ITPS-V/16/Report

Report of the Fifth Working Session of the Intergovernmental Technical Panel on Soils

Rome, Italy, 14-18 March 2016

Food and Agriculture Organization of the United Nations

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INTERGOVERNMENTAL TECHNICAL PANEL ON SOILS

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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1. Opening of the session

The fifth working session of the Intergovernmental Technical Panel on Soils (ITPS) was held at the FAO Headquarter in Rome from the 14th to the 18th of March. Mr. Eduardo Mansur (Director Land and Water Division, FAO) welcomed ITPS members and underlined the importance of the Status of the World's Soil Resources (SWSR) report as the main ITPS contribution. The SWSR was the main product of the International Year of Soils and as such, it raised attention to protect our global soils. In this context, the expectations from ITPS are very high. Mr. Mansur also highlighted the importance of the Voluntary Guidelines for Sustainable Soil Management (VGSSM), which will be hopefully presented to the upcoming GSP Plenary Assembly and the FAO Council. He congratulated the ITPS for the excellent work done so far and confirmed the high expectations for future work. He concluded that all these activities depend on ITPS work and contribution, so he wished a productive ITPS working session.

2. Adoption of the Agenda, Timetable and election of the Rapporteur

Mr. Luca Montanarella (ITPS Chair) called upon the panel for any additional agenda items or requests for modification of the proposed draft agenda. The agenda was dully endorsed as initially proposed.

Mr. Juan Comerma suggested a slight change in the agenda of moving the presentation of the 5 groups to the third day. This was accepted.

The Chair invited new ITPS participants to the meeting to introduce themselves.

Mr. Bhanooduth Lalljee and Mr. Siosiua Moala Halavatau agreed to be rapporteur and co-rapporteur respectively for the session with the support of the GSP Secretariat.

3. Report of the work performed since the 4th working session of the ITPS

Mr. Montanarella reported on the work performed by the ITPS since the 4th working session as follows:

- The zero-order draft of the VGSSM was developed as expected and was subject to an online consultation;
- Contribution to development of Implementation plans: the pillar 4 implementation plan was finalized during the INSII workshop where ITPS group 4 chair was present and active; other pillars are starting the process of developing implementation plans where ITPS members are ready to contribute to the process;
- A position paper on soil organic carbon was presented at the COP21 (where soils were discussed under the climate change agenda);
- ITPS started cooperation with IPBES in its land degradation and restoration assessment.
- Further to a question of an ITPS member, Mr Montanarella also gave a brief of ITPS participation at the COP 21 in Paris.

Mr. Montanarella concluded that ITPS successfully completed most if not all the activities that were agreed on the workplan 2015-2017. However, remarks were raised about the planned timetable of the VGSSM process and the expected role of ITSP members on the GSP Pillars. Mr. Vargas (GSP Secretary) clarified that the change on the timetable of the VGSSM process was due to the feedback

received during an email consultation with member countries. They suggested to speed up the process to use the momentum created by the IYS and also considering that the Committee on Agriculture (COAG) session is planned for September 2016. He also clarified that the ITPS Chairs for every GSP pillar are expected to be active members of the Global Working Groups who are tasked to develop Global Implementation Plans for every pillar, as well as to accompany the execution of those plans. It is hoped that ITPS Chairs will be keeping direct communication with all ITPS members when doing this work.

4. Review and finalization of the first draft of the Voluntary Guidelines for Sustainable Soil Management

Ms Lucrezia Caon (GSP Secretariat) presented the comments on the VGSSM zero-order submitted by participants of the E-consultation. This consultation was very productive and important as many comments and suggestions to the VGSSM were provided. The inputs received were of two types: a) general nature and b) specific thematic comments. The general and major points of attention are:

- Length of the document
- The use of the terms “soil” and “land”
- The focus of attention of the document only on agricultural soils
- Conservation agriculture
- The voluntary nature of the document
- The political and economic dimensions (e.g. the economics of soil degradation)
- Stakeholders and final users of the voluntary guidelines

ITPS members worked on the document in order to reflect the general comments provided as well as those specific thematic suggestions. Various iterations were performed before agreement was reached during this session. The chair of the Pillar 1 working group took the lead to finalize the first-draft of the VGSSM with the aim of incorporating all the suggestions made by ITPS members during these iterations.

It was decided to add a glossary to the document, shorten the text, concentrate mostly on agricultural soils without excluding other services, rethink the table of content, refer to “soil” only and better specify the topic and sphere of action of the guidelines in their introductive section. In order to make the guidelines accessible to the general public, it was decided to use a friendly terminology for those who are not soil scientists.

After a final editorial review, the first draft of the VGSSM (Annex 1) was endorsed by ITPS members on Friday 18th March.

It is important to note that the ITPS provided essential scientific and technical backbone to the document, leaving to the Open-Ended Working Group (OEWG) to deal with the more politically relevant elements of these guidelines.

5. Follow up of the Status of the World’s Soil Resources report

Regarding the launch of the Status of the World’s Soil Resources report, it was stressed the need to provide more visibility and easy access to the online version. Also, it was suggested to at least translate the summary report into French and Spanish. Mr. Kazuyuki Yagi also presented the Japanese version which was much appreciated. The Secretariat agreed to make all these efforts to

provide real visibility to this important document. It was also suggested to send a printed copy to key institutions.

Regarding the future version of this report, the GSP Secretariat informed that Mr. Freddy Nachtergaele prepared a draft proposal on how a new version could be developed by 2020. It was agreed that this draft will be shared with ITPS members for their consideration. Though it was noted that current members will not be part of ITPS by that time.

Meanwhile, ITPS established four specific working groups (Annex 2 includes the composition of these groups) tasked to closely follow up on the four main priorities for action identified by the SWSR:

1. Sustainable soil management and assessment of soil degradation and restoration (WG Leader: Gunay Erpul, Turkey)
2. The global management of soil organic matter (WG Leader: Miguel Taboada, Argentina)
3. Sustainable nutrient management aiming to stabilize or reduce global nitrogen (N) and phosphorous (P) fertilizer use while simultaneously increasing fertilizer use in regions of nutrient deficiency. (WG Leader: Gary Pierzynski, USA)
4. Improve soil data and information systems. (WG Leader: Neil McKenzie, Australia)

The 4 working groups will work towards contributing to the new version of the SWSR once the approach is agreed by ITPS members when considering the draft to be provided by the GSP Secretariat.

6. Follow up of the GSP Plans of Action and the Regional Implementation Plans

Mr. Vargas and Mr. Rainer Baritz provided a report on the status of the five GSP pillars. They highlighted that:

- Pillar 1: a professional will join the GSP Secretariat in April and will lead the development of the Pillar 1 implementation plan. A working group will be established for that aim. Meanwhile various activities are under development, including the VGSSM, Soil Doctors programme, the Abuja meeting on fertilizers, etc.
- Pillar 2: its implementation plan is under development and is facilitated by Ms. Caon. Various activities are planned, especially in relation to awareness raising via the World Soil Day and the establishment of the World Soil Prize. Also, capacity development activities are under implementation.
- Pillar 3: a professional will join the GSP Secretariat in April and will lead the development of the Pillar 3 implementation plan. Meanwhile, the GSP Secretariat has been participating in events where research was addressed and potential activities are under consideration.
- Pillar 4: it is the most advanced pillar as its Implementation Plan is already finalized. A meeting of the International Network of Soil Information Institutions was organized in December 2015 where the plan was finalized. After its formalization during the GSP Plenary Assembly, focus will be given to its execution.
- Pillar 5: a working group was established and is currently developing Pillar 5 Implementation Plan. The GSP Secretariat also participated in the Global Open Data for Agriculture and Nutrition (GODAN) workshop and supported some important workshops in Asia. The synergy between pillars 4 and 5 working groups was also emphasized,

Mr. Vargas invited ITPS members to be actively involved in the development/execution of Regional Implementation Plans. He concluded his intervention by reminding the role of each ITPS chair in the global working groups and the need to keep interacting with ITPS members in all those processes. After this presentation, the ITPS Chairs of each Pillar were invited to report about progress made after the last ITPS session in September 2015.

- Pillar 1: Mr. Dan Pennock (chair) reported that they are waiting to know who the GSP facilitator/chair will be. Mr. Vargas ensured him that they will be informed about it soon. Mr. Rainer Horn joined the working group for this pillar.
- Pillar 2: Ms. Maria de Lourdes Mendonça Santos Brefin (chair) asked the WG2 of the ITPS to actively participate in the development of the implementation plan, which started at the beginning of March.
- Pillar 3: Mr. Brajendra Parmar (chair) reported that they are still waiting to know who the GSP facilitator/chair will be. Mr. Vargas ensured him that they will be informed about it soon. Mr. Kazuyuki Yagi and Mr. Nsalambi V. Nkongolo joined the working group.
- Pillar 4: Mr. Neil McKenzie (chair) reported on the INSII meeting and the good momentum for Pillar 4 activities. Mr. Rainer Baritz (GSP Secretariat) and Mr. Vargas complemented his presentation by talking about the governance and structure of the INSII, underlining that the consultation process is over and that the document will be shared with the ITPS only for their information.
- Pillar 5: Mr. Bhanooduth Lalljee (chair) explained the links between GSP pillars 4 and 5 and this was supported by Mr. Baritz. Mr Lalljee stated that he had read all the regional implementation plans that were available and further stated the large commonalities among them. It was underlined the need for producing good standard and validated methods of soil analysis and soil descriptors in order for them to be accepted and applied worldwide. To conclude, the problem of standardizing soil organic carbon measurements was again mentioned. Mr. Peter de Ruiter and Mr. Brajendra Parmar volunteered to form part the working group.

7. Report on the collaboration between ITPS and SPI of UNCCD, IPBES and IPCC

The chair introduced a general summary regarding the collaboration between ITPS and other UN panels and asked ITPS members to introduce themselves. Then, he requested the different representatives of the UN panels to make presentations which was followed by a very interactive discussion.

SPI of the UNCCD

The representatives of the SPI of the UNCCD, Mr. Hamid Custovic and Mr. Victor Castillo, provided a presentation on the collaboration between SPI-UNCCD and ITPS. They highlighted the joint workplan that was agreed during the first joint meeting between these panels at the Global Soil Week in 2015.

Participants raised questions about specific topics and also suggested themes for collaboration. Among them, one was related to soil erosion as this was identified as priority number one of the SWSR. The SPI does not have specific activities on soil erosion but they have activities that indirectly consider it, e.g. soil carbon loss. Although at the moment there are not mandates on soil erosion in the SPI program, representatives stated that there is space for soil erosion issues in the objectives of

the SPI. ITPS members underlined the importance of addressing soil erosion and indeed, this could be a topic in which ITPS could contribute to SPI/UNCCD.

ITPS members could support the SPI on how to develop indicators for monitoring soil degradation, e.g. soil erosion, soil contamination. Additionally, they underlined the importance of having scenarios allowing to predict and foreseen soil degradation instead of just monitoring it.

After the interactive session, the following topics were concluded:

a) The SPI-UNCCD was requested to allow the ITPS to contribute with a chapter on soils in the Global Land Outlook that is currently under development.
b) ITPS responsibility on assessing soil organic carbon (including a new global soil organic carbon map by 2017) in the framework of indicator 15.3.1 of the SDGs and the endorsed metrics for the assessment of land degradation neutrality (LDN).
c) A joint global assessment of soil erosion will be performed under the leadership of Working Group 1 "Sustainable Soil Management" of the ITPS (Lead G. Erpul, Turkey).

Deliverables will be submitted to the 5th GSP Plenary Assembly and to the COP 13 of UNCCD in 2017.

IPCC

Mr. Mannava Sivakumar (Acting Secretary of the IPCC) provided a detailed presentation on IPCC work and the reporting process. He highlighted the priorities of IPCC, which are: the involvement of all the countries in writing the IPCC reports, the procedure behind the selection of the authors (it should be formal and supported by the governments), the organization of workshops for involving experts and collecting inputs, awareness raising in meteorology through the establishment of master course and meteorological institutes at country level.

After his presentation, a very dynamic interaction with ITPS members took place with the main question on how soils could be more prominent in the climate change agenda and how ITPS could collaborate and work with the IPCC. Mr. Sivakumar responded positively that soils are already indirectly part of the assessment reports, but certainly this could be improved. Both ITPS members and IPCC representative agreed to the following:

- Taking note of the importance of soils for climate change adaptation and mitigation, the GSP Secretariat and ITPS would officially request IPCC to consider the participation of the Intergovernmental Technical Panel on Soils at the IPCC fora on an Observer status;

- Considering the importance of soil organic carbon (SOC) in the climate change debate and after understanding the need for incorporating this issue into the IPCC Assessment Reports (especially AR6), the GSP Secretariat/FAO and ITPS would write a letter to invite IPCC to jointly organize a Global Soil Organic Carbon Conference during the first quarter of 2017. The aim of this conference would be to review the role of SOC in the climate change agenda with the view of proposing its incorporation into the IPCC ARs. Further details on the venue, dates and organization would be further discussed.

- The GSP/ITPS committed to help in increasing the visibility of the IPCC reports.

IPBES

Ms. Anastasia Brainich (IPBES Secretariat) provided a presentation about IPBES work, especially the one related to the Land Degradation and Restoration Assessment. Mr. Montanarella explained that ITPS is already collaborating with IPBES as he (in his role of ITPS Chair) is co-chairing this assessment.

Ms. Brainich presented the status and way forward of this important assessment. It was noted that a First Peer Review process of the report entitled "Land Degradation and Restoration Assessment" (LDRA) will take place from 30th May to 11th July 2016. After the presentation, questions were raised about the process and how to streamline the role of soils for ecosystem services and biodiversity beyond this assessment process. The main conclusions of this session are:

- It was noted that a First Peer Review process of the report will take place from 30th May to 11th July 2016. The GSP Secretariat and ITPS chair suggested to the IPBES representative to facilitate more collaboration between IPBES and ITPS. Practically, it was suggested that IPBES could formally request ITPS to peer review this report as a panel and not as individual independent experts.
- The GSP Secretariat offered to host the Third Author Meeting Draft assessment in FAO HQ (planned for June-July 2017).

The 4 pour 1000 initiative

As requested by ITPS members, Ms. Ségolène Halley des Fontaines (Permanent Representation of France to FAO) was invited to provide a short presentation on the 4 pour 1000 initiative. She explained that after its launch, they are working on a light governance and setting a scientific panel. Further details on the initiative are available at the 4/1000.org website. ITPS members asked about the potential synergies and the need to avoid duplication of efforts with other initiatives such as the GSP. At the same time, they suggested that ITPS is ready to support this initiative. At the end, Mr. Mansur informed that FAO is a member of the initiative and as such suggested that the GSP could embrace this initiative so to foster synergies and collaboration. He also suggested that the initiative is presented at the 4th GSP Plenary Assembly.

8. Review of the work plan for ITPS 2015-2017

The agreed workplan was reviewed in order to update it with recent activities that were agreed upon and those that were already implemented. As such, it was agreed that the following activities will be implemented in the period 2015-2017:

- The five ITPS working groups identified per each pillar will keep on working on the implementation plans;
- Four working groups will prepare reports on the progresses made in addressing the four priorities identified in the SWSR report;
- WG1 and WG2 will support the SPI-UNCCD;
- All ITPS members will review the LDRA from IPBES (if official request is received);
- WG2 and WG4 of the ITPS will participate in the preparation of the joint ITPS-IPCC SOC Conference which will be held in the first half of 2017;
- The ITPS will work on preparing the second edition of the SWSR.
- The ITPS should work on publishing scientific articles and position papers.
- Joint organization of an international conference on soil organic carbon.

9. Support to the SDG process through soil indicators

Mr. Montanarella reported that during a meeting on "Indicators for the SDG 15" held in Washington on 25-26 February 2016, the GSP was requested to task the ITPS to work on the indicators for target 15.3 of the SDGs. Mr. Montanarella took time to explain the process behind the approval of target

15.3 and the work of the UN statistic commission in identifying the indicators to be considered in the SDGs implementation.

Sub-indicators of target 15.3 are:

- Land cover: divided into “land cover” and “land cover change”. This sub-indicator is at the base of the other 2 sub-indicators;
- Land productivity;
- Organic matter. There was a specific request to the GSP and the ITPS to work on this sub-indicator.

Mr. Sergio Bonilla (GSP Secretariat) reported that indicators should have the following characteristics: (1) be country driven; (2) be simple, doable and implementable; and (3) they should be aligned with e.g. UN-country processes. Additionally, data should come from multiple sources like official statistics and earth observation, land use and management practices, surveys, sampling and citizen sourcing. The delivery time of the indicators should still be discussed, however this will be decided soon. ITPS committed to accompany this important process.

10. Preparation of an ITPS publication for 2016

During the meeting it was agreed to prepare a review paper on soil degradation. Particularly, the paper should deal with the stage at which soil degradation becomes an issue. Thereafter, the paper will report on the indicators currently available for assessing thresholds of degradation. Mr. Dan Pennock and Mr. Rainer Horn will lead the development of a draft paper for consideration of ITPS members. ITPS also agreed to be in alert in case a request or an opportunity arises for publishing articles or position papers that are relevant to ITPS work.

11. Report to the Fourth GSP Plenary Assembly

Mr. Montanarella will prepare a draft ITPS report for consideration of ITPS members, before its submission to the 4th GSP Plenary Assembly.

12. Date and venue of the next meeting

It was suggested to again consider the idea of hosting the next ITPS meeting outside Rome, for example in India. However, remarks were raised on the need to choose the location of the next meeting strategically, considering the concomitant happening of other activities and the possibility for the ITPS to promote actions in the region were the meeting is held. Mr. Vargas explained that the date and venue of the next working session could not be decided now as this depends on the outcomes of the GSP Plenary Assembly and the dynamics of the GSP implementation. However, the suggestions regarding the venue will be considered and the dates will be announced as soon as feasible.

13. Any other business

As requested a slot was given to Mr. Camillo de Camillis who introduced the Livestock Environmental Assessment and Performance Partnership (LEAP). He invited GSP/ITPS to develop synergies and jointly work on common issues such as assessment of nutrients such as nitrogen and phosphorus. His presentation was appreciated and he agreed to share further information for future consideration. .

14. Closing of the meeting

Appropriate thanks were expressed to all who contributed to a successful and productive meeting.

ANNEX I: First draft of the Voluntary Guidelines for Sustainable Soil Management

1. Introduction

1.1 Context for sustainable soil management

The United Nations designated 2015 as the International Year of Soil and the many activities held throughout the year highlighted the central importance of soils to human wellbeing and ecosystem health. The soil resource provides incalculable value to society through ecosystem services and there is a high return on investment into sustainable soil management (SSM). Widespread adoption of SSM generates many societal benefits especially for smallholder farmers who depend directly on their local soil resource.

An important development in the promotion of SSM is the Global Soil Partnership (GSP, established in 2012) and its scientific advisory body, the Intergovernmental Technical Panel on Soils (ITPS, established in 2013). The major objective of the GSP is to promote and support the global adoption of SSM practices. This objective cross-cuts the five Pillars of Action of the GSP.

The ITPS has published two key documents that set the context for the Pillars of Action. First is the revised World Soil Charter which is a statement of general principles that define SSM and specify a series of actions to be undertaken by stakeholders to facilitate its adoption. The World Soil Charter states that:

> *The overarching goal for all parties is to ensure that soils are managed sustainably and that degraded soils are rehabilitated or restored.*

The second document is the Status of the World's Soil Resources report[1,2] which provides a comprehensive summary of the key threats to soil function. The regional assessments in the report conclude that the most important threats are soil erosion, organic carbon change, and nutrient imbalance. The drivers of threats vary across the regions and in some they are closely related to poverty, the poor state of infrastructure and limited access to markets for agricultural products.

SSM has a much more general significance and it is especially relevant to the achievement of Sustainable Development Goals 2 and 15.

> ***Goal 2. End hunger, achieve food security and improved nutrition, and promote sustainable agriculture***
>
> *2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change,*

[1] Status of the World's Soil Resources Technical Summary

[2] Status of the World's Soil Resources Main Report

extreme weather, drought, flooding and other disasters, and that progressively improve land and soil quality.

Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

15.3 By 2030, combat desertification, and restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land-degradation neutral world.

Goal 2 recognizes that food security and nutrition requires establishment of effective sustainable agricultural production, which, in turn, is impossible without maintenance of soil functions. Sustainable soil management practices are essential for ensuring stable or increasing production from arable lands, pastures and forestry systems (including agroforestry). Combating soil degradation requires introduction of sustainable soil management systems that address the challenges of Goal 15.

The Paris Agreement is a legally binding acknowledgment that the international community must act upon in order to hold "the increase in the global average temperature to well below 2 °C, and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels". The same article of the Agreement (Article 2), refers implicitly to agriculture and to the way "to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production." Soil management plays a crucial role in achieving these goals through carbon sequestration and this is central to programs such as the French 4 per 1000 initiative which aims to increase soil organic carbon stocks by 4 ‰ per year.

This document presents the Voluntary Guidelines for Sustainable Soil Management (VGSSM). The guidelines provide a framework for the development and implementation of practices and policies at the local or regional levels to fulfill the overarching goal of the World Soil Charter. The guidelines focus on mostly on agriculture, broadly defined as the production of food, fiber, or feed, whereby provisioning is a key ecosystem service, although many of the principles described here have a significant influence on other ecosystem services provided by both managed and unmanaged soil systems.

1.2 Scope and objectives of the guidelines

The guidelines aim to provide an easily accessed and readily understood document for a wide range of stakeholders including farmers, land managers, extension officers, governmental officials, private investors and policy makers. All stakeholders are encouraged to follow the guidelines.

The *scope* of the guidelines is based on the following

- The guidelines focus on technical aspects of sustainable soil management and relate most directly to farm, forest and land management more generally. They also inform

strategic decision making by governmental levels at all levels. The guidelines do not replace databases of SSM/Sustainable Land Management (SLM) practices such as WOCAT and TECA which provide more detailed guidance on locally appropriate actions for managing soils. Selection of the most appropriate management practices requires careful consideration of a range of interacting factors including climate, relief, soil characteristics, previous land use, and available technology for the area in question.

- The guidelines focus on soils that are being managed for the sustainable production of food, fibre and fuel. The guidelines highlight the core characteristics of sustainably managed soils. They also provide a summary of ecosystem services provided by soils that are important to the environment and human well-being (see Table 1).
- The guidelines are of voluntary nature and are not legally binding.

The *objectives* of the guidelines are:

- to present generally accepted and scientifically based principles for SSM;
- to provide guidance to all stakeholders on how to apply and implement these principles whether it be for farming, forestry or land management more generally.

1.3 Definition of sustainable soil management

The definition of SSM used in these guidelines is drawn from Principle 3 in the revised World Soil Charter:

> *"Soil management is sustainable if the supporting, provisioning, regulating, and cultural services provided by soil are maintained or enhanced without significantly impairing the soil functions that enable those services. The balance between the supporting and provisioning services for plant production and the regulating services the soil provides for water quality and availability and for atmospheric greenhouse gas composition is a particular concern."*

The ecosystem services provided by the soil and the soil functions that support these services are specified in Table 1.

Table 1. Ecosystem services provided by the soil (left-hand column) and the soil functions that support these services (right-hand column).[3]

Supporting services: Services that are necessary for the production of all other ecosystem services; their impacts on people are often indirect or occur over a very long time	
Ecosystem Services	***Soil functions***
Soil formation	Weathering of minerals and release of nutrients
	Transformation and accumulation of organic matter
	Creation of structures (pores, aggregates, horizons) for gas and

[3] Status of the World's Soil Resources. Main Report

	water flow and root growth
	Creation of charged surfaces for water and ion retention and exchange
	Succession of soil biodiversity communities
Primary production	Medium for seed germination and root growth
	Retention and supply of air, nutrients and water for plants
Nutrient cycling	Transformation of organic materials by soil organisms
	Retention and release of nutrients on and from charged surfaces
Regulating services: benefits obtained from the regulation of ecosystem processes	
Water quality regulation	Filtering and buffering of substances in soil water
	Transformation of contaminants
Water supply regulation	Regulation of water infiltration into soil and water flow within the soil
	Drainage of excess water out of soil and into groundwater and surface water
	Water vapor exchange with atmosphere
Climate regulation	Regulation of CO_2, N_2O, and CH_4 emissions
	Soil organic carbon sequestration
Erosion regulation	Retention of soil on the land surface
	Resistance of soil aggregates against wind and water erosion
Flood regulation	Increasing infiltration and reducing runoff
	Slowing water movement from uplands to lowlands by surface-water retention and soil-water storage.
Provisioning Services: products ('goods') obtained from ecosystems of direct benefit to people	
Food supply	Providing (healthy) water, nutrients, and physical support for growth of plants for human and animal consumption
Water supply	Retention and purification of water
Fiber and fuel supply	Providing water, nutrients, and physical support for growth of plant, bioenergy, timber and fiber
Raw earth material supply	Provision of topsoil, aggregates, clay, peat etc.
Surface stability	Supporting human habitations and related infrastructure and provision of construction materials
Habitat	Providing habitat for soil fauna
Genetic resources	Source of unique biological materials (e.g. pharmaceuticals, biochemical, allelochemicals)
Cultural services: nonmaterial benefits which people obtain from ecosystems through spiritual enrichment, aesthetic experiences, heritage preservation and recreation	
Aesthetic and spiritual	Preservation of natural and cultural landscape diversity

	Source of pigments and dyes
Cultural Heritage	Preservation of archaeological and historical records

1.4 Management impacts on soil functions and ecosystem services

Soils have diverse chemical, physical and biological properties. As a consequence, they differ in their responses to management practices and in their inherent ability to deliver ecosystem services (see Principles 2 and 5 of the World Soil Charter). Some soils are resilient to disturbance whereas others are vulnerable to degradation. Despite the great global diversity of soils, those that are managed sustainably tend to have a common set of general characteristics.

1. Rates of soil erosion by water, wind and tillage are minimal.
2. The structure of the soil is resistant to degradation and provides a stable physical context for movement of air and water and the growth of roots.
3. There is sufficient surface cover (e.g. from growing plants and plant residues) to protect the soil surface.
4. The store of soil organic matter is stable or increasing, and close to the potential maximum for the local environment and land management system.
5. The flows of nutrients are appropriate – sufficient for high rates of biomass production relative to water availability, and efficient insofar as leakage of nutrients by leaching or retention, gaseous emissions or erosion is low.
6. Water is efficiently captured and stored (e.g. from precipitation and supplementary water sources such as irrigation) to meet the requirements of plants and ensure the drainage of any excess.
7. Contaminants are not concentrating to levels that cause harm.
8. The management systems for producing food, feed, fuel and fiber do not rely on large net inputs of energy.

All of the above characteristics must be present simultaneously – the absence of any one of them will undermine essential soil functions and limit the provision of ecosystem services. In the most extreme case, changes in soil management and land use can cause irreversible harm and eliminate the possibility of achieving SSM. Obvious examples of these irreversible changes include sealing of the soil surface during urban development, stripping of the soil for resource extraction (e.g. mining), and waste disposal.

2. Guidelines for sustainable soil management

2.1 Soil erosion

Soil erosion by water, wind, and tillage was identified in the Status of the World's Soil Resources report as the most serious threat to global soils and the ecosystem services they provide. Soil erosion causes the loss of surface soil layers containing organic and mineral nutrient pools, partial or complete loss of soil horizons and possible exposure of growth-limiting subsoil, and damage to private and public infrastructure. Water erosion further causes major issues with sedimentation and nutrient pollution in downstream water bodies.

2.1.1 Land-use changes (such as deforestation or grassland-to-cropland conversion) that cause removal of surface cover should be avoided or carefully planned where they are unavoidable.

2.1.2 A cover of growing plants or of plant or other organic residues that protects the soil surface from erosion should be maintained through implementation of appropriate measures such as conservation tillage or no-till, continuous plant cover, strip cropping, agroforestry/shelter belts, controlled vehicle traffic, and appropriate stocking rates and grazing intensities.

2.1.3 Water erosion on sloping sites should be minimized by measures that reduce runoff depth and velocity such as strip cropping, terrace formation and maintenance, and grassed waterways.

2.1.4 Where appropriate, riparian buffers, wetlands, and cover crops should be utilized to minimize export of soil particles and associated nutrients from the soil system.

2.2 Soil structure

Soil structural degradation decreases water infiltration (and hence generates higher runoff) and reduces the surface soil's resistance to wind and water erosion. Structural degradation can also slow water drainage and decrease aeration, limit root growth, and cause surface soil crusting. Soil compaction – the permanent deformation of soil caused by imposed stress – is a major cause of the degradation of soil structure.

2.2.1 Soil compaction by vehicles should be minimized by ensuring that the stresses applied to soils by machinery do not exceed their mechanical stability and resilience. Where machinery is used, this can be achieved by reduction or adjustment of machinery mass, tire contact area, and frequency of traffic.

2.2.2 Soil compaction by animals should be minimized by managing grazing intensity and stocking rates.

2.2.3 Crop rotations should include crops with dense and fibrous root systems that leave large amounts of residues after harvest, in order to favor the creation of stable soil aggregates.

2.2.4 If intentional disturbance of the surface (e.g. construction) requires removal of the topsoil or other soil layers, the individual layers should be carefully set-aside and then restored after the disturbance such that the original soil structure, seed bank, and soil biota are preserved.

2.3 Soil cover

A cover of growing plants or of organic residues provides a range of benefits beyond the minimization of erosion discussed above. An organic cover also provides food and shelter for many soil organisms, and is a source of energy for microbial growth. In water-limited environments, an organic cover reduces evaporation from the soil and hence increases soil water. A cover is also an important contributor (along with other physical and biological processes) to the creation of stable soil aggregates that resist soil structural degradation. These aggregates also protect organic matter from decomposition and hence promote soil organic carbon sequestration and regulation of CO_2 emissions to the atmosphere.

The amount of cover sufficient to provide these benefits differs depending on the context and use of the soil and should be locally determined.

2.3.1 Management practices such as cover crops, improved fallow plant species, reduced- or no-tillage practices, or live fences should be adopted that ensure the soil has a sufficient organic cover.

2.3.2 Where fire is integral to land management, the timing and intensity of burns should aim to maintain sufficient surface cover.

2.4 Soil nutrients

The concepts of sufficiency and efficiency apply especially to nutrient dynamics in the soil-water-plant root continuum. In some regions there is a gap between current crop yields and the potential yields that could be closed if nutrient limitations and imbalances were removed along with other soil constraints. In other regions, yields are at or close to the maximum given the climate and soil characteristics but excessive addition of nutrients creates a series of environmental problems.

The benefits of a sufficient and balanced supply of nutrients for plant needs are well-established and include: production of healthy food, fibre, and fodder at levels at, or close to, the maximum potential of the region; reduced need for pest control measures and for external application of organic amendments and mineral fertilizer; and enhanced soil carbon sequestration via maximum biomass production.

The consequences of excess nutrient levels in soils include transfer of excess nutrients (especially nitrogen and phosphorus) from agricultural fields to surface waterways causing deterioration of surface water quality; enhanced release of the potent greenhouse gas nitrous oxide from soils to the atmosphere; and leaching of mobile forms of nitrogen to groundwater with potential human health impacts, especially in infants.

2.4.1 Nutrient use efficiencies should be maximized by adoption of measures such the use of nitrification and urease inhibitors, slow release fertilizers, and soil organic amendments; use of inoculants that promote atmospheric nitrogen fixation and phosphorus solubilisation; and fertilizer application methods and timing to limit losses and promote crop nutrient uptake.

2.4.2 In regions where persistent nutrient limitations to crop growth occur, all practical sources of plant nutrients should be used including the precise and judicious use of organic amendments, inorganic fertilizers, and agricultural bio-products. These amendments and bio-products include liquid, semi-solid or solid manures, crop residues, composts, manures, household refuse, soil

amendments and inoculants.

2.4.3 Natural soil fertility and natural nutrient cycles should be strengthened and maintained through the preservation or enhancement of soil organic matter stocks and cycling. This can be attained by the utilization of crop rotations with legumes, green and animal manures and cover crops, in combination with reduced- or no-tillage, among other soil conservation practices.

2.4.4 Soil and plant-tissue testing that provides valuable guidance in diagnosing and correcting limiting factors in crop production related to plant nutrients, salinity, sodicity, and extreme pH conditions should be adopted and used.

2.4.5 Livestock movement and grazing should be controlled to maximize manure and urine deposition on crop fields.

2.4.6 Sufficient lime should be added to soils that have low resistance to acidification (i.e., inherently low-pH soils such as ancient, intensely weathered soils) in order to offset the acidification from particular fertilizers, product removal, and other sources.

2.4.7 Mineral fertilizer resources, like phosphate rock, should be efficiently used to maintain sufficient phosphorus for future generations.

2.5 Soil biodiversity

Soils provide one of the largest reservoirs of biodiversity on earth, and soil organisms play key roles in the delivery of many ecosystems services. Little is known about the degree of biodiversity required to maintain core soil functions. New tools on biochemical techniques and DNA analysis suggest significant progress in this area may be possible.

2.5.1 Monitoring programs for soil biodiversity, particularly focused on biological indicators (e.g. community ecotoxicology) and *in-situ* early warning signals should be undertaken.

2.5.2 Soil organic matter levels should be maintained or enhanced through the provision of sufficient organic cover, optimal nutrient additions, addition of diverse organic amendments, minimization of soil disturbance, and maintenance or restoration of vegetation such as hedgerows and shelterbelts.

2.5.3 The authorization and use of pesticides in agricultural systems should be based on the recommendations included in the International Code of Conduct on Pesticide Management and relevant national regulations. Integrated pest management should be encouraged.

2.5.4 The use of inoculants and introduction of species-rich swards, beetle banks, mycorrhizal spores and earthworms should be encouraged where appropriate.

2.5.5 Land use change should be minimized on areas with high biodiversity, consistent with international conventions.[4]

[4] Food and Agriculture Organization. 2011. Save and grow. A policymaker's guide to the sustainable intensification of smallholder crop production.

2.6 Soil water

A sustainably managed soil has rapid water infiltration, optimum water retention for plant use, and efficient drainage when saturated. Management options discussed previously in this report such as the maintenance of surface cover, stabilization of organic carbon, and reduction of soil compaction will all contribute to optimum water cycling in soils.

Improved management of soil water in dryland systems is fundamental to closing yield gaps and improving pasture productivity. In some dryland areas, inadequate soil water can be mitigated through water harvesting measures and irrigation; however the addition of salts from irrigation water is one of the major causes of human-induced soil salinization. Salinity is also a concern in coastal areas, where salts are introduced though both surface inundation and by encroachment of seawater into terrestrial aquifers.

Particular options for water management are needed for paddy fields where the cropping system requires constant flooded or saturated water regime in the soil during the cultivation period of rice. However, even in that case, proper infiltration, retention, and drainage of water suitable to paddy rice is necessary for sustainable soil management.

2.6.1 In dryland cropping systems, measures should be implemented to optimize water-use efficiency such as the management of previous crops, forages and fallows to increase soil water availability at sowing; reduction of evaporative losses from the soil surface; maximization of soil water extraction by the crop through the selection of appropriate cultivars and careful timing of agronomic operations; and ensuring that there is adequate water available at each stage of crop development. These measures often involve trade-offs and risks that must be recognized and managed.

2.6.2 The efficiency of irrigation water use by plants should be increased through improved conveyance, distribution, and field application methods (e.g. drip irrigation) that reduce evaporation.

2.6.3 Installation and maintenance of surface and sub-surface drainage systems should be installed and maintained to control rising groundwater tables, water logging and soil salinity.

2.6.4 Regular monitoring of irrigation water from all sources for potentially harmful substances such as highly soluble salts and sodium should be undertaken.

2.6.5 Outflows of flooded water from paddy rice cultivation after applying fertilizers and pesticides should be minimized.

2.6.6 In coastal areas, inundation of soils by saline water during cyclones and hurricanes should be minimized by ensuring that physical barriers such as grass strips and coastal forests are in place and maintained.

2.7 Soil contaminants

Contaminants can enter soils from a variety of sources including agricultural inputs, land application of by-products, atmospheric deposition, flood and irrigation water, accidental spills, and other means. Accumulation can occur if the rate of addition exceeds the rate of removal. Negative consequences may include plant toxicities and subsequent productivity declines, contamination of water, and increased human and animal health risks through food-chain transfer and direct ingestion of soil. Some contaminants can be degraded or decomposed over time, strongly adsorbed to the

soil, or be susceptible to leaching losses into groundwater or movement with soil sediment to surface water.

The soil resource is considered to be the world's largest filter provided that contaminants do not reach levels that affect plant productivity or compromise food safety. The importance of action on this issue is highlighted in Target 12.4 of the Sustainable Development Goals:

> *"By 2020, achieve environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce releases to air, water and soil in order to minimize their adverse impacts on human health and the environment."*

2.7.1 Governments should establish and implement regulations to limit the accumulation of contaminants beyond established levels to safeguard human health and well-being and facilitate remediation of contaminated soils that exceed these levels where they pose a threat to humans, plants, and animals (Action VII for Governments from World Soil Charter).

2.7.2 Management of local soil contamination requires surveys to detect sites that are likely to be contaminated, followed by site investigations to determine the extent of contamination. Risk assessment and remediation should be applied to reduce risks to humans and ecological systems.

2.7.3 Identify soils that are the most susceptible to the harmful effects of diffuse pollutants (e.g. acidification due to atmospheric deposition on strongly weathered soils). Special measures should be undertaken to reduce contaminant loads to these soils.

2.7.4 Highly contaminated soils should not be used for food and feed production but could be used for the cultivation of bioenergy crops.

2.8 Minimizing the loss of agricultural soils

Land take and soil sealing by settlements and infrastructure affect all soils but are of particular concern for productive arable soils given their role in food security. Land take covers all forms of conversion for the purpose of settlement, and the expansion of transport infrastructure such as roads, highways and railways. In many places, urban sprawl affects the most productive soils around the cities and settlements. Soil sealing and land take causes a largely irreversible loss of some or all soil functions and the ecosystem services they provide.

2.8.1 Existing policies and relevant laws for development of settlements and infrastructure should be reviewed and revised to take account of the value of soils and to ensure that preservation of productive arable soils are a priority.

2.8.2 Where policy and legislation aims to minimize land take, measures should be implemented to encourage re-use of existing urban areas such as derelict areas, brownfields and upgrading of degraded neighborhoods after appropriate reclamation measures have been implemented.

2.8.3 Soils with high potential for ecosystem services such as intensive carbon sequestration or supporting biological diversity should be protected from

land take by special legislation.

2.9 General considerations

The implementation of sustainable soil management as outlined above is conducive to agriculture characterized by low emissions of greenhouse gases and energy efficiency. This contributes to both climate change mitigation and adaptation. The adoption of SSM often involves the utilization of techniques such as precision agriculture, zone farming, integrated crop and pasture systems, biological fixation of nitrogen, no-tillage cultivation, and the use of organo-mineral and slow-release fertilizers.

The adoption of SSM is especially critical for smallholder farming, particularly in Sub-Saharan Africa and Asia, where soils are vulnerable to the risks of further degradation and nutrient depletion, soil exhaustion, climate change, and numerous biotic and abiotic stresses. Adapting SSM practices is essential.

Finally, techniques for sustainable management should be matched to local soil conditions. This requires access to information on local soil characteristics, their distribution across the landscape, and the likely responses to changes in management. This knowledge should be drawn from appropriate sources including up-to-date soil surveys at the requisite scale, the soil science research community, and, most importantly, from local users of the soil. The compilation and dissemination of this information is a critical task for extension specialists.

2.9.1 SSM practices should be carefully matched to local soil conditions. Decisions should be based on up-to-date field observations derived from sources such as soil testing, visual assessments from soil pits and local soil surveys at the requisite scale.

3. Implementation, monitoring, evaluation and communication

In accordance with the voluntary nature of the guidelines for sustainable soil management, governments have the responsibility for the implementation, monitoring and evaluation.

The successful implementation of the guidelines is possible only on the basis of a collective action of multiple stakeholders. Governments are encouraged to set up platforms and frameworks for collective action at local, national and regional levels or use the facilities of existing platforms and frameworks to implement these guidelines; to monitor and evaluate the implementation in their jurisdiction; and to evaluate the impact of improved soil management on food security, ecosystem services related to soil functions, and sustainable development goals. This process should be inclusive, participatory, gender sensitive, implementable, cost-effective and sustainable. Governments may seek technical support from FAO or other international and regional bodies.

Development partners, specialized agencies and programs of the United Nations, and regional organizations are encouraged to support voluntary effort by governments to implement these guidelines. Such support could include technical cooperation, financial assistance, capacity development, knowledge sharing, and transfer of technology.

The Global Soil Partnership (GSP) should be the global forum where all the stakeholders learn from each other's experiences, and assess progress toward the implementation of these guidelines and their relevance, effectiveness and impact. Therefore, the GSP Secretariat and the ITPS as its advisory body should report to the GSP Plenary Assembly on the progress of the implementation of the

guidelines, as well as evaluate their impact and their contribution to the improvement of soil management.

Communication and promotion of the guidelines at the regional level should be the responsibility of the Regional Soil Partnerships, which should report on the progress in communication to the GSP Plenary Assembly in the frames of their regular report.

ANNEX II: Composition of working groups

Working Group 1

Nsalambi V. Nkongolo (DRC); Isaurinda dos Santos Baptista Costa (Cape Verde); Amanullah (Pakistan); Talal Darwish (Lebanon); Ahmad S. Muhaimeed (Iraq); Saéb AbdelHaleem Khresat (Jordan); Juan Comerma (Venezuela); Fernando Garcia (Uruguay); Dan Pennock (Canada); Ganlin Zhan (China); Gunay Erpul (Turkey, Chair); Pavel Krasilnikov (Russia); Neil Mckenzie (Australia); Rainer Horn (Germany)

Working Group 2

Nsalambi V. Nkongolo (DRC); Martin Yemefack (Cameroon); Miguel Taboada (Argentina, Chair); Bhanooduth Lalljee (Mauritius); Brajendra Parmar (India); Maria Lourdes Mendonca (Brazil); Gary M. Pierzynsky (USA); Oneyda Lara (Cuba); Ganlin Zhan (China); Peter de Ruiter (The Netherlands); Siosiua Halavatau (Tonga); Kazuyuki Yagi (Japan);

Working Group 3

Martin Yemefack (Cameroon); Isaurinda dos Santos Baptista Costa (Cape Verde); Brajendra Parmar (India); Amanullah (Pakistan); Juan Comerma (Venezuela); Gary M. Pierzynsky (USA, Chair); Ganlin Zhan (China); Siosiua Halavatau (Tonga);

Working Group 4

Talal Darwish (Lebanon); Ahmad S. Muhaimeed (Iraq); Miguel Taboada (Argentina); Maria Lourdes Mendonca (Brazil); Fernando Garcia (Uruguay); Dan Pennock (Canada); Ganlin Zhan (China); Gunay Erpul (Turkey); Pavel Krasilnikov (Russia); Neil Mckenzie (Australia, Chair);