rate of soil erosion accompanying land-use change is judged to be the highest in the past 500 million years (Wilkinson and McElroy, 2007), and some regard it to be the greatest geomorphic agent on the planet today (Hooke, 2000).

What happens when the diversity of life within soil is lost? Wagg et al. (2014) found a strong relationship between ecosystem functions and indicators of soil biodiversity. Reductions in soil biodiversity contribute to eutrophication of surface water, reduced above-ground biodiversity and global warming. Declines in soil biodiversity cause declines in performance of a number of regulating and maintenance services (Bender, Wagg and Van Der Heijden, 2016). Alarmingly, if soil biodiversity were lost completely, the land-based food system would cease to function.

Soil biodiversity loss can be identified by combining quantitative estimates of the circumstances and substances that destroy soil organisms. They include habitat fragmentation, invasive species, climate change, urban sprawl over soils, soil erosion, and soil pollution such as industrial fertilisers and pesticides. Moreover, soil degradation accelerates runoff, and erosion moves the organic sediments, rich in macronutrients, to water bodies, resulting in eutrophication and oxygen collapse in aquatic ecosystems. Dead zones, as in the Gulf of Mexico, are an example.

Once lost, can soil biodiversity be restored? Reduced soil disturbance and increased organic matter as well as the use of deeper rooting crop varieties can help improve soil health, as can cover crops, changes to crop rotations, and no-till approaches. Such practices are the substance of 'organic farming', a subject that we return to in Chapter 16."

Fig. 2 Text reproduced from Dasgupta (2021) p. 112 Box 4.3, © Crown copyright, reproduced under Open Government Licence v3.0

mainstream soil health and the soil ecosystem services that flow from healthy biodiverse soils.

The TCFD has contributed to increasing board level engagement with concerns around sustainable soil management in the context of the climate agenda, referring to opportunities for 'carbon savings', that which ought, for transparency, to be classed as either 'avoided emissions' or 'carbon sequestration',[208] and which may often be overstated, and to the often under acknowledeged risks to business resulting from climate related, or exacerbated, land degradation.

The more recent TNFD initiative [209] provides further opportunity to focus on the importance of soil and its biodiversity for all its contributions to people, including 'ecosystem services'.

The TNFD is a market led initiative, with a Taskforce made up of representatives of financial institutions, corporates and market service providers, led by Co-chairs,

[208] Fee (2019).

[209] TNFD website.

Table 4 Targets 14 and 15 of the Kunming-Montreal Global Biodiversity Framework (GBF)—included under 'Tools and solutions for implementation and mainstreaming'

Target 14	Ensure the full integration of biodiversity and its multiple values into policies, regulations, planning and development processes, poverty eradication strategies, strategic environmental assessments, environmental impact assessments and, as appropriate, national accounting, within and across all levels of government and across all sectors, in particular those with significant impacts on biodiversity, progressively aligning all relevant public and private activities, and fiscal and financial flows with the goals and targets of this framework.
Target 15	Take legal, administrative or policy measures to encourage and enable business, and in particular to ensure that large and transnational companies and financial institutions: (a) Regularly monitor, assess and transparently disclose their risks, dependencies and impacts on biodiversity, including with requirements for all large as well as transnational companies and financial institutions along their operations, supply and value chains, and portfolios; (b) Provide information needed to consumers to promote sustainable consumption patterns; (c) Report on compliance with access and benefit-sharing regulations and measures, as applicable; in order to progressively reduce negative impacts on biodiversity, increase positive impacts, reduce biodiversity-related risks to business and financial institutions, and promote actions to ensure sustainable patterns of production.

Elizabeth Maruma Mrema and David Craig. Its mission has been "To develop and deliver a risk management and disclosure framework for organisations to report and act on evolving nature-related risks, with the ultimate aim of supporting a shift in global financial flows away from nature-negative outcomes and toward nature-positive outcomes." [210] In doing so, it aims to maximise consistency with the TCFD to enable integrated disclosures, and to align with the work of the new International Sustainability Standards Board (ISSB) and other standard setters, and to contribute to implementation of the CBD Kunming-Montreal Global Biodiversity Framework Target 15 (see Table 4 above).

Following a series of pilots, the final Recommendations of the TNFD were published in September 2023. The Executive Summary emphasises that "Nature is no longer a corporate social responsibility issue, but a core and strategic risk management issue alongside climate change. It needs to be brought into the strategy, risk management and capital allocation decisions of business and finance, fully integrating climate and nature considerations",[211] and points out that "the degradation of land and soil been found to adversely impact the market value of companies and increase credit risk to associated lenders."[212] 'Nature-related physical risks' are defined in the Recommendations as "risks resulting from the degradation of nature (such as changes in ecosystem equilibria, including soil quality and species

[210] TNFD website.

[211] TNFD (2023a), p. 8.

[212] TNFD (2023a), p. 7.

Table 5 Draft Long-Term Strategic Approach to Mainstreaming (LTAM) strategy areas and global action areasheadline actions

Strategy area I: Mainstreaming biodiversity across government and its policies
Headline Action 1: Fully integrate ecosystem and biodiversity values[a] into national and local planning, development processes, poverty reduction strategies and accounts,[b] integrating spatial planning and applying the principles of the ecosystem approach.[c]
Headline Action 2. Mainstream biodiversity in fiscal, budgetary and financial instruments, in particular by eliminating, phasing out and/or reforming incentives, including subsidies harmful to biodiversity in key economic sectors, by applying innovative technologies, and by developing and applying positive incentives for the conservation, restoration and sustainable use of biodiversity, consistent and in harmony with the Convention and other relevant international obligations, taking into account national priorities and socioeconomic conditions.
Strategy area II: Integrate nature and biodiversity into business models, operations and practices of key economic sectors, including the financial sector
Headline Action 3: Businesses in relevant economic sectors and at micro, small, and medium levels, and especially large and transnational companies, and those with the most significant impacts on biodiversity, actively transition towards sustainable and fair technologies and practices, including along their supply, trade and value chains, demonstrating decreasing negative and increasingly positive impacts on ecosystems and their services to people, biodiversity and human well-being and health, in a manner consistent and in harmony with the Convention and other international obligations.
Headline Action 4: Financial institutions at all levels apply biodiversity risk and impact assessment policies and processes, having developed tools for biodiversity financing to demonstrate decreasing negative impacts on ecosystems and biodiversity in their portfolios and increasing amounts of dedicated finance, to support sustainable business models and foster the conservation and the sustainable use of biodiversity.
Strategy area III: Mainstreaming biodiversity across society
Headline Action 5: People everywhere have relevant information, awareness and capacities for sustainable development and lifestyles that are in harmony with nature, reflecting the multi-faceted values[d] of biological diversity and its components,[e] and their central role in people's lives and livelihoods, and take gender-specific measurable steps towards sustainable consumption and lifestyles, taking into account individual and national socioeconomic conditions.

[a]See decision X/3, para. 9(b)(ii): the intrinsic, ecological, genetic, social economic, scientific, educational, cultural, recreational and aesthetic values of biological diversity and its components
[b]Sustainable Development Goal 15.9, with an updated timeline (2030 instead of 2020)
[c]See decision V/6. See also https://www.cbd.int/ecosystem/ (Last access: 22 June 2022)
[d]The intrinsic, ecological, genetic, social economic, scientific, educational, cultural, recreational and aesthetic values of biological diversity and its components; see decision X/3, para. 9(b)(ii)
[e]Sustainable Development Goal 12.8, with amendment to reflect the role of biodiversity values and actions taken

composition) and consequential loss of ecosystem services that economic activity depends upon".[213] The TNFD Recommendations include disclosures relating to (1) governance, (2) strategy, (3) risk management and (4) metrics and targets,[214] and the associated Guidance gave several examples of soil related

[213]TNFD (2023a), p. 131.
[214]TNFD (2023a), p. 9.

scenarios including relating to the impact of soil pollutants, and the nature-related dependence on soil quality and soil retention services.[215] The TNFD Recommendations also include 'total pollutants released to soil split by type' among its core disclosure indicators.[216]

Although a clear and highly significant step forward, disclosure requirements, especially if voluntary, will not alone result in the transformative changes that are needed, and must be backed up by strong law and policy, and ambitious targets, to support investors, businesses,[217] consumers and others in making nature positive choices.

8 Moving Forward

8.1 Soil Biodiversity Perception Checklist

For biodiversity mainstreaming, across all sectors and all stakeholders, dependencies and impacts on soil biodiversity need to be brought to the fore, encompassing the local, regional and global implications of decision-making. This following Soil Biodiversity Perception Checklist, developed by the author, is intended to assist with that process, by providing a structured set of questions to consider the relevance of soil biodiversity to particular land uses or activities, with a view to enabling more informed choices when decision-making. The basic framework may be useful for both practical and strategic decision-making purposes, for use by a range of actors in a range of circumstances, including for example, regarding land use and management choices, development of policy and regulation, and in relation to procurement and investment.

Box 1 Soil Biodiversity Perception Checklist
Soil Biodiversity Perception Checklist*

Site Specific Soil Biodiversity

1a How is soil biodiversity helping the **visible** land use or activity **on this site**?
1b How can soil biodiversity be **more effectively harnessed** to help the visible land use or activity on this site?

(continued)

[215] TNFD (2023b).

[216] TNFD (2023a), p. 83.

[217] See, for example, The Chancery Lane Project (TCLP), which includes 'Soren's Clause on sustainable soil management' (2022) for use and adaptation in contracts and other documents.

Box 1 Soil Biodiversity Perception Checklist (continued)

2a How is soil biodiversity helping the **invisible** land uses **on this site**?

2b How can soil biodiversity be **more effectively harnessed** help the invisible land uses on this site?

Neighbouring Soil Biodiversity in the Neighbouring Landscape and Seascape

3a How are any **negative spillover impacts of this site** land use or activity being **dealt with** by neighbouring soil biodiversity in the neighbouring landscape and seascape?

3b How can we **minimize spillover impacts** on neighbouring soil biodiversity?

3c How can neighbouring soil biodiversity be **more effectively harnessed** to help deal with spillover impacts from use of this site?

4a How is neighbouring soil biodiversity **providing additional resources and services** to the **visible** land use or activity at this site?

4b How is neighbouring soil biodiversity providing additional resources and services to the **invisible** land uses at this site?

4c How can neighbouring soil biodiversity be **more effectively harnessed** to help deal with the spillover impacts from use of this site?

Global Soil Biodiversity in the Global Landscape and Seascape

5a How is global soil biodiversity **providing resources and services** to the **visible** land use or activity at this site?

6a How is global soil biodiversity **compensating for/dealing with** the impacts of land use or activity at this site?

6b How can we **more effectively harness** global soil biodiversity to **compensate for/deal with** the impacts of land use at this site, while respecting land workers' rights, and the rights of subsistence farmers, women and youth, and indigenous peoples and local communities.[218]

*'Soil biodiversity' is here being used loosely to refer to 'soil organisms' as well as to their 'diversity'.

'Soil health' or 'soil ecosystem services' could be added to or substituted for 'soil biodiversity' in all these questions. The answers may not be very different!

[218] The use of the term 'compensate for' here does not condone 'offsetting' or 'land grabbing.' Respect for the rights of land workers', subsistence farmers, women and youth, and indigenous peoples and local communities is expected in the 'site specific' and 'neighbouring 'contexts, as well as in the 'global' context.

This checklist reveals that part of the problem with ‘visibility’ and perception stems not just from the ‘invisibility’ of soil and its biodiversity, but also from current ‘land use’ labelling. While labels may helpfully serve to identify the current ‘intended purpose’ and/or 'categorisation' of a site, they can obscure the fact that such 'categorisation', or ‘intended’ land use or activity, is not the only ‘use’ that the land on that site may have—in practice and in theory.[219] The 'land and soil' on the site is performing—or at least capable of performing—multiple functions or 'uses' at the same time. They may not all be of direct monetary benefit to the site owner/manager, but they may be of enormous value to society.

In addition to the questions in the checklist, one might also look in the other direction, asking ‘What might our on-site soil biodiversity contribute to providing resources and services to neighbouring areas and globally?’

The checklist is not only for use by landowners/managers. Anyone can use the checklist to consider a land use, activity, or policy, and make the choice to take action—practical, strategic or regulatory—that incorporates consideration of soil biodiversity, soil health and soil ecosystem services in a meaningful, and equitable, way.

8.2 Links with Other Regimes and Synergies

Soil biodiversity is increasingly being seen, in academic[220] and policy circles,[221] not only as a component of biodiversity overall, but as being at the heart of solutions to pressing global challenges.

The Plan of action (2020–2030) for the International Initiative for the Conservation and Sustainable Use of Soil Biodiversity explicitly seeks to contribute to the achievement of the Sustainable Development Goals,[222] in particular Goals 2, 3, 6, 13, 14 and 15, the Kunming-Montreal Global Biodiversity Framework,[223] the 2050 Vision for Biodiversity, the FAO Strategy on Mainstreaming Biodiversity across Agricultural Sectors,[224] the 2018–2030 Strategic Framework under the United Nations Convention to Combat Desertification (UNCCD)[225] and land degradation neutrality targets and objectives, the United Nations Framework Conven-

[219] Lilburne et al. (2020).

[220] Wall et al. (2015), Geisen et al. (2019a), Bach et al. (2020), Guerra et al. (2021), Köninger et al. (2022).

[221] FAO et al. (2020), p xxii, Montanarella and Panagos (2021).

[222] UN General Assembly Resolution, 25 September 2015, A/Res/70/1 (21 October 2015).

[223] CBD/COP/DEC/15/28, Annex 1.

[224] FAO (2020b).

[225] UNCCD Decision 7/COP.13.

tion on Climate Change[226] and the Paris Agreement,[227] and the objectives, commitments and initiatives under other conventions and multilateral environmental agreements, including the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal,[228] the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade[229] and the Stockholm Convention on Persistent Organic Pollutants,[230] and the Minamata Convention on Mercury,[231] as well as the United Nations Decade on Ecosystem Restoration,[232] and the United Nations Decade of Family Farming 2019–2028, to achieve multiple co-benefits of soil biodiversity processes for improved and more sustainable land-use practices.[233]

Mainstreaming of soil biodiversity in the context of broader CBD approaches to mainstreaming, and through soil biodiversity specific initiatives, deserves greater attention throughout all sectors and at all levels.

As Bach et al. (2020) have emphasized:

> The ways in which soil biodiversity interfaces with multiple ecosystem functions makes it a natural focus for advancing a holistic global sustainability agenda. Soil biodiversity is at the heart of natural solutions for climate, biodiversity, and humanity, including protecting natural areas, restoring degraded ecosystems, employing sustainable agricultural practices, and adapting urban areas for nature and people. As we work toward a sustainable future, let us not overlook the critical and diverse asset, right beneath our feet.[234]

9 Conclusion

Human and other species rely on soil and soil multifunctionality for the fundamentals of life—food, water, shelter, energy, disaster risk reduction (e.g. flooding, drought, landslides, wildfires), medicines, a habitable climate and recreation. Healthy soil, and the soil ecosystems services upon which we depend, in turn, depends on soil biodiversity.

Soil biodiversity must be brought centre stage, into the limelight, and its critical role acknowledged and valued. This requires inclusion of actions to mainstream soil biodiversity in NBSAPs, as well as action by actors at all levels of society.

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[226] UNFCCC 1992.

[227] Paris Agreement 2015.

[228] Basel Convention 1989.

[229] Rotterdam Convention 1998.

[230] Stockholm Convention 2001.

[231] Minamata Convention 2013.

[232] UN General Assembly Resolution, 1 March 2019, A/RES/73/284 (6 March 2019).

[233] CBD/SBSTTA/REC/24/6 (27 March 2022).

[234] Bach et al. (2020), p. 12.

This requires not only education at a young age and training of professionals. It requires that every university and college undergraduate, researcher and staff member be cognizant of the importance of sustainable soil management. An awareness of soil as 'habitat for' and 'being comprised of' soil organisms and soil biodiversity will help to instil a greater understanding of why to, as well as desire to, care for soil.

It requires that every land use, management and investment decision considers the ecosystem services that are and that could be provided by soil and its biodiversity. It also requires recognition that we are impacted not only by the use and management of land and soil in our own neighbourhood, but also by the use and management of land and soil elsewhere, including across borders.

It requires coherence and cooperation at a global level, through practical initiatives such as Soil BON, Soil BON Foodweb, and other activities organised under the auspices of the GSBI and GSP. It also requires collaboration and coordination of policy and activities pursuant to international treaties, alongside the CBD, including the UNFCCC, Paris Agreement, UNCCD, and waste and chemicals conventions.

It requires legislative and other regulatory support, including action at the regional, national and municipal level, such as adoption and full implementation of the proposed EU Soil Monitoring Law,[235] and other national or regional equivalents, domestically and in relation to operations beyond national borders.

It also requires 'doing things differently' at all levels: taking the initiative, and managing expectations, by explaining why the grass is being left a bit longer, or why the soil on a development site should be treated with care, why following agroecological principles makes economic sense; and why, in making land use and management choices, 'undisturbed' land is important.

It requires recognizing and promoting 'natural' solutions to contribute to supporting food security for subsistence farmers, and in the actions of larger operations. It requires globally and individually facing up to the need to transition towards a more plant-based diet. [236]

It means paying attention to and respecting the sustainable traditions and knowledge of indigenous peoples and local communities regarding sustainable land stewardship. And recognising not only the rights, but also the responsibilities, of sovereignty, and the common concern of all States regarding sustainable soil management, which is a vital component of climate mitigation and adaptation and the conservation of soil biodiversity, throughout the world.

Soil biodiversity has, to date, received limited attention in the implementation of the CBD mainstreaming agenda. This must change. The CBD International Initiative for the Conservation and Sustainable Use of Soil Biodiversity has existed for twenty years, providing a framework and now an updated plan of action 2020–2030 for mainstreaming soil biodiversity. This Initiative is additional to the underlying Convention obligations to include soil biodiversity in the CBD mainstreaming agenda. It provides guidance to Parties in implementing Convention obligations

[235] EC (2023).

[236] Benton et al. (2021).

and provides a framework for others to take steps for the conservation and sustainable use of soil biodiversity.

To this end, CBD Parties should include commitments and actions for conservation and sustainable use of soil biodiversity expressly in their NBSAPs. Despite any uncertainty over what ‘counts’ as soil biodiversity, and challenges involved in agreeing standard soil biological indicators, Parties can still take steps towards safeguarding soil biodiversity, by, for example, using available methodologies to begin establishing baselines for soil biological activity and diversity. Where relevant measures are already being taken, for the benefit of pollinators, or above-ground biodiversity, for example, additional justifications, relating to soil biodiversity, may be appropriate.

Where the physical and chemical aspects of soils are being taken into account, effort should be made also to require, or make express reference to, soil biodiversity.[237] Where soil, its biodiversity, and associated ecosystem services, are overlooked in relation to above-ground biodiversity concerns, efforts should be made to include them.

The variability in soil types and soil biodiversity communities, in combination with land use, and local climate, means that more local, site specific, understanding and expertise is required. We need to create conditions that facilitate increased international partnership, and participation of local actors, including in SoilBON, and to increase local knowledge, training and expertise, in local soils and in soil biodiversity, including identification and taxonomy.

Government, industry and the business community cannot seek to sidestep responsibility by focusing on individuals’ responsibility to drive change through their personal decisions regarding consumption.

Nevertheless, change can only come about through individuals. Meaningful change relies on individual decision making. Institutions, governments, companies and other organizations, are comprised of individuals. It is the individual and collective decisions of the individuals within those organisations that drive the larger and smaller transformative changes that must happen. The Soil Biodiversity Perception Checklist is intended to help identify opportunities for improved and transformative decision making. This includes in the context of investments.

This chapter has shown that there are more potential policy and legal drivers than may be being used to protect and enhance soil ecosystem services. It hopefully provides a springboard for ‘soils people’ to make more use of the broader ‘biodiversity mainstreaming’ agenda; and for ‘above-ground biodiversity people’ to embrace the importance and value of soil and its biodiversity for achieving their objectives; and for all policy makers and wider societal actors to take more account of biodiversity mainstreaming and soil biodiversity in their decision making.

Building on earlier contributions,[238] this chapter is intended as an opening for further future conversations regarding soil biodiversity. . . . There are many matters

[237] CBD COP Decision 15/28 Annex.IV.20(b); TCLP Soren’s Clause (2022).

[238] Wolff and Kaphengst (2017), Desrousseaux (2018).

not touched on here, including the important Protocols to the Convention,[239] and, for example, the significance of peatlands, forests, links with human health,[240] war, and microplastics—as well as practical issues to be dealt with, not least the funding gap, increasing interdisciplinarity, harmonising terminology, and upskilling land and food numeracy[241]—and important activities, such as the recently established International Network on Soil Biodiversity (NETSOB)[242] and launch of the Global Soil Biodiversity Observatory (GLOSOB)[243] yet to be addressed, each of which, along with other topics raised in this chapter, could merit a chapter in their own right.

It is hoped that in terms of increasing the visibility of soil biodiversity, and situating it more squarely in the CBD's mainstreaming agenda, this chapter provides food for thought. So, whether it be in the board room, in national and local government offices, in priority setting activities of international, regional and local initiatives, in devising sustainability strategies, in compiling investment reports, in calculating local and global impacts and dependences on nature, as well as in the dining area . . .

'Let's bring soil, and its biodiversity, to the table!'

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[240] CBD COP Decision 15/29, Wall et al. (2015); Singh et al. (2023).

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Part III
Regional/National Reports

Soil Protection Law in Japan

Miho Ishimaki

Abstract Environmental law has developed in parallel with the process of combating environmental pollution in Japan. However, while soil contamination has been recognized as a form of environmental pollution, legislation for measures against soil contamination has lagged far behind. Soil contamination on agricultural land was addressed with legislation in 1970, but soil contamination in urban areas was only addressed with legislation in 2002, with the enactment of the Soil Contamination Countermeasures Act. Even the Soil Contamination Countermeasures Act faces major challenges as it does not apply to voluntary investigations and measures. This is a significant concern because among the total number of soil contamination investigations and countermeasures, the number of voluntary measures significantly exceeds the number of measures taken under the Soil Contamination Countermeasures Act. Moreover, the liability scheme is such that liability is weighted more toward landowners than polluters.

1 Introduction

In Japan, soil protection is implemented within the framework of environmental law, and, therefore, the development of legislation for soil protection is closely linked to the development process of environmental law. Soil contamination, which must be prevented and removed for soil protection, is regarded as a form of typical environmental pollution under Japanese environmental law. The main issue in the legal system when addressing soil contamination is how the liability scheme should be structured. This article, therefore, presents the history of Japanese soil protection legislation and its specific contents and issues. Section 2 provides an overview of the history of legislation on measures against environmental pollution in Japan and explains how soil protection efforts have been implemented in this context. Section 3

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introduces the legal system for the prevention and removal of soil contamination in Japan. Section 4 discusses the biggest challenge in Japanese soil protection legislation—which party to hold responsible.

2 History of Environmental Pollution Control and Soil Protection in Japan

2.1 Tragic Environmental Pollution

Environmental law in Japan has evolved in its consideration of "environmental pollution" (*Kogai*). Mining developed on a large scale in Japan from around 1887, leading to air and water pollution and other problems around the country. In the postwar period, industrial recovery and rapid industrial economic development due to the Income Doubling Program, which started in 1960, caused serious environmental pollution. Since the 1950s, the following four major pollution-induced incidents occurred: Itai-Itai disease, Kumamoto Minamata disease, Niigata Minamata disease, and Yokkaichi asthma. Each caused health problems for the surrounding residents, resulting from environmental pollution caused by companies' industrial activities. These four major pollution incidents were horrendous and led to thousands of deaths. The victims and their families filed lawsuits against the companies responsible and won compensation for damages, forcing the government to take legal action to ensure that such severe pollution incidents would not happen again. Initially, pollution in the early postwar period remained at the local level and was handled by local authorities by enacting ordinances. However, following the four major pollution incidents, the state had to establish laws to address the situation.

Since the late 1950s, several laws have been enacted to manage pollution. In 1958, the Act on the Conservation of Water Quality in Public Water Bodies (Water Quality Conservation Act) and the Act on the Regulation of Factory Effluents (Factory Effluent Regulation Act) (together, the "two water quality acts") were established to address water pollution. In 1959, the Act on the Protection of Water Quality in Public Water Bodies (Water Quality Conservation Act) and the Act on the Control of Factory Effluents (Factory Effluent Control Act) were passed to control water pollution. In 1962, the Act on the Control of Soot and Smoke Emissions (Soot and Smoke Control Act) was enacted to address air pollution caused by soot and smoke. However, all these laws designated only heavily polluted areas as subject to regulation and were not nationally uniform regulatory systems. They also contained a provision known as the "economic harmonization clause," which prioritized the economy over environmental protection. As a result, these laws had little effect, and pollution increased with little progress in countermeasures. Under these circumstances, it became increasingly recognized that pollution *prevention* was necessary, rather than an ex post facto approach, such as designating areas subject to regulation after pollution had been detected.

2.2 The Basic Act on Environmental Pollution Control

In 1967, the Basic Act on Environmental Pollution Control was enacted. The Act (i) specifies six types of pollution (air pollution, water pollution, noise, vibration, land subsidence, and odor) that the government should take action against and requires the government to (ii) set "environmental standards" and specify environmental conservation targets, (iii) set "emission standards" based on the environmental standards, regulate emissions of pollution-causing substances, (iv) and develop pollution control plans. This Act established a comprehensive basic policy on pollution, but it had two main limitations. First, an economic harmonization clause was placed as the purpose of the Act. With this economic harmonization clause present, strict pollution control measures that would hinder industrial activities that contribute to economic development could not be realized. Second, the Act was only a basic law on "pollution" and did not cover the conservation of the natural environment or the protection of the historical and cultural environment. Incidentally, it should be noted that the definition of "pollution" at the time did not include soil contamination. The Basic Act on Environmental Pollution Control did not have soil protection as an explicit objective. This is because it was thought that the legal control of water and air pollution through the two water quality acts and the Soot and Smoke Control Act (amended in 1968 to become the Air Pollution Control Act) was sufficient to control soil contamination as soil contamination had been caused by water pollution or air pollution.[1]

In the 1970s, in addition to the need to address the limitations of the Basic Act on Pollution Control, new environmental pollution problems, such as photochemical smog and sludge, emerged in various regions, making environmental pollution a top national priority. Accordingly, 14 pollution-related laws were enacted or amended at the 64th extraordinary session of the Diet that year, and the Basic Act on Environmental Pollution Control was amended to remove the economic harmonization clause. The definition of environmental pollution was also changed to include soil pollution, increasing the six typical pollution categories to seven, and the government was required to take measures not only for environmental pollution but also for "protection of the natural environment." The two water quality laws were amended to become the Water Pollution Control Act, and the Air Pollution Control Law was partially amended, both of which removed the economic harmonization clause that had existed in the former acts and abolished the designated area system. Thus, pollution control measures came to be implemented without being subordinated to economic development, and regulations were no longer limited to heavily polluted areas but were applied on a uniform nationwide basis. These acts also clearly allowed local authorities to impose stricter regulations than national laws by ordinance (Article 4 of the Air Pollution Control Law and Article 3 of the Water Pollution Control Law). The challenges in conventional pollution control were, therefore, reflected in the amendments to the respective laws.

[1] Kato et al. (1996), p. 349.

In the early 1970s, legislation on pollution control and nature conservation evolved with the establishment of the Environment Agency, the enactment of the Natural Environment Protection Law as the basic law on the protection of the natural environment, the introduction of no-fault liability provisions in the Air Pollution Control Law (Article 25) and Water Pollution Control Law (Article 19), and the adoption of a total volume control system. However, as these various individual laws and regulations became successful, and the problem of intense pollution subsided, legislation on environmental protection stagnated.

2.3 The Basic Act on the Environment

The environmental movement once again gained momentum in the 1990s, when global environmental issues, such as climate change, came to the world's attention. Following the adoption of the Rio Declaration and Agenda 21 at the Earth Summit, United Nations Conference on Environment and Development (UNCED) in 1992, the Convention on Biological Diversity, and the United Nations Framework Convention on Climate Change, the Basic Act on the Environment[2] was enacted in 1993. The Act was intended to address global-scale environmental problems and new pollution problems, including waste management, that differ from conventional pollution. The Act superseded the Basic Act on Pollution Control and set out basic policies not only for environmental pollution control but also for environmental protection more broadly. The new act inherited numerous parts from the Basic Act on Pollution Control and retained the definition of the seven typical forms of pollution. However, the Basic Act on the Environment encourages a shift from conventional "environmental pollution control law" to "environmental law" in that it clearly outlines sustainable development and prevention of interference with environmental conservation as basic principles, refers to the introduction of economic methods that differ from traditional regulatory methods, and aims to achieve a society with a smaller environmental burden by involving the public.[3] Subsequently, based on the Basic Act on the Environment, a number of laws were enacted in response to various environmental issues, such as climate change, waste management (establishing a sound material-cycle society), landscape preservation, and chemical substance management.

While measures for most forms of environmental pollution were thus in place, measures for soil contamination never progressed smoothly. More specifically, by the mid-1970s, corresponding legislation had been enacted for all seven typical pollution types except soil contamination and environmental standards had been set successively. For soil contamination, however, environmental standards were

[2] English version is available on the website of the Ministry of the Environment at https://www.env.go.jp/en/laws/policy/basic/index.html (Last access: 22 June 2022).

[3] Otsuka (2020), p. 20.

only set in 1991 after a long period of neglect, with final legislation eventually enacted in 2002.

The following section presents the history and content of legislation addressing soil contamination.

3 Soil Contamination

In combination with the activities of microorganisms in the soil, the soil decomposes fallen leaves, animal waste, and so forth, stores nutrients, absorbs and purifies rainwater, and delivers rainwater to rivers and the sea underground. These functions of the soil, such as material circulation, water retention, and purification, are the basis for the survival of all living organisms on Earth. The water and food that humans need to survive is also nurtured by the soil.

What does it mean, therefore, for soil to be contaminated? When soil is contaminated by hazardous substances, its functions are reduced. Contamination spreads to the environment around the soil, further affecting human life and health. When hazardous substances are contained in the soil, (i) they remain in the soil semi-permanently; (ii) if they penetrate deeper into the soil and reach the groundwater, (iii) they will eventually flow into rivers and other waterways. Hence, people who come into direct contact with the soil at stage (i), people who drink groundwater at stage (ii), and people who eat fish from rivers and plants grown in the river basin at stage (iii) will each ingest hazardous substances. In other words, health hazards due to soil contamination can occur through two routes: the direct ingestion (e.g., by inhalation or dermal absorption) of hazardous substances and the indirect ingestion through groundwater.

The most distinctive feature of soil contamination is that—unlike air and water pollution—hazardous substances remain in the ground semi-permanently (known as stock pollution) unless they are removed artificially. Soil contamination can, therefore, originate from events that happened a long time ago, meaning that the polluter can no longer be identified or, if they can be identified, may already have become bankrupt or died. The difficulty of identifying polluters is the biggest problem inherent in soil contamination.

3.1 Legislation to Address Soil Contamination

There are two types of soil contamination mainly addressed by the laws on soil protections: that which occurs on agricultural land and that which occurs in urban areas.

3.1.1 Prevention and Removal of Soil Contamination on Agricultural Land

Soil contamination on agricultural land has been observed for a long time, dating back to the Ashio copper mine poisoning incident in the 1890s. This incident occurred when copper (mineral poison) from the Ashio copper mine flowed into the Watarase River, causing extensive damage to crops in the agricultural areas of Tochigi and Gunma Prefectures. Shozo Tanaka, a member of the House of Representatives at the time, appealed directly to the Meiji Emperor to take action against this incident. However, the government did not respond. On the contrary, the opposition of the residents was suppressed by government authorities, leading to the submergence of Yanaka village downstream of the Watarase River for the purpose of depositing mineral poison.[4] It was not until 1974, 90 years after the incident, that the companies responsible agreed to pay compensation to the affected farmers, which exemplifies how difficult it is to resolve environmental pollution problems in the absence of legal standards.[5]

The first case of serious damage to human life and health as the result of an environmental pollution problem was the outbreak of Itai-Itai disease in the 1950s. In this case, cadmium contained in wastewater from a mine contaminated the groundwater and farmland in the basin of the Jinzu River in Toyama Prefecture, and residents who ate the crops developed cadmium poisoning. The Ministry of Health finally recognized cadmium as the cause of Itai-Itai disease in 1968.

As these events indicate, the soil contamination of agricultural land with toxic substances, which are then transported through rivers and groundwater, is problematic because of its effects on crops grown in the soil and on the lives and health of people who ingest those crops.

In response to growing public concern about the soil contamination of agricultural land, legislation was enacted at the 1970 Diet session on pollution. Soil pollution was added to the definition of environmental pollution (Article 2, Paragraph 1 of the Basic Act on Pollution Control Measures), and the Act to Prevent Soil Contamination on Agricultural Land was newly enacted. This law protects not only human health but also the living environment and provides for the implementation of public works projects to prevent and remove soil pollution from agricultural land. The costs incurred for such public works are borne by the business operator in accordance with the Act on Entrepreneurs' Bearing of the Cost of Public Pollution Control Works.

[4] Otsuka (2020), p. 4.

[5] Otsuka (2020), p. 4.

3.1.2 Prevention of Soil Contamination in Urban Areas

Soil contamination in urban areas has been the focus of attention since the hexavalent chromium incident in 1973. In this case, a large amount of chromium was found to have been buried in the soil of a former factory site acquired by the Tokyo Metropolitan Government. More recently, the presence of soil and groundwater contamination in the Toyosu market, the relocated site of the Tsukiji market, became a major social issue. In the Toyosu market, the Tokyo Metropolitan Government purchased a former factory site. While the seller had conducted a soil contamination survey and the government had taken additional measures before signing the purchase contract, after the Tokyo Metropolitan Government acquired the site, inadequate soil contamination measures and groundwater contamination with benzene were discovered just before the market was to be relocated. Additional work became necessary.

Soil pollution in urban areas is mainly caused by landfills and the underground seepage of hazardous substances on factory sites (private property). Hence, prohibiting such activities is essential to preventing soil pollution. In 1970, the Waste Management and Public Cleansing Law was enacted to prohibit the illegal dumping of wastes (Article 16). With regard to infiltration, the 1989 and 1996 amendments to the Water Pollution Control Law prohibited the infiltration of hazardous substances into the ground and established provisions for ordering cleanup in the event of groundwater contamination (Article 12-3, Article 14-3). Furthermore, the Law Concerning Special Measures against Dioxins, enacted in 1999, required that measures be taken through public-works projects to prevent and remove soil contamination caused by dioxins (Article 29 and following).

Although several laws have been established to address soil contamination in urban areas, the enactment of a comprehensive law has been significantly delayed. The most contentious issue has been who should be in charge of soil pollution control. The Soil Contamination Countermeasures Act[6] was finally enacted in 2002 and substantially revised in 2009 and 2017.[7] Prior to the enactment of the Soil Contamination Countermeasures Act, many local authorities had established bylaws and other systems to counteract soil contamination in urban areas.[8] Some required operators to take measures against soil contamination when purchasing publicly

[6] English version available on the website of the Ministry of the Environment, https://www.env.go.jp/en/laws/water/sccact.pdf (Last access: 22 June 2022).

[7] With regard to soil contamination by radioactive substances, especially those resulting from the 2011 Fukushima Daiichi Nuclear Power Plant accident, the Act on Special Measures Concerning the Response of Environmental Contamination by Radioactive Substances Discharged by the Accident at Nuclear Power Plants Caused by the Tohoku-Pacific Ocean Earthquake of 11 March 2011 was enacted. Although the details are beyond the scope of this article for reasons of space, the Act is characterized by its emphasis on the state, which has promoted a nuclear energy policy, assuming social responsibility for environmental pollution caused by radioactive substances originating from the Fukushima Daiichi nuclear power plant accident.

[8] Otsuka (2010), p. 403 et seq.

owned land, when constructing buildings above a certain scale, when relocating or closing factories, and against soil contamination, regardless of relocation or closing. Some also assumed the polluter and the current operator to be the party responsible for the removal of soil contamination.

3.2 Removal of Soil Contamination in Urban Areas: Soil Contamination Countermeasures Act

3.2.1 Purpose of the Act

The purpose of the Soil Contamination Countermeasures Act is limited to "preventing damage to human health" caused by soil contamination (Article 1). The prevention of soil pollution itself is assessed to covered by the regulation of landfill and seepage activities under the Law on Waste Disposal and Cleaning and the Law on Water Pollution Control.

3.2.2 Overview

3.2.2.1 Specified Hazardous Substances

In light of the Act's purpose, the substances covered by the Act are also restricted to those that pose a health hazard if ingested by humans. These are called "specified hazardous substances" and currently comprise 26 designated substances (broadly classified as volatile organic compounds, heavy metals, and pesticides).

3.2.2.2 Soil Contamination Investigation

To manage soil contamination, it is necessary to know where it exists. Investigations for this purpose are carried out in accordance with Articles 3, 4, and 5 of the Soil Contamination Countermeasures Act. Under the current law, the triggers for investigation are as follows: (i) when a factory or workplace handling specified hazardous substances (hereafter, "workplace") ceases operations (Article 3(1)); (ii) when changes to the form or nature of land of 900 m^2 or more are carried out at a workplace that is temporarily exempted from investigation after it ceases operations (Article 3(7) and (8), Article 21-4 of the enforcement regulations of the Soil Contamination Countermeasures Act; (iii) when operating (i) changes to the form or nature of land of 900 m^2 or more are carried out at a workplace (Article 4); (iv) when changes to the form or nature of land of 3000 m^2 or more are carried out (Article 4); and (v) when soil contamination is suspected of causing a health hazard (Article 5). As of 2019, the actual number of investigations triggered by Articles 3, 4, and 5 accounted for only about 10% of all investigations, with voluntary investigations accounting for more than 80%.[9]

3.2.2.3 Designation of Areas and "Measures to Be Implemented"

Land where the presence of soil contamination has been confirmed following an investigation under Articles 3, 4, 5 or a voluntary investigation (Article 14) is designated by prefectural governors as either an "area which requires measures" (Article 6) or an "area for which changes to form or nature require notification" (Article 11). The former is designated when soil contamination by specified hazardous substances is found, and there is a risk of a health hazard (direct or indirect pathways exist). The latter is designated when soil contamination is found, but there is no risk of a health hazard. The difference between the two types of areas, therefore, lies in the presence or absence of a health hazard. If the area is designated as an "area which requires measures," measures such as the removal of soil contamination (hereafter, "measures") are taken (Article 7). Unlike in the case of agricultural land, public-works-type measures were not adopted because of the limitations of administrative resources and land authority in handling soil contamination on private land throughout the country through such measures. If an area is designated as an "area for which changes to form or nature require notification," only a notification is required when making a change to the form or nature of the land in this area (Article 12). Up to the financial year 2020, the cumulative number of designated areas that require measures is 712, and that of areas for which changes to form or nature require notification is 4000.[10]

However, even in "areas for which changes to form or nature require notification," measures are often taken in practice, and the number of such measures exceeds those in "areas which require measures." This difference is related to the "registry." Land with a designation of areas is entered into a coordinated registry for each of the two area types, but when soil contamination has been eliminated, the designation is canceled, and the area is recorded in a cancelation registry (Article 15). Although this registry system makes soil-contaminated land publicly known, voluntary measures are often taken to have the designated areas canceled, as the trading market shuns land with soil contamination (even if it is an "area for which changes to form or nature require notification" without risk of health hazards). Voluntary measures against soil contamination on land not designated as either of these areas account for 60% of the total number of measures taken.[11]

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[9] The remaining investigations (approximately 5% of the total) are based on local government bylaws. Data available in Japanese at the website of GEO-Environmental Protection Center, http://www.gepc.or.jp/04result/press_2020.pdf (Last access: 22 June 2022).

[10] Data available in Japanese on the website of the Ministry of the Environment, https://www.env.go.jp/press/post_5599/116436.pdf (Last access: 22 June 2022).

[11] Data available in Japanese on the website of GEO-Environmental Protection Center, http://www.gepc.or.jp/04result/press_2020.pdf (Last access: 22 June 2022).

Most measures taken involve excavation and removal. Although health hazards can be prevented if direct and indirect routes of soil contamination are blocked, it is preferable to remove the contamination completely from the soil. However, as measures of excavation and removal are expensive, legal disputes as to who bears this cost often arise.

3.2.2.4 Carrying Out and Processing Contaminated Soil

To prevent improper handling of excavated contaminated soil and the creation of new contamination elsewhere, the 2009 amendments established a new permit system and standards for carrying out and processing contaminated soil (Articles 16 to 22).

3.2.2.5 Soil Contamination of Natural Origin

Soil pollution is one of the seven typical types of "environmental pollution," which include air pollution, water pollution, soil contamination, noise, vibration, ground subsidence, and offensive odors, as specified in Article 2(3) of the Basic Environmental Law. Soil pollution as a form of "environmental pollution" is limited to "artificially occurring" pollution, following the definition of environmental pollution "as a result of business and other human activities" (Article 2(3) of the Basic Environment Law). Therefore, "naturally occurring" soil pollution was initially excluded from the scope of the Soil Contamination Countermeasures Act. However, as the Act's purpose is to prevent health damage from soil contamination, it is not necessary to distinguish whether the cause of the soil contamination is due to, for example, human activities or nature. For this and other reasons, the Act now covers soil pollution of natural origin, following a 2010 notification by the Ministry of the Environment[12] and a 2017 amendment to the Act (Article 18(1)(ii), (2), proviso to Article 12(1), Article 12(4)).

4 Who Is Responsible for Soil Contamination?

The "polluter pays principle" is a fundamental principle of Japanese environmental law, which requires that measures to address environmental problems and the costs of such measures are borne by those who caused the environmental problems. In Japan, experience with environmental pollution control led to the emergence of a polluter pays principle before the 1972 Organisation for Economic Co-operation and

[12] Data available in Japanese on the website of the Ministry of the Environment, https://www.env.go.jp/water/dojo/law/kaisei2009/no_100305002.pdf (Last access: 22 June 2022).

Development (OECD) recommendations. The origin of the principle in Japan can be found in the damage relief system adopted in the Act on Special Measures Concerning Pollution-related Health Damage Relief of 1969 and the Act on Entrepreneurs' Bearing of the Cost of Public Pollution Control Works of 1970. At present, provisions relating to the polluter pays principle are located in Article 8(1) and Article 37 of the Basic Environment Law (although these are not necessarily the general legal basis for the principle). The distinctive features of the Japanese polluter pays principle are that (i) its range of application extends not only to pollution prevention costs but also to restoration costs and damage relief costs and that (ii) it is regarded as a principle of justice and equity rather than of efficiency.[13] The Japanese polluter pays principle, which has such a strong legal aspect, has sometimes been criticized for being contrary to the OECD's polluter pays principle from an economic standpoint. The OECD has referred to it as the "punish polluter principle."[14] However, the idea of the Japanese polluter pays principle, which applies to restoration and victim relief, has been adopted in Europe and the United States as an effective pollution prevention, and some regard it positively as having been a global forerunner.

4.1 Landowners

In contrast to the polluter pays principle, the Soil Contamination Countermeasures Act foregrounds the owner, manager, or occupier of the land (hereafter, "landowners"), rather than the polluter, as the responsible party. First, the responsibility for carrying out investigations is placed entirely on the landowners. The justification for this is that the polluter is unknown at the stage of investigation, before the presence or absence of soil contamination is known, and that investigations cannot be carried out on private land without the landowner's permission.[15] Second, the landowner is listed as the first party responsible for implementing measures in an "area which requires measures" (Article 7(1)). The justification for this is that the landowner controls the dangerous situation caused by soil pollution, that soil pollution measures on private land cannot be implemented without the landowner's permission, and that soil pollution measures are carried out in consideration of how the land will be used in the future.[16] Incidentally, this concept of landowner liability

[13] The Environmental Agency (1976), p. 119 et seq.

[14] International Division, Environmental Agency (1978), p. 19.

[15] Soil Environment Division, Environmental Management Bureau, Ministry of the Environment (2019), p. 12.

[16] Soil Environment Division, Environmental Management Bureau, Ministry of the Environment (2019), p. 116.

(*Jotai Sekinin*) in Japanese law is modeled on *Zustandshaftung* under German administrative law.[17]

4.2 Polluter

However, the polluter can also be the responsible party. For measures in an “area which requires measures,” the polluter, not the landowner, is responsible only if the following three requirements are fulfilled: (i) the polluter is identified, (ii) it is reasonable to have the polluter implement the measures, and (iii) there are no objections from the landowner (proviso to Article 7(1)). Thus, while requirements are set for the polluter, the landowner is unconditionally responsible under any circumstances unless the above three requirements are fulfilled and a polluter is held responsible. This scheme of responsibility is based on a policy reason. To avoid the absence of a responsible party in cases where a polluter is difficult to identify, has already become bankrupt, or has died,[18] due to the characteristics of soil contamination as stock pollution, legislators included the landowner as the responsible party unconditionally in the Act. As a result, the polluter pays principle has been overshadowed by landowner liability.

If a landowner who has not caused the pollution becomes responsible for measures in an “area which requires measures,” they are obliged to prepare and submit a plan (hereinafter, “plan for contamination removal, etc.”) to the prefectural governor and implement measures in accordance with the plan for contamination removal, etc., pursuant to an indication by the prefectural governor (Article 7). Under Article 8, only the cost of the preparation and revision of the plan for contamination removal, etc. concerning the measures to be implemented and measures can be reimbursed by a polluter, if found. However, the proviso to Article 8(1) sets out the conditions under which the polluter is exempted from the obligation to pay costs (e.g., if the polluter has taken measures against soil contamination in the past, or if the landowner has purchased the land in question at a significantly lower price because of soil contamination[19]). If this exemption condition is met, the landowner cannot transfer the costs under Article 8 to the polluter.

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[17] Tagami (1996), p. 16.

[18] Otsuka (2020), p. 382 et seq.

[19] Data available in Japanese at the website of the Ministry of the Environment, https://www.env.go.jp/water/dojo/law/kaisei2009/no_100305002.pdf (Last access: 22 June 2022).

4.3 *Legal Disputes Concerning Soil Contamination*

Land suspected of being contaminated is shunned on the property transaction market, as owning soil-contaminated land can make the owner responsible for carrying out investigations and measures under the Soil Contamination Countermeasures Act and interfere with the intended use of the land. In many cases, while the land seller may voluntarily carry out soil contamination investigations and measures before the sale contract, soil contamination is often discovered after the sale has been concluded. Legal disputes may arise when owners who have unintentionally acquired soil-contaminated land try to recover the costs they have incurred in handling the soil contamination.

4.3.1 Lawsuits Against Polluters

The Tokyo District Court decision of 16 January 2012, HANREI TIMES No. 1392, p. 78 (on appeal, Tokyo High Court decision of 28 March 2013, HANREI TIMES No. 1393, p. 186) was a case in which the existence of liability as a causal party under the Soil Contamination Countermeasures Act was disputed. In this case, one of the issues was whether the city was a polluter under the proviso of Article 7(1) of the Soil Contamination Countermeasures Act as soil contamination was caused by the contractor's landfilling of waste brought in by the city. The court held that only the contractor, and not the city, was responsible as the contractor landfilled the waste based on the contractor's own calculations. The court also stated that as long as a measure order (Article 7(1) before the 2009 amendments, equivalent to an indication under Article 7(1) of the current law) had not been issued, the right to make a claim under Article 8 did not arise. The court's views in this decision on the 'polluter' and the limitation on the right to make a claim by a landowner who has voluntarily taken measures are open to debate.

4.3.2 Lawsuits Against Land Sellers

If soil contamination of the land in question is discovered after a land sale contract has been concluded, the land purchaser may pursue liability against the seller. Specifically, there are four possible means of holding the seller "liable for non-compliance with the contract," as follows: (i) a claim for completion; (ii) a claim for reduction of the price; (iii) a claim for damages; and (iv) termination of the contract (Articles 562–564 of the Civil Code). This type of liability was known as "liability for defects" in the old Civil Code (Articles 570 and 566) before the code's amendment in April 2020. (Before the amendment, only (iii) and (iv) were possible.) The most prominent case of liability for defects in the past concerning soil contamination is the Supreme Court decision of June 1, 2010, Minshu, vol. 64, no. 4, p. 953. In this case, fluorine became a specified hazardous substance under the Soil

Contamination Countermeasures Act only after the conclusion of the land sale contract. In light of the "concept of the transaction at the time the sale contract was concluded," the existence of soil contamination by fluorine on the land in question was not a "defect" that devalued the quality and performance of the object that the parties intended to exchange. The Supreme Court denied the seller's liability for damages. However, in many subsequent cases, the existence of soil contamination has been recognized as a defect, and a claim for damages has been accepted on the basis of the "concept of the transaction at the time of the conclusion of the sales contract" as a criterion for judging defects as set out in the case. In addition, there are cases in which the seller has been held liable for default of obligation (Tokyo District Court, September 5, 2006, HANREI JIHO No. 1973, p. 84) and tort liability (Osaka High Court, July 12, 2013, HANREI JIHO No. 2200, p. 70), and a claim for damages has been admitted.

4.3.3 Litigation Against the Administration

The illegality of the Soil Contamination Countermeasures Act, which imposes responsibility for soil contamination countermeasures on landowners who are not the cause of the contamination, was challenged in one case (Tokyo District Court, 7 February 2012, HANREI TIMES No 1393, p. 95). The case is particularly noteworthy because the court rejected the illegality of the application of Article 1(1) of the State Redress Act on the grounds that the failure to make provisions to exempt landowners who purchased land without knowledge of soil contamination (in good faith and without negligence, namely, "innocent") before the Act came into force was a matter within the state's "legislative discretion." In other countries' soil contamination legislation, consideration is generally given to reducing immunity for innocent landowners, but no such consideration is given in Japan. This is a major remaining issue for the Soil Contamination Countermeasures Act.

5 Conclusion

Japanese soil protection legislation was consolidated in 2002—later than in all other industrialized countries. Even though soil contamination has been listed as one of the seven typical types of environmental pollution since 1970, and the Basic Act on Environmental Pollution Control and its successor, the Basic Environmental Act, clearly stated that measures should be taken to address it, legislation on the removal of soil pollution in urban areas was neglected for more than 30 years. This is due to the government being unable to reach a conclusion regarding who should be the responsible party. As a result, the Soil Contamination Countermeasures Act stipulates that the landowner is responsible for removing soil contamination in urban areas unless the three requirements for making the polluter liable are fulfilled. There is, however, no consideration in the law or in judicial precedents to exempt bona fide landowners from liability, which has resulted in an unfair situation in practice and led to legal disputes. As noted above, the Soil Contamination Countermeasures Act introduced the landowner liability modeled on German administrative law. However, while Germany limits liability to cases in which the landowner is innocent under judicial precedent, Japanese courts do not take any such consideration of innocent landowners into account.[20]

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Soil-Related Laws in Thailand

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Abstract Rapid economic development and urbanization are changing land management systems in many countries, including Thailand, and climate change has emerged as a significant source of risks. These changes are having major impacts on the status of soil resources in Thailand. Therefore, the soils are under increasing pressure of intensification leading to soil degradation including erosion, contamination, the decline in nutrients, compaction, salinization, acidification, and biodiversity loss of soils. Therefore, sustainable soil management is important for maintaining the capacity of soil to function according to its potential and management strategies, which is essential for the maintenance of human well-being and the conservation of biodiversity. In addition, any assessment of soil threats, measures against soil threats, and their effects on soil functions and ecosystem services should consider local conditions, national and global strategies e.g. biophysical characteristics, economic society, policies, and laws. In Thailand, soil and land protection are regulated by legislation and land use planning document such as the Forest Act and the National Forest Act, the Law on Environmental Protection, the Law on Land Protection, and the Law on Agricultural Land. Land use planning regulations represent the basis for supervision of the land use of all types and purposes and the management of natural resources, implementing guidelines for space preservation and protection, and measures of sustainable use of land resources. Furthermore,

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there is a pressing need to determine the status of sustainable soil management efforts and raise awareness of soil in Thailand.

1 Introduction

The Kingdom of Thailand is located in Southeast Asia. The total land area is approximately 514,000 km^2. Thailand is a country of mountains, hills, plains and a long coastline along the Gulf of Thailand (1,875 km long) and the Andaman Sea (740 km long). According to the land use data from the Department of Land Development for the year 2010/2013, it was found that the agricultural area was 27.89 million ha (54.36% of the country's area), followed by the forest area of 3.08 million ha (34.06% of the country area), the urban and built-up land of 2.64 million ha (5.15% of the country area), and miscellaneous areas of 1.86 million ha (3.63% of the country area). The country land can be divided into two main categories: private land and public land. The land can be classified as legal forest area (42%), land with title deeds (40%), agricultural land reform area (Sor. Por Kor. 4-01) (10.7%), unclassified areas (5%), and state property land (Ratchaphatsadu land) (2.5%).[1]

For public land management in the past, the Thai government had set policies to accelerate economic growth. Therefore, the direction of economic development along with solving poverty problems for a better quality of life has increased pressure on the use of both public and private lands. The rapid expansion of the agricultural sector for increasing production had been prompted deforestation for farming. In the past, the state authority concerning land management created conflicts and provoked inappropriate land use, leading to economic, social, and environmental damage. The problems in land management were caused mainly as follows: encroachment into reserved forest area, the conflict of land management laws between the government and people, the conflict of land boundaries, the distribution of land holdings, landless cultivation or naked possession, large land holdings, and associated problems in management of land.

The pattern of land use in Thailand has changed considerably from the past. Many highlands have been converted for farming and tourism causing deterioration of the land and leading to the destruction of ecosystems that are difficult to recover. In addition, there has been an expansion in the urban and industrial sectors into the lowland plain area of agricultural land. Important driving forces are the development of infrastructure, mechanization, the introduction of irrigation, and the application of agrochemicals. This has resulted in not only higher farm incomes but also soil and water pollution, soil fertility loss, soil erosion, and in the reduction of biodiversity.

"Land" is considered an immensely valuable property. People desire to own their land and this demand is increasing. Especially in areas where civilization or public utilities are readily accessible, whether for use as residential, agricultural, industrial, or commercial purposes. It is highly expedient to have a cognizance of the soil-

[1] The Department of Land Development (2013); Summary of Land Use of Thailand 2010/2013.

related laws to have the right to manage land correctly and to avoid law-related problems later on. Therefore, integrated state land management by effective application the law is an important starting point to achieve sustainable and concrete management of the country's soil resources.

2 Soil Resources and Land Use in Thailand

Soils are key component of terrestrial ecosystems. To achieve the ecosystem services, soils support the productivity of the agricultural sector and ensure food security.[2] However, the increase in the global human population causes pressures on soil resources that are reaching critical limits. Consequently, soils are facing growing intensification pressures, which are accelerating the conversion of natural lands to croplands,[3,4] along with competition for land use in cropping, forestry, pasture, and urbanization. It has been demonstrated that soil degradation significantly impairs potential agronomic productivity. Currently, soils worldwide are globally threatened by various forms of soil degradation, including water and wind erosion, contamination, the decline in nutrients, compaction, salinization, acidification, and loss of biodiversity (de la Rosa and Sobral 2008; FAO 2015).[5,6] In Asia, approximately 40% of soils are classified as degraded (Cook et al. 2011). Future external factors (such as climate change, price fluctuations, and demand changes) and internal factors (such as shifting expectations, migration patterns) are expected to further exacerbate the risk of irreversible changes in these systems, potentially reaching tipping points that would have detrimental impacts on essential ecosystems services (ESS).

Thailand has a population of about 70 million, a land area of 510,890 km^2, and a coastline stretching 3,219 kilometers.[7] About 51.1% of the population resides is urban areas (37 million people in 2020). Approximately 41.2% of Thailand's total land area is classified as agricultural land, with arable land comprising 30.8%, permanent crops of 8.8%, permanent pasture of 1.6%, forested land of 37.2%, and other forms of occupied land of 21.6%.[8] The country's main agricultural products include rice, cassava, rubber, sugarcane, coconut, maize, mung beans, and soybeans.[9] In terms of soil resources, the Land Development Department (LDD) has documented around 300 soil series in Thailand. The Thai soils are classified into

[2] Millennium Ecosystem Assessment (2005).

[3] Alexander et al. (2015).

[4] Zdruli et al. (2014).

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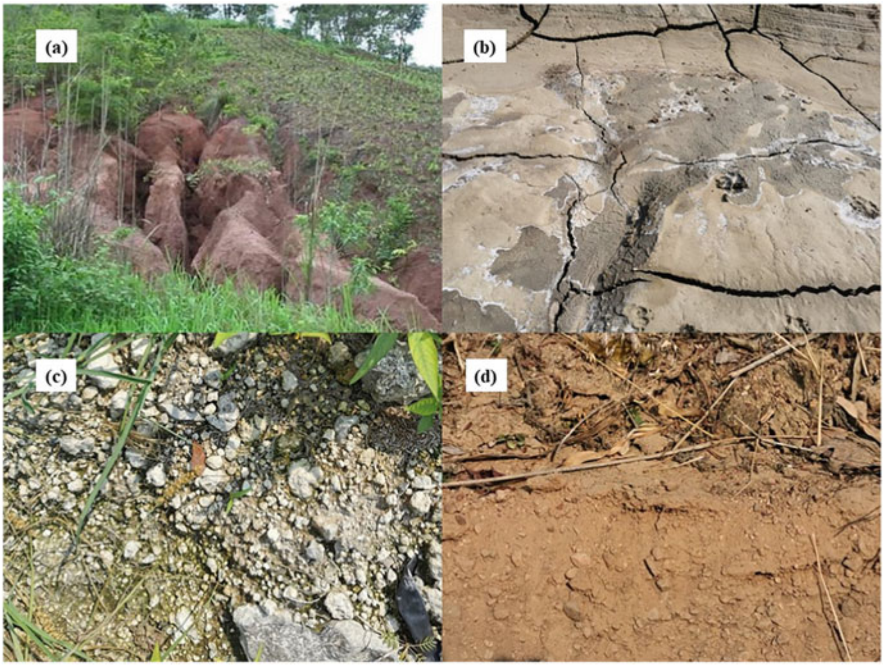

Fig. 1 Soil erosion at upland agricultural production in Thailand (**a**), saline soil (**b**), calcareous soil (**c**), and shallow soil (**d**)

9 orders based on the USDA Soil Taxonomy namely: Histosols (0.14%), Spodosols (0.12%), Oxisols (0.03%), Vertisols (0.81%), Ultisols (42.13%), Mollisols (1.17%), Alfisols (9.16%), Inceptisols (9.4%), Entisols, as well as slope complexes, water bodies and others (33.75%).[10] Recent major incidents in Thailand, such as extended flooding or recurrent severe droughts, have highlighted the vulnerability of human-managed ecosystems. The transformation of heterogeneous and diverse landscapes to intensively managed monocultures has led to severe soil degradation reducing the livelihood options and food security for farming households. In total, about 75% of agricultural land in Thailand has been degraded, with the major types of soil degradation being water erosion (65.5%), chemical degradation (7.3%), physical degradation (24.3%), and biological degradation (2.9%).[11] Upland agricultural production on steep slopes in Thailand plays a significant role in deforestation, soil degradation through erosion, and a range of environmental problems.[12] As a result, intensive cultivation of upland crops has resulted in substantial nutrient losses through soil erosion in upland areas.[13] The photos in Fig. 1 show the evidence of

[10]Land Development Department (2015).

[11]Hongprayoon et al. (2015).

[12]Ekasingh et al. (2004).

[13]Tsubo et al. (2006).

Fig. 2 Off-site effects of soil erosion

soil degradation in Thailand. It has been reported that soil erosion affected more than 338,675 km^2 of the cultivated land area in 1999.[14]

The eroded areas, however, are still being used for subsistence agriculture year after year, while the matrix lands are intensively utilized for income generation through cash crop production. Spatial variability of soil properties, soil loss, and crop yield in the upland areas is influenced by many factors such as landscape position, local climate, land cover, soil type, and management practices.[15,16] This is particularly evident in the intensively managed sloping lands of Northern Thailand, which are vulnerable due to their less favorable production conditions, relying on limited biophysical ecosystem resources, and suffering from a labor shortage.

This trend is associated with increasing mechanization even on steep slopes and excessive use of agrochemicals, which lead to acceleration of soil degradation and an increase in off-site effects (Fig. 2).

The assessment of soil and land degradation together with land use planning can be used to prevent land degradation and protect forests and water resources. Land degradation assessment requires two relevant parts of information: soil data and cropping system data.[17] At present, the LDD is one of the government agencies that has authority on land management. Therefore, LDD has established a pragmatic and integrated land-use plan that respects the sustainable and sufficient utilization of natural resources at different levels including district, sub-district, watershed, sub-watershed, and highlands in the north of the country. The land-use plan is prepared to assist decision-makers, planners, and local administration officers in managing land resources in an integrated manner to achieve better and sustainable land management and to coordinate land and water resources development activities with the development activities of other sectors. In addition, to prevent soil erosion in critical areas, LDD also supports other land development activities such as soil improvement with organic matter, improving acidic soils by increasing soil pH

[14] Kunaporn (1999).

[15] Tesfahunegn et al. (2011).

[16] Zhang et al. (2011).

[17] Land Development Department (2002).

values to the range for optimum plant growth, providing water supply, etc., to cover the entire land. The assessment of land degradation in land development regions provides information to be used by the Land Development Regional Offices and the Subdistrict Administrative Organization to plan land use or subdivide the area according to various land use activities in the area. This management is called "zoning".[18]

3 Context of the Land Use Plan in Thailand

During Thailand's economic development in the past several decades, the land has played a crucial role in agricultural production and other sectors, including industry, real estate, and services. The demands for land in various activities has increased rapidly and inconsistently with the country's economic expansion, leading to problems in land use and land ownership. Land use problems derive from the unsuitable use of land according to land suitability factors. Cropping practices in the forested highlands have caused soil erosion and landslides. In the consideration of land ownership, the main problems include lack of land title, insufficient land for agriculture, and land rental practices. The combination of these land use problems results in conflict between various government agencies, between government agencies and the villagers, and among villages. Moreover, institutional problems in Thailand's land use planning system encompass three interrelated aspects at three spatial levels: policy framework, organizations, and legal and other measures for implementing the plans.[19] This situation becomes more serious because of the ecological limitations of national land resources, while the demand for land use continues to rise. In principle, national land use requires both conservation and appropriately designated areas for development by establishing the "National Land Use Plan". Even the concept of the national land use plan was introduced before the National Economic and Development Plan No. 1 (A.D. 1961–1966) and other initiatives such as land classification for forest and agricultural areas, the delineation of national parks, wildlife conservation areas, agricultural economic areas, principal city plans, specific plans and the land use plan of the LDD. There was no initiative to cover all land use classes of the country, or with the consensus of relevant agencies, and it was adopted to be implemented intensively. The reason is that many agencies are working in land management and focus on their mission directly. Although there is coordination between the agencies, there is no agreed criteria or master plan that could be utilized by them. In this regard, it is very important to have the "Land Use Plan for Thailand" address the current land situation.[20,21] The land use plan is the

[18] Land Development Department (2000).

[19] Ratanawaraha (2016).

[20] The Secretariat of the House of Representatives (2018).

[21] Office of the National Economic and Social Development Board (2017).

master plan for all relevant agencies on land management that could use and mainstream land management by following the plan.

Therefore, the LDD has prepared the land use plan of Thailand to be a guideline for making policy recommendations on land use and land resource management to drive the nation towards sustainable development goals to comply with the Constitution of the Kingdom of Thailand A.D.2017 and the National Reform Plans. The land use planning procedure of Thailand has adopted land suitability, land use potential, and sustainable development criteria, consistent with Thailand's 20-year National Strategy, the 20-year Agricultural and Cooperatives Strategy, and other relevant policies, laws, and plans. In addition, socio-economic conditions, production barriers, demand and supply in agriculture, and climate change and natural disaster criteria for designing land use for Thailand (Fig. 3), leading to sustainable development, have been adopted.

The land use plan of Thailand is divided into the 8 following zones (Fig. 4 and Table 1).

1. Forest zone with an area of 21,613,676 ha, or 42.12% of total land area. It is characterized by national forest goal statement and outlines the problems in forest areas including policy, strategy, measures for the use of nature in protected forest areas, cabinet resolution and a related development plan.
2. Agricultural zone with an area of 24,509,524 ha, or 47.77% of total land area, characterized by land suitability, infrastructure development of agriculture, and irrigation system as a source of agricultural and food production. This zone enables Thailand to attain food security and export products to the world market, and earn more income.
3. Community zone with an area of 2,277,776 ha, or 4.44% of total land area. It is characterized by present land use together with a country plan and state property land (Ratchaphatsadu land) as a guideline of community management, including environmental conservation in each area harmonizing with wise land use.
4. Industrial zone with an area of 313,382 ha, or 0.61% of total land area, characterized by the present land use, an urban and rural development plan, and an industrial development plan that could apply in the future.
5. Ratchaphatsadu land or state property zone with an area of 1,318,335 ha, or 2.57% of total land area, consists of Ratchaphatsadu land as the state property managed by the Treasury Department. Ratchaphatsadu land includes all types of government-owned immovable property; the land which is specifically reserved for use for the state benefit; and land which is reserved for the government's benefit under the law (Somjit 2018).
6. Water resources zone with an area of 1,264,408.96 ha, or 2.46% of total land area. It characterized by the existing reservoirs (natural and man-made reservoirs) in present land use areas.
7. Historical zone with an area of 14,398 ha, or 0.03% of the total land area. It is characterized by the registered ancient sites and historical parks for the whole kingdom and organized by the Fine Arts Department.

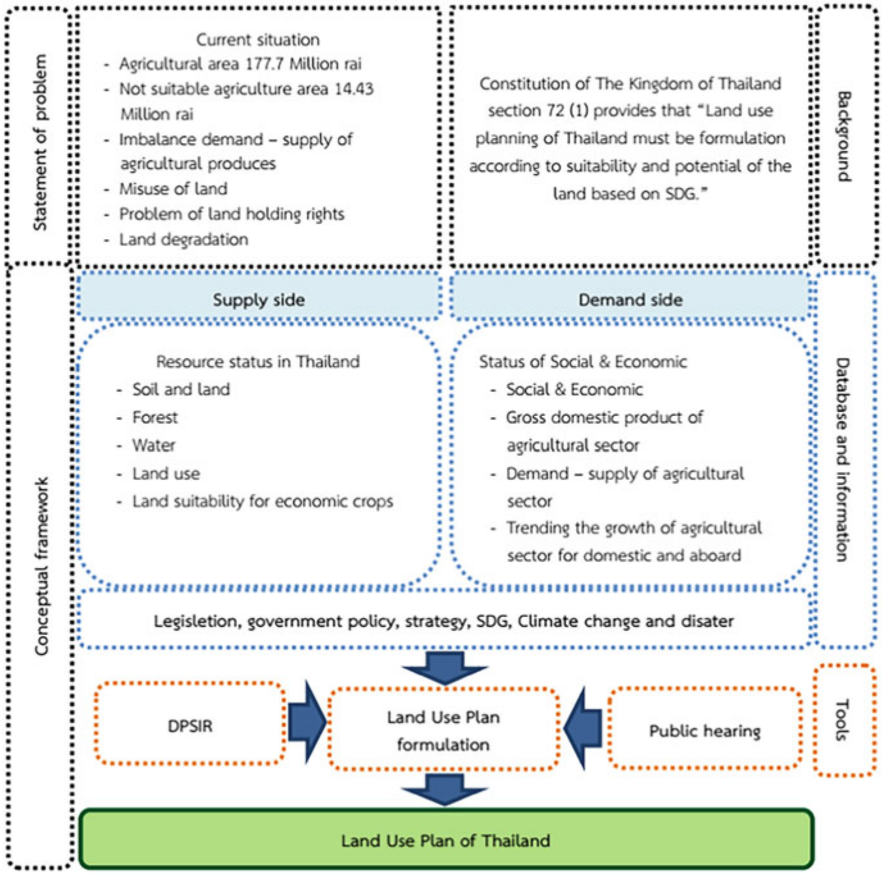

Fig. 3 A conceptual framework of land use planning of Thailand (Division of Land use Planning and Policy (2018). Reproduced from Land use plan of Thailand with permission from Land Use Planning Division, Land Development Department. The authors would like to thank the Land Use Planning Division, Land Development Department, Thailand for giving permission to use Table 1, Figs. 3 and 4 in this chapter.)

8. Recreation and open space zone, considered by the second tourism development plan (A.D. 2017–2021) that delineates the tourism development zone.[22,23]

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[22] Division of Land use Planning and Policy (2018).

[23] Somjit (2008).

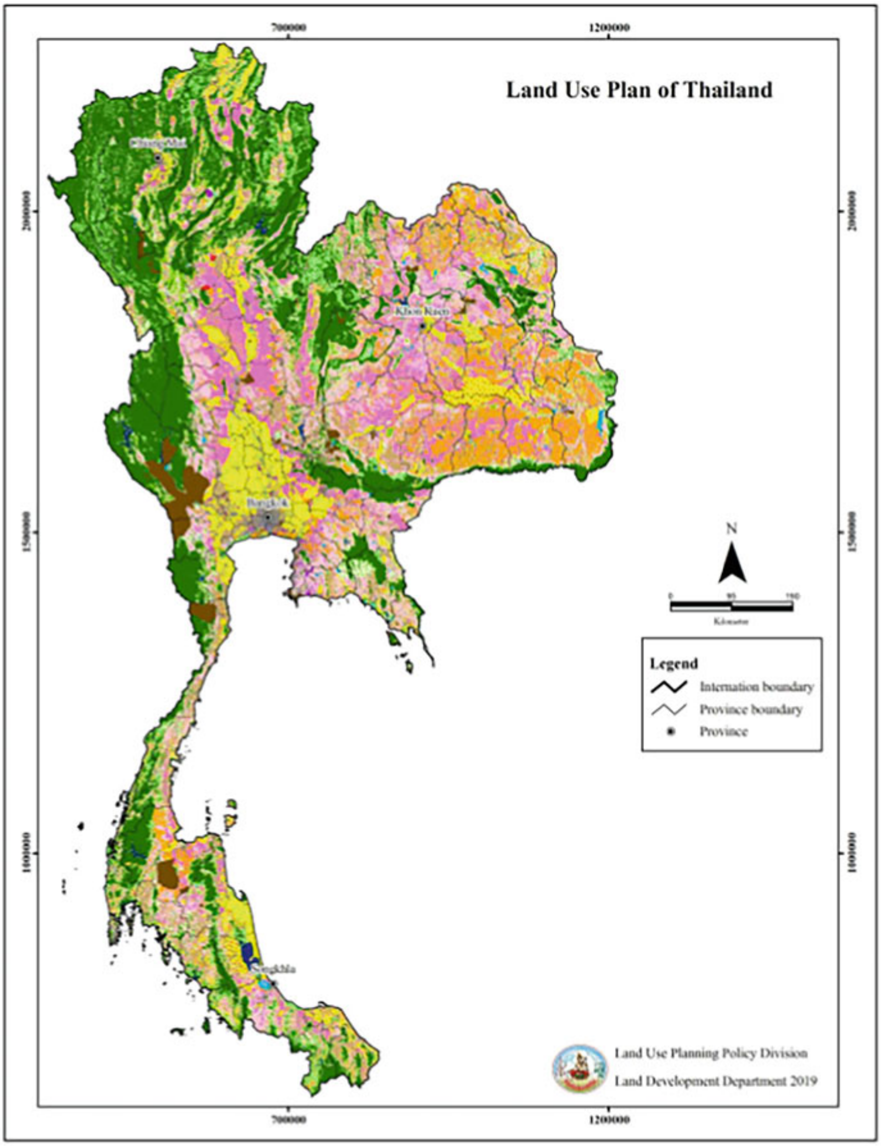

Fig. 4 Land use plan of Thailand (Division of Land use Planning and Policy (2019). Reproduced from Land use plan of Thailand with permission from Land Use Planning Division, Land Development Department.)

Table 1 The land use plan of Thailand[a]

Land Use Plan of Thailand		Regions				Total (Rai)	%
		North	Northeast	Central	South		
	1. Forest zone	69,755,770	25,375,895	20,767,972	19,185,843	135,085,480	42.12
	1.1 Conservation forest zone	60,674,935	17,266,912	16,552,393	16,079,618	110,573,858	34.47
	1.1.1 Protected forest zone	49,305,954	11,550,796	14,787,405	10,571,584	86,215,739	26.88
	1.1.2 Forest rehabilitation zone	1,389,849	793,899	334,596	375,796	2,894,140	0.90
	1.1.3 Conditional forest rehabilitation zone	9,979,132	4,922,217	1,430,392	5,132,238	21,463,979	6.69
	1.2 Economic forest zone	6,863,291	3,583,670	2,991,208	2,448,919	15,887,088	4.96
	1.2.1 Preservation forest zone	3,241,537	812,464	813,116	846,289	5,713,406	1.78
	1.2.2 Forest rehabilitation zone	313,923	341,029	73,173	60,781	788,906	0.25
	1.2.3 Conditional forest rehabilitation zone	3,307,831	2,430,177	2,104,919	1,541,849	9,384,776	2.93
	1.3 Preservation forest zone by cabinet resolution	2,217,544	4,525,313	1,224,371	657,306	8,624,534	2.69
	2. Agricultural zone	31,164,985	69,351,563	31,565,616	21,102,363	153,184,527	47.77
	2.1 Prime agricultural land	9,091,922	10,241,219	15,130,491	8,469,684	42,933,316	13.39
	2.1.1 Paddy zone	5,011,989	4,784,981	10,001,544	2,814,374	22,612,888	7.05
	2.1.2 Field crop, orchard, perennial plants	4,074,748	3,483,042	5,128,947	5,003,790	17,690,527	5.52
	2.1.3 GI plants zone (approved by EU)	5,185	1,973,196	-	651,520	2,629,901	0.82
	2.2 High potential agricultural land	17,699,488	34,313,018	12,646,643	8,534,799	73,193,948	22.83
	2.2.1 Paddy zone	10,266,785	17,329,941	3,796,275	2,333,835	33,726,836	10.52
	2.2.2 Field crop, orchard, perennial plants	7,432,703	16,983,077	8,850,368	6,200,964	39,467,112	12.31
	2.3 Low potential agricultural land	4,373,575	24,797,326	3,788,482	4,097,880	37,057,263	11.56
	2.3.1 Paddy zone	1,240,172	18,081,267	1,527,049	555,486	21,403,974	6.68
	2.3.2 Field crop, orchard, perennial plants	3,133,403	6,716,059	2,261,433	3,542,394	15,653,289	4.88
	3. Community zone	3,194,438	4,688,727	4,671,228	1,681,708	14,236,101	4.44
	4. Industrial zone	369,783	296,160	1,103,631	189,065	1,958,639	0.61
	4.1 Existing industrial zone	185,318	195,353	735,979	74,197	1,190,847	0.37
	4.2 Mining zone	184,465	100,807	367,652	114,868	767,792	0.24
	5. Ratchaphatsadu land or Royal property zone	990,556	1,328,846	4,846,437	1,073,760	8,239,599	2.57
	6. Water resources zone	1,392,317	3,232,800	1,782,285	1,495,154	7,902,556	2.46
	6.1 Water resources within forest zone	504,505	364,538	615,574	1,008,855	2,493,472	0.77
	6.1.1 Natural water reservoir	113,515	88,993	85,795	835,499	1,123,802	0.34
	6.1.2 Man-made reservoir	390,990	275,545	529,779	173,356	1,369,670	0.43
	6.2 Water resources out of forest zone	887,812	2,868,262	1,166,711	486,299	5,409,084	1.69
	6.2.1 Natural water reservoir	651,061	1,698,104	621,549	390,033	3,360,747	1.05
	6.2.2 Man-made reservoir	236,751	1,170,158	545,162	96,266	2,048,337	0.64
	7. Historical zone	79,654	8,170	2,167	-	89,991	0.03
	8. Recreation and open space zone	-	-	-	-	-	-
Total		106,947,503	104,282,161	64,739,336	44,727,893	320,696,893	100.00

1ha = 6.25 rai

1 ha = 6.25 rai

[a]Division of Land use Planning and Policy (2019). Reproduced from Land use plan of Thailand with permission from Land Use Planning Division, Land Development Department

4 The Legal Framework of Land Regulation and Governance

The five following major pieces of legislation constitute the core of Thailand's land regulation and governance framework.

4.1 *Thailand's Constitution of* 2017 in chapter VI: directive principles of state policies, section 72 provides for the state to take actions relating to land, water resources and energy as follows: (1) to plan the country's land use to be appropriate to the area conditions and potential of the land according to the principles of sustainable development; (2) to undertake town planning at every level and to enforce such town planning efficiently, as well as to develop towns toward prosperity and meet the needs of the people in the area; and (3) to provide measures for distribution of landholding's in order to thoroughly and fairly allow people to have land for making a living. (Kingdom of Thailand 2017).[24]

4.2 The *Land Code Promulgating Act of 1954 update 2008*, as amended, is Thailand's primary land legislation. The Land Code identifies various tenure types, including ownership and use rights, e.g. in chapter 2, land allocation for the people, chapter 3: delimitation of right in land, chapter 4: issuance of documents showing rights in land, chapter 6: recording rights and legal acts, chapter 7: limitation of rights in land for religious purpose, chapter 8: limitation of foreigners' right in land, and chapter 9: limitation of rights in land of some categories of juristic persons. The Land Code, as established by a National Land Allocation Committee, is responsible for identifying land for land allocation for the people, delimitation of rights in land, issuance of documents showing rights in land, land survey, recording rights and legal acts, limitation of rights in land for religious purpose, limitation of foreigner's rights in land, limitation of rights in land of some categories of juristic persons, trade in land, fees, and penalties. The Land Code sets the limitation of foreigner's rights in the land for agriculture of not more than 1.6 ha and not more than 0.16 ha for residence per family etc. The Land Code imposes ceilings on an individual basis, allowing households to have multiple landholdings by registering various plots in the names of individual family members. Landowners have seven years from the date of the Land Code enactment to sell or otherwise dispose of ceiling-surplus land (i.e., above ceiling limits). After that point, the state has authority to purchase any ceiling-surplus land and distribute it to landless and near-landless households.

[24] Kingdom of Thailand (2017).

The Land Code permits foreigners to hold land in lesser amounts than Thai citizens. By a 1999 amendment, foreigners investing in the country are permitted to own residential land so long as the land is used as their residence for at least three years.[25,26,27]

4.3 *The Agricultural Land Reform Act of 1975 w*as established on 6 March 1975, due to the importance of the agricultural sector in Thailand and issues relating to land ownership. The Agricultural Land Reform Office (ALRO) was initially formed to provide rent assistance to farmers not owning or leasing farmland with an unreasonably high rent. All land categorized as agricultural reformed land is specifically marked as such. During the initial phase of the land reformation, ALRO relied mostly on purchased private land, the king's property, and donated land. Later, the government adopted land reformation as a solution to forest encroachment in national forest reserves, by designating swathes of this land as areas for land reformation. As a result, ALRO obtained a large amount of government land as marked by the cabinet for distribution under the Land Reform Act. Since quite a large area of land had already been encroached illegally, many previous land occupants could not meet the criteria of the land reform law, i.e., they were neither farmers nor engaged in farming activities, and held more land than was permitted. Some lands were used for non-farming purposes, such as housing and trading shops. This law also provides regulation for leasing of agricultural reformed land to Thai citizens. The ALRO can allocate land to Thai agricultural workers or agricultural institutions subject to conditions (section 30, Agricultural Land Reform Act).[28] In section 4, the definition of "Agricultural land reformation" is amended by the Agricultural Land Reform Act B.E. 1975. It is applied to enhance rights and the holding rule of agricultural land, including the allocation of places for living on such agricultural land. The state brings its land or the land purchased or expropriated by it from the landowner who does not utilize his/her land by himself or who has land in excess of the right under this Act, for allocating it to farmers who have no land of their own or who have little land insufficient for making a living and to farmer institutions for hire-purchase, lease or utilization with the assistance of the state in developing agricultural occupation (Agricultural Land Reform Office (ALRO) 1994).

4.4 *The Land Development Act of 2008* established a national Land Development Committee to help improve the utilization and productivity of the country's agricultural land. The Land Development Act, A.D. 2008 replaced The Land Development Act, A.D.1983. The Act authorizes the committee to engage in land use planning; develop soil and water conservation measures; support farmers; conduct surveys; create plans for the improvement of soil.[29]

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[25] Kingdom of Thailand Land Code (1954).

[26] Kingdom of Thailand Land Code Amendment Act (1999).

[27] Kingdom of Thailand Land Code Amendment Act (2008a).

[28] Agricultural Land Reform Office (1994).

[29] Land Development Act (2008b).

4.5 *The Land Readjustment Act of 2004* governs processes for land re-plotting and development to improve land utilization. The Act established a national Land Re-adjustment Committee charged with developing policy and identifying areas for re-adjustment. The Act also set the rules for the creation of Land Associations made up of landowners in re-adjustment areas and Provincial Committees to govern the process.[30]

5 Laws and Policies Related to Soil and Land Resources

Soil is one of the essential components of land. It is a mixture of stone, gravel, sand, mineral, water, and other organic matters forming the texture of the soil.[31] Land refers to the planet surface not covered by seas, lakes, or rivers. It includes the total land mass including continents and islands. In the legal context, land refers to a piece of land. It consists of rocks, soil, vegetation, animals, ponds, buildings, etc.[32] Thailand is one of agricultural producers in the world. Thus, soil and land resources play a key role as the foundation of agriculture. Therefore, land quality and soil quality must be conserved. The development of agricultural land means the improvement of soil fertility to increase agricultural productivity.[33] In Thailand, the Land Development Department (LDD) under the Ministry of Agriculture and Cooperatives is the main organization with the responsibility to conserve and improve soil resources for agricultural productivity, food security, and sustainable land use.

In 1963, the LDD was established by three Acts of Parliament under the purview of the Ministry of National Development. In 1972, the LDD was transferred to the Ministry of Agriculture and Cooperatives. The LDD Act was been published in the Government Gazette in 1983.

The main purposes of the Land Development Act A.D. 1983, are as follows: (1) to define the definition of land development which means any activities on the soil or land to increase the efficiency and quality of the soil or land and to increase agricultural productivity and including the improvement of soil or land infertility because of utilization. Moreover, LDD provided soil and water conservation systems in order to maintain the natural balance for the suitability of agricultural land use; (2) to establish a land development committee. It consists of the Minister of Agriculture and Cooperatives and the chief executive of government agencies related to land development to serve as consideration for determining the land classification, land use planning, land development, the announcement of the land survey area, the establishment of soil improvement and soil and water conservation, and considering rules and regulations for requesting soil sample analysis; (3) to

[30] USAID (2011).

[31] Needelman (2013).

[32] Verheye (2010).

[33] Parikh and James (2012).

survey and to analyze soil or land to know the natural fertility and suitability for land use, land classification, land development and to conduct an agricultural census.[34]

Historically, Thailand had a problem with soil and land degradation because there was no agency with the responsibility and expertise in soil and water conservation practices. Soil erosion led to economic and social damage. The Land Development Act A.D. 1983 did not provide a provision for government agencies to prevent and maintain the risk area from landslides and severe soil erosion in order to make effective land use and maximize the benefits of the land. Under the circumstances, the Land Development Act A.D. 1983 was repealed and replaced by the 2008 Act. The Land Development Act A.D. 2008 has 25 sections in total, although all sections in this Act are based on the Land Development Act A.D. 1983. However, many aspects of the 1983 Act were substantially amended to improve their scope and jurisdiction, namely (1) improving the definition of the meaning to be appropriate; (2) increasing the number of land development committees and their expertise; (3) protecting areas of landslide risks and severe soil erosion; (4) improving the law to prevent and to ensure efficient and optimal use of the land; (5) establishing measures to survey soil fertility and suitability for land use, undertake analysis of soil samples or implement land improvements, as well as prescribing measures prohibiting any action, including contaminating the land with chemicals or any other objects.[35]

6 Land Rights and Land Documents in Thailand

Ownership of land in Thailand is governed by the Land Code Promulgating Act of 2008, the Civil and Commercial Code, the Land Reform for Agriculture Act A. D.1975, and the regulations set forth by the Ministry of the Interior. However, the process of declaring government land and the legal pattern of Thailand land tenure causes conflicts between government officers and the people. For example, the development of the land tenure system forces many farmers to be identified as landless cultivators, and some farmers become landless or 'contract farmers' due to the Forest Plantation Act in 1992 (Pongsapich 2011).[36] According to Udomkerdmongkol (2020),[37] it was reported that about 40% of farm households in Thailand did not have the land ownership.

In Thailand, a land title deed is issued by the Department of Lands. The Department of Lands is the only competent authority to deal with land and registering and transferring private rights over land. Transfer of the land ownership claimed over titles issued by other government departments than the Department of Lands cannot

[34] Kingdom of Thailand, Land Development Act. (1983).

[35] Kingdom of Thailand, Land Development Act. (2008b).

[36] Pongsapich (2011).

[37] Udomkerdmongkol (2020).

be registered with the Department of Lands or it is restricted for transfer. The land title documents show a personal right to land and registered encumbrances such as mortgages, leases, etc. on a property. Foreigners are not allowed to own land and cannot be named as the owner of land in Thailand but they can be the holder of certain rights like lease, right of usufruct, habitation, superficies, a mortgage which can be registered in their name on the title deed. Government lands or public lands do not have any title documents and it is not open for private use. Government land or public land include:

1. Forest; The Royal Forest Department and the Department of National Parks, Wildlife and Plant Conservation supervise Thai forest under the National Reserved Forests Act, 1964, the National Park Act A.D. 1961, the Wildlife Preservation and Protection Act A.D. 1992, the Wildlife Reservation and Protection Act A.D. 2003, No. 2, the elephant ivory tusks act A.D. 2015.
2. Reformed land; The Agricultural Land Reform (Sor. Por. Gor. 4-01) has the Agriculture Land Reform Office supervise this land under the Agricultural Land Reform Act A.D. 1975
3. Self-established estate; The Department of Social Development and Welfare supervise it under the Allotment of Land For Living Act A.D. 1968
4. State property land (Ratchaphatsadu land); The Treasury Department supervise it under the Ratchaphatsadu Land Act A.D. 1975
5. Highway; The Department of Highways supervise it under the Highway Act A.D. 1992.
6. River; The Department of Marine supervise it under the Maritime in Thai Waters Act A.D. 2003.
7. Public land and vacant land; The Department of Provincial Administration together with the Department of Local Administration take care of them under the Local Administrative Act A.D. 2014.

Title Deeds in Thailand may be mainly divided into 4 categories as follows:

1. Title Deed (Chanote or Nor. Sor. 4 Jor (NS4J)) is the only land title deed certificate that offers full certified private ownership of land in Thailand. Land held under title deed, known as "Chanote" in Thai, is accurately surveyed and GPS plotted in relation to a national survey grid, and marked by unique numbered marker posts set in the ground. Chanote titles are the highest land title and are commonly found in the developed areas of Thailand. The Chanote title land is the preferred title for both buying or leasing land in Thailand. Additionlly, a condominium unit title deed (similar document) provides full freehold ownership and is also issued and administrated by the provincial or local branch office of the land department.[38]

2. Land titles Nor Sor Sam

Land title deeds Nor Sor Sam (NS3) and Nor Sor Sam Gor (NS3G) are land title deeds registered and issued by the Land Department. They show the name of person

[38] Thailand Law Online (2021).

who has the right to possess the land and gain the benefit of the land as a private owner. However, it is not actually a full ownership title deed. The name shown on the land title deed is the person who has the right to the land and has the legal right to possess the land.

This right is recognized by law and can be used as evidence in any disputation with an ordinary person or the government. This type of land can be upgraded to a full ownership title deed, the “Chanote”.

By having Nor Sor Sam (N.S.3) without extension, it implies that the land has been confirmed possession, but not accurately surveyed and the borders of the land must be confirmed with neighboring land plots. This may cause problems in verifying the land area. This type of land may be sold subject to a 30-day notice period to see if anyone wants to contest the ownership. Disputations on the border or ownership are common with this type of land title.[39]

Having Nor Sor Sam with the extension ‘Gor’ or ‘Khor’ means that the land is accurately surveyed, and the land area parcel points are set using aerial survey methods. There is no need to publicize any legal acts (no 30-day notice), and it is possible to partition (divide) the land into smaller plots. This document is issued by the district land officer.

It is noteworthy that rights like a registered long-term lease, superficies or usufruct must be registered with the Land Department to complete and enforceable. If the land does not have a proper land title administrated by the Land Department, it is simply not possible to register anything against the land.

3. Other land titles and claims

There are several other forms of land titles, claims, or rights of private use, some issued by the Land Department and some by other government departments. Some of those issued by other government departments offer ownership rights (similar to the Chanote) and are accurately surveyed but cannot be sold; they can only be transferred by inheritance. Some claims are merely rights of possession or use and have practically no associated rights. It is also not possible to register them for a sale, lease, or usufruct, except for local exceptions regarding building permits.

Sor Kor Nung (S.K. 1) is a notification form of land possession. This document allows the holder to occupy and utilize the S.K. 1 land, but their rights are not confirmed by the land department. Sor Kor Nung land may be transferred to another person through a process that involves the current possessor giving up their possession of the land and delivering S.K. 1 to the transferee.

Possession may also be passed on by inheritance. Depending on the land’s location, this document may be upgraded to Nor. Sor. 3, Nor. Sor. 3 Gor or Nor. Sor. 4 (Chanote). Sor. Kor. 1 has never been issued after 1972. The land with S.K. 1 can still be upgraded, however only with the court approval.[40]

Nor. Sor. Song (N.S. 2) is a consent letter issued by the Land Department to the holder. This document entitles the holder to occupy and utilize the land for a

[39] Thailand Law Online (2021).

[40] Thailand Law Online (2021).

temporary period, the holder has to commence occupation and utilization on the N.S. 2 land within 6 months and complete it within 3 years from receiving the N.S. 2. The land with N.S. 2 may not be sold or transferred except through inheritance. Depending on the land's location, this document may be upgraded to Sor. 3, Nor. Sor. 3 Gor or Nor. Sor. 4 (Chanote), however, after upgrade the prohibition for sale or transfer is still effective in full force.[41]

4. Land documents issued by other government departments

There are several other forms of land titles, claims, or rights of private use, some issued by the Land Department and some by other government departments. Some which are issued by other government departments offer ownership rights (like the Chanote) and are accurately surveyed but cannot be sold and can only be transferred by inheritance. Some claims are merely rights of possession or use and have practically no rights associated with them, nor is it possible to register a sale, lease, usufruct or obtaining a or obtain a building permit, except for local exceptions regarding building possibilities.[42]

Sor. Por. Gor. 4-01 is an allotment of land from the Land Reformative Committee, and under no circumstance may this land be bought or sold. It confers the right to occupy only and be transferred only by inheritance. It appears that this land may be used for agriculture only.

Por. Bor. Tor. 5 is a piece of evidence showing that the occupier of a plot of land has been issued a tax number and has paid tax for making benefit of the land. This confers no rights but was formerly used to establish that the holder was occupying a plot of land. The land with Por. Bor. Tor. 5 could be applied for changing it to a Sor Kor 1.

Nor. Kor. 3 is a utilization certificate issued under the act of land allocation for living A.D. 1968. This document is issued only for members of self-help settlements.

Gor. Sor. Nor. 5 is a utilization certificate issued under the act of land allocation for living A.D. 1968. This document is issued only for members of the cooperative settlement (Nabangchang-Srisawalak 2006).[43]

7 Conclusion

The rapid economic expansion has led to intensive use of natural resources and land use changes. The conversion of forests into cash crop production and the utilization of unsuitable areas for agriculture are contributing to soil and land degradation, which affects agricultural productivity, human well-being, and global sustainability. Moreover, government actions can also impact people, land use and physical changes, and even the social environment. If the the government's actions lack

[41] Thailand Law Online (2021).

[42] Thailand Law Online (2021).

[43] Nabangchang-Srisawalak (2006).

effective planning, the control becomes futile. Therefore, soil and land management in Thailand still needs to update new technology, as well as the transfer of existing knowledge about soil and water conservation practices and soil development research to drive policies against poverty and land degradation. In addition, well-designed land use planning and land cover management, such as reforestation and the restoration of degraded lands, in conjunction with appropriate legal, political, social, and physical techniques, can pave the way for achieving sustainable soil and land quality controls. Simultaneously, these efforts can help to reduce conflicts over land use between government officers and the people.

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Effective Governance for Sustainable Soil Management at National Level: Selected Recommendations Based on African and German Soil Law Studies

Harald Ginzky and Oliver C. Ruppel

> *To forget how to dig the earth and to tend the soil is to forget ourselves.—Mahatma Gandhi*

Abstract Although soils provide social and ecological services which are of a clearly transnational dimension, the management of soils need to be addressed locally. Thus, an appropriate—or better—effective governance for sustainable soil management at national level is essential. This chapter provides some fundamental recommendations for an effective governance based on legal studies on soil governance in several African states and in Germany.

1 Introduction

The social and ecological services of soils such as hunger and poverty prevention, food security, climate mitigation and adaptation as well as host of biodiversity are increasingly recognised as fundamental and indispensable for the implementation of sustainability within planetary boundaries. Milestones of the "new awareness" were the outcome document "The Future – we want" of the Rio+20-conference in 2012 and the adoption of the 2030 sustainability agenda by the United Nation's General

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Assembly in 2015.[1] In the outcome document state´s leaders concluded that land degradation is a global challenge.[2] According to the 2030 sustainability agenda, states committed themselves to "strive to achieve a land degradation neutral world".[3] Strong and important words, which are obviously important for the establishment of international cooperation and for a commonly agreed objective. Nevertheless, soils are more or less immobile—not neglecting the mobilisation due to wind and water erosion—and thus primarily a local challenge with regard to their management.

This chapter intends to provide selected fundamental recommendations on how to establish an effective governance for sustainable soil governance at the national level. The recommendations are based on insights collected when analysing soil legislation in various African countries (Cameroon, Kenya and Zambia) and in Germany, which have been conducted by the authors in cooperation with other experts. It shows that despite of the very different economic and societal circumstances and environmental conditions in African countries and Germany, the fundamental challenge from the perspective of law and law implementation are to a certain extent comparable. Stemming from these comparable experiences, the recommendations are meant to provide "food for thought" when reconsidering current soil legislation or redesigning soil legislation in other countries and regions of the world.

2 Soil Legislation in Selected African States: Some Insights

The following deliberations are mainly based on the project *Mapping out options for model legislation for sustainable soil management in Africa*, which has been financed by the German Federal Ministry for Economic Cooperation and Development (BMZ) through the German Gesellschaft für Internationale Zusammenarbeit (GIZ), aimed at developing options for a model law for soil protection in Africa.

The aforementioned project was carried out from December 2018 until April 2020 by the Development and Rule of Law Programme (DROP) at Stellenbosch University, South Africa, together with the German Environment Agency (UBA). On the basis of three country studies in Cameroon, Kenya and Zambia by African experts, options for a model law were identified and summarised.[4]

[1] The reports of IPCC and IPBES has also been very instrumental to stress the importance of soils. See inter alia: https://www.ipcc.ch/srccl/ and https://www.ipbes.net/assessment-reports/ldr.

[2] United Nations (2012), The Future – we want.

[3] United Nations (2015), 2030 Sustainability Agenda.

[4] See Ginzky et al. (2021b), p. 380 et seqq.

It has to be mentioned that the close cooperation with the Pan-African Parliament, and in particular its Alliance for Sustainable Development, has ensured an effective link to the policy world. Therefore, it could well be envisaged that the instructive recommendations will soon be considered by various African parliaments. Furthermore, the Pan-African Parliament has committed itself to work towards a model law for sustainable soil management.

In addition, the insights have been instructed by two workshops on soil protection governance in Africa, which were organised by the German Environment Agency together with local partners, the Konrad Adenauer Foundation[5] and the Gesellschaft für Internationale Zusammenarbeit. The workshops were held in Kampala, Uganda, in 2017[6] and in Nairobi, Kenya in 2018.[7] These workshops were instrumental in getting to a better understanding of the specific challenges in African counties concerning the establishment of an effective governance of sustainable soil management.

2.1 Background Information: Main Soil Challenges

Africa is the world's second largest continent with more than 50 distinct states. The continent's population was estimated to be 1.2 billion in 2016. The major economic activity in Africa is agriculture. Other economic activities include mining, energy generation and investments and manufacture and any kind of trade. The local climates differ strongly in Africa, such as an equatorial climate, tropical climate, arid and semi-arid conditions and subtropical conditions in the highlands. The kind of vegetation and fauna in Africa depend on the local climate.[8] Still there are vast areas which are hardly affected by human activities.

Most African economies have developed differently. In some countries, industrialisation is already relatively well established while others are still struggling. But several conditions prevail in most, if not all, African states:

- Large parts of the population generate their living from agriculture and the Gross Domestic Product (GDP) of countries is largely based on agricultural activities.
- Most farmers practise on a small scale and are thus extremely vulnerable to external shocks due to climatic and/or economic changes.
- National income is often dependent on the export of natural resources. The level of processing, manufacturing and industrialisation are usually low.
- Foreign investment in land, agriculture and extraction of natural resources is an important economic factor.
- African states often face a high or very high levels of debt, which strongly hinders the ability to invigorate economic development by stimulus programmes.

In light of the aforementioned statements, it must be emphasised that soil is a very important resource in Africa due its economic dependence from agricultural sector.

[5] For a summarising report of the workshop see https://bit.ly/3qZQUnT, accessed 28 January 2021.

[6] See https://bit.ly/36ldijI, accessed 28 January 2021. See Yahyah (2020).

[7] See https://bit.ly/36kAdf7, accessed 28 January 2021.

[8] Detailed information is to be found in the three country studies by Kameri-Mbote (2021), Tamasang (2021) and Towela Sambo (2021).

Nevertheless, due to its overall low productivity hunger and poverty are still challenges in many African countries.

Given these circumstances as main drivers, the following activities need to be mentioned: Primarily agriculture, secondly mining, industrialisation and infrastructure, thirdly urbanisation.

Adverse climatic conditions often negatively influence the ability of farmers to establish sustainable agricultural practices. Due to the fact that a high percentage of farming is of small-scale nature resilience against these climatic changes is low, which in turn can lead to migration within states and beyond borders.

Moreover, societal circumstances like poverty, but also poor law implementation and enforcement as well as illegal or illegitimate foreign investment in land (e.g. "land-grabbing") can also be drivers of soil degradation.

Forms of degradation may include overstocking and overgrazing, erosion and land-slides, wrong use of nutrients and pesticides and in particular deforestation.

2.2 A Strengths and Weaknesses Analysis of Current Legislation: An Overview

The following section shall provide an overview on gained insights, reflecting strengths and weaknesses of current soil legislation in Cameroon, Kenya and Zambia. Only the most essential aspects could be mentioned here.[9]

The three country studies in Cameroon, Kenya and Zambia show that none of the national constitutions of the three countries entail explicit or substantive provisions on sustainable soil management although some have set out ambitious provisions on natural resources, environmental protection and, partly, even on benefit-sharing.[10] It was furthermore concluded that in none of the aforementioned jurisdictions an overarching policy on sustainable soil management and a coherent soil legislation exist. Given this status, it seems to be recommendable to introduce some kind of framework legislation on sustainable soil management that can inter alia serve the following purposes:

- Recognition of ecological and social services as legally binding objectives;
- recognition of soils as natural resources;
- imposition of an ex-ante control system.

Furthermore, it became apparent that none of the analysed legislation entailed provisions on the implementation of the objective "land degradation neutrality". This objective is one of the 169 targets of the 2030 Agenda for Sustainable Development, which has been adopted by the United Nations General Assembly in 2015.[11]

[9] Further information in Ginzky and Ruppel (2021), p. 31 et seqq.

[10] Ginzky et al. (2021b), p. 385 et seqq.

[11] See https://bit.ly/3p24MMY, accessed 10 February 2021.

Three primary aspects should be mentioned in legally declaring soil as a natural resource and stressing its ecological functions and the establishment of an ex-ante control system: Firstly, the costs of rehabilitation or restoration by far exceed the costs of sustainable management.[12] Secondly, sustainable soil management is important—together with other mechanisms such as avoidance of societal tensions and political and military conflicts, birth control, and fair-trade patterns—in achieving an improvement in the economic conditions in African countries, while contributing to sustainable development. Thirdly, as climate change is very high on the international political agenda, a number of relevant international funds have been established and made accessible for climate mitigation and adaptation projects.

As soil degradation is caused by almost all human activities regulatory provisions concerning the various drivers of soil degradation which are additional to the framework legislation are needed.

Concerning agriculture, in all the three analysed countries, slash and burn practices have been identified as being detrimental to soil health. In Zambia these practices are prohibited by the Environmental Management Act, while in Kenya the prohibition is pursuant to the Forest Conservation and Management Act. In the case of Cameroon, the 1994 Forest Act proscribes slash and burn practices.[13]

An additional challenge is the misuse of pesticides and fertilizers. Overgrazing and overstocking are additional issues of contention, which might lead to negative effects for soils.[14]

Three main approaches were discussed and recommended. Firstly, the need of clear scientifically based standards for those activities as the use of pesticides and fertilizers, which should be legally binding, putting competent authorities in a position to implement and enforce them.[15] Secondly, there is a necessity to raise awareness amongst the farmers on the negative effects of certain practices. Thirdly, extension services need to be strengthened.[16]

As stated, the analysis of the three country studies made it clear that legally binding standards are important as they enable competent authorities to implement legal provisions on the protection of soils. Standards should in particular be established for soil quality with regard to soil health as well as to physical parameters (e.g., for soil carbon, biodiversity and organic matter).

In order to determine these standards data and information on soils and other parameters are required. Information and data are often lacking or at least not available to the extent necessary as the country studies have shown.[17] Traditional knowledge in the communities is a (sometimes hidden) treasure of information,

[12] Further information may be found with the initiative "Economics of Land degradation", at https://www.eld-initiative.org/, accessed 10 February 2021.

[13] Ginzky et al. (2021b), p. 396 et seqq.

[14] See Kameri-Mbote (2021), Tamasang (2021) and Towela Sambo (2021).

[15] Ginzky et al. (2021b), p. 387 et seqq.

[16] Ginzky et al. (2021b), p. 396 et seqq.

[17] See Kameri-Mbote (2021), Tamasang (2021) and Towela Sambo (2021).

which is not seldomly neglected or even discarded in the absence of being considered modern or appropriate.[18] It is thus important to first collect and systematise all kinds of relevant information, including traditional knowledge, and to secondly disseminate it to all concerned actors. In this respect soil science entities can be instrumental as they can function as an institutionalisation of the science- policy interface.

Insufficient or even lack of adequate law enforcement is often a core issue in developing countries, in particular in counties of sub-Saharan Africa.[19] This was also strongly reflected in the findings of the country studies in Cameroon, Kenya and Zambia.[20]

Thus, in order to become effective, several management tasks need to be implemented by governmental bodies (while private institutions have to be managed by the governmental bodies in order to fulfil the specific tasks). First of all, information on soil conditions and soil quality, as well as on ongoing activities which might affect soils and on technological options, need to be collected and disseminated among the relevant competent authorities. Secondly, the management task involves standard setting, which is a complex, demanding and time- and resource-intensive task. Thirdly, soil authorities need to control potentially negative activities for soils in the frame of a prior permission regime. Finally, monitoring of soils is an additional task and competent authorities need to control and enforce the compliance with substantial provisions. In this context it seems to be beneficial that the roles, responsibilities amongst ministries and administrative branches are clearly demarcated and regulated. In order to take into account the local specificities, it seems to be reasonable to strengthen devolution processes and a decentralised administration.[21]

The potential advantages and benefits of an accountable and transparent administration can be highlighted as follows: Clarity concerning the procedures should foster trust in the process. Secondly, the reputation of states can be significantly increased—also at the international level. Clarity establishes a level playing field for all—including foreign investors. Thereby, a positive regulatory environment for fair and responsible investment can be formed, expelling detrimental foreign investments.

Workable arrangements for institutions and procedures can ensure that respective states can be in a better position dealing with future challenges, such as the effects of the climate crisis, poverty and hunger. The detailed determination of the specific roles, competencies and responsibilities of the various governmental entities is important to enable the implementation of the substantial provisions effectively. It needs to be stressed that the determination of specific roles, competencies and

[18] Ginzky et al. (2021b),, p. 431 et seqq

[19] Cf. for example: Kameri-Mbote et al. (2019).

[20] See Kameri-Mbote (2021), Tamasang (2021) and Towela Sambo (2021).

[21] Ginzky et al. (2021b), p. 432 et seqq.

responsibilities is a demanding issue. It needs to be legally stipulated, which ministry is responsible for which particular driver and for which concrete task.

Water, for example, is a problematic issue in many African countries. And in most, if not all, African countries there are water ministries and a complex administrative setting of competent authorities. A simple and perhaps promising approach might be to add the responsibility for sustainable soil management to the water-related entities.

Local chiefs and traditional leaders hold a strong and respected position in most African countries with regard to the living conditions of local communities. However, cases have been reported where local chiefs have misused their powers to either neglect the requirements of environmental protection or to make short-term and unjustified earnings to the disadvantage of the respective local communities. Therefore, in the context of soil protection it seems to be necessary to involve local chiefs and support them with advice from soil scientists'. As such they should be integrated in the soil-related administrative structure.[22]

Cameroon, Kenya and Zambia enacted legislation on access to environmental information, public participation, environmental impact assessment and access to justice. However, such legislation reflected various aspects of ambiguity leading to weak law enforcement.[23] It was recommended that environmental impact assessment should be mandatory by law for all activities, which might have significant effects on soils. Access to information on soil quality needs to be guaranteed and effective legislation should be enacted that clearly defines the scope and structure of public participation in soil protection decision-making. Specialised courts on environment and land matters seem to be one viable option to improve access to justice. In addition, the expertise of judges on soil and land topics could be strengthened. These mechanisms are of particular importance with regard to foreign investments in land and resource extraction, such as mining. This is also due in order to support local communities to raise their concerns and to enable them in seeking effective protection of the local environment.

Different land tenure types and policies strongly influence land-use practices and hence affect the quality of soils in Africa. Land tenure in the three countries—both statutory and customary—is characterised by insecurity, constituting a potential underlying driver of soil degradation. Differing and at times conflicting co-existing land tenure types can lead to conflict and foster unsustainable land and soil management practices. For example, communally 'owned' lands, in particular, in Cameroon and Zambia are insecure in a sense that they can easily converted into national lands for development purposes.

One reason for the insecurity of owned land is the high economic value which has increased the tendency of the most powerful to engage in land-grabbing and dispossession in Africa. This is often to the detriment of the most vulnerable parts of society that are increasingly being displaced from their lands, leading to heated

[22] Ginzky et al. (2021b), p. 434 et seqq

[23] Ginzky et al. (2021b), p. 438 et seqq

disputes and conflict. In addition, all three countries have weak governments when it comes to the problem of corruption.

The aforementioned insights have inter alia prompted the following recommendations: The multiplicity of legal instruments and requirements on access to land should be reduced by means of harmonisation and consolidation of the fragmented and dispersed pieces of legislation on land tenure should be amalgamated into a single, comprehensive and overarching land act. It is necessary that the "new" land act recognises customary laws relating to land tenure or at least ensures that procedures for access to land are comprehensible and accessible to all.

Measures by which corruption could be avoided and institutional capacity in land administration matters should be enhanced.

Foreign investors constitute one of the main groups of actors responsible for soil degradation in many African countries, as was seen in Cameroon, Kenya and Zambia. This necessitates more effective monitoring and control mechanisms, particularly but not limited to the mining and agricultural sectors. Thus, improving the legal control of foreign investors is critical to guarantee the effective protection of soils.

To enable new markets for sustainable development requires adequate regulatory frameworks (international, regional and national) in order to give investors the necessary confidence and at the same to guarantee the interests of local communities as well as to protect the environment.

There are several suggestions which need to be considered further:

- Imposition of environmental degradation by means of taxation, such as for pollution or soil contamination, to be paid by both foreign and domestic investors;
- land reforms should be promoted that limit the amount of land that can be acquired by foreign investors or that specify sizes of land depending on the activity to be carried out.

It should also be mentioned that the newly created African Continental Free Trade Area (AfCFTA) agreement will connect 1.3 billion people across 55 countries with a combined GDP valued at US$3.4 trillion. It has the potential to lift 30 million people out of extreme poverty but achieving its full potential will depend on putting in place significant policy reforms and trade facilitation measures.[24] Enabling free trade may also lead to potential negative externalities of trade, which may also affect soils. In this light, the enabled free trade needs to be implemented in a way that it maintains or even enhances the ecological and social services of soils.

[24] World Bank (2020).

3 Soil legislation in Germany: Some insights

Germany is—in contrast to the African overall circumstances—a highly-industrialised country with a myriad of small-middle scale enterprises and a complex and developed administration. In the following—again—some background information will be provided followed by some insights and recommendations from the current soil governance regime.[25]

3.1 Background Information: Main Soil Challenges

Due to its very diverse Germany's environment ranging from high mountains in the south, lakes and transboundary rivers like the Rhine and the Danube, hilly regions in central Germany, coastlines to the North and the Baltic sea, and its continental climate at least 12 different types of soils with regard to their texture, compaction and colour can be found in Germany.[26]

Germany's highly diversified industry, which is based on a strong labour force, a large capital stock, a low level of corruption, and a high level of innovation, has the largest national economy in Europe, which is also the fourth largest by nominal GDP in the world. The economic success is mainly built on exports as Germany is the third strongest export country in the world.[27]

Agriculture and forestry contributed less than one percent to the GDP in 2018.[28] Germany is highly populated, about 230 persons per square kilometre.[29]

According to Article 20 of the German Basic Law (the "Grundgesetz", Constitution of 1949), Germany is a "social and democratic federal state". In fact, the governmental structure with the sixteen constituent federal states, which are called "Länder", could be described as highly decentralised.

The legislative powers are divided between the Federation ("Bund") and the constituent federal states ("Länder"). Although the Constitution empowers the Federal Parliament to initiate legislation, in practice, most acts are drafted and submitted by the ministries in charge.[30]

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[25] UBA also commissioned numerous research projects on legal issues relating to the implementation of the Sustainability Development Goal of land degradation neutrality, and another on updating of international soil protection governance.

[26] The number of main soil types, found in Germany, is based on the German classification system. For more information see: https://www.umweltbundesamt.de/en/topics/soil-agriculture/soil-science/soil-types.

[27] Federal Ministry for Economic Affairs and Energy (2018).

[28] Federal Statistical Office (2019): Bruttoinlandsprodukt 2018 für Deutschland, p. 10.

[29] Federal Statistical Office (2018): Statistisches Jahrbuch, p. 26.

[30] See https://www.bundestag.de/en/parliament/function/legislation/passage-245704.

Subsidiary regulations, called ordinance ("Verordnung"), may be released by the Federal Government or specific ministries if according to Article 80 Basic Law they are entitled by the Parliament to do so ("Ermächtigungsgrundlage").

Decentralised powers are in particular in place with regard to the enforcement of most federal acts, which rests in the powers of the "Länder" according to Article 83 Basic Law.

Germany has been a member of the European Union (EU) since 1957. Given the transfer of additional competence over the years, the EU is empowered to set legal requirements with regard to most topics of environmental protection, which citizens and enterprises have to comply with.[31]

The EU has its own soil protection policy, although up to now no specific soil legislation has been put in force.

Concerning the main soil threads and drivers, it needs to be emphasised that due to both industrial and economic development and the population density, there is almost no land left, which is not cultivated or modified by human activities or due to human interests.[32]

As industrialisation commenced in Germany during the middle of the nineteenth century, due to lacking awareness and knowledge, severe contamination of soil compartments and the local groundwater bodies on (and below) former industrial sites and landfills have been caused over the years. Thus, the about 425,000 of such brownfields pose one mayor soil threads. Calculations for the costs for rehabilitation range up to more than 500 billion Euro.[33]

A second soil thread is linked to ongoing industrial activities. Urbanisation and related necessary infrastructural measures such as streets and railways are a third soil thread.[34] The land take in Germany is still unsustainably high with about 58 ha per day of which about the half is finally sealed.[35]

The fourth soil thread is linked to continuously intensified agriculture. Negative effects due to the contamination by fertilizer or pesticides, erosion through floods, wind or landslides and compaction though heavy machinery need to be mentioned.[36]

Impacts on soil in Germany caused by climate change is the last (but probably not least) soil thread, which has not yet been thoroughly scientifically assessed. It is, however, undisputed that soils are on the one hand extremely important to fight climate change, as they are the second largest biological sequester of carbon and for climate adaptation in particular in urban areas.[37] On the other hand, soils may be

[31] This concept is called "positive integration". For further reference see European Commission (2017), pp. 37 and 100.

[32] Kloepfer and Neugärtner (2016), p. 1122.

[33] Kloepfer and Neugärtner (2016), p. 1123.

[34] Wunder et al. (2018), p. 47.

[35] German Environment Agency (2015), p.14.

[36] Wunder et al. (2018), p. 47.

[37] Oceans sequester more carbon than soils.

severely affected by drought, increased water and soil erosion, decline of organic matter and biodiversity—all potential effects of the ongoing change of climate.[38]

3.2 German Soil Governance: Some Insights and Recommendations

This section will provide some insights and recommendations of German soil protection governance.[39]

The Federal Soil Protection Act (FSPA) has been enacted 1998. The related Ordinance, Federal Soil Protection Ordinance (FSPO) was put in force on year later. The FSPA and the Ordinance mainly entail provisions which address the management and sanitation of brownfields.[40]

Nevertheless, it has to be highlighted as a remarkable advancement that the FSPA acknowledges soil as natural resource and the ecological functions which soil can provide for society.

In addition, it could be stated, that the importance of soils for the society has been increasingly recognized only within the last twenty years and—as a consequence—specific soil protection governance came in late. Thus, the new soil provisions needed to be aligned with already existing environmental regulations.[41]

As a consequence, the FSPA was declared to be subsidiary to other already existing sectoral provisions as far as these deal with soil aspects. Thereby it was intended to avoid regulatory duplication and contraction. The existing sectoral provisions on forests, agriculture, mining and industrial facilities should be used for establishing an effective soil governance.

In a landmark judgement, the Federal Administrative Court (Bundesverwaltungsgericht)[42] decided that the specific scientific requirements of the FSPA and FSPO, in particular the trigger values for contaminants, must be considered when implementing other sectoral provisions. Thus, taking it from a practical perspective, the sectoral provision to a great extent implements the scientifically founded requirement to avoid further contamination.

This is possible as the FSPA clearly stipulates scientific requirements for contaminants, which are legally binding. The analysis of German soil governance clearly indicates that an effective soil protection governance needs clear specifications of scientific requirements in a legally binding manner. In addition, the

[38] LABO (2011), p. 4.

[39] The following is a kind of a summary of the results and recommendation of the analysis in: Ginzky (2021), pp. 295–333.

[40] Ginzky (2021), p. 308.

[41] Ginzky (2021), p. 328.

[42] BVerGE C 7 23.03.

provisions on sanitation of brownfields are effective as they clearly stipulate the responsibilities of the competent authority and the private actors.

Compared to soil contamination, the German law has not determined similarly clear scientific requirements for the other soil threats like erosion, compaction or the content of organic carbon. § [43] 17 FSPA entails principles for good agricultural practices which are very generic in nature. FSPA does not foresee a mechanism to specify them—neither by an ordinance delivered by the ministries in charge nor by administrative orders of the competent authorities.[44] Concluding, it seems very clear that the steering effect of non-binding objectives such as the mentioned principles of good agricultural practices or other political objectives such as the land take reduction objectives (20 or 30 ha by 2020/2030) or the LDN objective is low.[45]

Based on the EU directive on industrial emissions[46] the German regulation has put in force a new regulatory approach. The operator is requested to deliver a documentation of the status of soils at the beginning of the operation. When the operation is ended the operator is obliged to re-establish the original status, if significant negative effects on soil or groundwater are detected. This regulatory approach is certainly very sensible as it factually enacts an economic incentive for the operators of the industrial site to avoid negative effects on soils and groundwater.[47]

However, this concept only works for point sources such as industrial facilities as the documentation and the assessment of the current status before and after the operation for spatially extended areas such as agricultural activities would not be feasible. Thus, this concept could probably be applied for mining, but not for contamination caused for example by the use of pesticides or fertilizers in the case of agriculture.

Several studies have shown that climate change could severely affect soil quality and that soils as carbon sequester are at the same time extremely important for climate change mitigation. Moreover, there is strong support that soils are needed as climate adaptation measure in urban areas as temperature will increased in particular in larger settlement such as towns and cities.[48] Therefore, it is recommended that the ecological service of soils is explicitly addressed in Germany's soil protection governance, probably at best in the FSPA. To state the climate function of soils as an ecological function could be the formal basis to develop—legally binding—

[43] § is the German statutory equivalent for "Section / Article".

[44] Ginzky (2021), p. 315.

[45] Ginzky (2021), p. 329.

[46] Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control), under. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32010L0075.

[47] Ginzky (2021), p. 313.

[48] LABO (2011), p. 7 et seqq. and Willand et al. (2014) p 20 et seqq.

scientific requirements and to urge the competent authorities to consider this aspect when implementing the provisions of FSPA and the other sectoral provisions.[49]

As outlined, the "Länder" as empowered by Article 83 of the German Basic Law precisely determine by law the competences of the authorities, the division of labour, the responsibilities and the involvement of other bodies. Thereby, the effectiveness of the work of authorities and—from the perspective of citizens—transparency and accountability are ensured.[50] Although usually hardly addressed in scientific literature it needs to be highlighted that in order to establish an effective soil protection governance clarity on the competences of the authorities and the relevant procedures, including the involvement of other authorities and the general public, is similarly important as the substantial regulations.

Procedural regulations, such as free access to environmental data and the necessity of an EIA are also of eminent importance. The Federal Environmental Information Act uses the very inclusive term "environmental information".[51] There is hardly any information related to environmental protection which would not fall under this term.[52] Authorities are obliged to grant access to the environmental information available to them given that there are no reasons to deny the access. Environmental Impact Assessments are required for the listed categories of projects pursuant to the Environmental Impact Assessment Act.[53] The purpose of EIA in legal terms is first to provide more detailed information on the environmental effects which are to be compiled in an Environmental Impact Study and second to ensure that all relevant stakeholders are involved in the decision-making process.

It seems obvious that the probability of an effective soil protection governance increases if the general public or civil society organizations could control the acts of governmental entities although it was not feasible to substantiate by a sociological assessment in this paper.

The formal implementation of the LDN objective is so far weak in Germany.[54] The "intervention clause" of the Federal Nature Conversation Act in theory entails almost perfectly the first three elements of the UNCCD "LDN response hierarchy", which are "avoid", "reduce" and "reverse".[55] The "intervention clause" entails four main steps. Interventions on nature have firstly to be avoided, as far as possible. Unavoidable interventions secondly have to be compensated by measures that establish either (primarily) "similar" or "equivalent" nature functions. If the

[49] LABO (2011), p. 27 et seqq. and Willand et al. (2014) p. 38 et seqq.

[50] Ginzky (2021), p. 320.

[51] Federal Environmental Information Act, see: https://www.gesetze-im-internet.de/uig_2005/UIG.pdf The act transformed the EU directive on access to environmental information.

[52] See Kloepfer and Neugärtner (2016), p. 469.

[53] Federal Environmental Impact Assessment Act, Annex 1, see: https://www.gesetze-im-internet.de/uvpg/UVPG.pdf.

The act transformed the EU directive on EIA.

[54] Ginzky (2021), p. 320.

[55] UNCCD (2017).

compensation is not feasible, the authority has to thirdly decide whether the interests of nature protection or the project shall prevail. In this former case, the project operator has to pay monetary compensation.[56]

In practice however, the steering effect of the intervention clause in order to achieve the LDN objective is low. Firstly, the intervention clause does not necessarily—dependent of the different guidance documents of the "Länder"—require a compensation of the same nature function, which has been degraded by the project.[57] Thus, some guidance documents neglect to a certain extent soil functions as a core element of nature and focus more on the living "nature" such as flora and fauna.[58] Lastly, there is a lack of information and data on the current status of soils which impede the assessment of the effects.

There are arguments in favour of a "pure" soil related intervention clause in the FSPA as the recognition of soils within the "intervention clause"—based on the Federal Nature Conservation Act - has been debated in Germany for more than a decade—with limited success.

With regard to the LDN objective, two additional instruments have been discussed. First, to establish a permission regime for all substantial land use changes would allow competent authorities to control and manage these changes in a way that the effects on soils are minimized. Second, such a permission regime should be combined with a compensation requirement in order to ensure the required "neutrality".

As a consequence of the analytical results that non-binding programmatic objective does not render strong steering effects, it seems to be necessary to impose the LDN objective as a mandatory requirement.[59] Finally, as land/soil degradation is caused by many—very different drivers—planning instruments on a larger spatial scale are needed in order to manage effectively and with foresight the net balance of ongoing degradation and restoration/rehabilitation.[60]

At the end, it should be stated that clarity land tenure is only very seldomly an issue in Germany. Security of land ownership is ensured by the so-called "land charge register", which is an official documentation of all land titles. Any sale of land title must be documented in this register in order to be legitimate. Furthermore, it is legally required that any contract of real estate sale must be notarised by specialised advocates in order to come into effect.[61]

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[56] For a more detailed analysis of the "intervention clause" see Bodle and Stockhaus (2019).

[57] Federal Administrative Court (Bundesverwaltungsgericht) judgment of 10.09.1998 - 4 A 35/97; OVG (Higher Admistrative Court) Koblenz, judgment of 06.06.2000 - 8 C 11556/98.

[58] For example some of these guiding documents focus on the assessment and evaluation of existing biotopes, see i.a. North Rhine-Westphalia (https://www.lanuv.nrw.de/natur/eingriffsregelung/numerische-bewertung-von-biotoptypen/) and Saxony-Anhalt (https://lvwa.sachsen-anhalt.de/das-lvwa/landwirtschaft-umwelt/naturschutz-landschaftspflege-bildung-fuer-nachhaltige-entwicklung/eingriffsregelung/).

[59] Ginzky (2021), p. 330.

[60] Ginzky (2021), p. 320.

[61] Ginzky (2021), p. 309.

4 Some Recommendations

Considering the insights gained from German and African perspectives, despite the different levels of industrialisation, history, political system and societal realities, some fundamental recommendations could be distilled. The reason for this may be that the recommendations are addressing issues of good governance, legislation and law implementation. These are aspects which are—to a certain extent—independent from the specific circumstances and conditions of a specific state as they are—from a legal perspective—technical in nature. Therefore it is held, that the recommendations—at least to a certain extend—can also be applicable to other regions of the world.

It has to be emphasised that to establish an effective soil governance regime which complies with the aspirations of sustainability has to take into account the following two aspects. First, almost every human activity affects soils and almost inevitably causes—to a certain extent—the degradation of soils. Agriculture, forestry, viniculture, streets, even parks or graveyards, settlings and infrastructure as well as industrial facilities may have—mostly detrimental - effects on soils. Second, soil threats are very different with regard to the challenges they pose. This fact becomes even more complex as soil in itself significantly differs too.

Sustainable soil management is a cross-cutting issue, which has to be addressed by many sectoral provisions. Thus, all sectoral provisions must entail appropriate requirements to maintain and to enhance the ecological and social services of soils.

Given the German experience, it seems to be clear that a kind of a framework legislation certainly improves soil governance. It is essential that the maintenance and enhancement of ecological and social functions of soils should be established as general objective in legal terms. Moreover, soils need to be recognised as "natural resource" in the framework legislation. This is extremely important, as the African experience shows, where in general land has often been regarded as pure private asset on which the owner can decide for him/herself. If the social and ecological services are recognised as legal objectives, land owners would also be obliged to comply with these objectives.

In order to implement and enforce this objective, in the framework legislation—whatever form it may have—a permission control system for land/soil use change should be established. Thereby the competent authorities would be in a position to control and to manage human activities which might have negative effects on soils. In addition, a legal compensation obligation which obliges to offset all negative effects on healthy soils should be enacted. Thereby the objective of land degradation neutrality could be implemented. To even strengthen this approach, it would be instrumental to establish the LDN objective as a legally binding one.

Good Governance in general depend on data and information. This is also the case for soil management. The African experience show that traditional knowledge on how to sustainably use soils and land should be systematically taken into account. For the science-policy interface institutionalised soil science such as soil scientific institutions would be most instrumental. These entities should collect, evaluate and assess soil data and information and distribute it to policy makers and other users (private sector, farmers).

The German experience underscored that the success of soil governance in practice very much depends on standards, which are legally binding. German soil governance is particularly effective with regard to soil contamination for which legally binding environmental quality standards are in place. On the contrary, for the other soil threats no such standards exist and soil governance is clearly less effective. To sum up, legally binding standards are most important to implement and enforce a sustainable management of soil with regard to the various uses.

Access to land is also extremely important. A lack of legal clarity can be a strong impediment to sustainable soil management, in particular in developing countries as reflected in the African experience. Clarification of tenure rights can support poverty eradication, control of foreign investors and thereby lead to more justice for all. The distinct historical, societal and political realities on the ground always need to be considered. A formal documentation of land titles, private or collective ones, by a governmental entity seems to be one option, as the German example clearly reflects.

It is fundamentally important to establish effective institutional settings and arrangements for the implementation and enforcement. Smart provisions are only ink on the paper without effective implementation, enforcement and—at times also necessary—sanctions. Thus, the roles and responsibilities of the various ministries and competent authorities need to be clearly determined by legal provisions. Based on the experience in Germany and Africa it can be highlighted that the decision-making process to define the competences of the various entities is comparably complicated, demanding and time-consuming as is the drafting of good substantial provisions.

Furthermore, experiences in Germany and in African states show that there is a need to ensure an effective involvement of the society at large and in particular civil society organisations. Access to environmental information, public participation and access to justice are crucial mechanisms in this regard. The involvement of societal actors is important to control public authorities and foreign investors and to prevent all kinds of corruption.

International cooperation offers options for support—both thematically and financially—which could be considered, in particular by developing countries. The FAO provides significant guidance on soil aspects, ranging from pollution, erosion, sustainable agriculture and tenure rights.[62] In addition, soil management measures should be included in the Nationally Determined Contributions (NDCs) for UNFCCC reporting, which in turn opens opportunities for international funding.[63]

[62] See the FAO Soil Portal: http://www.fao.org/soils-portal/en/.

[63] Ruppel and Ginzky (2021), p.

5 Outlook

Germany is a country, Africa a huge continent, this holds true. Yet, the analysis of German and African insights on how to establish an effective soil governance provided some straightforward recommendations with the potential for consideration in other parts of the world. In many parts of the globe, it is time to bring such ideas forward. Soils are as high as never on the political agenda, most probably due to the interface with prominent political issues like climate change mitigation and adaptation, hunger and poverty prevention and migration policies. Just to name a few highlights: The Pan-African Parliament has requested to develop a so-called model law for sustainable soil management.[64] The EU has launched a consultation for a new healthy soil's strategy.[65] IPCC and IPBES have addressed soil/land issues in their annual or special reports.[66] FAO and its Global Soil Partnership regularly organise workshops on soil protection issues.[67] Already the fifth volume of the "International Yearbook of Soil Law and Policy"—each volume the size of about 400 pages—is about to be published.[68] The "Asian Research Institute for Environmental Law"—ARIEL has—together with IUCN and the German Environment Agency—run a webinar for soil governance in the South-Asian region.[69]

The Covid 19 pandemic—next to its dramatic effects for people´s health and life and to its enormous consequences for daily life—urges all of us to reconsider basic assumptions. New guiding principles for environmental and sustainability policy have been proposed, such as the one-health concept, resilience, structural justice and solidarity as well as an adaptive (in the sense of continuous update according to new information), emancipating and framing governance.[70] Furthermore, the new chances, opportunities and risks due to the emerging digitalisation—or better the potential new digital culture—need to be discussed in all societies.

Soils are essential—to cope with the challenges posed by climate change and the biodiversity loss and other mayor trends. Soil governance is one means to address these necessities. Best knowledge on available practices to which this article is intended to contribute can be of help, needs to be discussed further and should finally be implemented and enforced everywhere. Not one size fits all and local specificities apply. But what works, needs not be reinvented.

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[64] See the press release of March 2021 by the Pan African Parliament: https://www.africanparliamentarynews.com/2020/03/pap-maps-first-steps-for-model.html?m=1.

[65] See inter alia: https://www.ipcc.ch/srccl/ and https://www.ipbes.net/assessment-reports/ldr.

[66] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12634-New-EU-Soil-Strategy-healthy-soil-for-a-healthy-life.

[67] http://www.fao.org/soils-portal/en.

[68] See more detailed information at: https://www.umweltbundesamt.de/en/topics/international-yearbook-of-soil-law-policy.

[69] See the announcement of the webinar, at: https://www.umweltbundesamt.de/en/webinar-soil-governance-southeast-asia-in-focus.

[70] Ginzky et al. (2021a).

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Part IV
Cross-Cutting Issues

PFAS in Soil and Groundwater: Comprehensive Challenges and Progress in Regulation and Management in Germany

Annegret Biegel-Engler and Joerg Frauenstein

Abstract Per and polyfluorinated alkyl substances (PFAS) are substances of very high concern. Because of their persistence and their ubiquitous presence in the environment they are called forever chemicals. Some substances of the large group of PFAS are bioaccumulating and toxic, other substances are very mobile in soil and reach groundwater easily. Humans take up PFAS mainly via food including drinking water, which is often produced from groundwater. Thresholds for PFAS in drinking water are so low that environmental concentrations are often already above those levels. Thus, strategies to deal with PFAS in soil and groundwater are urgently needed. The number of (suspected) sites contaminated with PFAS is rising. The reason is that the awareness about PFAS is increasing and thus more areas are being investigated. However, clean-up and remediation of contaminated sites is costly and difficult, if possible at all. Until the implementation of legally binding values for PFAS in soil and groundwater and their verified derivation. a German guideline for PFAS assessment currently provides available media-related assessment bases and criteria. This paper covers the current state of knowledge on PFAS and suggests solutions for dealing with PFAS contaminated soils and groundwater.

1 Drivers and Pressures: Why Are PFAS in Soil and Groundwater of Concern?

Reports of findings of perfluorinated and polyfluorinated chemicals (PFAS) in groundwater and soil are increasing worldwide. Knowledge about PFAS in soil is of increasing concern, as PFAS can be transferred from soil to groundwater or from soil into crops. Insufficient and incomplete knowledge and understanding of the fate and behaviour of PFAS, their physical-chemical properties, persistence, accumulation and other effects in environmental compartments, in humans and the retrieval

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from material flows and cycles have favoured developments that have led to an aggravation of the problem. For example, lack of understanding but also carelessness lead to imprudence in product development and user behaviour. This favoured an increasing input of PFAS into the environment as well as the generation of problematic wastes.

The substance group of PFAS represents a challenge for environmental protection. The extraordinary scale, significant limitations of technical approaches, economic burdens to solve the problems additionally require a comprehensive strategy driven by knowledge and excellence and based on state-of-the-art research. This article addresses the current state of knowledge, management and policy issues regarding PFAS in soil and groundwater.

1.1 What Are PFAS and What Are They Used For?

Fluorochemistry is present within our daily lives, however, most people are not aware of it. The range of uses for PFAS is wide. PFAS give products outstanding properties; dirt and water repellence combined with high stability against heat, chemicals, UV-radiation. The applications are diverse and range from finished textiles, carpets, grease-repellent food packaging, to paints and impregnation of wood and tiles. Certain PFAS are used as emulsifiers in fluoropolymer production, such as polytetrafluoroethylene (PTFE), traces of PFAS can still be present in the final products. Fluoropolymers are used in various products to reduce either frictional drag (e.g. as coatings in automobiles and aircraft, in printing inks, waxes and lubricants) or adhesion (e.g. in cookware). PTFE is also widely used as a waterproof and breathable membrane i.e. in weather protective clothing.[1]

The abbreviation PFAS stands for a still increasing group of more than 5000 man-made chemicals.[2] The unique properties of PFAS are based on their common structural feature: a perfluorinated or polyfluorinated carbon chain. The atomic bond between carbon and fluorine is one of the strongest known in chemistry. A lot of energy is needed to break this bond. PFAS can only be mineralized at very high temperatures. This also means that PFAS are not broken down under natural environmental conditions. Although the non-fluorinated molecule moiety of polyfluorinated substances (so called precursors) can be degraded, the fluorinated moiety remains persistent. Neither biotic processes (e.g. bacteria) nor abiotic processes (water, air, light) can completely destroy these molecules and so they remain in the environment for a very long time.[3]

[1] OECD (2013); Glüge et al. (2020); Evich et al. (2022); OECD (2021) Glüge et al. (2020).

[2] OECD (2021).

[3] OECD (2013).

1.2 PFAS Are Distributed in the Environment Through Various Sources

PFAS are emitted into the environment during their entire life cycle, i.e. from the production of the chemicals, through their use phase, to the disposal of related waste (see Fig. 1). Point sources of PFAS include facilities where PFAS are produced and used. These can be, for example, chemical companies but also textile finishing industry, paper manufacturers, leather processing industry, electroplating plants, manufacturers and users of fire extinguishing agents, manufacturers of electronics and electrical engineering.[4] Landfills can also be a source of the chemicals. PFASs here can escape into the air or may be washed out with the leachate. Incineration plants may emit PFAS into the environment. Municipal and industrial wastewater treatment plants are among the most important point sources of PFAS in the environment. The pollutants are introduced into wastewater, for example, by washing textiles that have been treated with PFAS. The persistent perfluorinated chemicals are not degraded during the treatment stages in the wastewater treatment plant. PFAS are carried into surface water, but also adsorb to particles and accumulate in sewage sludge. If sewage sludge is applied to the soil in agriculture, e.g. as fertilizer, the soil is contaminated with PFAS. Increased PFAS levels in soil and groundwater are caused by the use of PFAS containing fire extinguishing foams. These so-called film-forming foams are used especially for extinguishing burning liquids (so-called AFFF foams).[5]

1.3 Properties & Behaviour of PFAS in the Environment

Fate and behaviour of PFAS in the environment is different compared with other substances known to be problematic (such as dioxins, heavy metals or polychlorinated biphenyls (PCB)). [6]

Due to the large number of substances, individual PFAS have very different properties. Some are water-soluble, others adsorptive, still others gaseous. Once the chemicals enter the environment, they enrich in different environmental media and remain there for a very long time. Especially the fully fluorinated compounds (perfluorinated) are resistant against transformation under environmental conditions and metabolism in plants, animals and humans. PFAS are therefore called forever chemicals. [7]

[4] Glüge et al. (2020); Dasu et al. (2022).

[5] Dasu et al. (2022); Evich et al. (2022); Lenka et al. (2021).

[6] Brendel et al. (2018); Vierke et al. (2012).

[7] Evich et al. (2022).

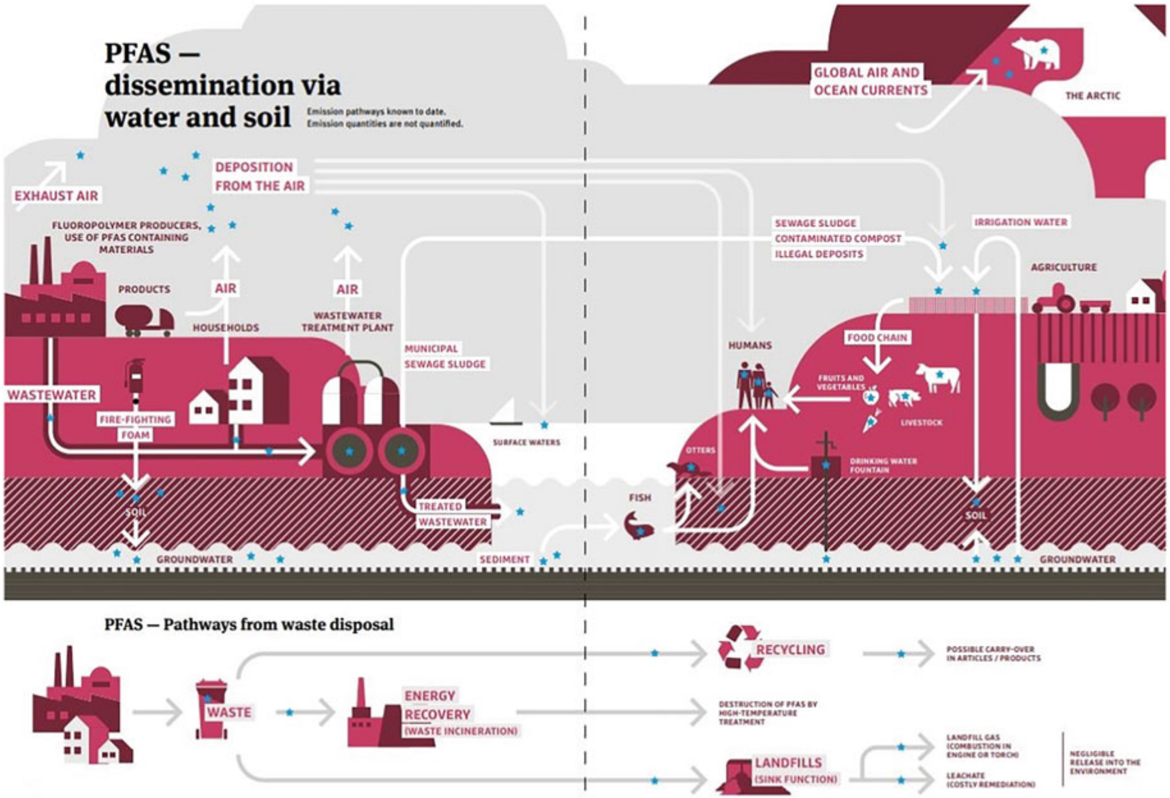

Fig. 1 PFAS pathways in soil and groundwater; source Umweltbundesamt 2020a

For decades, the persistence of PFAS has been seen as unproblematic, because with the standard test protocols, PFAS were found to be non-toxic. In recent years, it has become apparent that this original assessment was wrong. Because of the numerous applications, the chemicals are ubiquitously present in the environment, today. As they are so persistent and cannot be degraded under environmental conditions, they accumulate steadily in the environment. They are found in water, sediment, air and soil, biota, even in remote areas such as the Arctic.[8] Some PFAS are bio-accumulative and enrich along the food chain.[9] Thus, PFAS are found in top predators even in human blood of the general population.[10] Other PFAS accumulate less in humans, they are more mobile and can therefore contaminate ground and fresh water more quickly and are taken up into plants. Their toxicity is estimated to be lower, partly because of the lower accumulation potential in the body.[11] However, human- as well as eco-toxicological basis data are still developing and might change existing risk assumptions and legal value setting. So, the more science is learning about these substances, the more scientists become aware of their effects. It is therefore time to address these substances and take actions at a global level to protect humans and the environment from even higher pollutant loads.

1.4 PFAS Levels in Humans May Be Linked to PFAS in Soil

Humans take up PFAS mainly via food but also via inhalation of dust and air; thus, mainly from the environment.[12] More and more studies show how problematic PFAS are for humans. Today we know that some PFAS have extremely long half-lives in human blood and are toxic.[13] There is even evidence that high PFAS blood levels reduce vaccine efficacy in children.[14] This may be of special concern in view of the Covid-19 pandemic.

A study on human blood samples stored in the German specimen bank analysed a spectrum of 37 PFAS and found two prominent PFAS (perfluorooctanoate—PFOA and perfluorooctanoic sulphate—PFOS) in every sample of the 2009–2019 dataset. The results of this study indicate a decrease in human exposure to known PFAS in Germany over the last three decades.[15] However, an official German human

[8] Kotthoff et al. (2020); Butt et al. (2010); Ahrens and Bundschuh (2014); Washington et al. (2019); Sims et al. (2022); Brusseau et al. (2020).

[9] Letcher et al. (2018); Chen et al. (2021); Göckener et al. (2020a); Lesmeister et al. (2021).

[10] Göckener et al. (2020b).

[11] Brendel et al. (2018); Evich et al. (2022).

[12] Haug et al. (2011); EFSA (2020); Bundesinstitut für Risikobewertung (2021); De Silva et al. (2021); Domingo and Nadal (2019); DeLuca et al. (2021).

[13] Fenton et al. (2021); Sinclair et al. (2020); Pelch et al. (2019).

[14] Grandjean et al. (2012).

[15] Göckener et al. (2020b).

Table 1 Tolerable weekly intakes of PFAS determined by the European Food Safety Authority (EFSA)[18]

TWI in ng/kg body weight	2008 EFSA 2008	2018 EFSA 2018	2020 EFSA 2020
PFOS	1.050	13	4.4
PFOA	10.500	6	
PFHxS[a]	–	–	
PFNA[b]	–	–	

[a]Perfluorinated hexanoic sulfonate
[b]Perfluoro nonanoate

biomonitoring study on blood of children and adolescents came to the result that still one fifth of the participants in this study had concentrations of PFOA in their blood that were above the so-called **H**uman-**B**io-**M**onitoring values (HBM-I) level. This level is defined in such a way that if it is exceeded, harmful effects cannot be ruled out with sufficient certainty.[16]

Because of the known effects on human health, human intake of PFAS must be reduced. Therefore, many countries have applied guidance values or threshold values for drinking water.[17] The European Food Safety Agency (EFSA) has derived tolerable weekly intake rates (TWI) firstly in 2008 for PFOS and PFOA. In 2018 EFSA updated its assessment and published drastically lower values in 2018. Recently, the EFSA Panel on Contaminants in the Food Chain (CONTAM) decided to include epidemiologic data in its assessment resulting in a TWI of 4.4 ng/kg body weight for the sum of four PFAS in 2020 (Table 1).[18]

The outcome of EFSA's latest assessment is the driver for a number of other regulations to tighten values, e.g. in the EU Drinking Water Directive, where PFAS are now to be considered. The new EU Drinking Water Directive (EU 2020/2184) includes limits for total PFAS of 0.5 μg/L and the sum of 20 PFAS of most concern of 0.1 μg/L. The new directive entered into force on 12th January 2021, with EU Member States having a 2-year transitional period to develop national laws, by 12th January 2023.

The link between drinking water limits and soil protection is obvious. The lower the PFAS content in the soil, the less groundwater is contaminated. The lower the PFAS levels in groundwater, the less costly it is to provide clean drinking water from groundwater resources. The link between PFAS levels in food and soil protection is also evident. The lower the PFAS contamination in agricultural soils, the lower the uptake in plants and animals and the lower the amounts in human food. Moreover, using PFAS polluted groundwater for irrigation will again pollute soil as well as food and feed.

[16]Hölzer et al. (2021); Schümann et al. (2021); Duffek et al. (2020).

[17]I.e.: Post (2021); Umweltbundesamt (2020b).

[18]EFSA (2008, 2018, 2020).

2 State and Dimension of PFAS Contamination in Germany and Europe

2.1 PFAS in Soil & Groundwater

Nowadays it seems PFAS can be found everywhere, at most places in low concentrations, but there are also hotspots with very high concentrations in soil or water. Data of the German specimen bank show that concentrations of the regulated substances are decreasing in environmental samples. The situation is, however, different for unregulated substances. Here we see increasing concentrations in some samples such as in terrestrial organisms and plants. But having in mind the large group of compounds, it is impossible to monitor all PFAS—thus the dark figure is probably remarkable higher.[19] But even if the levels are decreasing in certain environmental media, the substances do not disappear. They are only shifted to other compartments. Researchers are still debating the global PFAS sink—it might be marine sediments and (marine) predators.

The first PFAS case in Germany was already reported in 2006. In the Moehne reservoir in North Rhine-Westphalia, which serves as a drinking water reservoir, exceptionally high PFOA and PFOS concentrations were measured. The people who were unknowingly supplied with PFAS-contaminated drinking water, presumably for years, showed elevated PFAS levels in their blood. This was investigated in long-term studies and thus first results on long-term behaviour and effects of PFAS in humans were derived. In further studies, anglers who consumed PFAS-polluted fish from Lake Moehne were also included in the investigations. The reason for the PFAS-pollution is most probably the (illegal) application of contaminated organic waste mixtures and soil improvers on agricultural land.[20] The subsequent intensive discussion of the topic showed that the causes of contamination of soil and water with PFAS are diverse throughout Germany and that the cases are numerous. For example, one of the cases is in Bavaria, where PFOA was detected in soil, groundwater and surface water samples from a 230 km^2 area near an industrial area with fluoropolymer manufacturers and users.[21] In Baden-Wuerttemberg, Germany, a water supplier detected PFAS contamination in drinking water in 2013, which it voluntarily tested for PFAS. Subsequent investigations revealed that soils and groundwater in the regions of Rastatt, Baden-Baden and Mannheim were contaminated with PFAS. It is suspected that the PFAS contamination was caused by mixtures of paper sludge and compost applied to agricultural land over several years. In the region of central and northern Baden, a mosaic of areas totalling

[19] Kotthoff et al. (2020); Göckener et al. (2021).

[20] Hölzer et al. (2008); Hölzer et al. (2009); Brede et al. (2010); Hölzer et al. (2011).

[21] Bayrisches Landesamt für Gesundheit und Lebensmittel.

1200 hectares is contaminated with PFAS, in some cases significantly. The contaminated land comprises 12% of the arable land within the area.[22]

Nationwide, however, many PFAS contaminations of soil and groundwater are mainly related to the use of fluorine-containing firefighting foams during firefighting operations and exercises, and to the use of PFAS-containing process materials in industrial plants, e.g. in electroplating, textile finishing. Duesseldorf Airport is mentioned here as representative of almost all airports. The groundwater contamination at Duesseldorf Airport also led to the contamination of a surrounding lake with PFAS, the use of which is therefore prohibited by the authorities. The lengthy remediation process will continue to incur high costs in the future. In other cases, well closures followed, so that irrigation of private gardens was no longer possible.[23]

Today we know there are a number of PFAS contaminated sites within Germany and most probably in every other country as well. An unpublished query of the German Laender Authorities about the PFAS contaminated sites yielded the following result: In 2019 about 1635 sites were under suspicion to be contaminated with PFAS, even about 685 sites were under investigation, 76 in remediation and 11 sites are remediated. And these numbers are a restricted of so far 8 from 16 Federal States only. These figures are often not the results of a systematic approach due to the fact that PFAS analytics is not yet fully integrated into standard field measurements.

Targeted investigations have mostly concentrated on point-sources inputs on areas suspected of being contaminated (airports including military sites, major fires using PFAS-containing fire extinguishing foams, disposal of contaminated sewage sludge) and have continuously improved the data situation for such cases. Nevertheless, this will always remain case specific information, which at best allows a quantitative, but not a qualitative and area-specific statement. To overcome this, a better and more comprehensive monitoring approach is required. Competent authorities see a massive gap of research referring to site investigation, especially in, regulated analytical methods and values, transfer-factors soil-(animal)-plants/crops, assessment criteria and remediation and management approaches.

Monitoring data on groundwater contamination across Europe stated that PFAS are widely detected in European groundwater above limits of quantification (Voluntary “Groundwater Watch List” (GWWL) Group of WFD CIS Working Group Groundwater 2020). However, European Member States usually analyse PFAS only when there is a suspected case. The EU network “Common Forum of Contaminates Sites” initiated a data collection in 2020 in which some EU Member States participated. It became clear that there is still no comprehensive and complete overview of PFAS incidents in soil and groundwater. The Common Forum also highlighted lacks of specific analytical and detection methods and methodological bases for the investigation, the assessment and for site-specific decisions in case of pollution.[24] The effectiveness of available remediation technologies is very limited. the

[22] Landkreis Rastatt (2016); Landesanstalt für Umwelt (2017).

[23] Düsseldorf.

[24] Common Forum on Contaminated Land (2020).

improvement of the knowledge base and exchange of experiences will make it possible to deal more efficiently with contaminated sites caused by newly emerging pollutants.

First studies on background contamination in soil have been published recently, indicating that PFAS are ubiquitously present in soil.[25] Unfortunately, the substance group or certain individual representatives of PFAS are not yet part of the standard analytic routines in relevant environmental media and transfer pathways. So, analytical investigation and their actual validity as well as applied monitoring schemes are not able to detect and investigate the diversity of individual substances in the substance group of PFAS systematically.

2.2 Conditions for Risk Assessment/Uncertainties

PFAS in the environment or soil mostly originate from emissions of previously unregulated PFAS. However, there are also many documented incidents of accidental releases. To track such releases, it is important to distinguish between low-level background contamination and legally relevant incidents. PFAS background levels are caused exclusively by anthropogenic substances and activities. It cannot be ruled out that PFAS used in the recent past may also currently result in airborne emissions into the soil, which would lead to a sustained increase in background levels. Moreover, an increase in background levels might reach a risk level for potential receptors with comprehensive consequences for any management option with regard to excavated soils and their disposal or re-use. An associated increase in groundwater concentration will lead to restrictions in further use (e.g. drinking water purposes and irrigation.)

In order to clarify these assumptions a suitable investigation approach and standardised analytical methods are required and should be harmonised. These processes should be investigated and, if necessary, continuously monitored.

Most laboratories can only analyse a small part of the large group of PFAS. A German standard protocol lists 13 PFAS that can be analysed in water and soil samples. Some laboratories are able to analyse a spectrum of up to 40 PFAS. Nevertheless, a large number of substances remain undetected. The problem is that most PFAS are difficult to detect. One possibility is to use sum parameters or a so-called Total Oxidizable Precursor Assay.[26] Here, the unknown polyfluorinated substances (precursors) are degraded under harsh conditions in the laboratory to the perfluorinated PFAS, which can then be analysed using standard methods. However, not all PFASs are detectable with this method, but a much better understanding of the dimension of PFAS contamination in soil or water is gained. Other sum parameters such as extractable organic fluorine (EOF) or absorbable organic fluorine

[25] Brusseau et al. (2020); Mattias et al. (2022).

[26] Houtz and Sedlak (2012); Göckener et al. (2021).

(AOF). May also be used to gather the dimension of a PFAS pollution in soil or groundwater.[27] In summary, PFAS analysis is expensive and laborious and cannot be performed by every laboratory. Thus, pressure also arises from a high degree of uncertainty, which comes in particular from a lack of analytical procedures and the consequent incomplete results of site investigations and monitoring data for PFAS. If non-detectable PFAS keep widely unconsidered by analyses, uncertainty remains on what dimension and influence just this part of the PFAS spectrum will have in its harmful effects on humans and the environment.

A detailed understanding of fate and transport of PFAS in the environment is essential to assess the risks occurring from contamination and to develop reliable conceptual site models. Such derivations are also complicated because a large number of different PFAS are present. Data to predict transport and fate are not available for most PFAS and for investigated ones a wide range of physical-chemical properties have been shown.

Precursors into perfluorinated and persistent PFAS (e.g. PFOA and PFOS) under environmental conditions has to be considered in risk assessments, model predictions and conceptual site models. To date, there is insufficient knowledge to safely predict actual risks, hazards and impacts PFAS. In consequence may be, an under- or overestimation of occurring risks, legal value setting might be inadequate as well as the criteria of related mitigation and remediation measures.

3 Responses

3.1 Regulation of Import, Manufacturing and Use of PFAS Within the EU

Over the past 20 years scientists have outlined how PFAS behave in the environment, how they accumulate, what effects they show in humans and the environment, and how they enter the environment. As a result, some measures have been taken to reduce PFAS emissions into the environment.[28]

At international level, one representative of the group-PFOS- was identified as a persistent organic pollutant (POP) and added to the list of the world's most harmful substances in 2009 (the Stockholm Convention) und thus most uses are banned at international level.[29] In 2019 another substance followed—PFOA—known as C8 or perfluorooctanoic acid. PFHxS—perfluorohexanoic sulfonate—a third PFAS has already been identified to fulfil the criteria to be a POP and has been added to Annex A of the Stockholm Convention in 2022. The substances listed in the Stockholm Convention are banned because they are persistent, bioaccumulative

[27] von Abercron et al. (2019); Simon et al. (2022).

[28] OECD (2015).

[29] Stockholm Convention on Persistent Organic Pollutants.

Table 2 Regulation of PFAS within the EU; European Chemicals Regulation (REACH)

Substance	CAS No	Properties of concern according Annex XIII of REACH[a]	Restriction (REACH Annex XVII)[a]
Perfluorooctanoic acid and its salts, **PFOA**	335-67-1	Toxic for Reproduction, PBT[b] (2013)	Manufacturing and use restricted with derogations (enforcement in July 2020).
Perfluorononanoic acid, **PFNA**	375-95-1	Toxic for Reproduction, PBT[b] (2015)	Manufacturing and use restricted with derogations (enforcement 25 February 2023)
Perfluoroundecanoic acid, **PFDA**	2058-94-8	Toxic to Reproduction, PBT[b] (2012)	
Perfluorobutanoic sulfonate, **PFBS**	29420-49-3	Equivalent level of concern having probable serious effects to human health & the environment (2020)	
Perfluorohexane-sulfonic acid, **PFHxS**	70225-16-0	vPvB[c] (2017)	
Perfluoro-2-methyl-3-oxahexanoic acid, **GenX**	67118-55-2	Equivalent level of concern having probable serious effects to human health & the environment (2019)	

[a]European Chemicals Agency
[b]All precursor substances are included
[c]Persistent, bioaccumulative and toxic
[d]Very persistent, very bioaccumulative

and toxic and can be transported over long distances and reach remote areas. The EU regulates substances listed under the Stockholm Convention via the EU regulation on persistent organic pollutants (REGULATION (EU) 2019/1021). The EU further restricted manufacturing, use and import of some other PFAS (Table 2). Additionally, some PFAS have been identified as substances of very high concern and have been added to the so-called Candidate List for authorization. The properties of concern that are the basis for regulation are stated in Table 2 below. However, most PFAS are still unregulated. Scientists have stated the need for immediate action.[30] The European Chemicals Agency (ECHA) has proposed a restriction proposal for firefighting foams containing PFAS. The EU Commission's decision is foreseen in the course of 2023. Moreover, within the EU the ban of the whole group of PFAS was prepared by Germany, Denmark, Netherlands, Norway, and Sweden and a restriction proposal was submitted to the European Chemicals Agency (ECHA) in January 2023. The restriction proposal aims to reduce emissions into the environment and make products and processes safer for people. The proposal includes all uses except those identified as essential. As a next step the scientific committees for risk assessment and socioeconomic assessment will prepare opinions. The adopted opinions will be sent to the European Commission for the final decision on the potential restriction.

[30]Ritscher et al. (2018).

Many specific research and regulatory issues there is also the need for a comprehensive strategy for emerging pollutants. The European Commission therefore launched a non-toxic environment ambition and a PFAS-Action Plan.

However, environmental policy is often a response to negative or even irreversible effects that have already occurred. A general change is needed in order to strengthen precautionary principles. Therefore, a management approach for emerging pollutants is meaningful and a comprehensive PFAS strategy might be used as blue print.

Finally, the detection of PFAS in soil or groundwater results in authorities having to decide how to deal with the situation. Whether remediation is possible, the soil must be excavated and disposed of, or whether the entire area may have to be closed to certain uses.

3.2 *Dealing with PFAS Contaminated Soil & Groundwater in Germany*

Until recently, in Germany there were no legal binding values available for PFAS in soil. The Federal States that were already confronted with PFAS contamination in soil and groundwater had already developed their own rules for dealing with the damage. However, these were different, so that there were various solutions on how to deal with excavated soil containing PFAS, for example. This resulted, among other things, in PFAS-containing excavated soil not being accepted by some landfills and being able to be disposed of in other Federal States without any requirements. Thus, it was necessary to have common recommendations for the uniform nationwide assessment of soil and water contamination and for the disposal of soil material containing PFAS. The harmonised guidance is an agreement of certain committees, such as the committee for preventive soil protection, the committee on contaminated sites, and the committee for waste disposal. The recommendations have recently been published and can now be used until the ful set of legal regulations is available.[31]

In Germany the greatest attention is paid to groundwater protection regarding PFAS. In 2017, so called insignificance thresholds values were derived for PFAS in groundwater.[32] The insignificance threshold values for PFAS are based on human toxicological impacts and on the provisions of the German Drinking Water Ordinance. These insignificance thresholds are also used for the assessment of soil or soil material. For this purpose, soil eluates are prepared and analysed for PFAS. The 2021 revision of the German Federal Soil Protection and Contaminated Sites Ordinance includes the insignificance threshold values as trigger values for the soil-groundwater pathway. However, the latest results of the EFSA assessment

[31] Federal Ministry for the Environment (2022).

[32] von der Trenck et al. (2018).

have not yet been considered in the derivation of the significant threshold values. It needs to be clarified whether this makes sense, as it might lead to extremely low levels that are hardly measurable.

For the deposition of soils so far, no binding rules are available. Thus, the guidance sets recommendations, which levels in the materials are tolerable for unrestricted open emplacement, restricted open emplacement in areas with elevated PFAS concentrations, and restricted emplacement in technical structures with defined safety measures.

Sewage sludge used as soil fertilizer must not exceed 100 μg/kg total PFOS plus PFOA in Germany. Where the concentration exceeds 50 μg/kg this must be indicated on the label. The limit value introduced in 2008, however needs to be updated, as it represents the knowledge from that time, e.g. the fact that the precursors contained in the sewage sludge are disregarded. Today especially having in mind the low EFSA values, it seems careless to allow such high PFAS levels to be applied to soil. The application of sewage sludge might result in the insignificance threshold value in groundwater being exceeded, subsequently. As mentioned before, in Germany some large areas of agricultural land are polluted with PFAS. Thus, solutions had to be found by local authorities to deal with the situation. The land has been polluted with mainly those PFAS were neither regulations nor guidance was available regarding human health. Therefore, authorities implemented a so-called pre-harvest monitoring to ensure that highly contaminated food and feed do not reach the market. A number of studies have been carried out to find out which plants readily take up PFAS and which plants are suitable for cultivation on polluted soils.

3.3 Measures: Remediation and Management

Once soil is contaminated with PFAS , e.g. through the use of sewage sludge or firefighting foams containing PFAS, it can take years for PFAS to leach into the groundwater. Some PFAS are extremely mobile and are hardly retained by the soil. Therefore, they are very rapidly translocated from the soil to the underlying water phase. Thus, competent authorities need science-based support in selecting, evaluating, and decision-making about appropriate and proportionate remediation solutions and management approaches. This includes consideration of the legal framework in order to be able to order flanking measures without discretionary error as competent authority. Furthermore, advantages and disadvantages of the different approaches, technical and legal requirements, but also their sustainability are important criteria to find a suitable remediation option. PFAS contaminated sites represent enormous challenges for the management of contaminated soils and groundwater. Thus, to support competent authorities in decision making a handbook containing a toolbox as a working aid was developed with the support of experts from Germany and Switzerland.[33] The working aid describes the PFAS-specific fundamentals that are essential and relevant for subsequent remediation decisions. This includes, in particular, the impact pathways and receptors, the designation of competent authorities and affected legal areas, as well as information on sampling, lead parameters and precursors.

Further, the handbook is focusing on the remediation of PFAS point sources. This is not fundamentally different from the remediation of conventional pollutants that has been practiced for over 30 years. However, PFAS exhibit some peculiarities that make it advisable to explain them specifically. Additionally, the handbook contains special features of remediation management and options for action are presented i.e. cases where waste legislation need to be considered. Also the current situation in the context of the circular economy in Germany is described and administrative and technical recommendations and assistance are given followed by recommendations for public participation accompanying remediation measures. The handbook moreover contains detailed information of currently applied assessment methods and remediation procedures are presented.

In case soil and/or groundwater remediation is required, the options to ensure destruction of PFAS are indeed cost driving. Destructive PFAS technologies often require treatment times of several hours which make them unsuitable for continuous treatment of pumped contaminated groundwater. They may, however, be used to decontaminate concentrates which arise e.g. after sorbent desorption. The moderate to high solubility of some PFAS and their low sorption capacity to soil are the reasons why PFAS cause long contaminant plumes in the aquifer. So far, such extended aquifer contaminations cannot be remediated cost-effectively with in-situ technologies. Besides pump-and-treat, barrier technologies like Permeable Reactive Barrier (PRBs) are feasible. These systems use reactive materials for adsorption like Granular Activated Carbon (GAC). In addition, there are foam fractionation systems in groundwater circulation wells, which concentrate PFAS dissolved in the groundwater into a foam.

Within case related proportionality considerations decontamination methods will be excluded in many cases due to enormous costs. In-situ-soil flushing, barrier technologies or in the simplest way only point of use or end of pipe decontamination (e.g. within drinking water facilities) could make a difference to this overarching decontamination measures. Further, containment, immobilisation, safety and protection measures offer alternatives, but they are in many cases also not equivalent because they do not eliminate the problem in a sustainable manner. They are often associated with considerable follow-up costs and re-use restrictions for affected sites. Mostly, due to existing limitations in source removal for PFAS, landfilling is seen as “easy alternative”. If excavated soil with remaining PFAS contamination leaves the site interfaces with waste legislation are of relevance. The regulations of a circular economy in Europe are consistently focussed to the goal of avoiding waste or keeping waste within material cycles. PFAS-contaminated soils, which, as shown, cannot be cleaned and for which there are currently no possibilities for subsequent use, increase the mass flow balance without an actual recycling option. Without reliable values for excavated materials, there will be a growing uncertainty for of

[33] Held and Reinhardt (2020).

landfill operators, an increasing deficit on landfill capacities and a decreasing acceptance to landfill PFAS-contaminated materials.

4 Conclusions

This article attempts to illustrate the complex challenges caused by PFAS for man and the environment. A better PFAS-understanding has led to considerable political pressure and a need for action in the national, European and international environment and has addressed numerous legal, scientific and engineering needs.

In the European Union manufacture, use and import of chemicals is controlled via REACH, the European chemicals regulation. Some PFAS have already been identified as substances of very high concern and for some PFAS the manufacture, use, and import are restricted with derogations. However, still a number of uses are allowed, emissions of PFAS into the environment still occur. There are no legal binding requirements for industry emissions into air or waste water—those are urgently needed to efficiently reduce PFAS emissions into the environment. On the other hand, the thresholds for PFAS in drinking water and food are at such a low level, that environmental concentrations are often already above those levels. The article focusses mainly on the PFAS contamination of soil and groundwater in Germany, however, similar cases will most probably exist in many countries. Thus, awareness rising and monitoring is essential to address PFAS contamination.

Therefore, a crucial need for environmental monitoring and environmental law and enforcement requirements for the protection of the affected environmental media need to be addressed. The central pillars are the extension and scope of analytical methods to overcome the uncertainty for non-detectable PFAS. With the accelerated increase in knowledge in the human and ecotoxicological assessment of PFAS exposure and the associated tightening of tolerable limits, a comprehensive reassessment of the state of the environment is necessary. In the result this should reveal numerous regulatory developments and action requirements and demands their immediate implementation. This article presents the enforcement-relevant working aids and guidelines, which are intended to help harmonize enforcement in the Federal States and create methodological foundations for this.

A strategy change is necessary in order to pursue more promising approaches through improved soil monitoring and related data. The German Environment Agency is currently working on the determination of PFAS-background levels in soil. These will be used to derive further measures to assess PFAS levels in soil and groundwater with the aim to protect humans and the environment from PFAS exposure but also to be able to reuse soil. As a first step significance thresholds for groundwater have been derived for some PFAS. They have been included in the amended German soil ordinance. However, these significance thresholds still have to be adapted with regard to new toxicological findings of EFSA.

In the meantime, the currently available media-related assessment bases have been made available in PFAS working aids. The primary purpose is to assist competent authorities in their evaluation of PFAS inputs into water bodies and soil. In addition, the work aid provides summary basics on the substance group of PFASs, on possible remediation and management options, and on the currently available engineering options.

The EU has an ambitious sustainability plan—the European Green Deal. PFAS have been incorporated within the Zero Pollution Ambition and the goal of a non-toxic environment. Nevertheless, and to put it briefly—the best way forward is a PFAS group restriction, e.g. under REACH connected with strict regulation of industrial emissions for the remaining uses. Advocating for concerted international cooperation and successful EU-networking is crucial. Otherwise, we cannot narrow existing gaps between the development and release of new chemical substances and mixtures and successful approaches to protecting environmental media like soils and groundwater.

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An African Legal, Cultural and Religious Perspective of Sustainable Soil Governance

Pamela Towela Sambo

Abstract This chapter adopts a desktop review of diverse literature to understand the legal, cultural and religious underpinning of sustainable soil governance in Africa. The role of traditional knowledge systems in achieving sustainable soil governance in Africa will also be evaluated. The African Union recognises five geographic regions on the continent namely, North, South, West, East and Central. A sixth region consisting of people of African descent living outside the continent is also categorized but it is not materially relevant for the present analysis. The countries highlighted in this chapter are only used representatively of the entire continent to the extent possible. Africa is a large continent with diverse traditions, cultures and religions upon which the legal systems responsible for natural resources and environmental protection are anchored. It is therefore impossible to discuss any issue pertinent to the continent with homogeneity. Africa is no doubt one of the most resource-abundant continents. Natural resources such as gold, diamond, oil, natural gas, copper, uranium, among others are mined in different parts of the continent. Almost every country in Africa has a deposit of natural resources because the continent is endowed with about 97% of the world's chromium, 90% of the world's cobalt, 85% of the word's platinum, 70% of the world's cocoa, and 60% of the world's coffee. Despite this abundance of natural resources, Africa is also among the poorest continents. One of the factors that has led to the continent's extreme poverty levels is that the extraction of land or soil based natural resources is minimally utilised to the benefit of the African countries themselves. The process of natural resources extraction causes immense damage primarily to land and soil as well as the general environment. Against this background, this chapter assesses how culture, traditional norms and religion have shaped sustainable soil governance in Africa.

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1 Introduction

According to Schimel, soils define a people's culture and society more strongly than any other environmental variable.[1] Healthy soils in a community can achieve much more than food security and environmental harmony. This chapter adopts a desktop review of diverse literature to understand the legal, cultural and religious underpinning of sustainable soil governance in Africa. The chapter also evaluates the role of indigenous knowledge systems (IKS) in achieving the goal of sustainable soil governance in Africa. The African Union recognises five geographic regions on the continent namely, North, South, West, East and Central.[2] A sixth region consisting of people of African descent living outside the continent is also categorized, but is not materially relevant for the purpose of analysing soil governance in this chapter.

The chapter progresses by critically evaluating relevant literature drawn from the five regions of Africa, focusing on the legal, traditional, cultural and religious perspectives of soil governance. The data elicited from the literature is only used representatively of Africa. Africa is a large continent with diverse traditions, cultures and religions upon which the legal systems responsible for natural resources and environmental protection are anchored.[3] It is therefore impossible to discuss any issue pertaining to the continent with homogeneity.[4]

Africa is no doubt one of the most resource-abundant continents. Natural resources such as gold, diamond, oil, natural gas, copper, uranium, among others are mined in different parts of the continent, with almost every country having a deposit of natural ores.[5] The continent is endowed with about 97% of the world's chromium, 90% of the world's cobalt, 85% of the word's platinum, 70% of the world's cocoa, and 60% of the world's coffee.[6] Despite this abundance of resources, Africa is also among the poorest continents. One of the factors that have led to the continent's extreme poverty levels is that the extraction of natural resources, most of which are land or soil based, is hardly utilised to the benefit of the African countries themselves. In the process of natural resources extraction, there has been immense damage primarily to land and soil as well as the general environment. What soil governance mechanisms exist in Africa to ameliorate this gloomy outlook?

This chapter assesses the culture, traditional norms and religious practices that have shaped legal approaches towards soil governance in Africa. There can be no meaningful discussion about sustainable soil governance without a critical analysis of how sustainable development interfaces with African culture, traditional norms

[1] Schimel (2010), p. 301.

[2] https://au.int/en/member_states/countryprofiles2 (Last access: 22 June 2022); Strydom (2015), p. 25.

[3] Lal and Stewart (2019), pp. 3–4.

[4] Van Pinxteren (2020), p. 73.

[5] Erdogan et al. (2021), pp. 360–369.

[6] https://jocu.journals.ekb.eg/article_181404.html (Last access: 22 June 2022).

and religion. To start with, Sect. 2 provides the rationale for the global sustainable soil governance agenda, while Sect. 3 builds upon the previous section to review how sustainable development and indigenous knowledge systems (IKSs) have defined sustainable soil governance in Africa generally. Section 4 appraises the role of culture, traditional norms and religion in ensuring sustainable soil governance in Africa. This will be achieved in a brief review of some soil legislation initiatives in Africa as well as an analysis of African *Ubuntu* philosophy and Sect. 5 provides a summary of the chapter.

2 Rationale for the Global Sustainable Soil Governance Agenda

As far back as 1976, legal scholars have been unanimous that the world order for the protection of the environment and its associated components would only succeed through concerted global cooperation,[7] and involvement of local communities. In more recent years, scholars are agreed that "voluntary soil protection measures are not sufficient to achieve sustainable soil management at a global scale".[8] There is need to move towards more coercive measures of ensuring global sustainable soil management.

2.1 International Soil Governance Initiatives

There are several international soil governance elements which include treaties, institutions and non-binding instruments. According to Bodle, some of these are Agenda 2030 and the Sustainable Development Goals (SDGs), United Nations Convention to Combat Desertification (UNCCD), United Nations Convention on Biological Diversity (CBD), African Convention on the Conservation of Nature and Natural Resources (Maputo Convention) and United Nations Food and Agricultural Organisation (FAO).[9]

It is worth echoing researched views to the effect that none of these instruments and institutions is specifically mandated for protecting soil or providing a comprehensive framework for soil governance. The history and state of existing international soil governance suggests that the case for addressing soil at the international level is not self-evident.[10]

[7] McDougal and Schneider (1976), pp. 177–188.

[8] Erdogan et al. (2021), pp. 360–363.

[9] Bodle (2022), p. 2.

[10] Boer et al. (2017), pp. 49–58; Bodle et al. (2020).

Although the pressure on soil is increasing and the condition of soil is deteriorating worldwide, the community of states is yet to join hands towards international soil-specific initiatives. This is in contrast to many other environmental issues such as air, climate change, biodiversity, water and pollutants. The future of the global soil governance agenda, is however bright given numerous initiatives that have since been undertaken in the recent past. For instance, Bodle et al. have taken stock of global initiatives to improve international soil governance in the short, medium and long term, and provide options, among which is the possibility of a new treaty or institutions.[11]

A detailed assessment of the global legal force of the available instruments, although useful to the resource-potential of the African continent, is beyond the scope of this chapter. This section will only focus on the provisions of the African Convention on the Conservation of Nature and Natural Resources ("the Maputo Convention").

2.2 The African Convention on the Conservation of Nature and Natural Resources ("the Maputo Convention")

The Maputo Convention was adopted in 2003 as an African regional treaty. The Convention has one article dedicated to land degradation and soil conservation and requires parties to establish long-term integrated strategies for land resources and land-use plans. Although it is not necessarily soil-specific, it addresses the facilitating role of land tenure policies. Besides prevention, the Convention parties have to plan and implement mitigation and rehabilitation measures for areas affected by land degradation. According to Bodle, the Maputo Convention is at a vantage point of being an important regional instrument for soil protection.[12]

3 Sustainable Development, Indigenous Knowledge Systems and Soil Governance in Africa

The UN Conference on Environment and Development (UNCED), 1992 is viewed as having initiated interest in the contribution of indigenous knowledge aimed at bettering the understanding of improved livelihoods in communities by highlighting the urgent need for developing mechanisms to protect the earth's biological diversity through local knowledge. This period also marked the stage at which sustainable development "began to influence the conceptualisation of global development and

[11] Bodle et al. (2019), pp. 160–173.

[12] Bodle (2022), pp. 3–4.

development policy,"[13] culminating into the adoption of the Convention on Biological Diversity (CBD) at the UNCED. Article 8 (j) of the CBD makes provision for respecting, preserving and maintaining indigenous knowledge that is "relevant for the conservation and sustainable use of biological diversity" and to "promote" its application. Further, Agenda 21 of the UNCED emphasized the need for governments to work towards incorporating indigenous environmental management knowledge systems into contemporary socio-economic development programmes in order to attain sustainable development.

3.1 Implementation of Soil-Related SDGs in Africa

The SDGs in themselves are not specifically focused on sustainable soil governance. However, scholars have argued that all of the SDGs, especially those relating to poverty and food security and others are interdependent and directly or indirectly depend on the provision of ecosystem services where soils play a foundational role.[14]

The evolution of SDGs to solve global disasters can be explained through the analysis of philosophical thinking in development that originates from a humanistic perspective, not far from Africa's *Ubuntu* philosophy which is discussed in greater detail in Sect. 4.2.3 of this chapter. *Ubuntu* signals leadership by calling for collective participation especially in goal 17 on partnerships in order to achieve the SDGs. This chapter has underscored the fact that soil is the basis of life in Africa and other parts of the world, and therefore all communal activities must be pooled together to realise the ends of sustainability.

In creating a bridge between the environment and culture, it has been argued that the environment, with its air, water and soils is a product of a cultural worldview. Government agencies must implement SDGs within their states using the prevailing culture. Culture is perceived not only as a route towards SDGs, but also an end in itself which must be preserved. According to the 2030 Agenda for Sustainable Development Resolution on Culture and Sustainable Development, culture ought to be protected within cultural rights; giving recognition to culture as creative knowledge and expressions and also an indispensable tool for sustainable development.

According to Lal et al., there are at least eleven (11) SDGs that are intricately connected to soil health.[15] The key SDGs in respect of the resource-wealth and relevance of the African continent are SDGs 1-3 on ending poverty, zero hunger and good health and wellbeing.

[13] Hinz (2019), p. 107.

[14] https://sustainablesoils.org/soil-and-the-sdgs (Last access: 22 June 2022).

[15] Lal et al. (2021).

3.1.1 Importance of IKS to Sustainable Soil Governance

According to Ayaa, indigenous and local people have formed “a science” by engaging in annual cycles of subsistence activities that have evolved into knowledge systems and technologies useful in maintaining and preserving the bio-physical environment within such a community.[16] With their local knowledge, values and interests, local communities have studied and intimately known their flora and fauna, and developed their own classification systems as well as variations in their overall environments, and this includes aspects of sustainable soil management. In direct reference to sustainable soil management in Africa, it has been shown that traditional knowledge in the local communities is a “sometimes hidden treasure of information”[17] that must be tapped in order to understand the intricacies of conserving the important natural resource.

In a research using a case study approach, Hinz found that in many instances, indigenous knowledge is ‘normal’ when it expresses something which any person outside of a particular community would be able to discover by just going the extra-step to unravel it and accept that locals will usually know their environments better than newcomers, and this includes issues of soil health and sustainability. This notwithstanding, indigenous knowledge may still be over and above the lived experiences of local communities.[18]

The appropriate role of indigenous knowledge in environmental protection, particularly soil management, is to use the African experience as a way that the community relates with environment. It is crucial to apply and utilize the IKS, broad and mostly undocumented as it may be. Most indigenous knowledge has been marginalized and even lost in the process of colonization and arguably contributed to poverty, famine, and disease; inefficient and unequal distribution of resources, economic opportunity and erosion of sustainable environment.[19]

Unfortunately, in most cases the involvement of the community and indigenous knowledge systems are only carried out in the project implementation stage and not the planning stage, which is an oversight even under international law environmental law.

SDG 17, which seeks partnerships to achieve the implementation of the SDGs, appears to be the most important goal in relation to the use and preservation of IKS. At the centre of any partnership is the working together of individuals and institutions, with the local community being the most important partner since communities sustain development. Generally, African values seek to work with nature and not against nature. African culture contributes effectively to development and environmental protection.[20]

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[16] Ayaa and Waswa (2016), pp. 467–470.

[17] Ginzky and Ruppel (2022), p. 3.

[18] Hinz (2019), pp. 122.

[19] Ayaa and Waswa (2016), pp. 467–470.

[20] Barasa (2005), p. 150.

It is important and desirable that IKS be maintained and promoted by governmental action in Africa. A number of regional and national initiatives for the promotion and maintenance of IKS are presently in place in Africa and some of these are discussed below. The discussion that follows also addresses the question on how these initiatives could be instrumental for sustainable soil governance in Africa and beyond.

3.1.1.1 The African Regional Intellectual Property Organization (ARIPO) Swakopmund Protocol on the Protection of Traditional Knowledge and Expression of Folklore

The African Regional Intellectual Property Organization (ARIPO) is mandated by the Swakopmund Protocol on the Protection of Traditional Knowledge and Expression of Folklore ("the Protocol") to protect the holders of traditional knowledge against any infringement of their rights and protecting expressions of folklore against misappropriation, misuse and unlawful exploitation.[21] The Protocol was adopted at a Diplomatic Conference of ARIPO in 2010, in Swakopmund, Namibia and entered into force in 2015. There are presently eight Contracting States to the Protocol namely Botswana, Malawi, Namibia, Rwanda, The Gambia, Liberia, Zambia and Zimbabwe.[22]

Despite criticism levelled against its rationale being embedded in Intellectual Property,[23] the Protocol has created a viable regional commitment for African states to unite in the protection of the much—treasured local traditional knowledge. The Protocol has subsequently inspired the enactment of various national laws and policies which are likely to be important for more specific environmental concerns like soil governance in the sub African region as well as more general environmental well-being.

3.1.1.2 National Legislative Initiatives on IKS

In South Africa, Zambia, Kenya and Malawi, the national legal frameworks create the enabling environment for the development and maintenance of IKS. These countries are used only for illustration; several other countries in Africa have implemented effective constitutional and legal frameworks in relation to the protection and preservation of IKS.

The Protection, Promotion, Development and Management of Indigenous Knowledge Act 6 of 2019 of South Africa is aimed *inter alia* at providing for the

[21] Section 1.1, Swakopmund Protocol.

[22] https://www.aripo.org/ip-services/traditional-knowledge/ (Last access: 22 June 2022).

[23] https://cipit.strathmore.edu/african-traditional-knowledge-and-expressions-of-folklore-rethinking-swakopmund-protocol-as-a-model-law-and-sui-generis-system/ (Last access: 22 June 2022).

protection, promotion, development and management of indigenous knowledge; management of the rights of indigenous knowledge communities; establishment and functions of the Advisory Panel on indigenous knowledge; and access and conditions of access to knowledge of indigenous communities; and for matters incidental thereto.[24]

In Zambia, the Protection of Traditional Knowledge, Genetic Resources and Expressions of Folklore Act, 2016 has been in effect since 2016. This piece of legislation provides for a transparent legal framework for the protection of, access to, and use of, traditional knowledge, genetic resources and expressions of folklore in Zambia. Further, in the preambular section, recognition is given to the spiritual, cultural, social, political and economic value of traditional knowledge as well as the importance of promoting the preservation, wider application and development of traditional knowledge and the protection of the inalienable rights of traditional communities, individuals and groups over their traditional knowledge. The legislation also confers rights on traditional communities, individuals and groups and promotes the conservation and sustainable utilisation of the country's biodiversity; to promote fair and equitable distribution of the benefits derived from the exploitation of traditional knowledge, genetic resources and expressions of folklore and undertakes to give effect to the African Regional Intellectual Property Organisation (ARIPO) Swakopmund Protocol on the Protection of Traditional Knowledge and Expressions of Folklore 2010, any other relevant initiatives and international treaties or conventions to which Zambia is a State Party.[25]

From the Kenyan perspective, the Constitution obligates the state to support, promote and enhance the Intellectual Property (IP) and ‘indigenous knowledge’ associated with biodiversity and ‘genetic resources of the communities.’[26] The Constitution also recognizes culture as the foundation of the nation and cumulative civilization of the Kenyan people and nation.[27] Further, the Constitution enjoins Parliament to enact legislation, to ensure that ‘communities receive compensation or royalties for the use of their cultures and cultural heritage’[28] and to recognize and protect the ownership of genetic resources and associated knowledge by indigenous peoples. With legal strength drawn from these constitutional provisions, the Protection of Traditional Knowledge and Cultural Expressions Act, 2016 was enacted in Kenya with the aim of providing a framework for the protection and promotion of traditional knowledge and cultural expressions in Kenya.

In 2020, Kariuki examined the role of traditional governance systems in Kenya in protecting traditional knowledge and facilitating access and benefit sharing. The

[24] Preamble, the Protection, Promotion, Development and Management of Indigenous Knowledge Act 6 of 2019 of South Africa.

[25] Preamble, Protection of Traditional Knowledge, Genetic Resources and Expressions of Folklore Act, 2016 of Zambia.

[26] Constitution of Kenya (2010), Article 69 (1)(c) and (e).

[27] Constitution of Kenya (2010), Article 11 (1).

[28] Constitution of Kenya (2010), Article 11 (3) (a).

author utilises data gathered from three (3) communities and concludes that traditional justice systems have been in use by communities to strike a balance between ensuring protection and safeguarding of traditional knowledge and that the successful use of traditional justice systems as appropriate *sui generis* frameworks requires collaboration with the intellectual property regime.[29]

In a research exploring the extent to which indigenous knowledge-systems can contribute to the achievement of food security, Kamwendo and Kamwendo draw on examples drawn from Malawi to illustrate how indigenous knowledge-systems can assist in food preservation and food storage, thereby leading to food security. The authors conclude that the abandonment of IKS is one of the causes of food insecurity as it is presently being witnessed in Malawi, Africa and globally.[30]

In concluding this discussion on IKS, it is important to return to the question on the possibility of IKS mechanisms contributing to sustainable soil governance in Africa. This chapter rides on the argument advanced by Kariuki that traditional justice systems should continue in use by communities and be adapted towards protection and safeguarding all traditional knowledge. Further, and as shown in the case of Malawi, IKS is important in many ways that are related to sustainable soil governance and must therefore be preserved.

3.2 African Charter on Human and Peoples Rights as a Link to Sustainable Soil Governance

The African Charter on Human and Peoples Rights ("the Charter) is an innovative and different embodiment of human rights in many ways. It is distinct from existing human rights instruments owing to its focus on Africa's approaches to freedoms and rights. The Charter incorporates historical traditions and values of African civilisations, and responsiveness to the real needs of Africa, one of which is the achievement of socio-economic development in the region.[31]

In particular, Articles 14 and 21 of the Charter embolden the African peoples' entitlement to their natural resources and soils. For instance, Article 14 relates to the right to property, which may only be "encroached upon in the interest of public need or in the general interest of the community" and in accordance with the provisions of appropriate laws. These qualifications fall squarely within the communal ownership and use belief system in most of Africa. More often than not, the most revered property in Africa is land and its natural resources while the crops and animals are subordinated to the land and its inherent resources.

Article 21 of the Charter focusses more directly on "wealth and natural resources" and that this right is exercisable in the "exclusive interest of the people," and that in

[29] Kariuki (2020), pp. 100–103.

[30] Kamwendo and Kamwendo (2014), pp. 97; 100–101.

[31] Amechi (2009), p. 60.

no case shall a people be deprived of it. Other parts of Article 21 proclaim that in the event of spoliation, the dispossessed people shall have the right to the lawful recovery of its property as well as to an adequate compensation.[32] Further, State parties are enjoined by the Charter and ought to individually and collectively exercise the right to free disposal of their wealth and natural resources with a view to strengthening African unity and solidarity. The principles of unity and solidarity again speak to the communal cultural beliefs and values that prevail in Africa.

Given the legal force of the Charter and the specific focus it has on human and peoples' rights, the protection of natural resources, soil inclusive, is placed within the cultural approaches prevalent in Africa. The main African cultural approach according to Makau is that the philosophy of the group-centered individual evolves through a series of carefully taught rights and responsibilities at the root of which are structures of social and political organization, with the ultimate result of solidarity and the continued existence of the community into perpetuity.[33]

4 Sustainable Soil Governance Law, Culture, Traditional Norms and Religion in Africa

According to Oruka, beliefs, values, norms and duties that produce the normative field of ideology are what is good to mankind and forms the ethos, which are principles that guide any belief system.[34] It is through this ethos that rights, status, obligations and duties of a society are found, culminating into a defined social and cultural structure.

In the cultural structure, ethics, laws, morals and knowledge on the environment are included and this is the most relevant aspect to this section of the chapter. Soils and their management, are so closely connected to the culture and civilization of an ethnic group living in a given place, including their religion, thoughts, livelihood and health. It is important for people to protect the soil, their agriculture and the environment because the collapse of soil leads to the collapse of human culture, civilization, livelihood and health.[35]

According to Oosthuizen, despite the high rate of urbanization in Africa, both modern and traditional worldviews are prevalent, with Christianity and Islam influenced by the African Traditional Religion, and all three influenced by secularisation.[36] On this basis, it is arguable that conceptions of soil governance and environmental stewardship in Africa in general, are equally infused with Christianity, Islam, African Traditional Religion and secularism.

[32] Article 21 (2), African Charter on Human and Peoples Rights.

[33] Makau (1995), p. 361.

[34] Odera Oruka (1990), p. 42.

[35] Minami (2009), pp. 603–604.

[36] Oosthuizen (1991), p. 36.

4.1 Review of Soil Legislation Initiatives in Africa

It has been shown in Sect. 3.2 of this chapter that the African Charter is an embodiment of the traditions and culture of the African people. Within Article 17 of the African Charter, the African Commission has previously noted that culture is dualistic in nature, individual and collective, national or ethnic, composed of religious and linguistic minorities. Further, the Commission opined that culture manifests itself in diverse ways, including a particular way of life associated with the use of resources, especially by indigenous people.[37] Indigenous knowledge systems and traditional knowledge are tools for comprehensively understanding the environment and using culture against exploitation to minimize potential misunderstandings of SDGs. I indigenous knowledge is capable of making it a moral duty to live life in a sustainable way and to protect the common interest.

Indigenous knowledge can refer to knowledge that identifies with a specific ethnic group. For example, indigenous knowledge is the local knowledge that is unique to a given culture or society. It is the basis for local-level decision-making in agriculture, healthcare, food preparation (gastronomy), education, natural resource management and a host of other activities in rural communities.

In essence, indigenous knowledge is that knowledge used to run/manage all the sectors and sub-sectors of the traditional or local or rural economies/society. Less specific to indigenous knowledge is locally bound and indigenous to a specific area; culture and context-specific; non-formal knowledge; orally transmitted and generally not documented; dynamic and adaptive; holistic in nature and; closely related to survival and subsistence of many people worldwide.

4.2 African Environmental Ethics, Culture and Traditional Norms

Okoth-Ogendo, one of Kenya's distinguished professors in property and land use law and policy, environmental governance and natural resources once argued that the 'African Commons' represents "ontologically organized land and associated resources available exclusively to specific communities, lineages or families operating as corporate entities."[38] The 'associated resources' in this definition refer to and include air, soil and water at the very minimum. This conception of the 'African Commons' was made decades before the sustainable environmental principles of intergenerational equity and partnership were captioned into the SDGs. Okoth-Ogendo's African conception of protecting resources for future generations and having the common good goes beyond individualism and the tragedy of the

[37] *Centre for Minority Rights Development (Kenya) and Minority Rights Group International on behalf of Endorois Welfare Council v. Kenya,* 276/2003.

[38] Okoth-Ogendo (2000), p. 107.

commons. It also resonates with the *Ubuntu* philosophy and other African traditional norms of community responsibility considered in this chapter and critical in understanding soil governance in Africa. Environmental interests and governance for usage of resources and development in Africa have historically been communal and not individual, naturally incorporating the protection of past, present and future generations' interests.

4.2.1 African Environmental Ethics

Ethics are discussed in this chapter in relation to their position in the environment and the extent to which they value or devalue the environment and its constituent elements such as soil. It may be asked, are African ethics in a position to promote respect for the environment, reduce greed and enhance human beings' relationship with the environment for a public good such as soil? Do African ethics recognize that environmental "goods" such as air, water, forests and soils have value in and of themselves apart from human beings; and that environmental goods are related to a certain particular land and therefore not movable? Responses to these questions are useful in understanding what African environmental ethics can achieve.

According to Minami, soil is erroneously thought of as "little more than dirt" despite it being vital for the existence of humans and civilization. It is the soil that, created the earth's biosphere, and it could very easily become worn out in our lifetimes.[39] Soil is the basis of life, civilization, culture, livelihood and health. If humanity cannot pass healthy soil to the next generation, human cultures cannot be passed on and will surely perish. Where there is no ethic for the environment, including the soil, the water and the air, as there are ethics for people and society, the world will surely start to retaliate against humanity as it has done through global warming and soil erosion.

Most Africans, even those living in urban areas, have a strong connection to land, which enables them to appreciate land and the environment as important for their wellbeing. African ethics generally offer an interconnection between humans, soils and the environment- fertile soils form an important basis for survival for humans, but also for animals, plants and ecosystems and their services, on which all terrestrial organisms rely. Soil is not only of central importance to the global provision of food and in the fight against hunger; climate, biological diversity and water bodies are also highly dependent on soil quality. However, owing to several factors, among them, population growth and rapid urbanisation, soil degradation continues to pose enormous challenges to the global community.

Within the African context, the environment, like the land and its soils, is priceless. For instance, Africans believe that when some calamity or death that is disruptive is imminent, the weather is gloomy as a natural sign from the environment. According to Mbiti, an African's life is intertwined with the environment,

[39] Minami (2009), p. 614.

through religious influence, in sowing seeds or harvesting new crops, or celebrating life seasons; human beings are intertwined with the environment- and the environment and its components including soil range from being sacred to being a living thing that can for example empathize with its people.[40]

The environment is therefore regarded as being able to reward and cooperate on its own will; it is valuable but can also be a destructive or negative moral agent, which makes some communities perceive tragedy in a tree falling. In addition, the traditional practice of making libation, where one pours drink to the ground for the ancestors to drink before partaking of it, demonstrates how much the environment connects the individual with the ancestors who are believed to ultimately own the land.[41] In this example, the specially brewed drink, usually of an alcoholic variant is usually poured directly on the ground into the soil or water and this must have cultural significance in relation to soil health. In essence, the environment becomes like the umbilical cord between the living and the dead, and the direct interconnector is the land and soil.

Unlike other ethics, African ethics protect the environmental community interest, which might be different at times from an individual interest. Therefore, an action can be judged as bad if it does not promote a shared identity among people.[42] An act like selling ancestral land with its fertile soils or destroying the environment can be seen as wrong because it impairs a shared identity and destroys the bond of kinship—the African idea of community. According to African ethics, it is possible for a greedy person who is engaged in wanton destruction of the environment to lack in humanity and be a lesser person.[43] This focuses on an individual and the attitude portrayed towards the environment and society generally. These ethics urge people never to see the environment as an agent by itself but rather encourage the larger question as to what each individual does for their community, including the environment.

4.2.2 African Culture and Traditional Norms

The African idea of a community, people and the environment are interdependent. The environment including the soil is a communal asset. Depending on how one is able to live harmoniously with the community and environment, a person can fail or succeed at being a person; and to be a person, therefore, a person must be able to live with the goal of improving their capacity to be more human; consequently, a person who wantonly destroys the environment is less of a person and needs to apply more

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[40] Mbiti (1969), p. 110.

[41] Molefe (2018), p. 219.

[42] Molefe (2018), p. 220

[43] Ojomo (2011), pp. 574–575; Molefe (2018), pp. 217–221.

personhood. In the African context, a 'full' person is one who lives harmoniously with the community, which will include the environment.[44]

Within this context, culture can be defined as a product of the environment as much as it influences it and is the means through which an individual can differentiate between the artificial and the natural and what we do to the environment and what environment does for the human population.[45] The rationale for this view is that since the environment is culturally constructed then the ethical propriety of African communitarianism can be reviewed as the proper equilibrium for environmental governance. Other authors like Minami argue that culture includes everything in a society- food, clothing and shelter, technology, academia, art, morality, religion, politics, and other livelihood-shaping modes.[46]From this definition, it can be deduced that soil and the ecological services it offers are all part of the culture of a given society.

It is generally accepted that African culture and values on environment can help to humanize the environment, and make sustainable development holistic. This aspect is lacking in other ethics, which have not only undermined the environment but also led to loss of human value as they sometimes turn self from being to having. Additionally, weaknesses in the common good usually threaten the environment and its important constituent elements like soil and water through unsustainable consumption and production patterns.

Arguing from the Ghanaian perspective, Tetteh postulates that the socio-cultural set up of most African countries is such that it presents a challenge for sustainable soil protection and management.[47] According to Tetteh, sustainable soil management technology transfer initiatives need to operate at the local community level, yet in most African countries, it is not possible to secure effective 'face to face' extension; and further some traditional norms, for instance in Northern Ghana and many other parts of African countries do not allow females to be in public meetings in the absence of their spouses.[48]

On the contrary, some socio-cultural set ups, for instance in Ethiopia have been hailed to yield positive results for soil sustainability. In the Tigray region, the commitment of the community to "change and transformation, strength and resilience in the formal and informal leadership structures" led by the head of the village and relying on local cultural knowledge and practices have seen tremendous improvement in natural resources conservation.[49]

[44] Mbiti (1969), pp. 108–109.

[45] Ochieng'-Odhiambo (2020), p. 155.

[46] Minami (2009), p. 603.

[47] Tetteh (2019), p. 8.

[48] Tetteh (2019), pp. 8–10.

[49] Reda and Gidey (2019), p. 101.

4.2.3 African *Ubuntu* Philosophy

Ubuntu is a philosophy of life that is concerned with the reinforcement of unity, oneness and solidarity among the Bantu people of Africa.[50] Before analysing soil governance in the context of the *Ubuntu* philosophy, it is important to first explain who the 'Bantu' are.

The word 'Bantu' or 'Bantu people' mainly refers to the linguistic classification of more than 500 different African languages,[51] which incorporates approximately 85 million speakers of the myriad languages of the inhabitants of almost the entire southern projection of the African continent.[52] The classification of the 'Bantu' is primarily linguistic, for the cultural patterns of the speakers are extremely diverse and this linguistic connection identifies their possible common area of origin as the region in or about present-day Cameroon-Nigeria.[53] With this common heritage, the Bantu people, who represent almost 30% of the total African population,[54] have several common cultural and traditional practices and beliefs. It is therefore on this basis, that some form of homogeneity is assumed in relation to the practice of *Ubuntu*.

The *Ubuntu* philosophy is integrated into all aspects of day-to-day life, including environmental stewardship; and is a concept shared by almost all tribes in Southern, Central, West and East Africa amongst the people of Bantu origin.[55] In a thesis answering three questions – 'what is *Ubuntu*; where does *Ubuntu* come from; and how can *Ubuntu* be located?'- Ulvestad argues that *Ubuntu* can best be described in terms of it being reflective of an 'African homogeneity' representing a religio-cultural unity and diversity with a "distinctive elasticity and practical nature thus making it applicable to almost all facets of human life."[56] It is therefore an African philosophy capable of being utilized to fight the root causes of poverty, hunger and other emerging national and global challenges. Looked at from this perspective, this section argues that the *Ubuntu* philosophy is a meaningful vehicle for addressing soil governance in Africa.

Although *Ubuntu* has gained tremendous prominence in recent years, it is difficult to define it. This difficulty in defining *Ubuntu* is mainly because the concept is "elastic and pragmatic" as it is used in almost all the spheres of Bantu world-views.[57] Current definitions of the concept tend to focus on human to human relationships but *Ubuntu* also includes human to community and human to society

[50] Chibvongodze (2016), p. 163.

[51] Huffman (1972), p. 3.

[52] Guthrie (1948), p. 11; Guthrie (1967–1971), pp. 23–25.

[53] Ehret (1972), pp. 1–9.

[54] Ehret (1972), pp. 1–9.

[55] Rwelamila et al. (1999), p. 338.

[56] Ulvestad (2012), p. 30.

[57] Mabovula (2011), pp. 45–46.

and environment relationships. This means that *Ubuntu* exists not only at individual level but at local community, country and societal levels.

Ubuntu is also defined as an ancient African worldview which is based on the primary values of intense humanness, caring, sharing, respect, compassion and associated values which ensure a happy and qualitative human community life in the spirit of the family.[58] *Ubuntu* also means qualities such as warmth, empathy, understanding, communication, interaction, participation, reciprocation, harmony, a shared worldview and co-operation. *Ubuntu* implies a collective personhood in which an individual becomes a person through other people, and as a philosophy, it is allergic to any form of discrimination.[59]

Museka and Madondo further argue that it is a way of living that contributes positively to the welfare of all members who make up the universe. *Ubuntu* is also seen as an effort to help people in the spirit of service, to show respect to others and to be honest and trustworthy.

The African concept of *Ubuntu* is not only about the human being but extends to the environment since humanity is part of nature. However, there has been insignificant attention to the philosophy of *Ubuntu* in relation to environmental conservation, while areas such as health, education, judicial systems, religion and politics have long been incorporated in the philosophy.

The philosophy of *Ubuntu* plays a critical role in environmental conservation. This is further buttressed by the fact that according to the *Ubuntu* philosophy, the community is important and individual needs are secondary to family and community needs. If a person's behaviour is deemed to benefit the community, then one is deemed to be human. If a person's behaviour endangered the whole community such behaviour was chastised. For example, among the Shona of Zimbabwe, behaviours what bring about problems to the community are avoided; such behaviours include environmental or land and soil degradation or pollution.[60] Failure to avoid such behaviours would result in the whole community being punished by God or the guardian spirits, with punishment affecting the whole community in the form of droughts, hailstorms, locusts or worms.[61] People therefore showed their *Ubuntu* by being friendly to the environment by ensuring its sustainability as their philosophical responsibility to the community. This shows that *Ubuntu* values are not limited to fellow human beings, but must be extended to flora and fauna, soil inclusive.

For instance, in Guinea and the forests of West Africa, there is a hidden history of enriching the soil with natural techniques handed down through generations to sustain food crops without artificial fertilizers.[62] Solomon et. al. analysed 150 sites in northwest Liberia and 27 sites in Ghana and discovered that the enriched soils,

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[58] Chibvongodze (2016), p. 157.

[59] Museka and Madondo (2012), p. 245.

[60] Mabovula (2011), p. 39.

[61] Museka and Madondo (2012), p. 260.

[62] Fulton (2016) https://www.nationalgeographic.com/culture/article/africa-soil-farming-sustainable (Last access: 22 June 2022).

dubbed "African Dark Earths,"[63] contain approximately 200 to 300 percent more organic carbon than any other surrounding soils and can support more intensive farming. Further, the soils also contain 2 to 26 times greater amounts of pyrogenic carbon, which persists longer in soil than other carbons and is important for soil fertility, and that these methods of soil enrichment may offer a model for the future of agricultural carbon sequestration and remain a "neat example of traditional practices transforming soil properties to improve agriculture."[64]

Ubuntu would abhor drivers of environmental degradation such as inequality of access to natural resources and unsustainable utilization of natural resources. According to Mawere, some parts of Zimbabwe are prone to environmental conservation mismanagement-related phenomena which can also result from climate change; and that while it is arguable that the natural phenomena and secondary causes can be blamed for environmental degradation, causes such as veld fires and deforestation are among the secondary causes. The "subversion and relegation of the philosophy of *Ubuntu*" in environment conservation projects is the underlying cause.[65]

4.2.4 Religious Attitudes Towards Sustainable Soil Governance

In the face of global soil degradation and other severe ethical and environmental problems in Africa and elsewhere, solutions would require collaboration of scientists and religious leaders around the world. It is usual to find that religion offers the place of congregation for collaborative efforts, after all, over 80% of the global population self-identify with some form of religion.[66] In this section, the chapter focuses on the predominant religious views towards soil governance in Africa. It starts by understanding the role of African Traditional Religion with country-specific examples, followed by an analysis of Christian and Islamic approaches.

4.2.4.1 Country-specific Examples of African Traditional Religion (ATR)

According to Gathogo, African Traditional Religion is:

> ... an indigenous system of beliefs and practices that are integrated into culture and the worldviews of the African peoples. Like in other primal religions, one is born into it as a way of life with its cultural manifestations and religious implications. African Traditional Religion is thus an integral part of the African ethos and culture.[67]

[63] Fulton (2016); Solomon et al. (2016), p. 72.

[64] Fulton (2016); Solomon et al. (2016), p. 72.

[65] Mawere (2012), p. 9.

[66] Bunge (2019), pp. 342–343.

[67] Gathogo (2007), p. 164.

This definition advances the view that any system of beliefs and practices that are not indigenous may not be included into what qualifies to be referred to as African Traditional Religion. In order to qualify as indigenous, the system of beliefs and practices must be identified as truly originating among the local inhabitants and includes ways of worship, consultation of priests, rituals, symbols, arts, practices, and the society's relationship with its environment and general surroundings.

In support of this argument is the view that most Bantu speaking people, such as the indigenous Zambians and the Ila tribe in particular, have "a deep religious and spiritual heritage vouchsafed in myths, rituals, and symbols" and this is what is referred to as the African Traditional Religion.[68] In their research focusing on whether there is a relationship between African Traditional Religion and Christianity in Zambia, Podolecka and Cheyeka found that Zambian Christianity is generally influenced by the African Traditional Religion belief-system which is practiced by up to 10% of Zambians. Although the research did not generate statistical data to establish how many churches allowed pre-Christian practices grounded in African Traditional Religion, the belief in spirits and witchcraft was found to be so strong that all churches believed and followed it.[69]

The research by Podolecka and Cheyeka shows that there is a somewhat seamless relationship between African Traditional Religion and Christianity in Zambia, with one belief system influencing the other. What is apparent from this research is that any conflicts between the two belief systems are usually resolved at individual level.

A similar example emerges from Cameroon, a secular state with over 250 ethnicities and 250 languages and many religious groups including Christianity, Islam, and African Traditional Religions.[70] Cultural diversity even across agricultural practices that are soil dependent is quite obviously inherent in this type of multiethnic society where African Traditional Religious beliefs and cultures are practiced in conjunction with Catholicism. By way of background, foreign religions were resisted in Cameroon in the 18th century in order to maintain the local traditional religious culture. Until lately, the Pentecostal churches found it very difficult to attract adherents because they advocated the destruction of traditional religious symbols.[71]

The Catholics, however devised means for Africans to convert to Christianity without directly attacking their traditional religious values; choosing to tread a fine line by embracing some of the African cultural and religious practices that did not markedly deviate from their Western church's own canons. For example, Mass service in many parts of Africa is practiced very differently from the way it is practiced in Europe or in North America, owing to the adoption of African religious and cultural practices.

According to Ndemanu, in the Bangwa land region in Cameroon, African Traditional Religion influenced some of the rituals that occurred in church such as

[68] Podolecka and Cheyeka (2021), p. 2.

[69] Podolecka and Cheyeka (2021), p. 22.

[70] Ndemanu (2018), p. 70.

[71] Ndemanu (2018), p. 73.

harvest thanksgiving, tithing in cash and in kind, choral music, twin-dance procession with a green leafy peace tree whose stems are often cut off and used as a symbol of peace during a church choir.[72] There is a cultural and religious symbolism of this peace tree and using it in a church choral procession and to decorate the altar. Further, in-kind tithing with kola nuts, fruits, and other edible items instead of money is reminiscent of the African Traditional Religion in which an elder takes the best harvest to the shrine to make sacrifices to God.[73]

It can generally be argued that with rapid urbanization, most African cities have taken on a more cosmopolitan outlook. There has been infusion of African culture with modernity, Islam and Christianity; thereby resulting in a dynamic and possibly tripartite cultural strand.[74] This however, does not rob African culture of its distinctiveness or vibrancy. There remains, a cultural appropriateness of African values in making other moral considerations on what the environment is, since it balances between individual and community oversights, unlike modern values that have given priority to individual autonomy.[75]

From the Kenyan perspective, the case *Centre for Minority Rights Development (Kenya) and Minority Rights Group International on behalf of Endorois Welfare Council v. Kenya,* 276/2003 is relevant. The argument was advanced that the land around Lake Bogoria connected the locals in a special way with their ancestors and religion; that they could not exist as a group without accessing that land. The Africa Human Rights Commission agreed with the locals that because they are a land-based religion; they could only worship in a specific place, and without it their survival as a people was impaired. What is instructive in this case is the recognition of the land-based nature of the religion. By extension, the other resources on this particular land such as forests, water and soils are important and would assume the same revered status of the land.

For most African communities and the Shona people of Zimbabwe in particular, all aspects of nature, plants and wildlife and water bodies are under the mystical tutelage of ancestral spirits and guardian animals.[76] People are therefore mandated to use natural resources sustainably on behalf of these owners spiritual-beings. It was also seen that there are environmental taboos that are intended for the ethical use of the environment. These taboos help keep people away from further depleting the environment. The Shona people, for example, have a rich indigenous knowledge system which if used wisely may help in environmental conservation. However, it must be noted that this Afrocentric perspective has its own weaknesses just like any other school of thought,[77] but might prove effective in terms of entrenching sustainable soil governance.

[72] Ndemanu (2018), p. 73.

[73] Ndemanu (2018), pp. 71–72.

[74] Ojomo, (2011), pp. 573–574.

[75] Awoniyi (2015), p. 217.

[76] Mawere (2012), p. 11.

[77] Mabvurira et al. (2021), p. 116.

The Shona people also believe that there are spirits that guard water sources and they migrate if the source is polluted and this results in drying up of the water source. On this basis, Mabvurira et al argue that there is an urgent need for Zimbabweans to be reconnected to their traditional beliefs if environmental degradation is to be reversed.[78] More directly relevant to the discussion on sustainable soil governance, the Shona believed in the sacredness of flora; cutting down trees in certain areas was prohibited because the flora minimized runoff thereby ensuring that the water table did not fall and preventing, soil erosion and sedimentation of water sources ultimately ensuring sustainable environmental wellbeing.[79]

From Nigeria, a different example of conflict and tension between African Traditional Religion and Christianity emerges. In a research investigating the nature, pattern and rationale of the conflicts which exist between the two religions in Igbo land of the country, Okeke et al. found that Igbo religion is traditionally rooted in their culture, received and transmitted by oral authority through generations, with the effect of being widely diffused among its adherents and of deeply coloring their conscience.[80] The Igbo have three objects of worship - God, nonhuman spirits, and the ancestors—and the Earth, referred to as *Ala* is held sacred for the sustenance it provides in the form of food, crops, water, forests and the soils for agricultural purposes.[81]

In about 1857, with the advent of Christianity in Igbo land of Nigeria, the Igbos feared that if they became Christians, their gods would bring disaster to them, their culture would be adulterated. This was because the early Christian missionaries wholesomely condemned traditional religion and any symbols of it such as statues, images and artistic works were destroyed.[82] Conflict between the two religions started arising mainly in relation to totems and sacred animals, healthcare, sorcery, magic charms and witchcraft amongst many others.

In relation to environmental wellbeing and soil governance, the emergence of impunity to violate sanctions of the traditional religion by the first overzealous converts to Christianity resulted into taboos and abominations. In some parts of the Igbo community, there are certain animals deemed sacred under the traditional religion and are, therefore, not hunted or killed for food. Such animals are respected and treated kindly by the adherents of traditional religion and to harm them is a serious taboo and abomination. On the contrary, Christianity professes the cleanliness and purity of everything created by God; that man has dominion over them, and as such, can kill and eat them.

In Anambra state, one of the major Igbo states in Nigeria, *eke* or the royal python is regarded as a totem and nobody can deliberately kill it without incurring the

[78] Mabvurira et al. (2021), p. 115.

[79] Mabvurira et al. (2021), p. 117.

[80] Okeke et al. (2017), pp. 2–3.

[81] Okeke et al. (2017), p. 3.

[82] Okeke et al. (2017), pp. 1–3.

ostracism of the people.[83] Most early Christians in the area, however killed the *eke* and used it as food, in full view of the traditional religionists, who were then forced to offer special sacrifices to cleanse themselves from the abomination. Similarly, it was unfathomable for the Igbo to eat fishes from sacred streams which were dedicated to the god of the stream. The Christian converts, however caught and ate fish just to show that the gods of the traditionalists were subordinate to their supreme being. This brought the first physical conflict between the traditional religionists and the Christians.

4.2.4.2 Christian Teachings

It is important to consider the Christian teachings on soil given that statistically, Christians are in the majority in Africa. In a study examining the numbers and percentages of Christians and Muslims in Africa in 2001, 2009, and 2020 with a view to having a better understanding of the trends, Kaba found that of the 1.82 billion people in Africa in 2020, Christians accounted for 51.3%, while Muslims accounted for 43.1%, people who practiced Traditional African Religion accounted for 2.7%, and those who are "Unaffiliated" accounted for 2.54 percent.[84] Of the five regions in Africa, Christians accounted for the majority in Eastern and Southern Africa, while Muslims accounted for the majority in Northern and Western Africa. People who practiced African Traditional Religion had their highest proportion in Southern Africa.[85] This statistical analysis shows that Christian and Muslim perspectives on approaches towards soil governance are likely to influence more Africans than the African Traditional Religious beliefs.

From the Catholic Christian perspective, Pope Francis in the environmental and social encyclical "Laudato si'" underlines that we humans are the "dust of the earth" in line with Biblical teachings.[86] God created Adam, from the dust of arable soil.[87] According to Hansjürgens, this is why human beings are closely related to "our Sister, Mother Earth", as Pope Francis states under reference to his patron saint, St. Francis of Assisi, and his "Canticle of the Creatures."[88] God loves "each of His creatures" so He also loves the Earth and her important constituent, soil, and He is therefore not indifferent to human beings plundering, mistreating and ravaging the planet. Such behaviour is "a crime against the natural world and a sin against ourselves and a sin against God".[89] For this reason, the Biblical Laws on the prescribed rest periods-the Sabbath (rest on the seventh day), during the Sabbath

83 Okeke et al. (2018), p. 5.
84 Kaba (2022), pp. 39–40.
85 Kaba (2022), p. 40.
86 Kaba (2020), p. 40.
87 The Bible, Genesis 2:7.
88 Hansjürgens (2018), p. 3807.
89 Hansjürgens (2018), p. 3807.

or fallow year (no planting in the seventh year) and during the year of Jubilee (restoration of the original ownership after seven times seven years)-command regular care and relieving of pressure, is not only for human beings and animals, but also for soils, for the salvation of all created by God.[90]

Based on the Christian perspective, Vogt has recently argued for the adoption of "ten priorities, rules or 'commandments' of soil protection," some of which include, stopping soil loss and degradation, reducing land consumption, asserting social responsibility and the polluter pays principle with regard to soil, and making sustainable use of church areas because churches have a "decisive function as role models in soil protection."[91]

4.2.4.3 The Islamic Approach

In a research aimed at encouraging the consideration of Islamic perspectives in solving environmental problems such as land degradation and soil depletion amongst others; activating the role of religious and scientific institutions in preserving the environment, and providing appropriate solutions, BSoul et al found that the Prophetic traditions and their teachings dealt extensively with many environmental aspects, such as preserving natural resources, reclamation of land, and maintaining the cleanliness of the environment. The authors argue that sustainable behaviour is promoted though criticism of overconsumption, as the Prophet Muhammad (peace be upon him) forbade extravagance in consumption or any other form of luxury.[92]

According to the teachings of Islam, the essential elements of nature—earth, water, fire, forests, and light—belong to all living things and not only to the human race. Islam emphasises the importance of preserving the environment and protecting natural resources. The Qur'an and the Prophet Sunnah/traditions are considered a guiding light in promoting the concept of sustainable development in Islamic countries, and throughout the world. The Qur'an also refers in many chapters/surahs and verses to the concept of the environment and essential principles for preserving it, as it sets general rules that determine the extent to which humans benefit from various natural resources.[93] God Almighty commanded human beings to avoid misusing natural resources and abstain from any action that would destroy and degrade the environment and has made the human race the guardian over natural resources.

The first principle that directs Islamic teachings towards environmental sustainability is the concept of guardianship. The fact that a person is considered the caliph or "guardian" implies that he can benefit from what God has created without overindulgence, because it is not for him alone but for society and future generations.

[90] The Bible, Exodus 20: 8–11; 23:12; Leviticus 19:3.30; 25:4 f.8–31.

[91] Vogt (2019), p. 366.

[92] BSoul et al. (2022), p. 230.

[93] BSoul et al. (2022), p. 229.

Man must take all the necessary steps and measures to ensure the preservation and maintenance of these properties and should pass them on to succeeding generations in the best way possible. According to Afgan, this aligns with the Bruntland Commission's conceptualization of sustainable development as, development that meets the needs of the present without compromising the ability of future generations to meet their own needs.[94]

Therefore, environmental sustainability is firmly embedded in Islam, and man is the entrusted guardian of nature and must coexist in harmony with all other creatures and resources such as water, forests and soil. All human beings must therefore respect, care for, and preserve the environment.[95] The mismanagement of natural resources is often portrayed in the Qur'an and clearly marked as a corruption (fasÉd). Further, human beings who mismanage natural resources, including excessive environmental exploitation, resulting in industrial pollution, damage to the ecosystems, recklessness, and mismanagement of natural resources, are abhorrent to Almighty God. According to Islam, moderation, refraining from being extravagant and excessive is environmental stewardship. Furthermore, according to the Prophet, planting trees, purifying rivers, digging wells, and other beneficial works were considered ongoing charitable acts.[96]

When analysed closely, the Islamic belief system which has been adopted in several African countries emphasises environmental and natural resources sustainability. Soil governance may not necessarily be a focus in Islam, however, the due attention given to overall environmental sustainability is couched in a manner that supports soil sustainability as well.

5 Conclusion

African soils and other natural resources need to be protected in their own right and also in line with global aspirations of food security, amelioration of climate change and other environmental challenges. Several questions have been posed in this chapter, the central one being in relation to the soil governance mechanisms that are in existence in Africa. In addressing this question, this chapter has assessed the culture, traditional norms and religious practices that have shaped legal approaches towards environmental management and sustainable soil governance in Africa. It has been shown that sustainable development is not only a global vehicle for environmental and economic development, but that also a mechanism for interfacing with African culture, traditional norms and religion.

A number of international soil governance initiatives have been identified in this chapter, although the discussion has centered more on the local national and regional

[94] Afgan (2011), p. 459.

[95] Boisard (1983), pp. 48–54.

[96] Bsoul et al. (2022), p. 233.

ones such as the Maputo Convention. This chapter supports the view that the Maputo Convention is an important regional instrument on whose basis sustainable soil governance efforts can be supported in Africa. Further, the importance of IKS to sustainable soil governance is evident in this chapter. For example, it has been shown in the cases of Kenya and Malawi that traditional knowledge in the local communities needs to be tapped in order to understand the intricacies of conserving the important natural resource. Furthermore, the Swakopmund Protocol on the Protection of Traditional Knowledge and Expression of Folklore under the auspices of the African Regional Intellectual Property Organization (ARIPO) has also been identified as an important regional resource likely to improve harnessing of IKS in Africa; and has also inspired the development of national legal frameworks. In addition, the quest for sustainability in the management of natural resources provides an avenue through which IKS in Africa could be woven into global efforts towards sustainable soil governance. Closely related to IKS is the African *Ubuntu* philosophy, which is explained in the chapter as a reinforcement of unity, oneness and solidarity among the Bantu people of Southern, Central, Western and Eastern Africa. It must be reiterated that the *Ubuntu* African philosophy is capable of being utilized to fight the root causes of poverty, hunger and other emerging national and global challenges such as inadequate mechanisms for soil governance in Africa. The chapter has shown that *Ubuntu* extends to environmental well-being since humanity is part of nature, however, there has been insignificant attention to the philosophy of *Ubuntu*. The provisions of the African Charter on Human and Peoples Rights relating to wealth and natural resources, underscore the strong cultural approach of building communality and solidarity in Africa, which in themselves are an expression of *Ubuntu* as shown in this chapter.

The examples of the different religious approaches that have been pointed out in this chapter show that the possibility of conflicts arising as a result of diverse belief systems is potentially high and if not addressed in a holistic manner, could disrupt unified efforts towards the common goal of sustainable environmental and soil governance. Consequently, in order to strengthen sustainable soil governance in Africa, there is need to find reconciliation among the more dominant religions African Traditional Religion, Christianity and Islam. Although statistics show that there is a low rate of Secularism in Africa; and this chapter has not specifically analysed how Secularism can contribute towards the enunciation of a sustainable soil governance approach in Africa, it is important to be inclusive of all existing belief systems. Should legal mechanisms for sustainable soil governance be developed in Africa, and the different countries, there must be dedication towards seamless incorporation of workable aspects of each religion, including Secularism.

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