Food and Agriculture Organization of the United Nations

CONCEPT NOTE

GLOBAL SYMPOSIUM ON SOIL EROSION

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UNCCD SPI Science - Policy Interface

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Nuclear Techniques in Food and Agriculture

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INTERGOVERNMENTAL TECHNICAL PANEL ON SOILS

GLOBAL SOIL PARTNERSHIP

Global Symposium on Soil Erosion (GSER19) |Concept note

Co-organized by the Food and Agriculture Organization (FAO) of the United Nations, the Global Soil Partnership (GSP), the Intergovernmental Technical Panel on Soils (ITPS), the Science-Policy Interface (SPI) of the United Nations Convention to Combat Desertification (UNCCD) and the Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture

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1 Introduction

Soil erosion is one of the ten major soil threats identified in the 2015 *Status of the World's Soil Resources* report (FAO and ITPS, 2015) and subsequently addressed in the *Voluntary Guidelines for Sustainable Soil Management* (VGSSM) of the FAO (FAO, 2017a). Soil erosion is defined as the removal of soil particles, soil aggregates, organic matter and nutrients from the land surface through three major pathways: water, wind and tillage. Water erosion occurs mainly when overland flow transports soil particles detached by raindrop impact (i.e. splash erosion) and runoff, often leading to clearly defined channels such as rills or gullies. Wind erosion occurs when dry, loose, bare or sparsely vegetated soils are subjected to strong winds and soil particles are detached from the land surface and transported elsewhere. Tillage erosion is the direct down-slope movement of soil by tillage and results in the displacement of soil material from the top of hill slopes and its accumulation at their base.

Erosion is a natural process that is part of soil and landscape formation and evolution, but the rate of erosion is typically significantly increased (or accelerated) by human activities such as conventional tillage, overgrazing and shifting cultivation associated with agriculture (Borrelli et al., 2017). Climate change, land levelling, land use change (e.g. conversion of forests into agricultural land) and farming on marginal lands further exacerbate soil erosion and eventually lead to extreme events such as landslides (Borselli et al., 2006; Lal, 2004; Routschek et. al., 2014; Zhang et al., 2018). Estimated rates of soil erosion on conventionally ploughed agricultural land or intensively grazed lands have been found to be on average 1-2 orders of magnitude greater than rates of soil erosion under native vegetation (Montgomery, 2007). These erosion rates are also much higher than soil formation rates, which are typically well below 1 tonnes ha^{-1} yr^{-1} with median values of about 0.15 tonnes ha^{-1} yr^{-1} (FAO and ITPS, 2015). The large difference between soil loss rates under conventional agriculture and soil formation rates implies that we are depleting what is considered to be a non-renewable resource (FAO and ITPS, 2015).

Soil erosion affects soil quality by removing the highly fertile topsoil and exposing the subsurface horizon that has low organic matter content. This process can result in soil structure degradation, nutrient loss or poor microbial activity. However, the detrimental removal of soil and nutrients from upland fields may be partly offset through the deposition of the eroded soil and nutrients in depositional areas. While this is true, such gains should not be exaggerated: the deposition of sediments and nutrients in large floodplains is not directly coupled to actual agricultural soil erosion, as in most cases sediments are provided by other sources (natural erosion, landslides) and the residence time of such sediments in large river systems is several thousands of years. In areas of moderate to severe soil losses it is common to experience a 30 to 50% loss in crop yields, which translates into 5 to 10% of crop production at the field scale in many regions. A synthesis of meta-analyses (FAO and ITPS, 2015) on the soil erosion-productivity relationship suggests that a global median loss of 0.3 percent of annual crop yield occurs as a result of soil erosion. If the median value of 0.3 percent annual crop loss is valid for the period from 2015 to 2050, a total reduction of around 10 percent could be projected to 2050. This yield loss due to continued soil erosion would be equivalent to the removal of 1.5 M km^2 from crop production or 45 000 km^2 yr^{-1} (e.g., approximately one soccer pitch every five seconds) (FAO and ITPS, 2015).

Soil erosion by wind and water, which is exacerbated by tillage, induces nutrient loss from agricultural land that creates the need for increases in fertilizer use (FAO, 2017b). The annual economic cost of erosion-induced fertilizer use increase was found to be US$ 33-60 billion for nitrogen and US$ 77-140 billion for phosphorus (FAO and ITPS, 2015). Concerns have consequently arisen that soil erosion may contribute to carbon dioxide emissions from the agricultural sector and compromise the carbon sequestration potential of the soil itself. However, the impact of soil erosion in soil carbon cycling remains poorly quantified (Borrelli et al., 2017; Lugato et al., 2018) as erosion may increase CO_2 emissions through enhanced soil organic carbon mineralization (Lal, 2004) or decrease CO_2 emissions by increasing carbon sequestration in sediments (Van Oost et al., 2007).

On-site, soil erosion can also negatively affect the soil water infiltration capacity, the soil water storage of plant available water and the drainage of saturated soil, resulting in waterlogging and water scarcity. Additionally, it reduces the rooting depth of plants. Off-site, sediments associated with soil particles displacement by wind and water can lead to off-site soil and water pollution as well as reservoirs siltation, ecological disturbance in riverine systems, damages to the infrastructures as well as surface waterways obstruction (Lal, 2014). To note that other processes such as bank erosion, landslides and natural surface erosion contribute to reservoir sedimentation and are often dominant at large scales.

In this framework, soil erosion poses a major threat to global food security and to the achievement of the Sustainable Development Goals (SDGs). Indeed, soil erosion control can be related to the achievement of SDG13 as soil health is key to combating climate change (UNFCCC COP23, Koronivia Decision – UNFCCC, 2018) and further extended to the achievement of SDGs 2, 3, 6 and 15 on food security, clean water provision, desertification and biodiversity loss halting, respectively. Over the last few decades, the international community has taken action to assess, quantify, map, model, monitor, mitigate and attempt to reverse soil erosion, which remains the major “land degradation process”. The need for a global assessment of soil erosion under the umbrella of land degradation was first highlighted by the United Nations Conference on the Human Environment in 1972. Since then, several attempts have been made to develop methodologies that will allow for systematic assessment and monitoring of global land degradation.

Systematic work started in 1975, when FAO and the United Nations Environment Programme (UNEP) collaborated in a study to develop a provisional method for soil degradation and desertification assessment and mapping (FAO, 1975). It continued with the Global Assessment of Human-Induced Soil Degradation (GLASOD) in 1988 and the compilation of a Global Land Degradation Information System (GLADIS) in 2011. In 2006-2010, the Land Degradation Assessment in Drylands (LADA) project was implemented to assess and map land degradation at different spatial scales either in drylands or in other ecosystems with minimal required adaptation. However, the complexity of the subject and the lack of reliable data made these methods difficult to apply. To date, no systematic monitoring is in place. The Status of the World's Soil Resources report by FAO and the ITPS (2015) is the most updated document providing indications on the status of soil at the global and regional level in relation to soil erosion and the other major threats to soil: organic carbon change, nutrient imbalance, salinization and sodification, soil sealing and land take, loss of soil biodiversity, contamination, acidification, compaction and waterlogging.

According to the FAO and ITPS (2015), there are major differences in the condition and trend for soil erosion in the different regions of the world. Parts of Europe, North America, and the Southwest Pacific show a stabilizing to improving trend, although this follows many decades of significant soil loss due to erosion associated with agricultural expansion and intensification. In the United States, average water erosion rates on cropland were reduced from 10.8 to 7.4 tonnes ha^{-1} yr^{-1} between 1982 and 2017, while wind erosion rates reduced from 8.9 to 6.2 tonnes ha^{-1} yr^{-1} over the same time span. Sub-Saharan Africa has a variable trend in erosion, whereas Asia, Latin America and the Caribbean, and the Near East and North Africa have severe to extreme soil erosion conditions and a deteriorating trend. In North Africa wind erosion is the primary cause of the very poor soil conditions and trend. Although less documented, significant decreases in erosion occur wherever minimum or no-tillage has been adopted, such as in large areas in Latin America.

In 2012, the Global Soil Partnership (GSP) was established to take inclusive actions to preserve and improve soil health and ecosystem functions, as well as to restore degraded soils. Actions are being implemented under the five Pillars of Action[1] of the GSP, which also address practical problems that have been hampering the development of more accurate soil assessment and monitoring, including soil erosion measurement, data collection and analysis.

The UN FAO and its GSP, along with the Intergovernmental Technical Panel on Soils (ITPS), are organizing global symposia on the ten soil threats highlighted in the Status of the World's Soil Resources report in order to bring scientific evidence and set an agenda for action together with multiple stakeholders. The Global Symposium on Soil Erosion will be organized by ITPS/GSP, FAO together with the Science-Policy

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[1] The five pillars of Action are the following: (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, (4) Information and data and (5) Harmonization of methods, measurements and indicator for the sustainable management and protection of soil resources.

Interface (SPI) of the UNCCD and the Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture as a common platform to present and discuss the latest knowledge on the status of interventions and innovations in the field of soil erosion management, under a scientific and policy point of view. The symposium is a bold action to promote the implementation of the Voluntary Guidelines for Sustainable Soil Management (VGSSM) in terms of combating soil erosion and achieving the Sustainable Development Goals (SDGs), to review and discuss success stories in combating erosion, to review existing soil erosion assessment frameworks and to launch global collaborative efforts to promote the implementation of management practices, techniques, instruments and mechanisms that reduce and, where possible, arrest or reverse soil erosion.

2 Aim and objectives

The Global Symposium on Soil Erosion represents a critical step toward implementing the Voluntary Guidelines for Sustainable Soil Management in terms of minimizing the soil erosion and mitigating its risks. The Symposium aims to bring together science and policy communities/experts to review the status of soil erosion control and address related grand challenges. In this regard, it will provide concrete examples of effective and ineffective Sustainable Soil Management (SSM) practices, techniques, instruments and mechanisms, which would ultimately expose challenges such as scientific, technological and legislative gaps. Because of the importance of soil health for the 2030 Agenda for Sustainable Development, the link between soil erosion control and the achievement of the SDGs will be highlighted and discussed.

Overall, the symposium's output should provide scientific evidence, supported by concrete and quantifiable economic impacts, for the development of sound policies with concrete actions to minimize soil erosion and promote the restoration of eroded sites for sustained soil conservation, enhanced ecosystem services, and improved food security.

Specifically, the objectives of this symposium are to:

1. Identify options to consolidate, generate and harmonize soil erosion data and assessment tools for promoting their use in decision making at all levels;
2. Review and discuss existing national and international policies, agreements and frameworks addressing soil erosion prevention, management and remediation in order to assess their effectiveness and propose ways to enhance them;
3. Critically reflect on the economics of soil erosion paying attention to which SSM practices are cost effective and which others not and why, investigating options for measures that do not give a short/medium term financial benefit; and
4. Advocate for an agenda for action to prevent, mitigate and monitor soil erosion.

3 Expected outcome

The symposium output will be an outcome document highlighting the scientific evidence on the status of soil erosion, its impacts and an agenda for action in the framework of achieving the SDGs. The document will also provide recommendations for developing sound environmental policies and programmes to encourage the use of sustainable soil erosion control practices.

4 Symposium structure

The symposium will be a science-policy meeting, held over three (3) days at the FAO headquarters in Rome, Italy, from 15-17 May 2019, with an expected over 400 participants with a balanced geographic/regional representation.

The meeting will open with high level plenary addresses by representatives of the hosting organizations to present the importance of soil erosion in the context of achieving food security, halting migration, combating and adapting to climate change, and overall achieving the Sustainable Development Goals. Following the introduction of the policy-oriented context of the symposium, its desired outputs will also be presented.

Keynote presentations will be given by invited leading experts in relation to the following main themes (further information is available at "Symposium themes and key questions to be addressed"):

- Theme 1: Use of data and assessment tools in soil erosion control[2]
- Theme 2: Policy in action to address soil erosion
- Theme 3: The economics of soil erosion control and restoration of eroded land

Parallel sessions

Parallel sessions will be held for all the themes, to be organized by session conveners. The format of the parallel sessions will be determined by the conveners (in close collaboration with the organizing and scientific committees) to ensure the themes are adequately presented and discussed to explore the key aspects needed for the outcome document.

Abstracts and papers

A call for extended abstracts will be open until the 10th March 2019. The Organizing committee is currently accepting abstracts that will compete for oral and poster presentations during the symposium. Abstracts should be related to one of the three themes identified by the Organizing and Scientific committees, and incorporate case studies from different countries. The extended abstracts shall be written in English, maximum 2000 words in Word format. The extended abstracts must be submitted in the prescribed format (Extended abstract template) and emailed to GSER-19@fao.org, indicating "Call for extended abstracts/Your full name/Preferred Theme" in the subject line. They will be revised by the GSER19 Scientific Committee, and authors will be notified with a decision regarding their abstract submission by 31 March 2019 and details for oral and poster presentations will be provided.

[2] The term "erosion control" refers to soil erosion assessment, mapping, intervention, rehabilitation and monitoring

Participants

Participants will include representatives from UN FAO member states, UNCCD-SPI, Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture, presenters whose abstracts are accepted, scientists and practitioners, representatives from NGOs, civil society, farmers associations, land users and the private sector.

5 Symposium committees

The following Committees have been established:

Organizing committee

This committee is comprised of representatives from each of the co-organizing partners (FAO/GSP/ITPS, UNCCD-SPI and the Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture). It will oversee the overall organization of the symposium, guide the formats of the parallel sessions, and will oversee the finalization of the symposium outcomes.

Scientific committee

The Scientific Committee is comprised of representatives from the co-organizing organizations, as well as additional leading experts in the three main themes. This committee will be responsible for evaluating submitted abstracts and papers, as well as ensuring the scientific quality of the parallel sessions and symposium outputs.

6 Symposium themes and key questions to be addressed

The symposium is articulated around three complementary themes, bringing together experts in science, policy and economics of soil erosion, with the aim of sharing knowledge, experience and views, as well as advising future actions.

Theme 1. Use of data and assessment tools in soil erosion control

Natural and anthropogenic causes of soil erosion have been widely investigated, and several tools for assessing and monitoring soil erosion rates have been developed. Because soil erosion occurs through three major pathways, water, wind and tillage, and it is typically a scale dependent phenomenon, it is complicated to assess and conclusively measure. In addition to field observations, the models mostly used to assess soil water erosion are derived from the Universal Soil Loss Equation (USLE) or the Revised Universal Soil Loss Equation (RUSLE) (Lal et al., 2014), which were originally conceived to assess sheet and rill erosion at field scales in agricultural lands of the US. These models represent an acceptable compromise between the input data requirement and the reliability of the estimates. However, several studies, including an FAO Malawi case study (FAO, UNEP and UNDP, 2016), have reported several limitations e.g. these models are restricted to sheet and/or rill erosion, are not suited to predict soil loss on an event basis, and do not take into consideration the process of transport/deposition. Some research teams have approached these limitations by linking RUSLE factors with spatially distributed sediment delivery models, like the SEDD, through GIS (Borrelli et al., 2018; Fu, Chen and McCool, 2004). Recent studies combine RUSLE measurements with soil organic matter (SOM) content because decreases in SOM lead to decreased cohesion between soil particles, thereby increasing the susceptibility of soil to water or wind erosion (Deng, Liu and Shangguan, 2014; Lal et al., 2014). These studies suggest that regional SOM profiles could be used to project national soil erosion risks. On the other hand, the parameters of the RUSLE can be used as risk factors for other types of erosion (gullies, mass movements, wind erosion), both at plot and watershed/regional scales. Theme 1 will discuss ways to consolidate soil erosion data and assessment methods and tools for the purpose of promoting their use in decision making at all levels, including how to prioritize areas of intervention. The baseline for developing a global soil erosion map will be discussed.

Core questions:

- What are the current deficiencies in the current methods/models for assessing and mapping soil erosion? What role for the Web and mobile technologies?
- What soil erosion assessment outcomes and decision-making tools for soil erosion control are available and how can these be improved, taking into consideration the issue of inconsistencies in methods and uncertainties in results?
- Why do we need a global assessment of soil erosion, and can such an assessment be the basis for a global monitoring system?
- How can information products (e.g. maps and reports) be concretely used in controlling soil erosion and in prioritizing areas of intervention?

Theme 2. Policy in Action

Global frameworks like UNEP (1972), UNCCD (1996), GSP (2012) and the SDGs (2015) were established with the purpose of preserving and sustainably managing precious and scarce natural resources such as soil. Since their establishment, major efforts were put in to increase societal awareness of the importance of soil for human wellbeing and life on Earth, strengthen institutional capacities, and overcome the lack of coordination of action between concerned institutions. Under the umbrella of the GSP, the International Year of Soil 2015 was launched, the World Soil Day was established and celebrated every year on 5 December, and a series of policy-oriented documents like the revised World Soil Charter and the Voluntary Guidelines for Sustainable Soil Management (VGSSM) were developed for guiding all stakeholders towards the preservation and improvement of soil health through the practice of sustainable soil management.

As defined 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 either the soil functions that enable those services or biodiversity. The balance between the supporting and provisioning services for plant production and the regulating services the soil provides for water quality and availability and for atmospheric greenhouse gas composition is a particular concern" (FAO, 2015).

Additionally, the GSP took action to address the lack of reliable information to guide decision making and strongly supported the inclusion of soil in the SDGs. In this context, SSM can play a key role in combating hunger (SDG2), water scarcity (SDG 3 and 6), climate change (SDG13), and desertification and biodiversity loss (SDG15). Looking at land tenure and socio-economic vulnerability issues that could contribute to increase soil degradation rates, the FAO also endorsed the Voluntary Guidelines on Responsible Governance of Tenure (VGGT) in 2012. As above argued, global tools for decision making and policy development are available but to some extent not used. The site-specificity of soil conservation practices is indeed one of the most important drawbacks to implement effective measures. Theme 2 aims to review and discuss environmental policies with a focus on soil erosion prevention, management and remediation: what is missing and what can be done to assist governments in improving and/or developing their national policies, but more importantly implement them? The Theme will also look into lessons learnt and the contribution that policy development and implementation could make to the achievement of the SDGs.

Core questions:

- Which erosion control measures have proven to be effective in the 21st century?
- What government policies are currently in place that are effective in advancing the implementation of erosion prevention, remediation, or mitigation practices by land managers?
- What new policies could be introduced to help governments support the introduction of effective soil erosion prevention, remediation, or mitigation measures?
- What are the most useful means of implementing erosion prevention, remediation, or mitigation policy into practical action?

Theme 3. The pay back of soil erosion prevention, management and remediation

Though the necessity for SSM is widely recognized, its practical application is commonly jeopardized by the increase in cost required for crop production under SSM. Extra costs are often incurred for the additional measures to protect soils, as well as the often-needed change in farming equipment that requires initial investment. The broad concept of Economics of Land Degradation (ELD) is based on the contrast between "action" that is implementation of SSM practices, and "inaction" that is conventional farming or "business as usual" (von Braun et al., 2013). By default, it is considered that "action" costs more than "inaction", which in practice is not necessarily true: for example, the recommendation to avoid land use change and soil disturbance does not lead to direct costs, though it may lead to lost profit. Nonetheless, the extra cost of SSM when present is often the main barrier for the implementation of the practices recommended for sustainable farming. In many regions, farmers do not have available capital to cover the cost of SSM, especially if their investment would not be recompensed in the near future. To consider is also that the implementation of conservation measures does not, as such, directly increase yields or efficiencies while the detrimental effects of erosion on the soil capital only become visible over time scales that range from decades to centuries. Hence, farmers do not have a direct incentive to adopt soil and water conservation measures.

The ELD approach widely uses the total economic value (TEV) concept to highlight the importance of reducing the rate of land degradation: the contribution of indirect use plus non-use values in many cases exceeds direct use value of an agroecosystem. However, the beneficiary of the profit other than direct use value is humankind and not the particular farmer who bears all the expenses. Thus, the mechanisms of transferring some part of the public goods produced due to SSM to the farmer should be discussed. The discussion of payment for SSM is not strictly private but of public order. Lands and soils have social functions and we cannot forget the role of governments in the implementation of economic and institutional mechanisms promoting land conservation. This Theme links to investment and, more specifically, it aims at showing which SSM practices paid back and which others not and why.

Core questions:

- What are the associated costs of soil erosion for agriculture and development, based on the cost of one ton of soil loss?
- What are the on-site costs in loss of soil fertility and crop production, the indirect costs of greater input use, and the off-site costs to the environment and human infrastructure?
- Are the costs of implementing soil erosion control practices offset by current and future benefits of more, or more profitable, production?
- What technologies and innovations exist to decrease the costs of implementing soil erosion control practices compared to that of conventional soil management?
- Could society compensate farmers for the public benefits (ecosystem services) from the implementation of soil erosion control practices?

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