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Follow up on the post-2015 development agenda
Monitoring progress towards a sustainable development goal on land degradation and associated target
Monitoring the contribution of sustainable land use and management to climate change adaptation/mitigation and to the safeguarding of biodiversity and ecosystem services

Monitoring the contribution of sustainable land use and management to climate change adaptation/mitigation and to the safeguarding of biodiversity and ecosystem services

Note by the secretariat

Summary

The Conference of the Parties (COP), by its decision 23/COP.11, established the Science-Policy Interface (SPI) and requested the secretariat, in paragraph 16, to report to the Committee on Science and Technology at its twelfth session on the implementation of that decision.

Document ICCD/COP(12)/CST/3-ICCD/CRIC(14)/7 contains the report of the SPI on objective 1 of its work programme 2014–2015 which was to “Bring to the other Rio conventions the scientific evidence for the contribution of sustainable land use and management to climate change adaptation/mitigation and to safeguarding biodiversity and ecosystem services”.

This document provides complementary information on the implementation of objective 1. Information is provided on the scientific evidence for the contribution of sustainable land management to the objectives of the United Nations Framework Convention on Climate Change and the Convention on Biological Diversity, and examples are given of practical application of resilience assessment.

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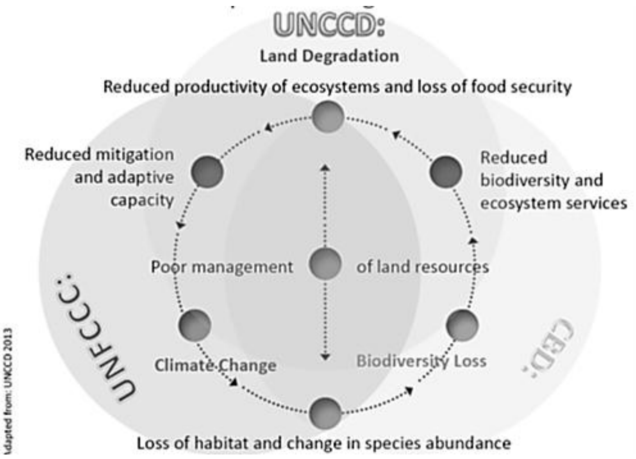
Contents

I. Background

1. The closely-linked and interrelated processes of desertification, land degradation and drought (DLDD), climate change, and loss of biodiversity are threatening a range of natural resources (soil, water, biodiversity) and essential ecosystem services, as well as human well-being across the globe. Negative 'feedback loops' can develop through land degradation, biodiversity loss and climate change, whereby the loss of soil organic matter and vegetation increases greenhouse gas (GHG) emissions and vulnerability to climate change, leading to further land degradation and biodiversity loss (see the figure below). Loss in productivity drives further land use conversion for agriculture, which can lead to increased deforestation and pressure on natural resources (Cowie et.al, 2011).

Figure
Negative feedback loops amongst the three Rio conventions, caused by poor management of land resources



2. The United Nations Convention to Combat Desertification (UNCCD) and its sister conventions, the United Nations Framework Convention on Climate Change (UNFCCC) and the Convention on Biological Diversity (CBD), aim to halt or mitigate the deterioration of ecological processes upon which life and human well-being depend. Management to protect and enhance terrestrial carbon stocks in vegetation and soil is of central importance to the three conventions, and research, reporting, training, technology transfer and public education commitments are a shared requirement of their Parties. However, despite the similar thematic considerations of all three conventions, limited coordination between them at international and national level, in terms of both actions and reporting, has been highlighted as an issue, as noted above.

3. There is scope for synergy in the joint implementation of the three Rio conventions, such as integrated monitoring and assessment frameworks and the implementation of sustainable land management (SLM) strategies beneficial to the goals of the three conventions. Parties to the Rio conventions recognize the value of SLM. While Parties to the UNFCCC have recognized that SLM technologies are part and parcel of climate change

adaptation and mitigation,[1] Parties to the CBD and UNCCD see SLM as a priority set of practices for the rehabilitation and/or restoration of landscapes and ecosystems in order to support the provision of ecosystem services, while acting to minimize and even reverse land degradation.

4. This document summarizes scientific evidence for the contribution of SLM to climate change adaptation and mitigation, and to safeguarding biodiversity and ecosystem services. Taking into account the plethora of operational definitions (United Nations Earth Summit, 1992) and success stories (WOCAT[2]), this document refers to SLM as environmentally-, socially- and economically-sound use and management of land and other ecosystem services in order to maintain, recover or increase their productivity, and to minimize adverse off-site impacts in a sustainable manner under present and future climate conditions. In this context, it also analyses how a focus on SLM can create synergies amongst the Rio conventions in terms of devising effective interventions, and ensuring the efficient monitoring and reporting of their implementation.

5. This study is based on analysis and synthesis of: scientific assessments on SLM included in the Impulse Report (Reed and Stringer, 2015) underpinning discussion and debate at the UNCCD 3rd Scientific Conference; the scientific presentations and conclusions arising from workshops held during the conference; discussions held at the 5th International Conference on Deserts, Drylands and Desertification (DDD) (2014); a dedicated scientific session and discussion workshop at the European Geosciences Union (EGU) General Assembly (2015); the first joint Science-Policy Interface-Intergovernmental Technical Panel of Soils (SPI-ITPS) meeting organized at the 3rd Global Soil Week (GSW) (2015);[3] and peer-reviewed literature on SLM practices.

II. Scientific evidence for the contribution of sustainable land management to climate change adaptation and mitigation and to safeguarding biodiversity and ecosystem services

6. SLM includes established approaches such as soil and water conservation, natural resource management, integrated ecosystem management, ecosystem-based adaptation, sustainable rangeland management, community-based adaptation, and it involves a holistic approach to achieving productive and healthy ecosystems by integrating social, economic, cultural, physical and biological needs and values. SLM recognizes that people and the natural resources upon which they depend are inextricably linked. By definition, SLM practices consider all ecosystem elements together to obtain multiple ecological and socio-economic benefits. Extensive research has been conducted to identify, develop and assess SLM practices and systems for a wide range of environments and socio-economic conditions across dryland areas (Reed and Stringer, 2015; Fleskens and Stringer, 2014; Gabathuler et al., 2009; Schwilch et. al., 2014).

7. SLM practices that conserve moisture and maintain or enhance species diversity, such as conservative grazing,[4] retention of crop residues, replacement of annual species

[1] See the Nairobi work programme of the United Nations Framework Convention on Climate Change, available at: <http://unfccc.int/adaptation/workstreams/nairobi_work_programme/items/5137.php>.

[2] The World Overview of Conservation Approaches and Technologies (WOCAT) (www.wocat.net/) is an established global network of Soil and Water Conservation (SWC) specialists, dedicated to SLM.

[3] For more information on the joint -Science-Policy Interface- Intergovernmental Technical Panel of Soils (ITPS-SPI) meeting, see ICCD/COP(12)/CST/6 and ICCD/COP(12)/CST/INF.4.

[4] Conservative grazing means a range of different practices designed to maintain ground cover and pasture productivity.

with perennial species, mulches and green manures, reforestation and revegetation to create windbreaks and shelter belts, and the use of native species, simultaneously and synergistically contribute to the objectives of the Rio conventions (Cowie et al., 2007).

8. The role of SLM in the protection and enhancement of soil organic carbon (SOC) is an area of particular synergy between the UNCCD and the UNFCCC. Likewise, the CBD acknowledges that SLM practices increase the diversity of production species and systems, reducing vulnerability to pests, diseases, and climatic variation and enhancing the diversity of soil organisms (Cowie et al, 2011). Furthermore, SLM can enhance productivity and income thereby helping to achieve, inter alia, Sustainable Development Goals 1 (End poverty), 2 (End hunger, achieve food security and improved nutrition and promote sustainable agriculture), 13 (Take urgent action to combat climate change and its impacts) and 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) (Global Land Indicators Initiative (GLII), 2015).

A. Contribution of sustainable land management to climate change adaptation and mitigation

9. SLM can contribute to the mitigation and adaptation commitments of the UNFCCC. The ultimate objective of the UNFCCC is to ensure the *“stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system”*, ensuring that *“food production is not threatened”.* Furthermore, Parties to the UNFCCC *“should take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects”* and *“[…] cooperate in preparing for adaptation to the impacts of climate change”*. These paragraphs of the UNFCCC clearly imply the commitments of the Parties to mitigating climate change and adapting to its effects with an emphasis on the food provision services of ecosystems.

10. SLM can be a starting point for improving the resilience, sustainable use and productivity of ecosystems within the context of climate change. The objective is twofold: (1) maintaining ecosystem functions (nutrient turnover, regulation of water quality and quantity, biodiversity conservation); and (2) increasing the productivity (quality, quantity and diversity) of goods and services, including long-term safe and healthy food production.[5]

11. Successful rehabilitation and/or restoration of drylands through particular SLM practices has led to a significant increase in soil carbon in various geographies (Tongway and Ludwig, 2009). SLM practices that protect soil organic matter, maintain vegetative cover and conserve biodiversity are vital to improving resilience and the capacity to adapt to the anticipated impacts of climate change (Cowie et al, 2011), such as a higher frequency of extreme weather events including drought and storms.

12. Besides contributions to adaptation, soil carbon management is considered one of the most cost-effective climate change mitigation options (Al-Juaied and Whitmore, 2009). At the global scale, soils store more than double the carbon (2,700 gigatons) of the combined total of the atmosphere (780 Gt) and biomass (575 Gt) (Lal, 2008). Land use is responsible for a significant proportion (around 20 per cent) of anthropogenic emissions targeted by the UNFCCC mitigation commitments (Intergovernmental Panel on Climate Change (IPCC), 2014; Le Quéré et al., 2015). Soils in the world’s agroecosystems

[5] See the Terrafrica website <http://terrafrica.org/>.

(croplands, grazing lands, rangelands) have lost 25–75 per cent of their original SOC pool, depending on climate, soil type, and historic management (Lal, 2011). This challenge is an opportunity to address land degradation through SLM interventions; the carbon sink capacity of the world’s agricultural and degraded soils is estimated to account for 50–66 per cent of the historic carbon loss of 42 to 78 gigatons of carbon (Lal, 2004). Dryland soils are a significant component of this opportunity as they contain more than a quarter of global organic carbon stores (Safriel et al., 2005). Improved range management, for instance, has the biophysical potential to sequester 1.3-2GtCO_2e worldwide by 2030 (Smith et al., 2007).

13. There are many SLM options for addressing land degradation and climate change adaptation and/or mitigation, however details of the methods must be adapted to each socio-ecosystem. Common SLM strategies that simultaneously address land degradation and climate change adaptation and/or mitigation include (Reed and Stringer, 2015; Food and Agriculture Organization of the United Nations (FAO), 2011; Almagro et al. 2015):

(a) Enhancing soil organic matter through the use of manures, composts and mulches, and increased perenniality. The results are enhanced soil carbon stocks and improved soil properties (better aeration, higher infiltration, less compaction and surface sealing and a higher nutrient-holding capacity), and, in turn, increased plant production, – with more carbon sequestered – and improved resilience of agricultural systems;

(b) Measures to conserve water (increased infiltration and water holding capacity, reduced runoff), which enhances yield in drylands as the climate becomes more variable;

(c) Measures to reduce soil erosion, thus maintaining soil carbon and land productivity, and reducing siltation causing reduced storage capacity in reservoirs;

(d) The integration of shrubs and trees into agricultural systems (e.g. agro-forestry, shelter belts) which increases vegetation carbon stocks, modify the microclimate and promote the effective use of resources;

(e) Livestock systems enabling migratory activities or novel animal husbandry systems facilitating mobility in order to ensure the maintenance of ground cover during dry periods.

B. Contribution of sustainable land management to safeguarding biodiversity and ecosystem services

14. Dryland ecosystems have high levels of plant diversity – sometimes higher than more humid biomes (Sala et al. 2000) – and are also characterized by highly diverse soil microbial communities (Housman et al., 2007). This biodiversity is fundamental to vital ecosystem functions such as nutrient cycling and the production of SOC, which is essential to both productivity and carbon sequestration. Above-ground plant diversity leads to diverse carbon inputs below ground, and this soil heterogeneity subsequently supports below-ground biodiversity (Coleman and Whitman, 2005). Positive correlations have been found between plant diversity in drylands and the ability of dryland ecosystems to maintain multiple functions and services simultaneously (Maestre et al. 2012).

15. SLM can contribute to the CBD strategic goals, particularly Strategic Goal B of reducing direct pressure on biodiversity and promoting sustainable use, and Strategic Goal D of enhancing the far-reaching benefits of biodiversity and ecosystem services. Given that SLM is presented here as “land use that maximizes production and minimizes environmental externalities for a reasonably long period”, it is noted that: (i) maximizing production through SLM supports the sustainable use of biodiversity (the agricultural and

livestock products are generated by and/or constitute biodiversity components); and (ii) minimizing environmental externalities through SLM reduces negative impacts on biodiversity and ecosystem services.

16. The scientific basis for the link between SLM and the CBD strategic goals is well-established. At farm scale, SLM contributes to safeguarding biodiversity and ecosystem services through (Henry and Murphy, 2015):

(a) Ecologically-based approaches that seek to minimize chemical inputs and enhance biological activity, such as organic agriculture, permaculture and integrated pest and weed management;

(b) The incorporation of shrubs and trees, mixed cropping/livestock systems, inter-cropping, crop rotations and mixed species plantations that enhance species diversity and improve the resilience of production systems;

(c) The protection of native vegetation remnants that provide the habitat and resources needed by pollinators, biological control agents and other beneficial organisms;

(d) Maintenance of ground cover and enhancement of soil organic matter, which enhances soil biodiversity.

17. SLM also produces off-farm benefits: it builds soil productivity and thus reduces pressure to expand agriculture into natural areas; increased nutrient-use efficiency and enhanced soil organic matter reduce the use of chemical fertilizer and other agro-chemicals, reducing runoff and the leaching of nutrients and harmful chemicals, and limiting negative impacts on waterways and adjacent natural areas (Govers et al., 2013).

18. Although SLM promotes management practices that mitigate land degradation, the impacts of a changing climate and biodiversity loss, trade-offs nonetheless occur, and outcomes for all objectives of the Rio conventions cannot be always maximized (Cowie et al, 2011).

C. Operationalizing joint reporting through sustainable land management

19. The Rio conventions acknowledge the interactions between environmental issues and the consequent need to simultaneously address each of their goals. Activities have been undertaken to improve coordination in terms of the implementation of the conventions (Chasek et al., 2011). The remaining challenges to achieving synergy between the conventions can be overcome by implementing appropriate adaptation, mitigation, rehabilitation and restoration tools such as SLM practices (CBD, UNCCD, UNFCCC, 2012).

20. Coordinated action on SLM between the Rio conventions can optimize outcomes and increase the efficiency of monitoring and reporting, thus reducing the total cost of pursuing the conventions’ goals (Chasek et.al. 2011).

21. The UNCCD’s ten-year Strategy includes several framework elements reflecting SLM objectives. The methodologies used by Parties of the UNFCCC for estimating carbon stock changes in soil and woody vegetation through practices such as cropland management, grazing land management and revegetation are applicable to monitoring certain aspects of SLM. Likewise, the 2010 Biodiversity Indicators Partnership (BIP) proposed a harmonization framework that forms the basis for a collaboration between the UNCCD and the CBD (Cowie et al, 2011).

22. Given the future interactions likely to occur between climate change, land degradation and biodiversity loss, monitoring and evaluation frameworks should seek to simultaneously assess status and trends amongst these issues. For assessment and

monitoring, a combination of direct measurements, proxy measures (or indicators) and model-based approaches (top-down or bottom up) is most appropriate for understanding the complex interactions between climate change, land degradation and biodiversity loss, and monitoring their impacts. A number of integrated frameworks enable this combined approach (Reed and Stringer, 2015), as summarized in the table below.

23. The frameworks of the table below share common features, to a greater or lesser degree:

(a) They are able to identify, map and describe the ecosystem or ‘system’ affected by DLDD, climate change or biodiversity loss;

(b) They have the capacity to quantify the socio-economic and environmental benefits provided by SLM measures;

(c) They are based on participatory processes;

(d) They identify causes or drivers of changes;

(e) They incorporate scientific and local/indigenous knowledge;

(f) They provide information on the identification of indicator sets; and

(g) They acknowledge that biophysical assessments must be complemented with socio-economic data within specific cultural settings in order to develop realistic and locally-based responses. This helps to create a discourse for public communications in order to target high-level decision-makers (UNCCD, 2013).

24. A framework to monitor the contributions of SLM to the objectives of the Rio conventions will be effective and useful for country Parties if indicators relevant at national and subnational levels are incorporated.

Table
Examples of integrated frameworks with potential application to sustainable land management interventions, and reporting on their contribution to advancing the goals of the Rio Conventions

Approach	*Salient features*
Driver-Pressure-State-Impact-Response (DPSIR)	Enables Integrated Assessments (environmental and socio-economic pillars) to address complex issues through various scientific disciplines, while incorporating local, regional and/or national social actors (Kristensen, 2004). Adopted by the United Nations Environment Programme (UNEP) to conduct global, regional, sub-regional and national State of Environment Reports; by the Food and Agriculture Organization (FAO) of the United Nations for the Global Land Degradation Assessment (GLADA); and the European Environment Agency (EEA), amongst others.
Driving force-Pressure-State-human/environment Impact-Response (DPSheIR)	Modification of the DPSIR recommended by the ad hoc advisory group of technical experts (AGTE) (UNCCD, 2013). Identifies national and local indicators to measure progress towards the UNCCD strategic objectives. Integration of multi-scale information and stakeholder participation are key principles.

Approach	*Salient features*
Resilience, Adaptation Pathways and Transformation Assessment (RAPTA)[a] Framework	Users understand the critical attributes and indicators for their system to allow effort and resources invested in measuring and reporting to be targeted at indicators of those key variables (O'Connell et al. 2015). Indicators for these attributes/controlling variables may have already been reported in the UNCCD, the Convention on Biological Diversity (CBD), the United Nations Framework Convention on Climate Change (UNFCCC), the Global Environment Facility (GEF) tracking tools, in other databases or in the literature, although some may require additions or modifications. The development of new regional-specific indicators may be required if they do not exist. The procedure includes four elements: • Element A: System Description: scope, resilience, governance, agro-ecosystem functions. • Element B: Assessing the System: alternative regimes, general and specific resilience, identification of the need for adaptation or transformation, etc. • Element C: Adaptive governance and management: possible intervention options, etc. • Element D: Multi-stakeholder engagement (see Annex).
Land Capability (USDA)/ Land Suitability assessment by the FAO	Land capability and land suitability assessments have formed the basis for some adaptation assessments, given their ability to assess changes in the productive potential of the land in relation to soil quality, land use and climate. Land capability models have been used to assess the likely productivity of agricultural land under climate change scenarios and identify future land uses and crops. In some cases, these models have been linked to soil erosion models to consider how such adaptations might interact with land degradation processes (Reed and Stringer, 2015).
The Economics of Land Degradation (ELD)	Intends to highlight the value of sustainable land management (SLM) and provides a global approach for the analysis of the economics of land degradation. The conceptual framework of analysis involves: (i) Biophysical modelling of supporting ecosystem services (ESs); econometric modelling of the loss of supporting ESs; and modelling the provisioning of ESs; (ii) Estimation of nutrient and crop production losses in recent years; economic valuation of the costs of inaction (benefits of action) against land degradation; cost of SLM, and cost-benefit analysis; and (iii) Policy action (Kumar, 2015).
WOCAT framework	To assess SLM interventions at a local level through: 1. assessment of local case studies of successful response options and their local reach and adoption, including the institutional pathways to implementation; 2. use of a standardized framework enabling comparison and transferability beyond the local area; 3. inclusion of socio-economic and biophysical aspects; 4. use of the knowledge of both specialists and land users as data sources, triangulated with scientific data where possible, and the simultaneous use of the same tools for both (self-) evaluation and knowledge sharing (based on Schwilch et al., 2011 as cited in Reed and Stringer, 2015).
Impact Monitoring and Assessment approach (SLM-IM)	Series of tools for use in rural development projects with a focus on SLM (Herweg and Steiner, 2002).
SELPS	Toolkit for Indicators of Resilience in socio-ecological production landscapes and seascapes (SELPS) (United Nations University et al. 2014).

Approach	*Salient features*
Landscape Function and Analysis (LFA)	A method to assess landscape degradation and track any subsequent restoration or rehabilitation. The functional status of the landscape is monitored by creating indices based on simple field indicators that reflect the measured variables of stability, water infiltration and nutrient cycling. “Function” refers to how well the landscape performs as a biophysical system. Once the functional assessment of a landscape is determined, a ‘societal needs’ assessment is conducted, which is expressed in terms of the condition of a particular landscape for a particular purpose or land use (Tongway and Hindley, 2004).

[a] The framework has formerly been known as the Resilience Adaptation and Transformation Assessment (RATA) Framework, and the Resilience, Adaptation and Transformation Assessment and Learning Framework (RATALF).

25. Another operational challenge is selecting what to measure in order to capture land degradation and, in turn, aspects of climate change mitigation and adaptation and biodiversity conservation. Two alternatives have been proposed: i) Measuring the *process* of concern, i.e., land degradation; or ii) Measuring *what matters to people*, i.e., trends in land condition and productivity.

26. Focusing on measuring what matters, the GLII, in line with the UNCCD secretariat’s contribution to the Sustainable Development Goal process, suggests that three bio-physical indicators be used to complement existing socio-economic indicators of resilience within a prospective monitoring and evaluation framework for the Rio conventions (GLII, 2015): the indicators follow a tiered approach with enhancement possible at the national and sub-national level. Very similar to the UNCCD progress indicators, the list of global land and soil indicators encompasses: 1) land cover/land use change; 2) land productivity change; and 3) SOC change. It is important to emphasize that these three indicators alone do not capture the complexity of land dynamics or the benefits of SLM interventions. The value of these indicators is dependent on the larger monitoring and assessment framework within which they may be used, as previously documented in detail in (i) document ICCD/COP(11)/CST/2 which led to decision 22/COP.11; (ii) the work of the GLII; and (iii) the Impulse Report (Reed and Stringer, 2015) and its executive summary, as contained in document ICCD/CST(S-4)/2.

27. Through adopting a nested approach to indicator development, it may be possible to locally develop relevant indicators around a core set of global indicators such as those previously mentioned; this would enable both cross-scale comparisons and accounting benefits from adopting SLM practices. However, even with detailed field data, it is sometimes difficult to directly attribute changes to adaptation interventions. Socio-economic data are also essential to triangulate and supplement biophysical data in order to determine whether observed changes in biophysical variables enhance sustainability (e.g. if the vegetation is palatable to livestock) or further worsen land degradation (e.g. if the vegetation represents encroachment by unpalatable species, or only exists because of unsustainable use of groundwater for irrigation). Such data are also necessary to detect changes in natural capital (which may be observed using biophysical indicators) within the context of changes to other capital assets (financial, physical, human or social capital) in order to interpret the overall impact of interventions on livelihoods and well-being (Reed and Stringer, 2015).

28. The UNCCD encourages the Parties to use a nested (combined bottom-up and top-down) approach to assess the progress of its ten-year Strategy. A set of core progress indicators (i.e., trends in land cover, trends in land productivity or functioning of the land) is to be complemented with formal and narrative indicators at national and local scale, based on existing data collection systems and databases, and local storylines. Developing

indicators at local or project scales is relatively straightforward, and existing indicators and datasets from established monitoring systems can often be used (Abraham et al., 2006). Qualitative data and analysis from case studies and expert judgment are equally important. Storylines can help provide context with specific information that indicators often miss. Case studies can also be used to validate global or local indicators (GLII, 2015).

D. Institutional arrangements

29. Analyses of recent research and best practice point to a knowledge gap on the most useful indicators (or indicator set) available to each Rio Convention for joint reporting on land issues. Previous sections of this document evidence a growing knowledge base on the contribution of SLM practice and activities to simultaneously mitigating and adapting to climate change, addressing land degradation, and safeguarding biodiversity. Furthermore, integrated frameworks exist with the potential to assess and monitor the benefits of SLM interventions and the cross-cutting goals of the three conventions. These Integrated frameworks at sub-national, national, regional and/or global scale could bring more consistency to reporting under the three conventions. However, the implementation and operationalization of a monitoring and evaluation framework and system for reporting on land issues common to the three conventions remains a challenge for the global community.

30. Most multilateral environmental agreements (MEAs) require Parties to report on national implementation on a regular basis, which holds true for the three Rio conventions. Reporting requirements under the Rio conventions are agreed and periodically adjusted by the governing bodies of MEAs, or by the secretariats under guidance from the governing bodies. As such, the reporting format of each convention has undergone development, often involving substantial adjustments, and these formats continue to change (UNEP and GEF, 2012). It is also important to recognize that both the UNCCD and UNFCCC have different reporting formats for different categories of Parties. The UNCCD differentiates between affected and unaffected country Parties and developed country Parties, while for the UNFCCC the reporting requirements differ for Annex I and non-Annex I Parties. In 2011, the CBD and UNCCD developed new formats for their reporting, and the UNCCD moved to a new indicator-based reporting system.

31. For many years, Parties to the conventions have raised concerns about the increasing reporting burden placed on Parties, and the fact that this is often exacerbated by a lack of coordination across MEAs. The fact that responsibility for reporting to the individual conventions is often housed within different ministries, at country level, creates a further challenge in terms of integrated reporting. A number of initiatives have explored and tested options for streamlining, harmonizing and/or integrating approaches to reporting and associated information management, but operational systems remain a challenge.[6]

III. Summary of findings

32. This SPI objective searched for scientific evidence for the currently prevailing notion that SLM contributes to the commitments of the UNFCCC (adaptation and mitigation) (UNFCCC, 1992), to the strategic goals of the CBD (safeguarding biodiversity and ecosystem services) and associated Aichi Biodiversity Targets (CBD, 2012). This evidence was used to sustain the hypothesis that indicators used by the UNCCD Parties for

[6] <www.rioconventionsreporting.net/>.

detecting degrading and sustainable land management might also be useful for indicating the state of climate change adaptation and mitigation, and that of biodiversity and ecosystem service conservation. Likewise, the indicators used by the UNFCCC and the CBD might be useful for detecting degrading and sustainable land management by the UNCCD Parties. As all three conventions approach land in very different ways, part of the larger scientific assessment of this SPI objective was to identify the most useful indicators used by each Rio convention for joint reporting on land issues (see ICCD/COP(12)/CST/3-ICCD/CRIC(14)/7).

A. Contributions of sustainable land management

33. SLM is fundamental to achieving the goals of the three Rio conventions. Adoption of SLM practices and policies that contribute simultaneously to the goals of the three conventions requires (Thomas, 2008):

(a) Assessment of current land conditions and, where possible, a change in conditions over time. This could be achieved using a combination of remote sensing tools and ground measurements, combining scientific and community-based monitoring techniques (WAC, 2014);

(b) Assessment and improved understanding of the interplay of climatic and socio-economic factors that result in loss of productivity and land degradation;

(c) Risk assessments of climate variability and long-term changes using seasonal and longer-term forecasting linked to agricultural activities and insurance schemes for the poor in rural areas;

(d) Tackling of the bottlenecks to mainstreaming linked efforts on land degradation, adaptation to climate change and prevention of biodiversity loss into development, conservation, restoration and/or rehabilitation processes (legal and policy frameworks and incentives);

(e) Development of low-cost monitoring, evaluation and modelling tools for use by land users, extension services and policy makers for decision-making, and compliance purposes (SOC content, carbon sequestration);

(f) Field and modelling research at various spatial and temporal scales to provide the necessary evidence-based rationale for investing in SLM. This includes developing methods to quantify and value ecosystem services,[7] both on-site and off-site, and assessing the resilience of SLM practices to environmental change.

B. Indicators for joint reporting on land-issues

34. Even considered jointly, three biophysical indicators such as those suggested by the GLII and the UNCCD progress indicators do not comprehensively address all aspects of land. It is therefore essential to monitor these indicators and establish necessary linkages with the other Rio conventions within the context of broader global observation and monitoring strategies based on an integrated framework that uses direct measurements, additional indicators and model-based approaches (top-down or bottom up) to assess the complex interactions between climate change, land degradation, and biodiversity, and the influence of interventions such as SLM. Furthermore, as proposed by the UNCCD (2013)

[7] Valuations should also include the economics of land degradation and climate change, considering the costs of action and inaction including non-monetary values (see ICCD/COP(12)/CST/2).

and reinforced in decision 22/COP.11, it is crucial to establish complementary indicators at the national and sub-national scale to monitor issues relevant to specific national contexts while taking full advantage of the synergies between the three Rio conventions. Moreover, the usefulness of monitoring indicators at a global scale can only be maximized if accompanied by national and local initiatives that comprehensively engage stakeholders to ensure the linkage of bottom-up and top-down approaches (UNCCD, 2013). Scientific knowledge combined with understanding of local knowledge leads to cost-effective development of appropriate land management choices, facilitating adaptation to climate change and supporting the conservation of biodiversity.

35. Monitoring SLM at the local level can and should involve a locally relevant mix of indicators. While the importance of each indicator will vary depending on local conditions, three are invariably essential. Sustained high land cover (easiest to measure), high productivity (measurement requires technology) and high SOC (hardest to measure) are generally attributed to land uses practising SLM. Moreover, land productivity, vegetation cover and soil carbon stocks – recently and frequently proposed as DLDD indicators – are tightly interlinked, and can be monitored using established methodologies.

36. A common assessment and monitoring framework for the three Rio conventions would facilitate more balanced monitoring of multiple ecosystem services, and provide insight into the multiple benefits of SLM, including multiple win options for land, biodiversity, climate and poverty reduction. Monitoring should factor in all landscapes, on-site and off-site effects, and make use of field studies, stakeholder engagement and technology such as Geographic Information Systems (GIS) and remote sensing, where necessary. This could also be complemented with modelling studies for extrapolation and assessment of the resilience of adaptation practices to environmental change (STK4SD, 2015).

37. Further research is needed to develop a monitoring and assessment framework for joint reporting on land issues common to the goals of the three Rio conventions. The framework should: i) optimize the reporting obligations of the Parties; ii) enable data sharing for multiple purposes and produce policy-relevant information; iii) integrate knowledge from multiple fields (scientific, local, indigenous), and be based on participatory processes in relation to known good practice principles, in order to increase awareness and acceptance of solutions (Reed and Stringer, 2015); and iv) build a positive feedback loop (in both directions) between local and global scales.

38. Land-based indicators for assessing and monitoring SLM interventions are relevant for climate change adaptation, and for the safeguarding of biodiversity and ecosystem services. A conceptual framework for monitoring and evaluation acknowledging underlying biophysical and social-ecological relationships should help to identify locally-relevant indicators. Land-based indicators developed through this approach should assist in:

(a) Targeting and prioritizing effective policies and measures to build adaptive capacity where needed;

(b) Establishing baselines on the state of land, including levels of land degradation, to monitor the effectiveness of SLM interventions for climate change mitigation, adaptation and LDDD;

(c) Devising effective and cost-efficient interventions that balance trade-offs and optimize the benefits of addressing climate change and the management of land degradation and biodiversity;

(d) Communicating the effectiveness and outcomes of land-based adaptation to climate change to policy- and decision-makers and other stakeholders; and

(e) Drawing lessons to be shared / transferred on adaptation progress and achievements within and across sectors, regions and countries.

IV. Conclusions

39. The SPI concludes that enhanced monitoring of the contribution of SLM to climate change adaptation/mitigation and to safeguarding biodiversity and ecosystems services requires:

(a) Parties of the UNCCD to work collaboratively with major international fund agencies with a mandate to address land degradation, climate change and biodiversity loss; to pilot-test an integrated framework supporting land-based activities with synergistic effects on the goals of all the Rio conventions; and to develop a system for effectively addressing the reporting needs of the three Rio conventions;

(b) The UNCCD secretariat to work jointly with the UNFCCC and CBD to devise and adopt a common land-based data collection, monitoring and assessment platform using a multi-tier approach with a core set of global indicators complemented by nationally developed ('nested') indicator systems. This multi-tier platform will address the information needs of decision-makers at various operational scales (local, national, regional, global);

(c) Parties to adopt policy-relevant tools for the implementation of land-based indicators for assessment and monitoring, including: approaches that use remote sensing data, validated by ground data, including participatory crowd-sourced data to assess the resilience of agro-ecosystems to climate change and LDDD over large areas; and a common framework that can be used to apply resilience across the three Rio conventions;

(d) Parties to enhance capacities at individual and institutional level in order to facilitate multi-stakeholder engagement in the SLM monitoring processes. Strategies should focus on short-, medium- and long-term capacity building measures;

(e) The UNCCD secretariat to assess the success of SLM practices, considering the degree to which these practices are adopted by other communities and their cost benefit ratios, including market and non-market benefits. The secretariat should also work with its SPI to offer easily accessible, convincing and succinct SLM results to enable policy-makers to make objective decisions.

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Annex

Application of resilience concepts to sustainable land management

1. Resilience is a new focus of sustainable development, and is particularly relevant to food security, especially in dryland areas, where agricultural systems are faced with climate variability and climate change, amongst other shocks and stresses. The Rio conventions have a common interest in building and maintaining the resilience of agroecosystems. The Global Environment Facility-Scientific and Technical Advisory Panel (GEF-STAP) worked with the Commonwealth Scientific and Industrial Research Organisation (CSIRO) to develop a conceptual framework for identifying indicators to assess the resilience of social-ecological systems, which could be applicable to all Rio conventions. The Resilience, Adaptation Pathways and Transformation Assessment (RAPTA) framework (see ICCD/COP(12)/CST/3-ICCD/CRIC(14)/7), built on resilience theory and practical experience offers a structured approach to understanding and assessing resilience, and could be used for project- to national-scale reporting.

2. Application of the RAPTA framework could:

(a) Facilitate mutual learning and the development of narratives among stakeholders;

(b) Guide project and programme development by providing a structured process for problem definition, engagement of stakeholders, and adaptive management;

(c) Guide users in the identification of project-specific indicators relevant to their social-ecological system, providing a clear rationale for choosing where to focus effort in monitoring and assessment;

(d) Provide scalable indicators suitable for monitoring and reporting: (i) high-level summary indicators reflecting the outcomes of the assessment process; and (ii) process indicators reflecting the coverage and quality of the assessment;

(e) Inform initiatives to build the resilience of “desirable” agro-ecological systems (where “desirable” is defined by the stakeholders), and guide users through adaptation and transformation planning processes, using “adaptation pathways” to guide the system away from undesirable states and towards agreed sustainability goals;

(f) Help local communities to participate in planning and implementing interventions;

(g) Increase the likelihood that development initiatives will generate sustained positive impacts.

3. The RAPTA framework will be trialled and refined through its application in the GEF’s integrated approach pilot on “Sustainability and Resilience for Food Security in Sub-Saharan Africa”. RAPTA has been demonstrated in desktop case studies in Niger and Thailand, and the concepts on which RAPTA is built have been applied in the development of catchment plans in Australia. Other initiatives to build resilience apply similar approaches. The following section provides examples of the application of RAPTA and similar approaches based on the resilience and adaptive learning concepts underpinning RAPTA.

I. Examples of the application

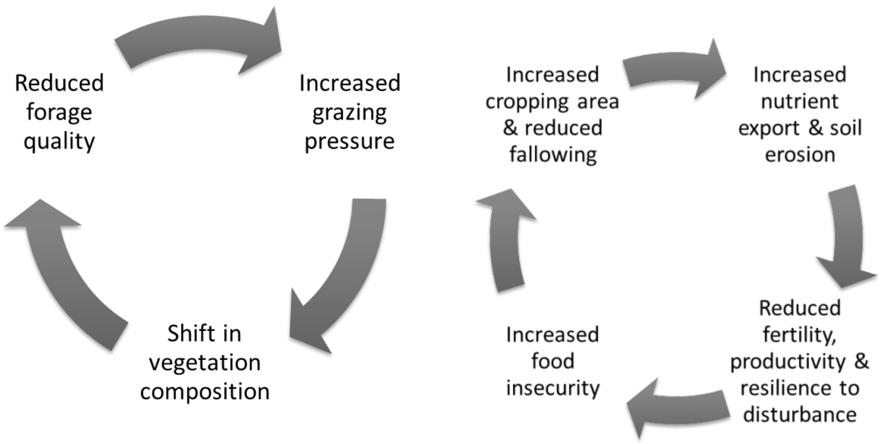
A. RAPTA case study: Niger (Grigg et al. 2015)

4. In the Fakara canton in Niger, two agrarian cultures co-exist: village household crop farmers (Jerma people) grow millet and sorghum, while camp household pastoralists (Fulani people) herd cattle, sheep and goats and traditionally rely on transhumance. Challenges include rapid population growth, climate variability and climate change, low income, gender inequality and land access inequality. Farmers face challenges in maintaining the productivity of acidic soil low in organic matter, nitrogen and phosphorus. Pastoralists are affected by reduced access to watering points, transhumance routes and land as cropping expands. Social factors such as marital status and access to off-farm employment are also significant.

5. Each social-ecological system is influenced by feedback loops, such as those illustrated in the figure below.

Figure

Conceptual models of the feedback loops in pastoral (left) and cropping (right) social-ecological systems in Niger



6. Identified thresholds (table 1) include the extent of fallowing and herbage intake, while indicators of general resilience include species diversity, opportunities for transhumance and off-farm employment, empowerment of landholders, gender equality and capital reserved (table 2).

7. Interventions to enhance adaptive capacity include diversification of crop production, strategic use of fertilizers, pesticides, feed supplements and vaccinations, inclusion of agroforestry, training in animal husbandry, and greater farmer empowerment.

Table 1
Indicators of specified resilience for an agro-pastoral system in Niger

Indicator	*Rationale and assumptions*
Index of sustainability (cropping): extent of fallowing	To maintain fertility, at least 3/8 of arable land should be in fallow
Index of sustainability (grazing): herbage intake	Total intake by livestock should not exceed 1/3 of the mass of palatable herbage at the end of the growing season
Farm-scale nutrient balance	If fertilizer and manure are used to enhance soil fertility, indicators of farm-scale nutrient balance will be required
Household economic self-sufficiency index	Household needs should not exceed agricultural production

Table 2
Indicators of general resilience for an agro-pastoral system in Niger

General resilience Indicators	*Rationale and assumptions*	*Potential sources of information on levels and trends*
Ecosystem diversity and productivity of rangelands	Species diversity enhances general resilience, and degradation trends are eroding diversity	Remote sensing, field measurements
Connectivity of transhumance routes	Loss of seasonal transhumance options places more pressure on rangelands in the wet season, reducing quality forage productivity	Household surveys, land use maps
Seasonal migration opportunities	Options for off-farm employment through dry-season migration relieve pressure on household food stores and bring in additional household income	Household surveys
Participation in farmer-led institutions	Farmer empowerment (for men and women) strengthens the sharing of conceptual models (between farmer groups, and with researchers and development agencies), learning and experimentation	Household and institutional surveys, statistics on membership of associations and political parties
Human Development and Gender Inequality Indices	These indices reflect human and social capital	United Nations Development Programme (UNDP), access to education, health, communication services
Capital reserves (per capita)	Human, natural, social and built capital reserves all create options	National accounts, availability of insurance, banking, grain stores, livestock census
Institutions governing access to shared resources	Good stewardship of shared resources increases general resilience	Household surveys, National laws, local policies

B. Avon catchment natural resource management strategy

8. The Avon catchment in south-western Australia covers 12 million hectares, dominated by mixed crop-livestock systems producing wheat and sheep. It also contains a significant global biodiversity hotspot, and mining activities. Application of resilience

thinking using an approach similar to RAPTA has allowed the community to work together to identify their goals and values (Wheatbelt NRM Inc., 2014). Experts helped to determine the key interactions in this social-ecological system (table 3 column 3), and to identify "thresholds of potential concern", that is, the critical limits for the key controlling variables (table 3 column 4). Monitoring is focused on assessing proximity to these thresholds, allowing generation of a catchment "report card" (table 3, column 5), and interventions are based on management actions designed to reduce the risk of crossing thresholds (table 3, column 7).

Table 3
Report card showing status of the Avon catchment with respect to thresholds of potential concern. (See Wheatbelt NRM Inc. (2014) for explanations of terms, and the sub-regional map)

Theme	*Big resource issue*	*Key controlling variable (slow or fast moving) System Indicator*	*Thresholds of potential concern (TPC) causing a fundamental system change*	*Where are we now?*	*Big drivers (controls) moving the system towards or away from a threshold*	*Points of intervention and associated management actions*
Ecosystem health	Species viability (abundance and richness)	Cleared land	<30-40% bushland	30% (range 6% to 99%)	Land clearing Climate change	Sub-regions where < 30% bushland is enhanced and protected Sub-regions where > 30% remaining bushland is improved, protected and managed
		Fragmentation	Intact bushland patch size <10ha	(see sub-regional map)	Over grazing Feral & weed invasions Fire frequency Climate change Land clearing	Bushland patch size where < 10ha is buffered and reconnected Bushland patch size where remaining > 10ha is improved, protected and managed
Soil health	Soil productivity	Organic carbon	<1% soil organic carbon (SOC)	0.4-1%	Land use Land clearing	Promote soil testing and increase land cover in sub-regions < 1% SOC
		Acidity	50% topsoils < pH 5.5	80%	Fertilizer use efficiency Lime application	Promote soil testing and lime application in sub-regions where > 50% soils pH 5.5
Aquatic health	River function (Avon river and major tributary)	Sedimentation	>30% waterways degraded	30%	Waterway and riparian management	Sub-regions > 30% degraded streams are fenced and re-vegetated Sub-regions < 30% degraded streams are managed and enhanced

Theme	*Big resource issue*	*Key controlling variable (slow or fast moving) System Indicator*	*Thresholds of potential concern (TPC) causing a fundamental system change*	*Where are we now?*	*Big drivers (controls) moving the system towards or away from a threshold*	*Points of intervention and associated management actions*
		Eutrophication	The Avon River > 0.06mg/l total phosphorus and/or > 1mg/l total nitrogen	(see sub-regional map)	Fertilizer use efficiency Climate	Encourage improved fertilizer use efficiency in sub-regions with > threshold Total Phosphorus or Total Nitrogen levels
		Acidity	Waterways pH < 6.5	(see sub-regional map)	Deep drainage	Encourage retrofit of local dam disposal of saline discharge in sub-regions with pH < 6.5
Community health	Agriculture industry viability	Farm financial viability	➢ 25% farmers with > 3:1 debt to income ratio	10-15%	input costs Market price Climate Government policy Management decisions	Develop alternative, viable industry in sub-regions where > 25% farmers are approaching a 3:1 debt to income ratio
	Community viability	Population trend	< 70% residents and farmers within 50km of towns of > 600 people population change > 0%	74% 2% (range 9-10%)	Farm amalgamation Employment High school Aging community Government policy	Work with partners to promote lifestyle and support land use planning in sub-regions where < 70% population resides within 50km of towns of > 600 people (or < 0% population change)
Whole of system health	System viability	Salinity	>10% landscape saline	4%	Climate land use (perennial vegetation) Land clearing	Re-vegetate and adapt to saline land in sub-regions with < 10% saline land Promote re-vegetation to protect local assets in sub-regions with > 10% saline land
	Catchment water availability	Drying catchment	catchment run-off threshold < 0	-2	Climate change Land clearing	Protect strategically-important environmental flows and adapt to climate change impacts in sub-regions where the catchment run-off threshold is < 0

C. Building resilience in the Mongolian steppe

9. In the Sükhbaatar Province of Mongolia, transhumant grazing of sheep, goats and cattle has been practised for centuries. The region receives around 250mm of annual rainfall and is characterized by grasslands dominated by Stipa species. Recent changes in transport and lifestyle have led to increased grazing pressure around towns, causing land degradation due to loss of ground cover. The "Regenerating the Stipa grasslands of Eastern Mongolia" project aims to combat land degradation through a holistic approach to building resilience of the social-ecological system, which will in turn sustain the livelihoods of the nomadic herders. The project applies the "positive deviance" social change technique[8] to identify situations where uncommon practices have been more successful than the common practice. Discussion with the herders revealed that discontinuation of traditional practices has led to reduced health of the grasslands. Landscape function analysis (Tongway and Hindley, 2004) has been proposed as a tool to assess land condition and inform management decisions and trials. Indicators of successful grassland management in these rangelands include diversity of species, canopy cover of palatable perennial pasture plants, recovery of perennial grasses after grazing, a well-developed litter layer, and grazing strategies that promote litter decomposition and germination, and the establishment of new perennial grasses.

II. Conclusions

10. The Science-Policy Interface (SPI) concludes that:

(a) Frameworks such as RAPTA should be used to guide the planning of management interventions to combat land degradation, and to select indicators to monitor progress in building agro-ecosystem resilience; and

(b) RAPTA could be applied to inform narrative indicators and resilience assessment in future UNCCD reporting.

[8] <www.positivedeviance.org/>.