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The global standard bearers of soil governance

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ABSTRACT

The need for effective governance of soil resources is critical. This article outlines five levels of national soil governance against which states may assess themselves and highlights those the authors consider to be in the top category. Responding to the question *Which countries or political states can be viewed as 'global standard bearers of soil governance?'* it describes exemplars of national and subnational best practice that, if widely emulated, could significantly improve the condition of land and soil globally.

1. Introduction

As both human impact on the environment and human knowledge have grown exponentially, the process of natural resource management and governance has adapted, but this is not to say that it is currently fit for purpose. The global threat to natural capital is as great as it has ever been and at the heart of the wider Anthropocene crises of climate change and species extinction. The need for effective governance of soil resources is critical. International initiatives and instruments are important for unifying and galvanising states to collective action but are typically only effective if followed up with local, regional or national policies and laws (Hannam and Boer, 2004), which in turn must be enforced. Each state has followed its own unique path with respect to soil governance. While greater wealth and institutional maturity has undoubtedly facilitated more comprehensive processes, it has not guaranteed sound governance. Other factors appear to have influenced the choices some states have made and the practices they have followed. This article addresses the question: who are the global standard bearers of soil governance providing examples for others to emulate?

In answering this question, we considered the following list of criteria:

1 A national soil policy, or one or more other policies that prominently feature soil as a priority.
2 One or more laws that offer unambiguous protection or amelioration for soil from degradation, e.g. erosion, contamination, nutrient depletion, salinization or structural damage.
3 Promotion of soil health and strengthening of soil ecosystem services (SES), including climate change mitigation, supported by soil monitoring.
4 Legal protection for natural ecosystems and fostering of forestation or ecological restoration.
5 Legal protection for prime farmland from urbanization.
6 Implementation of Land Degradation Neutrality (LDN) or its equivalent via land protection and/or restoration, or land take limits.
7 A commitment to the UN SDGs including no poverty and zero hunger, addressing for example, food security, land tenure, farm support, gender equality, and Indigenous peoples' rights.
8 Schemes encouraging RA, agroecology, SLM and SSM including inter alia, agroforestry, minimum tillage, cover crops, leys, organic farming, CSA, IPM and PES.
9 A program of soil science education, professional training and accreditation, support for soil related research, as well as general

Abbreviations: ALC, Agricultural land classification; CSA, Climate-smart agriculture; FAO, UN Food and agriculture organization; GEF, Global environment facility; IPM, Integrated pest management (an environmentally-sensitive pest control strategy that minimises the use of synthetic pesticides); IUCN, International union for conservation of nature; LDN, Land degradation neutrality; OECD, Organisation for economic co-operation and development; PES, Payments for ecosystem services to farmers or landowners; RA, Regenerative agriculture; SDG, Sustainable development goal(s); SES, Soil ecosystem services; SLM, Sustainable land management; SSM, Sustainable soil management; SWC, Soil and water conservation; UNCCD, United Nations convention to combat desertification; VGSSM, Voluntary guidelines for sustainable soil management.

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communication to citizens of the importance of soil to society and to the environment.
10 Effective governance, i.e. implementation of best practice, enforcement of laws, respect for legal rights, freedom of information and a lack of corruption.
11 Policies and practices that also reflect a regional and global perspective on all of the above.

In creating this synthesis, at least as important as details of soil-related law and policy instruments were independent critical accounts of flaws or omissions in the process of national or local governance - crucially whether practice follows theory and laws are enforced, and also regarding other issues, such as transparency, equity, access to information, consultation and participation, all prerequisites of sound governance. An article of this scope and size cannot fully address every aspect of each state's soil governance and the global implications of its policies, and our choice of criteria and identification of exemplars is necessarily subjective to some degree, as well as constrained by the information considered. The authors are aware of the risk of criticism any such exercise and selection may bring. The aim is not just to showcase examples of best and innovative practice, but to stimulate discussion, promote further and more comprehensive empirical and comparative research and analysis, and encourage collaboration to advance soil governance to improve outcomes on the ground.

2. Material and methods

Five types of information were sourced for this study: (1) FAO databases, FAOLEX and SoiLEX, (2) literature review, (3) government websites, (4) personal communication, via email and meetings, and (5) independent country rankings, and from this, states were classified into one of five soil governance levels described in Section 3 below. Searches of FAOLEX and SoiLEX were used to initiate a spreadsheet of national soil and land use laws and policies, supplemented by information from other sources, some of which also facilitated assessment at subnational level. These documents were often in the local language. Where necessary, Google Translate was used. The literature review included academic articles, NGO reports, government websites, media articles, and theses. Information was also obtained by contacting individuals with professional expertise, such as scientists, academics, government officials, journalists and representatives of NGOs. A final source of information was from country rankings in the Corruption Perceptions Index (Transparency International, 2020). The Environmental Performance Index (EPI) and the UN Sustainable Development Report 2021 rankings were also reviewed, but with caution, because of the wide range of criteria they apply, as well as some controversy over the methods used (Miola and Schiltz, 2019). There is no overall SDG defined for soil, but soil governance is relevant to all SDGs in direct and indirect ways (Bouma et al., 2019; Lal et al., 2021).

3. Levels of soil governance

3.1. Level 1: little or no soil governance

This refers to states where generalised environmental or agricultural policies may exist, but soil-related law and policy appears to be virtually absent. In contrast to certain places such as some small island or desert nations, where what little soil or cultivable land there is may already be carefully managed and protected for reasons precluding legislation, level 1 encompasses states where the lack of soil instruments has contributed to serious negative impacts to soil and SES, especially in areas of poverty or conflict (Abu Hatab et al., 2019; Metternicht, 2018; Mouël et al., 2018).

3.2. Level 2: inconsistent enforcement often amounting to soil governance in name only

This group includes states that have law and policy instruments to address soil governance, some very robust in language, but coupled with ineffective governance including widespread lack of enforcement. There are multiple causal factors, but common problems include immature administrative and legal institutions, and large disparities of wealth and power, leading to economic pressure to ignore best practice policies or to circumvent legislation (Guereña, 2016; Nkonya et al., 2016). Other complicating factors can be informal land tenure and communal rights (McPike, 2015; Mouël et al., 2018).

3.3. Level 3: limited or tactical soil governance

Many states, including most of the world's top ten economies, have achieved a measure of success in formal soil protection, but good intentions are not always supported by effective implementation or enforcement. Most states following this course tend to apply a range of law and policy measures, including economic measures, e.g. zoning, taxation, incentivisation or ad hoc land acquisition, rather than a holistic and consistently rigorous approach, resulting in associated pitfalls, such as complexity, inconsistency and many opportunities for determined stakeholders to circumvent regulations. There are four predominant issues underlying these shortcomings:

a) Intense economic pressure to develop land for housing or industry (Bren d'Amour et al., 2017).
b) Complex, inconsistent and volatile laws, which confuse landowners and administrators alike. This is often related to decentralised control or convoluted attempts to satisfy competing stakeholders or adapt to rapidly changing circumstances (Nishi, 2019; OECD, 2010).
c) A global shift since the 1980s away from natural resource protection towards economic outcomes, due to both faltering environmental ambitions in the political arena and monetarist economics (Mol, 2016). Subsequent environmental concerns, especially alongside the climate agenda, have ushered in legislation in favour of nature, but sometimes at the expense of prime agricultural land (Stankovics et al., 2018).
d) Policies not translated into binding laws, or laws not effectively enforced due to political pressure or institutional weakness, especially in middle income states that are transitioning (Shen et al., 2019).

3.4. Level 4: progressing from tactical to strategic soil governance

This level identifies a small number of states that typically apply tactical soil governance to a high standard, in some situations taking a leading role, and may be on the cusp of embracing new approaches or legislation that could elevate them to the level of best practice.

3.5. Level 5: strategic and effective soil governance – the "standard bearers"

This select group consistently operates best practice soil governance, regulating and enforcing soil use and protection in the common interest, embodying to a significant extent the concepts of soil security (McBratney et al., 2014), SSM (FAO, 2017) and the objectives of the SDGs. Such states typically have a defined soil-specific policy or other policy wordings that safeguard soil as a valuable resource. There are effective legal instruments to monitor soil quality, prevent or remediate many, if not all, types of soil degradation, restrict soil sealing and preserve prime farmland. Furthermore, the legal frameworks of these governments explicitly recognise and prioritise critical SES far beyond basic agricultural utility. These states generally demonstrate a high standard of probity, rule of law, and environmental justice, alongside an

ethos that transcends narrow national goals.

4. Results and discussion

Globally, dedicated soil legislation remains conspicuous by its absence. Where soil protections do exist, they are more likely to be embedded within other types of legislation, such as those dealing with the environment, agriculture or spatial planning and, even then, often without any direct reference to soil.

Allocating each country to the appropriate level described in Section 3, and regarding the first two levels as broadly ineffective, the results suggest that soil resources are being somewhat protected in less than a quarter of the countries of the world. Not only is this deeply troubling, but it is inescapable that governance is typically weaker in lower income countries. This stark conclusion emphasises the necessity for wealthier countries to do more to facilitate transfer of resources, capacity strengthening, and local and international knowledge exchange, to support states and communities seeking such cooperation to improve soil governance, not only for ethical reasons, but as a global imperative.

For reasons connected with climate change, food production and biodiversity, the cause of soil governance has advanced (Weigelt et al., 2015). One result of this and a cause for optimism is that a small number of exemplars have emerged to lead the way and show how sound soil governance can work in practice. Not all of these states are countries, as defined by the UN; some of them are self-governing entities within countries. These "standard bearers" are presented in alphabetical order in Section 4.1 below. In addition, several states that are not at level 5, or necessarily even level 4, have been highlighted in Section 4.2 for extraordinary achievements in the soil governance arena, sometimes in the face of great adversity.

4.1. The standard bearers of soil governance

4.1.1. Cabo Verde

The small Sahelian archipelago of Cabo Verde is exceptional in its combination of extreme environmental constraints and Herculean human achievements in mitigation and resilience. Water scarcity is its most critical limitation, underlying a legacy of unproductive and degraded soils, bare eroding slopes and droughts that triggered extreme poverty and famine in 1947–48 (Baptista et al., 2015). Modest attempts at remediation by the colonial authorities were followed by post-independence initiatives of reforestation and SWC and several national policies and programs aimed at environmental protection, SLM and poverty reduction. Cabo Verde was the second country in the world to ratify the UNCCD and is fully committed to achieving the SDGs (Baptista, 2016).

While there is no standalone soil legislation, other specific soil protections and improvements are woven into several policies and national plans, and demonstrably put into practice via the collaboration of several government departments (Baptista, 2016). Cabo Verde also has a record of sound governance (African Development Bank, 2019). There has been successful reforestation (Government of Cabo Verde, 2021a) and afforestation mainly via agroforestry (Tavares et al., 2014), raising forest cover from zero to about 85,000 ha or 21% of the territory. CSA and IPM (FAO et al., 2019), and PES (Government of Cabo Verde, 2021b) are also being gradually adopted. While there are no explicit legal constraints on the consumption of prime farmland, there is abundant barren land on which to build, and what little fertile land exists is assiduously preserved by default (António Ferreira, personal communication, January 2022). Cabo Verde is a very rare example of a state where best practice soil governance exceeds formally documented legislation.

Room for improvement: Cabo Verde could benefit from a definitive soil policy and soil laws, and soil monitoring and data could be enhanced.

4.1.2. Cuba

With 77% of its productive soil already degraded by a combination of deforestation, intensive industrial monocropping and climate change, and a high susceptibility to droughts and hurricanes (Aguilar et al., 2015), Cuba experienced the catastrophic economic blow in 1989 of the collapse of socialist bloc trade and support, compounded by tightening of the US trade embargo in the 1990s (Gonzalez, 2003). This sudden turnaround necessitated greater self-reliance and triggered a systemic return to decentralized small-scale RA and SLM, facilitated by land reform (Aguilar et al., 2015; Wunder et al., 2013). These traditional methods had never disappeared from Cuba but have now become so entrenched that many refer to this as a new "agroecological revolution" (Lucantoni, 2020; Machín Sosa et al., 2013) and in 2006 Cuba was judged the world's only sustainable country (WWF, 2006). This transformation has not only substantially increased food security, but the nosedive in agrochemical application, alongside ongoing reforestation, has had multiple environmental benefits (Galford et al., 2018). Another distinctive outcome has been the development of urban agriculture, at first informal, but subsequently an efficient state-sponsored system that supplies substantial quantities of organically grown food (Funes-Monzote, 2008).

Cuba has a soils policy, soil laws and a single public body responsible for soil, all of which are strongly integrated with environmental, agricultural and planning policies (Machín Sosa et al., 2013; Montaño-Lopez et al., 2021) and international commitments such as LDN targets (CITMA, 2020). Cuba's associated legal and administrative frameworks are regarded as sound (FAO, 2020; GEF, 2013). Although some large-scale agriculture persists, the national target is for pest control to be 80% organic and 100% IPM, and for increased soil monitoring (CITMA, 2007). Cuba demonstrates a strong commitment to scientific and educational support for soils, and international collaboration (Betancourt, 2020; Chang, 2021).

Room for improvement: Cuba lacks specific legal protection for prime farmland from urbanization. Arguably, that this is not a local priority, given the extent to which urban agriculture has transformed and even redefined the concept of urban zones, alongside the national goal to continue the process of transferring abandoned state farmland to small-scale farmers. However, urban expansion has increased (Stuhlmacher et al., 2020) while highly productive land is scarce (Funes--Monzote, 2010).

4.1.3. Salzburg länder (Austria)

Austria goes further than many countries with respect to soil governance, but some of its federal policies depend on voluntary guidelines (Austrian Government, 2020) and its 2030 target to reduce land consumption to less than 2.5 ha/day is being exceeded fivefold (Netsch, 2021). The nine federated *bundesländer* (states) determine their own laws and spatial planning and of these, only Salzburg and Upper Austria have extensive soil laws that incorporate SES evaluation (Minixhofer et al., 2019). However, Salzburg's all-embracing Soil Protection Act is not restricted to agricultural soils.

Since 1992 regional planning in Salzburg has served as a model for the rest of Austria (ÖROK, 2018) and employs a masterplan to control everything from zoning to pollution (ESPON, 2020). Furthermore, the spatial planning regulations include guidelines called "Soil protection in planning projects" which adheres to the 2013 Austrian Standards Institute *Principles of soil function evaluation* as well as complying with federal, Alpine and local soil laws (Knoll et al., 2011). All soil functions are assessed and incorporated into a scoring matrix. Hence, while sealing prime farmland is not technically prohibited in Salzburg, in practice greenfield land take is highly restricted because productive soil is arguably even better protected than it would be by conventional land evaluation criteria. In 2020 Salzburg's land take was well below the national average and met the 2030 target, per capita and per land area (Austrian Federal Environment Agency, 2021).

RA is widely practised in Austria, which has the highest proportion of

organic farms in the EU, Salzburg having the highest within Austria, at 50% (Darnhofer and Strauss, 2015). Salzburg complies with or exceeds national policies regarding forest protection (Austrian Government, 2015), PES and CSA (Grandl et al., 2016), the SDGs (Austrian Government, 2020) and LDN (Bodle et al., 2019). Moreover, Salzburg's own soil and planning laws are exemplary and, combined with federal policies, meet virtually all criteria listed in the Introduction above.

Room for improvement: Both Austria and Salzburg lack a published soil policy.

4.1.4. Switzerland

In 2020 Switzerland adopted a new National Soil Strategy (Swiss Government, 2020) with six far-reaching objectives. The first objective commits to an LDN target of zero net land consumption by 2050. Switzerland's 2030 Sustainable Development Strategy adds that an intermediate 2030 target is to reduce soil consumption by one-third, compared to 2020. Any loss of soil functions due to construction must be compensated by soil rehabilitation elsewhere. The second requires the use of SES data to make soil consumption sustainable. The third embodies conventional soil protections. The fourth aims to rehabilitate degraded land. The fifth addresses soil awareness and stewardship. The final objective recognises that SES and soil degradation do not stop at national borders. The strategy emphasises Switzerland's commitment to UNCCD and calls for an international instrument to protect soils worldwide.

The Swiss government is active in a wide range of soil management and research, via the Federal Offices for the Environment (FOEN) and Agriculture (FOAG), and affiliated research institutes (Baumann et al., 2021; Braun et al., 2020; Gubler et al., 2019; Schwilch et al., 2019; Tobias et al., 2018). Within FOAG, Agroscope oversees the Swiss Soil Monitoring Network (NABO) which has been monitoring soils on selected sites for nearly 40 years (Gross et al., 2021). Switzerland has pioneered organic farming and no-till methods, demonstrating that such systems not only confer soil benefits, but can be economically viable alternatives to conventional agriculture (Anken et al., 2004; Büchi et al., 2015; Krauss et al., 2020; Seitz et al., 2018).

Switzerland restricts urban sprawl and protects farmland, as well as green spaces and natural ecosystems, with a combination of zoning, land evaluation and land take limits, but goes much further in this respect than most other countries. Protected arable land was based on the area needed to feed the country in a crisis (Tobias, 2013) which equates to approximately 10% of the country's surface and almost all of the prime cropland (Oliveira et al., 2019), but is now protected for more holistic SES reasons. Land is sometimes unsealed to compensate for infrastructure (Tobias et al., 2018). Soil restoration is incorporated into construction project regulations to a high standard (Geitner et al., 2017) and waste disposal law prescribes the reuse of excavated soils ("ADWO," 2015). One of the few emerging systems that encompasses an SES assessment of soils to guide spatial planning, SQUID (Soil QUality InDicator), is under development in Switzerland (Drobnik et al., 2018).

Room for improvement: Soil mapping has been inconsistent amongst Swiss cantons and much of the agricultural land still needs to be accurately surveyed (Oliveira et al., 2019).

4.1.5. Uruguay

Uruguay has abundant land and productive soils, but also a long history of overgrazing, soil erosion and degradation and longstanding attempts to address these issues (Zurbriggen et al., 2020). In the 1960s a Land Research office (CONEAT) was established to map the soils of Uruguay, a first for Latin America (World Bank and CIAT, 2015). The resulting CONEAT index to guide land use also identifies prime farmland which is strictly protected (Government of Uruguay, 2018a). The soil conservation law of 1968 coincided with the promotion of mixed farming to minimise both overgrazing and over-tilling (Zurbriggen et al., 2020). Over time the soil legislation has been strengthened and since 2013 it has been mandatory for most farmers to adhere to a soil use and management plan (SUMP) which aligns in part with the FAO VGSSM (FAO, 2017) and provides data for soil-related aspects of the SDGs (Pérez Bidegain et al., 2018), and which some local policymakers regard as Uruguay's flagship environmental legal instrument (Zurbriggen et al., 2020). Soil quality and farmer compliance is monitored by using a GIS to synchronize SUMP plans with satellite data (World Bank and CIAT, 2015; Zurbriggen et al., 2020), and landowners have been made jointly liable with their tenants for cases of regulatory violation (Pérez Bidegain et al., 2018).

Uruguay was one of the pilot countries evaluating the FAO/GEF/IUCN participatory assessment of land degradation based on the principles of SLM (Cortés Capano et al., 2020). Soil features in the "Uruguay Green Growth" initiative of the World Bank, which states: "*Uruguay enforces one of the most advanced soil protection regimes for arable land in the world.*" (World Bank, 2017). Regionally and internationally Uruguay is highly proactive and legally committed on environmental issues, including climate change, which pervades its agricultural sector and soil policy (Government of Uruguay, 2017; World Bank and CIAT, 2015). Crop-pasture rotations, agroforestry and other forms of RA have long been encouraged (García Préchac, 2020) and Uruguay has one of the highest proportional areas devoted to organic farming in the world (Inés and Perazzoli, 2017), but the recent Agroecology Law promises to elevate these practices into a holistic national strategy incorporating socioeconomics and SES (Government of Uruguay, 2018b).

Roomfor improvement: Substantial afforestation and expansion of croplands has been at the expense of native prairie and concerns have been raised that this threatens biodiversity and that exotic tree species can acidify the soil and reduce carbon sequestration (Brazeiro et al., 2020; Carrasco-Letelier et al., 2004), and that soil degradation results from both livestock (Febrer et al., 2021) and intensive soybean production (Castaño-Sánchez, 2017).

4.1.6. Wales (UK)

The UK, one country in FAOLEX and SoiLEX, includes the four nations of England, Scotland, Wales and Northern Ireland. With respect to soils, the "letter of the law" varies little across the four countries, but the interpretation, enforcement and supporting infrastructure of Wales sets it apart from its neighbours. With respect to land take and soil sealing, three UK-wide policies that have been applied with varying degrees of success are: (1) green belts, (2) a brownfield development target (since 1998) of 60% of all new build, and (3) guidance to protect the "best and most versatile (BMV) land", all of which have been recognised internationally (Prokop et al., 2011). The third policy, aimed at greenfield sites outside green belt zones and based on ALC,[1] has been progressively diluted since the 1980s and left to the discretion of local authorities throughout most of the UK (Menadue, 2013; Thurston et al., 2011). In Wales, however, the primacy of ALC and BMV land has been maintained (British Society of Soil Science, 2021; Rollett and Williams, 2019), and even features in Welsh planning policy at the highest level (Welsh Government, 2021a, 2021b).

The Welsh Government takes proactive steps to protect its soil for future generations, in line with the Well-being of Future Generations Act (Wales) 2015. In 2017 an online predictive ALC map was created allowing anyone to obtain land use recommendations for any parcel of land in Wales (Welsh Government, 2019a), with adjustments for future climate change (Keay, 2020). Studies based on ALC criteria were commissioned to assess the effect of multiple climate change scenarios on 118 crops and on afforestation suitability to meet the Welsh contribution to the UK net zero by 2050 target (Bell et al., 2020). A key aim of the Welsh land management schemes (Glastir) is to improve soil quality and management (Welsh Government, 2019b) and the restoration and preservation of peatlands is being addressed (Welsh Government, 2020). A high rate of remediation of contaminated soils is also evident in Wales

[1] Scotland uses its own system called the Land Capability for Agriculture.

(Rollett and Williams, 2019).

The Welsh Government frequently refers to soil in its planning policies, in the context of sustainable resources, future generations and global responsibility, including a direct reference to the SDGs (Welsh Government, 2021a), as well as highlighting the negative impact of soil sealing on wildlife habitat and drainage (Welsh Government, 2017). Unusually for a high income country, an entire chapter is devoted to the concept of SLM, in the local context of ALC, but also in the context of having no adverse global impacts, e.g. concerns that the loss of farmland in Wales could lead to expansion of production into environmentally sensitive zones overseas (Welsh Government, 2019c).

Roomfor improvement: Unlike England and Scotland, Wales lacks a published soil policy, but Natural Resources Wales is in the process of appointing a senior research fellow to help develop a soil policy in 2022 (Welsh Government Soil Policy Team, personal communication, December 2021).

4.2. Special commendations

The following states are identified as demonstrating exemplary effort and outcomes in soil governance.

4.3. Bhutan

The small landlocked Himalayan kingdom of Bhutan, which is in one of the world's 36 biodiversity hotspots, with over 70% of its land area forested (60% mandated) and over 50% of its land protected, was declared the world's first carbon-negative country in 2013 (Tshewang et al., 2021). Bhutan is fully committed to SLM, RA, CSA and LDN targets, having participated in the 2015 LDN pilot study, and has prioritised action on SDGs 1 (No poverty), 13 (Climate action) and 15 (Life on land) (Choephyel et al., 2019). In 2006 Bhutan became the first country formally aspiring to become fully committed to organic agriculture, by 2020 (Royal Government of Bhutan, 2006), a goal which has been deferred, although organic methods are widespread and synthetic pesticide restricted by the use of IPM (Tshewang et al., 2021).

Key weakness: Bhutan has no soil policy or soil laws, so soil protection is only indirect. There are also inadequate legal constraints on the consumption of prime farmland (Chhogyel and Kumar, 2018; Zam, 2020).

4.4. Canadian provinces of Ontario, Québec and British Columbia

Canada has relatively robust federal soil laws, but with considerable regional variation. For decades several provinces have experimented with strategies to preserve prime farmland (Eagle et al., 2015), primarily led by Québec, Ontario and British Columbia (BC). Connell (2021) considered Québec's legal framework to be the strongest, followed by BC's Agricultural Land Reserve and the Ontario Greenbelt. The latter, a fraction of the province with a multipurpose aim of protecting watersheds, biodiversity and farmlands, provides huge ecosystem service benefits (Wilson, 2008). Ontario is the only province with a published soil policy, one which demonstrates a holistic appreciation of SES (Ontario government, 2018), alongside a particularly strong track record in managing soil contamination and restoration (Ontario government, 2020). Québec excels in terms of agri-environmental schemes and RA, as articulated in its Sustainable Agriculture Plan (Gouvernement du Québec, 2020). A voluntary ethos of soil health has a stronger foothold than PES in Canada, especially in Ontario and Québec (Équiterre and Greenbelt Foundation, 2021).

Key weakness: While some Canadian provinces or zones demonstrate comprehensive soil governance of the highest level, federal and even provincial consistency is lacking.

4.5. Costa Rica

Costa Rica has transformed itself into a pioneer of sustainable development. In the decades leading up to the 1980s Costa Rica had one of the highest deforestation rates in the world but achieved negative net deforestation by the early 2000s, due mainly to stringent forest laws and its early implementation of PES in 1997 (Pagiola, 2008). It more than doubled its forested landmass from 26% in 1984 to 52% by 2011, becoming the first tropical country to reverse deforestation (Oviedo et al., 2015). Costa Rica participated in the 2015 LDN pilot study and has set LDN targets. There is a national soil policy with a comprehensive soil law and associated regulations and land use plans (Stubenrauch et al., 2018). The 2015 policy of *Política Agroambiental* is an attempt to further integrate agricultural, biodiversity and climate change goals while minimizing land use competition (Wallbott et al., 2019), and the recent National Decarbonization Plan 2018–2050 contains several actions related to agriculture, including soil conservation and enhancement (Government of Costa Rica, 2019).

Key weakness: Costa Rica's soil law is not effectively enforced (OECD, 2017).

4.5.1. New Zealand

New Zealand was one of the world's first countries to pass soil-related laws (Beattie, 2003) and continues to take a leading role in some aspects of soil governance. The 1991 Resource Management Act (RMA) embodies sustainable soil health and protection (New Zealand Government, 2020). Various initiatives address RA (Grelet et al., 2021), PES (Cameron et al., 2020) and CSA (Negra et al., 2014). The proposed *National Policy Statement for Highly Productive Land (NPS-HPL)*, if passed, will merge and strengthen regional policies into one that protects all prime farmland (New Zealand Government, 2019).

Key weakness: New Zealand has a legacy of intensive land use (New Zealand Government, 2018). A national soil strategy could consolidate regional policies and piecemeal initiatives (Grinlinton, 2019) and establish national standards.

4.5.2. Oregon (US)

The US state of Oregon has a long history of taking a lead in natural resource awareness and legislation (Gosnell et al., 2011; Sullivan, 2012), coupled with a robust and participatory governance framework which integrates central and local planning (Armstrong and Jacobs, 1996). Most of the state's forest and farmland has been preserved by controlling the demand side of land consumption via Urban Growth Boundaries (UBG) and controlling the supply side by protecting arable land from development, known as Exclusive Farm Use (EFU) zoning, as well as forest zones. Both measures are strictly enforced, and agricultural land protection extends even beyond so-called "prime" land, to include areas of lower capability, especially where the land is of high value for specific crops (Sullivan and Eber, 2009).

Key weakness: Marginal land has been mis-zoned for EFU or forestry, potentially putting pressure on more valuable land (Campbell, 2019), and permitted non-farm activities have had negative impacts on EFU land (Shackelford, 2020). Other soil policies and laws differ little from the rest of the US (Don Wysocki, personal communication, December 2021).

4.5.3. Sikkim (India)

In 2016 the Indian state of Sikkim became the world's first all-organic state and in 2018 was awarded the Future Policy Gold Award on Scaling up Agroecology, largely due to the holistic approach it had taken (Varini and Guzmán, 2019). Government policy and practice, commonly described as both socioecological and socioeconomic, recognises SES and strongly supports SWC, SLM, CSA and the promotion of soil health through indigenous RA, such as agroforestry and agro-pastoral rotational grazing (Mishra et al., 2021; Sharma et al., 2016), as well as soil testing and pollution control (Government of

Sikkim, 2019). This strategy co-exists with a programme of afforestation and strictly enforced environmental laws to protect forests and biodiversity (Government of Sikkim, 2010; Mishra et al., 2020).

Key weakness: Soil and land protection is bound up with other policies, but lacks explicit laws, which leaves scarce prime farmland highly vulnerable to consumption (Sharma and Acharya, 2013; Sharma et al., 2016).

5. Conclusions

While these standard bearers have been selected as exemplars, this does not imply that their systems of soil governance cannot be improved. Effective soil governance does not guarantee environmental governance or sustainable development, although it is a prerequisite. Most states also still have a long way to go in terms of soil monitoring and reporting. Wealthy industrialised countries typically aspire to high standards of governance and create comprehensive legal instruments to protect their environment but, at the same time, such countries have the greatest need to do so and rarely if ever achieve full compliance. Some poorer countries, like Cabo Verde and Cuba, achieve much more with much less. Even a lack of legislation itself does not always imply lawlessness or neglect, because local context is important.

It does not make sense to conserve soil locally, only to displace the problems of land degradation and soil sealing to another part of the world. Law and policy to protect national land and soil must be accompanied by meaningful external policies of cooperation, support and financial assistance to protect land and soils across the globe. This requires, as a minimum, that international commitments be fulfilled. It also necessitates appropriate regulation of international trade and investment, and of transnational companies and supply chains, and robust application of screening and safeguarding procedures to protect land and soil, and those who depend on them. There is a need for better integration of land and soil governance with climate and biodiversity agendas, including soil biodiversity (CBD/SBSTTA, 2020, CBD/SBSTTA, 2021), and the urgent need to protect and restore high-carbon soils in wetlands, peatlands, rangelands and mangroves (IPCC, 2019).

It is notable that many states, including our standard bearers to varying degrees, have relied on livestock production, including systems aiming to be regenerative (Gosnell et al., 2020), partly because some of their soils, terrain or climate arguably favour that over other forms of land use (Suttie et al., 2005). Yet livestock and feed production, as well as raising concerns about their environmental impact in general (Carter et al., 2014; Garnett et al., 2017), have also encroached on forest or otherwise valuable soils. Conversely, afforestation can damage soils and ecosystems less suited to forestry, or to certain tree species. This reinforces the point that effective soil governance includes matching land capability with appropriate land use. There is also a need to prioritise economic incentives and markets to support sustainable soil use.

Soil literacy, governance and ethics (Heuser, 2018) should be expanded and integrated into formal and informal education. Standard bearers lead by example as well as learning by doing, demonstrating innovative and adaptive management in relation to soil governance. It is the authors' hope that this will encourage others to consider how they might evaluate and characterise their own soil governance, highlight examples of good practice, identify gaps and be inspired to seek solutions.

Declaration of Competing Interest

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