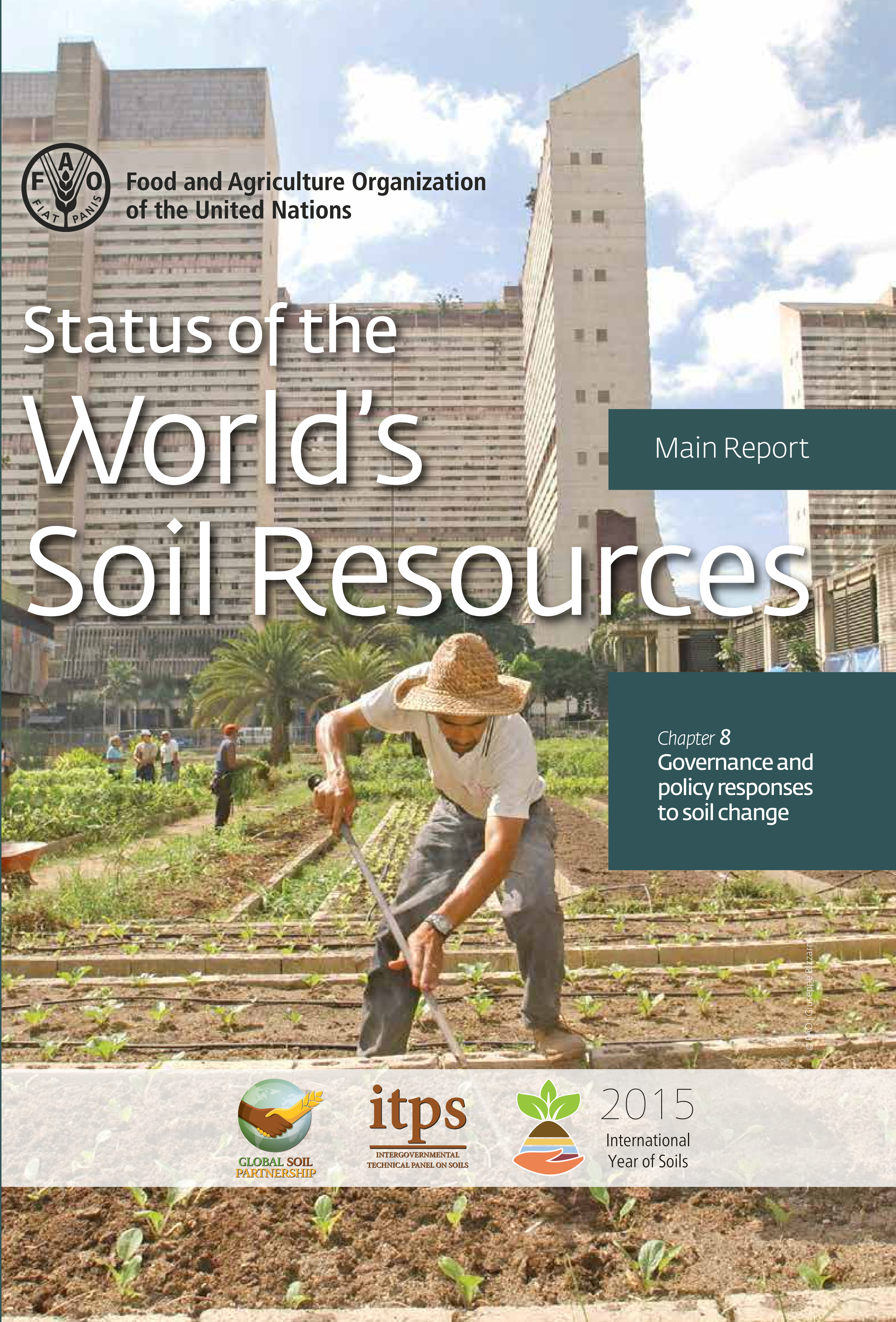

Food and Agriculture Organization of the United Nations

Status of the World's Soil Resources

Main Report

Chapter 8
Governance and policy responses to soil change

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GLOBAL SOIL PARTNERSHIP

itps
INTERGOVERNMENTAL TECHNICAL PANEL ON SOILS

2015 International Year of Soils

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8 | Governance and policy responses to soil change

8.1 | Introduction

This chapter provides an overview of policy and governance responses to soil change. While most attention is given to issues at the global, regional and national levels, it is emphasized that effective responses nearly always have a basis in local action by individual land managers. Indeed, understanding the interconnectedness and the consequences of actions at each level is central to effective governance and policy.

This book, and in particular the regional assessments of soil change (Chapters 9 to 16), demonstrate that at the global scale there is a qualitative appreciation of the pressures on soil resources but limited consistent evidence on their condition and trajectories of change. These assessments reveal that some of the world's soil management challenges are immediate, obvious and serious – they arise partly because of the nature of soils in different regions and their associated history of land management. Other problems are more subtle but equally important in the long term – they require vigilance and a sustained policy response over decades. At present, few countries have effective policies to deal with these problems. In short, the world's soils need to support at least a 70 percent increase in food production by 2050 (FAO, 2011) but there are some fundamental uncertainties. For example:

Is there enough arable land with suitable soils to feed the world in coming decades?

Are soil constraints partly responsible for the apparent yield plateau for major crops?

Can changes to soil management have a significant impact on the seemingly unsustainable global demand for nutrients?

Can changes to soil management have a significant impact on atmospheric concentrations of greenhouse gases without jeopardising other functions such as food and fibre production?

Will the extent and rate of soil degradation threaten food security and the provision of ecosystem services in the coming decades?

Can water-use efficiency be improved through better soil management in key regions facing water scarcity?

How will climate change interact with the distribution of soils to produce new patterns of land use?

A comprehensive global view is needed to respond to these questions. A comprehensive view is also needed to deal with the trans-national aspects of food security and soil degradation. Through trade, most urbanised people are protected from local resource depletion. The area of land and water used to support a global citizen is scattered all over the planet. As a consequence, soil degradation and loss of production are not just local or national issues – they are genuinely international.

The consideration of soil in policy formulation has been weak in most parts of the world. Reasons for this weakness include the following.

Lack of ready access to the evidence needed for policy action.

The challenge of dealing with a natural resource that is often privately owned but is at the same time an important public good.

The long-time scales involved in soil change – some of the most important changes take place over decades and they can be difficult to detect. As a result, communities and institutions may not respond until critical and irreversible thresholds have been exceeded.

Perhaps even more significant for policy makers is the disconnection between our increasingly urbanized human societies and the soil. The task of developing effective policies to ensure sustainable soil management is neither simple to articulate nor easy to implement. This is true regardless of a country's stage of development, its natural endowment of soil resources, or the threats to its soil function.

8.2 | Soils as part of global natural resources management

In setting the stage, it is useful to examine the major drivers, pressures and institutional responses to land use and then set these within the broader international sustainable development agenda (see Table 8.1).

8.2.1 | Historical context

The 'Great Dust Bowl' of the 1930s in the United States of America was pivotal because it triggered widespread public concern about land use, degradation and the need for sustainable management. Severe wind erosion resulted from the opening up of vast areas for cereal production through mechanisation, with associated loss of protective vegetation cover. In response, the Soil Conservation Service of the USDA was established in 1935. This served as a model for many other countries facing similar issues (Young, 1994). In 1937, the United States President Franklin D. Roosevelt famously stated '*The nation that destroys its soil destroys itself*.' This is perhaps the most succinct and sharpest challenge for policy makers and it remains an all-too-real contemporary challenge for policy makers in many countries.

After World War Two, many countries experienced food shortages and governments responded by increasing their investments in agricultural research. Understandably, most of this research focussed on increasing crop yields and food production. During this period there was also a large investment in soil and land resource surveys, particularly in Africa and Asia. In the following decades, soil science was strongly supported, with diverse institutional responses emerging in different regions. In some countries, there was close integration with other aspects of natural resource management while in others, separate soil agencies were established. The FAO played an important role in developing influential technical standards (e.g. FAO, 1976) and supporting within-country programs that aimed to establish sustainable soil and land management. The production of the FAO-UNESCO (1980) Soil Map of the World was a landmark achievement.

The success of the Green Revolution (Borlaug, 2000) along with large increases in crop yields in North America and Europe eventually led to less investment by public agencies in agricultural science and related activities. The emphasis shifted to environmental issues, a transition which occurred during the 1970s and 1980s, particularly in developed western countries. During the 1990s and 2000s, disinvestment in soil science was widespread and many soil departments in universities or governments were either closed or incorporated into natural resource or environmental units. The UN commitment to soil resources through the FAO and related agencies was also scaled back dramatically.

The food price rises in 2007 and 2008 shocked many policymakers out of the belief that stable or declining food prices and assured supplies could be taken for granted (Beddington *et al.*, 2012). This period also marked the start of a critical re-examination of the capacity of the world's soil resources to support sustainable agriculture, assist with climate regulation, and safeguard ecosystem services and biodiversity. Before exploring this topic in more detail, it is useful to review some of the key global agreements relating to soils that emerged from the 1980s onwards.

8.2.2 | Global agreements relating to soils

In 1982, the FAO adopted the World Soil Charter and UNEP published the World Soils Policy (FAO, 1982; UNEP, 1982). It has been difficult to assess the practical impact of these initiatives. Nevertheless, the principles and definitions provided useful guidance for national governments that pursued actions on sustainable soil management.

The first United Nations Conference on Environment and Development (UNCED, 1992, also known as the 'Earth Summit') launched the global environmental agenda (Table 8.1). The UN Convention to Combat Desertification (UNCCD) addressed issues of desertification, land degradation and drought; the UN Framework to Combat Climate Change (UNFCCC) was to tackle climate change; and the Convention on Biological Diversity (CBD) dealt with the challenges of biodiversity conservation and sustainable use (CBD). Supported by the Global Environment Facility (GEF), these conventions have raised awareness and mobilised increased efforts by countries and partners to generate global environmental benefits. These conventions also cover, albeit with less prominence, issues of soil conservation, sustainable land management and land use change, taking into account human as well as ecological perspectives (Hurni *et al.*, 2006).

The ecosystem approach promoted by the CBD between 1998 and 2004 (CBD, 2014), recognised that human management is central to biodiversity conservation and sustainable use. This ecosystem approach was further developed in the Millennium Ecosystem Assessment of 2005. This paved the way amongst international agencies and donor funds for more integrated ecosystem approaches in agriculture. These approaches emphasized the need for sectoral integration, with increased attention given to the benefits of mixed agroforestry and agro-silvo-pastoral systems. Similar approaches had already been developed in many countries. Globally, there was a trend towards the use of incentive measures to encourage land users to adopt sustainable practices which not only enhance production but also maintain biodiversity and ecosystem services (FAO, 2007; MA, 2005; UNEP, 2004). Soils came to be seen in relation to the services they provide for human well-being and poverty reduction. However, compared to other functions, soil-related matters did not feature prominently in policy or programmes.

Following the food crisis in 2008, policy makers at the international level began to appreciate that soils were finite and an important factor that had to be considered in the debate on food security. Within the framework of UNCCD's 'Zero Net Land Degradation', discussions were initiated about the need for quantitative targets and indicators to measure soil degradation (UNCCD, 2012). Concerns over food insecurity, water scarcity, climate change and increasing pressures on limited land and water resources led to much greater dialogue, advocacy and partnerships supporting integrated approaches to this complex set of issues (Beddington *et al.*, 2012; Steffen *et al.*, 2015).

The UN Conference on Sustainable Development (Rio+20), took place in June 2012, two decades after the Earth Summit. In the resulting document, *The Future We Want*, the international community agreed on the need to achieve a *land degradation neutral world in the context of sustainable development* (UN, 2012). The conference also initiated the process of developing universal Sustainable Development Goals (SDGs).

All of the above developments relating to soils and land degradation are framed by the broader issue of climate change. Again, there is a long institutional history but it is useful to start with the establishment of the Intergovernmental Panel on Climate Change (IPCC) in 1988 by the UN Environment Programme (UNEP) and the World Meteorological Organization (WMO). The IPCC provides the world with scientific and technical information on climate change and its socio-economic impacts. The next major development was adoption of the Kyoto Protocol in 1997 by the UNFCCC. The Protocol, which entered into force in 2005, committed industrialized countries to stabilize greenhouse gas emissions, in particular carbon dioxide (CO_2). The Protocol started as a non-binding agreement but later progressed to legally binding agreements on emission reduction targets. The Protocol is of great importance for soils and land management because soils are important carbon sinks. The Protocol recognized opportunities for better management of carbon stores and for the enhancement of carbon sequestration in forestry and agriculture. There was thus clear recognition that soil management can be a vehicle to achieve climate goals – and conversely, that soils can be managed to avoid the loss of carbon through land degradation. Because of the climate system's sensitivity to soil processes, soil-related issues are set to attract increasing attention in future climate agreements.

In recent years, FAO and its member countries have made significant progress in supporting strategies and policies to improve global governance of soil resources. In order to meet the need for a multilateral agreement focusing specifically on soil challenges, and to advocate for sustainable soil and land management at global level, the Global Soil Partnership1 (GSP) was proposed by FAO and the EU and then established in September 2011. The GSP strives to raise awareness among decision makers on the role of soil resources in relation to food security, climate change, and the provision of ecosystem services (Montanarella and Vargas, 2012). Technical and scientific guidance is provided by the Intergovernmental Technical Panel on Soils (ITPS). The ITPS complements related scientific advisory panels including the Intergovernmental Panel on Climate Change (IPCC), the Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES), and the UNCCD's Science-Policy Interface (SPI).

The ITPS has been key to the development of the Plans of Action for the five pillars of the Global Soil Partnership (Table 8.2). It has also been engaged in the development of the Sustainable Development Goals and the initiation of formal reporting mechanisms, including the present book. An indication of the emerging priority accorded to soils and a measure of the impact of the GSP was the declaration by the United Nations General Assembly of 2015 as the International Year of Soils.

1 www.fao.org/globalsoilpartnership

Table 8.1 | Recent Milestones in soil governance and sustainable development

Year	
1982	FAO World Soil Charter
1988	Intergovernmental Panel on Climate Change (IPCC)
1992	UN Conference on Environment and Development
	Rio Declaration
	Agenda 21
	Global Environmental Facility
	UN Convention to Combat Desertification (UNCCD)
	UN Framework to Combat Climate Change (UNFCCC)
	Convention on Biological Diversity (CBD)
1997	Kyoto Protocol
2000	Millennium Development Goals (MDGs)
2005	Millennium Ecosystem Assessment
2008	UNCCD's Zero Net Land Degradation
2011	Global Soil Partnership initiated (FAO/EU)
2012	Rio+20
	Sustainable Development Goals (SDGs) and Post-2015 Development Agenda
2013	Intergovernmental Technical Panel on Soils (ITPS) of the GSP
	Updated FAO World Soil Charter
	Land and Soils integrated in the Open Working Group of the Sustainable Development Goals
	Regional Soil Partnerships of the GSP
2015	International Year of Soils declared by the UN General Assembly

Table 8.2 | The 5 Pillars of Action of the Global Soil Partnership.

Pillar No.	Action
1	Promote sustainable management of soil resources for soil protection, conservation and sustainable productivity
2	Encourage investment, technical cooperation, policy, education awareness and extension in soil
3	Promote targeted soil research and development focusing on identified gaps and priorities and on synergies with related productive, environmental and social development actions
4	Enhance the quantity and quality of soil data and information: data collection, analysis, validation, reporting, monitoring and integration with other disciplines
5	Harmonize methods, measurements and indicators for the sustainable management and protection of soil resources

8.3 | National and regional soil policies

8.3.1 | Sustainable soil management – criteria and supporting practices

International agreements on soil and land resources are helpful but they are all to no avail unless there are complementary policies and coordinated activities at regional, national, district and local levels. Appropriate and effective policies need to reflect the local context in terms of the natural resource issues, culturally acceptability and economic feasibility. However, a unifying scientific narrative is also needed. In broad terms, the criteria for determining whether a landscape is functioning effectively and whether soils are being managed sustainably are as follows.

Leakage of nutrients is low.

Biological production is high relative to the potential limits set by climate and water availability.

Levels of biodiversity within and above the soil are relatively high.

Rainfall is efficiently captured and held within the root zone.

Rates of soil erosion and deposition are low, with only small quantities being transferred out of the system.

Contaminants are not introduced into the landscape and existing contaminants are not concentrated to levels that cause harm.

Systems for producing food and fibre for human consumption do not rely on large net inputs of energy

Net emissions of Greenhouse Gases are zero or less.

We can manage what we can measure, so the task is to ensure that the above criteria can be measured against locally appropriate benchmarks. Without this information, policy makers and land managers do not have indicators of whether they are moving towards sustainability or going backwards. Policy makers also require an appreciation of how soil and land management practices can be applied to achieve desired outcomes. Regardless of the level of mechanization and technological sophistication, farming practices in general need to (FAO, 2013):

Minimize soil disturbance by avoiding mechanical tillage in order to maintain soil organic matter, soil structure and overall soil function.

Enhance and maintain a protective organic cover on the soil surface, using cover crops and crop residues, in order to protect the soil surface, conserve water and nutrients and promote soil biological activity.

Cultivate a wide range of plant species – both annuals and perennials – in associations, sequences and rotations that include trees, shrubs, pastures and crops, in order to enhance crop nutrition and improve system resilience.

Use well-adapted varieties with resistance to biotic and abiotic stresses and with improved nutritional quality, and to plant them at an appropriate time, seedling age and spacing.

Enhance crop nutrition and soil function through crop rotations and judicious use of organic and inorganic fertilizer.

Ensure integrated management of pests, diseases and weeds using appropriate practices, biodiversity and selective, low-risk pesticides when needed.

Manage water efficiently.

Control machines and field traffic to avoid soil compaction.

Thousands of different soil and land management practices have been developed around the world in response to local biophysical, social and cultural settings (e.g. WOCAT, 2007). Most cultures have deep connections with the land, and soil is venerated in diverse ways (Churchman and Land, 2014). In many regions, traditional knowledge still plays an important role in determining land management. However, most traditional systems have been disrupted or modified for a wide range of reasons. The two most common reasons have been the loss of access to land (e.g. invasion and displacement; increasing population densities causing shorter fallow periods on smaller areas; loss of access to grazing lands) and the arrival of new technologies.

8.3.2 | Education about soil and land use

Regardless of the culture or landscape setting, knowledge of soil and land resources is the foundation for achieving sustainable soil management (Dalal-Clayton and Dent, 2001). Spreading knowledge about soils requires formal education, preferably at all levels of schooling. Some countries are developing comprehensive and imaginative curricula that use an understanding of soils as a basis for teaching a wide range of cultural, social, scientific and economic subjects. At a more advanced level, training is needed in a range of soil science sub-disciplines (e.g. soil physics, soil chemistry, soil biology and pedology), Training in soil science needs to be linked to related disciplines including geology, ecology, forestry, agronomy, hydrology and other environmental sciences. Mechanisms for outreach, vocational training and extension are also needed.

Policy makers need to ensure that education systems provide sufficient understanding and training for a nation to achieve sustainable soil management. In particular, farmers and others directly involved in soil management require sufficient knowledge to manage their soils profitably and sustainably.

8.3.3 | Soil research, development and extension

The second key area where policy makers have responsibility is in relation to research, development and extension. The pioneering work of the Soil Conservation Service in the United States and the technical innovations of the Green Revolution are two examples that demonstrate the power of agricultural science and technology. The Green Revolution also highlights how trade-offs are required when there is a focus on a single ecosystem service (food production) at the expense of others (e.g. water quality). Contemporary science policy often focuses on impact and public benefit. In this regard, soil research is often considered simply as a means to an end. Although soil science is vital to several important ends, notably agriculture, environment, water management and climate change, it is often overlooked in priority setting exercises. More formal recognition of soil resources as a cross-cutting issue in science policy is necessary to ensure it receives sufficient support. The recent Australian initiative to achieve a more integrated view of soil research, development and extension is instructive in this regard (Australian Government, 2014).

8.3.4 | Private benefits, public goods and payments for ecosystem services

The amount of regulation on land use and management varies substantially between countries depending largely on the degree of government intervention. Effective regulations on land use and management require a good information base for setting critical limits, implementing various zoning schemes and monitoring compliance. In practice, regulating soil management practices (e.g. application of manure, moderating or increasing fertilizer use, control of dryland salinity) and implementing zoning systems (e.g. to protect the best agricultural soils) involves complex technical, institutional and policy challenges.

Countries that rely less on regulation often opt for incentive schemes to achieve outcomes. Incentives can range from subsidy systems (e.g. for fertilizer in poor countries or for equipment for conservation tillage in developed countries) through to various forms of certification for the adoption of specified soil management practices (e.g. organic farming). Some of these systems have strong economic drivers because they are mandatory for market access (e.g. participation in supply chains to supermarkets).

Implementing effective policies requires organized systems for monitoring soil conditions and an understanding of the relationship between soils and land management. Without this basic information, policy makers have no way of knowing whether regulations and incentive schemes are achieving the desired result.

8.3.5 | Intergenerational equity

Ensuring intergenerational equity is becoming more difficult as human pressures on soil resources reach critical limits. Most traditional cultures and systems of family farming have strong cultural norms that ensure tribal lands or family farms are passed to the next generation in the same or better condition than when they were inherited. However, dramatic changes to land management associated with intensive agriculture, the adoption of Green Revolution technologies, and intensification of land use more generally, are having a major impact on soil resources. The area of arable land per capita is decreasing sharply (0.45 ha in 1961, 0.25 ha in 2000 and a forecast of 0.19 ha in 2050). Future generations will inherit a radically modified land and soil resource.

Many countries have sophisticated reporting systems for assessing issues relating to intergenerational equity (e.g. long-term forecasts to determine the viability of pension and health systems; decadal plans for critical infrastructure). Scenario analysis and futures forecasting are essential to national preparedness and long-term sustainability. There is now an imperative for policy makers to assess the current trends in soil condition and natural resource scarcity summarised in this book and to factor in the consequences to scenario analysis and futures forecasting.

8.3.6 | Land degradation and conflict

Land degradation and resource scarcity can play a role in the rise of conflicts, but these conflicts are rarely purely resource driven. Where tensions about access and use of natural resources do exist, they depend on a variety of factors – the outcomes of which may sometimes cascade from tension into violent conflict, but certainly not always. More often than not, natural resource degradation is a result of conflict rather than a cause. The existence of land degradation can also lead people to seek cooperative solutions. Policy makers and others involved in land management can not only act to resolve resource conflicts but also help to prevent them and to find peaceful mutually acceptable solutions (Frerks *et al.*, 2014; Bernauer, Böhmelt and Koubi, 2012).

8.4 | Regional soil policies

8.4.1 | Africa

Africa has a diverse range of soils and land use systems. However, very large areas, particularly in West Africa, are infertile or of low fertility, and unsustainable systems of land use are widespread. A leading cause of low fertility is nutrient depletion (Smaling, 1993; Stoorvogel, Smaling and Janssen, 1993). This is considered to be the chief biophysical factor limiting small-scale farm production (Drechsel, Giordano and Gyiele, 2004) although other factors including limited organic matter and erosion are significant as well (Bossio, Geheb and Critchley, 2010). Mounting concern over these issues contributed to the creation of the New Partnership for Africa's Development (NEPAD). This is a vision and policy framework produced by the African Union (AU) that aims to provide member countries with guidance over their development agenda. Within NEPAD, the Comprehensive Africa Agriculture Development Programme (CAADP) sets out an agenda targeting annual growth of 6 percent in agricultural production. The Abuja Declaration on Fertilizers, agreed in 2006, laid out the vision for an *African Green Revolution*. Central to this was the aim of increasing the level of fertilizer application from 8 kg ha^{-1} to 50 kg ha^{-1}. However, only slow progress has been made in implementing this agenda at regional and country level (NEPAD, 2012).

Food policy and agricultural development in Africa pose challenges beyond the scope of this book. However, there are some promising developments even for countries facing the most daunting difficulties owing to rapid population growth, very low incomes, weathered and infertile landscapes, low levels of literacy, vulnerability to climate variability and change, disease and significant potential for social unrest. Two of these promising developments have been supported by the Bill and Melinda Gates Foundation.

First is the AGRA Soil Health Programme which aims to increase income and food security by promoting the wide adoption of integrated soil fertility management (ISFM) practices among smallholder farmers and creating an enabling environment for wide adoption of these improved practices across sub-Saharan Africa. The objective is to improve supply and access to appropriate fertilizers, as well as access to knowledge on IFSM for over four million smallholders and to strengthen extension and advisory capacity. The Programme also seeks to influence national policy in favour of investment in fertilizer and ISFM. Some 1.8 million smallholders are reported to be using ISFM, including fertilizer micro-dosing, manure and legumes in crop rotations, with yields in the Sahel up three to fourfold in good seasons.

The second promising initiative is the AgWaterSolutions Project. The project concept builds on the existence of sizable untapped groundwater systems in the region and on the recent availability of small affordable motorized water pumps. The project promotes small-scale distributed irrigation systems that rely primarily on groundwater. In these systems, the access point for water, the distribution system and the irrigated crop all occur at or near the same location. These systems are typically privately owned and managed by individuals or small groups. The potential in countries such as Burkina Faso is large. This initiative is helping to shift the attention of policy makers and planners away from large scale irrigation developments.

There are many other significant soil policy issues facing the region. Examples include: the costs and benefits of subsidy schemes for fertilizers; the growing pressure on land resources and the consequent shortening of fallow periods; the challenge of making inputs affordable and ensuring market access in areas where poverty is prevalent; and addressing urban and peri-urban planning so that more intensive and safe food production systems can develop in and around the rapidly growing African cities.

8.4.2 | Asia

In regions of rapid development in Asia, urbanization, industrialization and intensive land use lead to unbalanced use of agro-chemicals, poor waste management and acid deposition caused by urban air pollution. These factors have contributed to increasing soil contamination and acidification. In China, for example, a soil pollution survey found that 6.4 million square kilometres of arable land are contaminated and that this represents an alarming threat to human health (Yue, 2014). In consequence, China's Environmental Protection Law was revised and strengthened in 2014. However, in China and all across the region the greatest environmental challenges arise from the gap between legislation and implementation (Mu *et al.*, 2014).

In recent years government policy responses across the region have encouraged improved land use practices that increased tree cover for carbon sequestration. Carbon-financing schemes have been implemented. However, government policies have been less effective in dealing with the issue of foreign investment in agricultural land. In some countries, foreign companies have begun a variety of contractual arrangements with local farmers, resulting in some cases in the loss of land for smallholders (Fox *et al.*, 2011).

8.4.3 | Europe

Europe has well-established and strong formal governance mechanisms to address environmental issues at regional, national and sub-national levels. European Union (EU) environmental policies are agreed at central level but legislated and implemented at the national level. However, the experience with soils policy has been more complex and only a handful of member states have specific legislation on soil protection. With the objective of protecting soils across Europe, the European Commission adopted a Soil Thematic Strategy in 2006 which consists of a communication, a proposal for a framework directive (under European Union legislation) and an impact assessment (EC, 2006). The proposal for a Soil Framework Directive would require member states to adopt a systematic approach to identifying and combating soil degradation. However, this could not be agreed by the required majority in the European Council and the draft Directive was consequently withdrawn by the European Commission at the end of 2014. The failure to adopt the directive was largely due to concerns about subsidiarity, with some member states maintaining that soil was not a matter to be negotiated at the European level. Others felt that the cost of the directive would be too high, and that the burden of implementation would be too heavy. However, the Seventh EU Environment Action Plan, which entered into force in 2014, recognises the severe challenge of soil degradation. It provides that by 2020 land in the EU should be managed sustainably, soil should be adequately protected, and the remediation of contaminated sites should be well underway. Furthermore it commits the EU and its member states to increasing efforts to reduce soil erosion, to increase soil organic matter and to remediate contaminated sites (EC, 2013).

8.4.4 | Eurasia

Eurasian countries have well-developed environmental policies and regulations. However following the break-up of the Soviet Union, the system of environmental monitoring and conservation collapsed and has only recently been partially restored. Countries all across the region have maintained and even improved environmental and soil conservation legislation in recent years, but in most countries the mechanisms for quality control and environmental monitoring have been weakened. For example, only Belarus and Uzbekistan maintain their soil survey institutes, and even there soil monitoring has been discontinued.

Ukraine, Russia and Kazakhstan are the countries with the largest under- or unused agricultural lands in the world. The World Bank (2011) states that these countries have the capacity to meet the growing global demand for food. In Russia in 2002 the area of abandoned land reached 70 million ha. Since then there has been a slow decrease in the area of unused land (Nefedova, 2013). However, it should be noted that most land abandonment occurred in badlands, wetlands, steep slopes and areas with an unfavourable climate, while in areas with fertile soils the investment in land management increased. In countries such as Ukraine and Georgia, where land tenure legislation allows land ownership by non-residents, foreign capital is being invested in farmland. Non-transparent land grabs on a large scale are expected to increase, and might have far reaching consequences for the livelihoods of the rural population (Visser and Spoor, 2010).

8.4.5 | Latin America and the Caribbean (LAC)

This region is one of the richest in the world in terms of natural resources. However, rapid exploitation and export of these resources (minerals, gas, forests, and pastures) is occurring with associated dramatic land use changes and widespread land degradation. Nonetheless, some countries in the region have developed and implemented good policies and approaches to mitigate land degradation. These policies, implemented at national and sub-national levels, are good practice examples that could be replicated in other countries in the region (UNEP, 2012).

Uruguay provides a good example of soil and land conservation policies: here the soil conservation policy was designed by the Ministry of Livestock, Agriculture and Fisheries (MGAP) within a programme promoting agricultural intensification, with the objective of implementing a sustainable intensification model. Under this policy, crop producers must submit soil management plans and state the rotation sequence on each plot. They must stay within the maximum tolerable soil erosion amount based on local soil characteristics (Hill, Mondelli and Carrazzone, 2014).

Another example is Cuba's National Environmental Strategy of 2011/2015 which characterizes soil degradation as one of the fundamental environmental challenges in the country. The Cuban government has also implemented action plans to fight desertification and, since 2001, has undertaken programmes for soil conservation (CITMA, 2011). Brazil's Forest Code was updated in 2012: it establishes general standards for protection of forests and other native resources, including soil and water resources. The Forest Code also integrates legal and economic incentives to promote sustainable production activities. However, closer analysis of the updated Forest Code suggests that it may in fact allow more deforestation than the previous version, in response to the demands of agricultural intensification (Soares-Filho *et al.*, 2014).

8.4.6 | The Near East and North Africa (NENA)

This region is considered as the most water scarce and arid region in the world. Moreover, given the scarcity of land and water resources, this region is particularly vulnerable to the impacts of climate change, increasing drought, declining soil fertility and consequently declining agricultural production (Wingkvist and Drakenberg, 2010; Drine, 2011). There are government programs to improve land management in several countries, especially countries that are party to international agreements and are in receipt of donor support. Most actions promoting sustainable land management have been to combat desertification under the framework of the UNCCD (UNCCD, 2012).

Despite significant improvements in the region in tackling the root cause of land degradation, there are still challenges in enforcing environmental regulations and implementing environmental conservation policies. The main implementation constraints are: the weakness of institutions at all levels; the difficulty of coordinating action across sectors, themes, donors and stakeholders; the lack of participation of the local communities; and tenure insecurity.

MENARID (Integrated Natural Resources Management in the Middle East and North Africa) is a partnership working for improvement of the governance of natural resources, including water. MENARID supports restoration of natural resources. In particular, the programme aims to improve the livelihoods of target communities through the restoration of degraded natural resources, including land and soils. It offers a platform for coordination between stakeholders and information sharing in the countries (ICARDA, 2013).

The NENA region is endowed with oil and gas reserves. In areas of rapid urbanization and oil production, soil pollution and soil sealing are associated challenges. Parts of the region are extremely sensitive to political conflicts, and peace and post-conflict are the main focus. Land degradation issues become more pronounced, but inevitably they have to take second place to other concerns.

8.4.7 | North America

In the United States, federal policies favour market-based instruments within an overall environmental governance framework, and these instruments have superseded traditional regulatory instruments. Land use is a priority issue on the political agenda, due to its contribution to GDP through forestry and agriculture. Governments diminish environmental impacts by paying land managers to implement sustainable land management practices and soil conservation. Taxes and incentives encourage land and farmland preservation programmes through payment for ecosystem services (UNEP, 2012).

The United States Conservation Reserve Program (CRP) pays farmers to remove land from agricultural production in order to prevent soil erosion and improve ecosystem functions. This set-aside generates economic benefits of around US$1.3 billion per year (Hellerstein, 2010). However, high prices have made agriculture more profitable and the rates of payment from CRP have not risen so fast. The amount of land enrolled in the programme is therefore expected to decline (Wu and Weber, 2012). The Environmental Quality Incentives Program and the Observation Security Program of 2002 are other programmes that reward farmers for applying sustainable land management practices. It has been estimated that soil erosion could be reduced by 17 percent, saving around 36 million tonnes of soil annually. Valued at US$2 per tonne, the cost of conservation would thus be US$34 million annually, compared to the cost of restoring the soils, estimated at up to US$332 million (Hellerstein, 2010).

In Canada land-use planning is a provincial responsibility and legislation differs widely among provinces. British Columbia has a long-standing Agricultural Land Reserve Program that prohibits development on approximately 4.7 million ha of agricultural land throughout the province. In the early 2000s Ontario created a Greenbelt that protects 0.7 million ha of agricultural and natural lands in the most populated region surrounding Toronto. Generally in Canada the implementation of Payment for Ecosystem Services needs still to be complemented with land use planning frameworks in order to become more effective at all levels of government (Calbick, Day and Gunton, 2003).

8.4.8 | Southwest Pacific

The scale of land degradation across the countries of the Southwest Pacific has given rise to a range of significant policy responses all with a strong emphasis on participative engagement and local action. Perhaps most significant has been the rise of the Landcare Movement in Australia. It began with an unlikely alliance between traditional opponents (conservationists and farmers) and grew into a movement with thousands of groups in Australia and in other countries. The activities of Landcare Groups transformed many landscapes with large areas being revegetated and restored. Youl *et al.* (2006) provide a good outline of the history and factors that were important for success. They conclude that the strength of Australian Landcare is that community groups and networks, with government and corporate support, conceive their own visions and set goals for local and regional environmental action. Working from the ground up to achieve these goals creates freedom and flexibility, giving communities a great sense of purpose.

The Secretariat of the Pacific Community (SPC) is a regional intergovernmental organisation whose membership includes both nations and territories in the Pacific Ocean and their metropolitan powers. The Land Resources Division assists the Pacific Community to improve food, nutritional and income security and sustainable management and development of land, agriculture and forestry resources.

In New Zealand, there are few regulatory instruments directly related to soil. Where they exist, they focus on soil conservation. However there is an increasing number of national policy instruments that legislate against the impacts of unwise soil use. The Resource Management Act is given effect at regional level and regulates activities not outcomes (through regional policy statements, plans and resource consents). These regulatory instruments typically focus on ensuring soil intactness. However, new initiatives are increasingly looking at the consenting of land use according to soil capability. New Zealand has also used non-regulatory approaches to achieve good soil management. These approaches include direct payments, support to the development of industry codes of practice, and certification schemes to ensure market access.

8.5 | Information systems, accounting and forecasting

The distribution and characteristics of the soils in any district or nation are neither obvious nor easy to monitor. As a consequence, understanding whether a land use is well-matched to the qualities of the soil requires some form of diagnostic system to identify the most appropriate form of management and to monitor how the soil is functioning. Important components of the diagnostic system necessary for sustainable land use and management are:

an understanding of spatial variations in soil function (e.g. maps and spatial information)

an ability to detect and interpret soil change with time (e.g. via monitoring sites, long-term experiments, environmental proxies)

a capacity to forecast the likely state of soils under specified systems of land management and climates (e.g. through the use of simulation models)

an understanding of the edaphic requirements of plants

Preparation of this book was severely constrained by the lack of relevant information. Soil map coverages are variable and, in some regions, out-of-date. The capacity to monitor and forecast soil change is also rudimentary. All nations require coordinated soil information systems that parallel those that exist in many countries for economic data, weather and water resources. Action on soil information systems is enshrined in the World Soil Charter's guidelines for action for governments (Sections VIII and IX) and international organizations (Sections I and II). However, creating appropriate institutional systems for soil information gathering and dissemination is challenging for the following reasons:

All levels of government need reliable information on soil resources but often no single level of government or department has responsibility for collecting this information on behalf of other public sector agencies.

Public and private interests in soil are large and overlapping – mechanisms for co-investment by public and private agencies are therefore needed.

Market failure in relation to the supply and demand of soil information is a significant and widespread problem. Simply stated, beneficiaries of soil information do not usually pay for its collection and this reduces the pool of investment for new survey, monitoring and experimental programmes.

Partly as a result of the above, soil-information gathering activities in many countries are currently funded through short-term government programmes, private companies or individuals or are produced in response to specific regulatory requirements. This piecemeal approach does not result in the kind of enduring, accessible and broadly applicable information systems that are needed to meet the requirements of stakeholders.

The following sections outline some specific requirements that policy makers have of soil information systems.

8.5.1 | Soil information for markets

The various types of markets regulated by governments and other institutions need to be sufficiently informed to ensure economic efficiency and the desired allocation of resources.

These markets include:

- traditional real-estate markets where information is needed on the capital value of soil resources (e.g. the nutrient status of a farm, presence of contaminants, and options for improved soil management)
- carbon trading schemes
- cap-and-trade systems for nutrient loading or other pollutants
- forecasting of within-season production of agricultural commodities
- insurance (e.g. crop insurance, disaster insurance, risk analysis of supply chains).

Oversight and regulation of market activities is a central function of governments in most countries. A key responsibility for policy makers is to ensure the availability of reliable soil information.

8.5.2 | Environmental accounting

A closely related area where policy makers are starting to need better information is environmental accounting. Globally, national accounts of economic activity are recorded and indicators such as gross domestic product (GDP) are widely used in government and policy to assess economic activity and progress. However, indicators such as GDP measure mainly market-based transactions and are not a good indicator of welfare; GDP ignores social costs, environmental impacts and income inequality (Costanza *et al.*, 2014). GDP also does not deduct the direct cost of the depletion of natural resources on national income nor does it take into account the impact that our resource extraction and use of nature has on the continued functioning of the Earth system for life support.

In light of these limitations of the current national economic accounting system, the ecosystem services approach seeks to include nature in our accounting and acknowledge that it has value and its use is not simply free and limitless (Westman, 1977; Daily, 1997; Costanza *et al.*, 1997; MA, 2005; Robinson *et al.*, 2014). In this context, soils make an important contribution to the supply of ecosystem services (Daily *et al.*, 1997; Wall, 2004; Robinson, Lebron and Vereecken, 2009; Dominati, Patterson and Mackay, 2010; Robinson *et al.*, 2013).

One proposal to address the deficiency of the current national accounts is to have a set of complementary accounts. Since the early 1990s, the international official statistics community has been developing such a set of accounts, named the System of Environmental Economic Accounting (SEEA). The over-arching objective of the SEEA approach is to develop an accounting structure that integrates environmental information with the standard national accounts and hence to mainstream environmental information in economic and development policy discussion.

The SEEA accounts are presented in two volumes. First, the SEEA Central Framework (UN *et al.*, 2014) which was adopted as an international statistical standard in 2012, and second, SEEA Experimental Ecosystem Accounting (UN *et al.*, 2014) which was endorsed in 2013. The SEEA Central Framework deals with individual environmental assets (minerals, timber, fish, water, soil, etc.), the flows of mass and energy between the environment and the economy, and the space in which this occurs (Obst and Vardon, 2014). SEEA Experimental Ecosystem Accounting is focused on the function of ecosystems and the generation of ecosystem services which is dependent on ecosystem extent, condition and quality.

The SEEA Central Framework identifies seven individual components of the environment as environmental assets; mineral and energy resources, land, soil resources, timber resources, aquatic resources, other biological resources (excluding timber and aquatic resources, for example, livestock, orchards, wild plants for medicine, wild animals that are hunted), and water resources.

SEEA Experimental Ecosystem Accounting uses the same definition of environmental assets but rather than considering individual components as assets, it seeks to consider the way in which these components function jointly as ecosystems. To apply this logic it defines spatial areas, such as different vegetation habitats (forests, wetlands, agricultural land etc.) as ecosystem accounting units. In this approach soil is considered a component within a broader ecosystem rather than being considered as a distinct ecosystem.

Soils form an important part of the Central Framework, being recognized as an environmental asset in their own right. An important distinction is made between land and soil resources. Land is considered in terms of space and location often referred to as Ricardian land (Daly and Farley, 2011). Soil resources are the volume of biologically active topsoil, and its composition in the form of nutrients, soil water and organic matter. The accounts are structured to recognize, and distinguish between, the use of an asset (e.g. soil volume and area within the asset accounts); and the use of the soil resource or elements of the soil resource (e.g. carbon, nutrients and soil moisture in the physical flow accounts). Fundamental to the accounting process is the measurement of change for both the environmental and ecosystem accounts, which is underpinned by the availability of good quality data (Obst, Edens and Hein, 2013). The major aspects of soil of interest for the environmental accounts are: the volume of soil moved or extracted; the area of soil under different land uses; carbon, nutrient and moisture stocks; and changes in these three aspects. Hence the understanding and quantification of soil change is central to environmental accounting (Robinson, 2015).There is still no agreed set of soil indicators, although soil carbon content is widely seen as being perhaps the main indicator. There is still much work to do to synthesize soil quality work into the SEEA framework for the creation of useful, informative accounts, and to encourage countries to adopt this unified approach.

8.5.3 | Assessments of the soil resource

It is essential to have some form of regular reporting on the rate and extent of soil change along with the likely consequences for society at local, national and global scales. Some countries now have various forms of audits and state-of-the-environment reports. However, most countries do not produce regular assessments showing where land management systems can operate sustainably within the constraints set by changing climate, weather and soils. These are necessary given the economic and environmental significance of soil resources.

Regular reporting forces policy makers to impose an operational discipline on the management of soil information. Systems for collecting and analysing data can be progressively improved and a body of knowledge will be developed over several cycles of reporting. The assessments need to adopt a highly participative mode of engagement so that all stakeholders are represented and then empowered to make the necessary changes to land management.

The World Soil Charter addresses this issue directly. It encourages governments to develop a national institutional framework for monitoring implementation of sustainable soil management and overall state of soil resources. International organizations are encouraged to facilitate the compilation and dissemination of authoritative reports on the state of the global soil resources and sustainable soil management protocols.

This book is a sign that progress is being made in relation to regular assessment and reporting. Further progress will depend on successful implementation of Pillar Four of the Global Soil Partnership - *Enhance the quantity and quality of soil data and information* – and of Pillar Five - *Harmonize methods, measurements and indicators for the sustainable management and protection of soil resources*.

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