Food and Agriculture Organization
of the United Nations

A Minimum Set of Environmental Indicators for Improving Rural Statistics

Publication prepared in the framework of the Global Strategy to improve Agricultural and Rural Statistics

November 2016

A Minimum Set of Environmental Indicators for Improving Rural Statistics

Table of Contents

Acknowledgements

This technical report was written by Mark T. van Wijk, Senior Scientist at the International Livestock Research Institute (ILRI). Susan Offutt (independent consultant coordinating the GSARS work focusing on improving Rural Statistics), Flavio Bolliger (Research Coordinator – GSARS) and Arbab Asfandiyar Khan (Economist - GSARS) peer-reviewed the report and provided input on the structure and text.

Acronyms and Abbreviations

CBD	Convention on Biological Diversity
DPSIR	Driving force-Pressure-State-Impact-Response framework
ELS	Environmental Livelihood Security framework
FAO	Food and Agriculture Organization of the United Nations
FDES	Framework for the Development of Environment Statistics
GHG	Greenhouse Gas
GIS	Geospatial Information System
GSARS	Global Strategy to Improve Agricultural and Rural Statistics
IUCN	International Union for Conservation of Nature
MDG	Millennium Development Goals
NaRIA	Natural Resource Integrity Assessment
NRI	Natural Resource Integrity
NSO	National Statistical Office
RHoMIS	Rural Household Multiple Indicator Survey
SDG	Sustainable Development Goals, (as defined by the United Nations)
SDI	Sustainable Development Indicator
SEEA	System of Environmental-Economic Accounting
UN	United Nations
UNCBD	United Nations Convention on Biological Diversity
UNCCD	United Nations Convention to Combat Desertification
UN FCCC	United Nations Framework Convention on Climate Change

Executive Summary

The Global Strategy to Improve Agricultural and Rural Statistics (GSARS) seeks to provide information to guide the decision-making processes of national and multilateral agencies on designing, funding, and evaluating rural development policy. This research topic aims to assemble guidance for developing countries that intend to improve their systems for compiling rural statistics. In particular, it will be sought to identify a set of indicators for measuring the progress made by policies to reduce poverty and promote environmental sustainability. In addition, a set of definitions of "rural" elements will be elaborated, to organize the collection and interpretation of indicators. This technical report, written by Mark T. van Wijk, focuses on defining a minimum set of indicators of environmental sustainability.

The report first provides an overview of the existing frameworks of environmental indicators that focus on the mutual interactions between rural livelihoods and their biophysical environment. It also presents the approaches currently used within the United Nations (UN) and the Food and Agriculture Organization of the United Nations (FAO), as well as the Sustainable Development Goals (SDGs) concerning the environment specifically. This is followed by the establishment of a set of criteria to be used in defining the minimum indicator set; of these, the five generic criteria of relevance, methodological soundness, measurability, parsimony and ease of communication are the most important. These criteria – in combination with the desire to overlap with existing initiatives in the different UN conventions, to ensure that the efforts supported by the GSARS make use of and coincide with ongoing efforts, thereby ensuring consistency and efficiency in ongoing data collection and data (re-)use – have led to the definition of the minimum indicator set.

The final set of indicators are:

1. Sustainability of biomass extraction (compartment: land)
2. Environmental health (compartment: air and water)
3. Water availability and quality (compartment: water)
4. Land degradation (compartment: land)
5. Biodiversity (compartment: land, water and air)

Each of the indicators will be explained further. The variables required to quantify them will also be defined.

1

Introduction

The GSARS is a statistical initiative that was launched in 2011 in response to concerns on the quantity and quality of agricultural statistics in many countries. The concerns reflected the understanding that significant connections exist between improved information, improved agricultural performance and improved standards of living for millions of poor rural people. Its main objective is to develop and implement approaches to the collection and use of statistics relevant to agricultural and rural issues. An integral element to these issues is the state of the environment: indeed, human well-being depends on a healthy environment, because it provides water, energy, biomass and food.

Monitoring environmental indicators provides quantitative information on the state of the environment and its changes, the quality and availability of environment services, and the impact of human activities on the environment. Recent international agreements have set targets for environmental or environment-related conditions, such as biodiversity, greenhouse gas (GHG) emissions and land degradation. The SDGs are among the most important set of targets established by the global community, specifying a range of environmental targets to ensure the "sustainability" of the activities pursued, which otherwise takes on a "livelihood" lens. The monitoring of environmental indicators is essential to measure the progress made towards these global targets. It also provides key information on the social actions and economic measures that societies can take to restore and maintain the environment's capacity to provide the services that are essential for life and human well-being.

Rural policies can play an important role in achieving global targets like the SDGs by influencing the decision-making processes of rural livelihoods. "Livelihood" is defined as:

"a means of making a living. It encompasses people's capabilities, assets, income and activities required to secure the necessities of life. A livelihood is sustainable when it enables people to cope with and recover from shocks and stresses (such as natural disasters and economic or social upheavals) and

enhance their well-being and that of future generations without undermining the natural environment or resource base."

In this definition, the relationship between livelihoods and their natural environment is explicit. There is a two-way interaction between rural livelihoods and their natural environment: the environment is strongly affected by decisions made by rural livelihoods; and the environment also affects rural livelihoods, for example with regard to the collection of wild food, drinking water or fuelwood extraction.

In practice, the design and operation of monitoring systems to quantify the state of and changes occurring in the natural environment presents countless theoretical, technical, political and logistical challenges. The ability to address these issues in robust, transparent and cost-effective ways has remarkable consequences for the success or failure of global agreements. The global monitoring of key performance indicators should be based on comparable and harmonized data. National statistical agencies play an essential role in collecting this information, and efforts are under way to establish reporting mechanisms that ensure the consistent transfer of country-level information to the international statistical system. These mechanisms can be improved by strengthening the coordination function of national statistical offices by National Statistical Offices (NSOs) and other national institutions (UNSC, 2015). One of the key practical challenges is the disparity in the financial and technical capacities of NSOs in collecting and processing this information. Therefore, to obtain information that is consistent among low-income countries, a minimum indicator set should be designed. This set should be capable of ensuring that 1) information can be collected in a relatively simple and cost-effective way; and 2) the most important aspects of the state of the environment are tracked.

This report will contribute to the harmonization efforts being made in the environmental indicator sets within the GSARS framework. This will be achieved by 1) providing an overview of the existing major frameworks for environmental indicators; 2) describing how these frameworks are used as a basis to establish a minimum indicator set for the monitoring of environmental indicators in relation to rural livelihoods; 3) defining what is meant by a minimum indicator set and how lean data approaches can help to achieve it; and 4) establishing the minimum indicator set and the variables to be measured in the field, to calculate these indicators.

This report will focus on environmental variables that are – in physical terms – beyond rural livelihoods, but are influenced by their decisions. The emphasis will be on environmental variables that are not covered in other GSARS-related activities. Therefore, indicators of agricultural sustainability and climate change, as well as environmental indicators that one may reasonably expect to be explored in this report (for example, GHG emissions or soil quality) will be covered in other publications.

2

Current Global Efforts in Collecting Environmental Indicators

The demand for statistics on environmental indicators is increasing, in conjunction with continuing environmental degradation, uncertainty on the possibilities for improved and cost-effective environmental management, and the recognition that human well-being depends on a healthy environment. Given the growing list of environmental issues on which governments, businesses and households must decide (such as climate change, biodiversity and degradation of natural resources), there is an urgent need for a consistent and concise set of environmental indicators.

Currently, there is no shortage of environmental indicators. A wide range of aspects may be covered to characterize the state of the environment, from biodiversity, water quality, emissions and land cover to soil quality. For each of these indicators, monitoring entails a large set of associated practical and scientific problems (what to measure, where to measure, how to measure, in relation to the cost of measurement). Recently, several scholars and institutions have attempted to develop pragmatic solutions to these problems.

This section will provide an overview of several important frameworks for assessing environmental indicators. However, first, the key indicators of interest within the SDGs will be described, because the SDGs form an overarching "umbrella" under which the GSARS must function and to which it must deliver. Therefore, although the environmental indicators selected within this GSARS activity will be more detailed than what is strictly required within the SDG indicator set, they will comply with the SDG indicators selected. The frameworks discussed include several generic frameworks that attempt to integrally quantify the state of the environment (the Framework for the Development of Environment Statistics – FDES – and the System of Environmental-Economic Accounting, or SEEA), and the reporting requirements for three key environment-focused UN conventions: the Climate Change Policy (CCP), Convention on Biological Diversity (CBD) and the

United Nations Framework Convention on Climate Change (UNFCCC). This section will also introduce some relevant approaches that have been presented in recent scientific literature.

2.1. The United Nations' Sustainable Development Goals

On 1 January 2016, the world officially began the implementation of the 2030 Agenda for Sustainable Development – the transformative plan of action based on 17 SDGs – to address urgent global challenges over the next 15 years. The 17 SDGs are:

Goal 1: End poverty in all its forms everywhere
Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture
Goal 3: Ensure healthy lives and promote well-being for all at all ages
Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
Goal 5: Achieve gender equality and empower all women and girls
Goal 6: Ensure availability and sustainable management of water and sanitation for all
Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all
Goal 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
Goal 10: Reduce inequality within and among countries
Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable
Goal 12: Ensure sustainable consumption and production patterns
Goal 13: Take urgent action to combat climate change and its impacts
Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development
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
Goal 16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

Goal 17: Strengthen the means of implementation and revitalize the global partnership for sustainable development

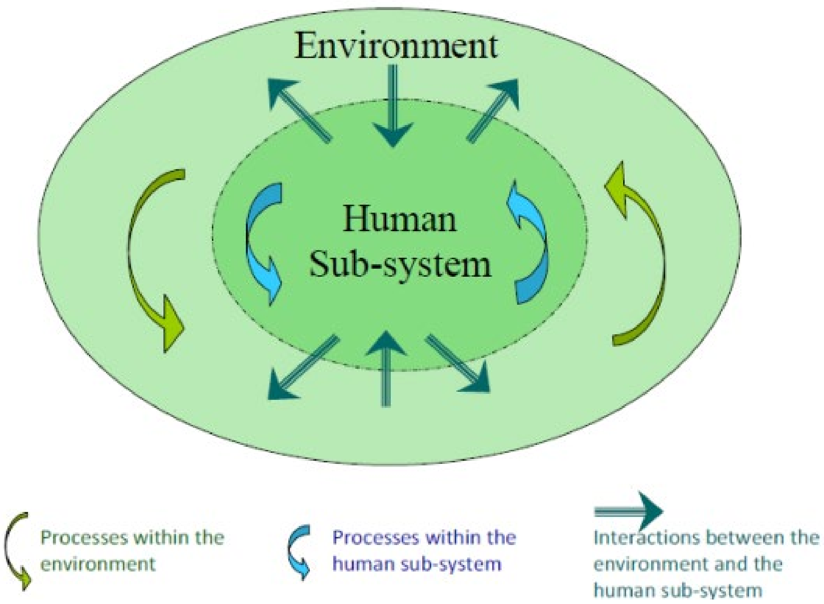
Goals 6, 7 and 15 are particularly relevant to this report, which focuses upon environmental indicators that are affected by actions taken by rural livelihoods. The definition of the 17 SDGs was followed by work to define the indicators that would be used to monitor progress towards them. For this purpose, the Inter-Agency and Expert Group on Sustainable Development Goal Indicators was formed, which, in collaboration with the United Nations Statistics Division, originally defined a set of 229 indicators. Currently, 123 indicators are being used, together with a series of supplementary indicators. Indicators 6 and 7 (clean water and access to affordable and clean energy) are primarily defined from the perspective of human well-being; however, the indicators of interest are the use of freshwater sources (and not their availability), access to renewable energy sources, and the percentage of households having access to electricity. The indicators used for SDG 15 (terrestrial ecosystems) are also of direct importance to the subject of this report. These indicators seek to measure the forested area, the proportion of areas that important for biodiversity that are protected and the extent of the protected areas for mountain-related biodiversity specifically; in addition, they ascertain the existence of red-list species and evaluate the expenditure and policies in place for the protection of (semi-) natural areas.

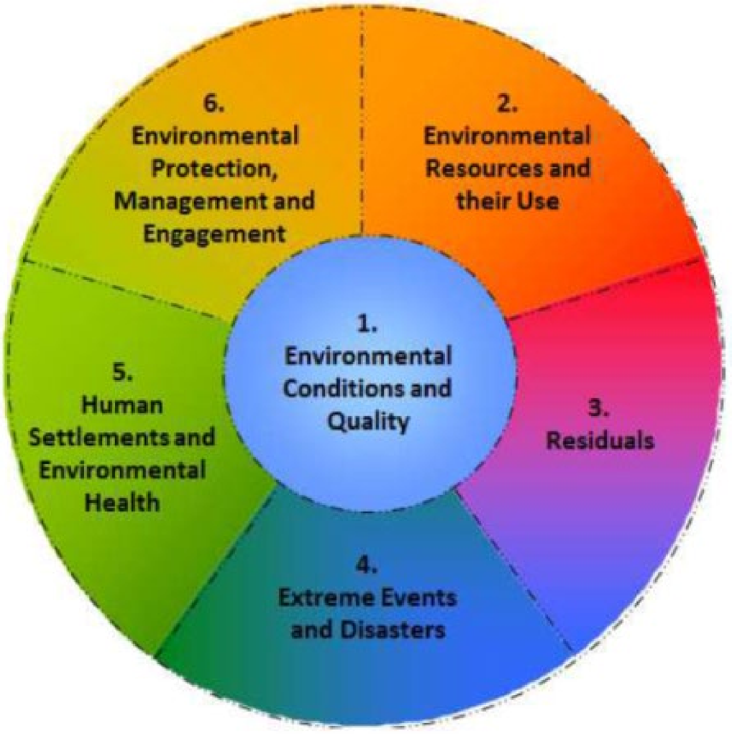
2.2. Framework for the Development of Environment Statistics (FDES) 2013

The Framework for the Development of Environment Statistics 2013 (FDES 2013, updated and published in FDES, 2016) is a flexible, multi-purpose conceptual and statistical framework. Comprehensive and integrative in nature, it provides a structure to guide the collection and compilation of environmental data and to synthesize data from various subject areas and sources. The FDES 2013 targets a broad user community, including environment statisticians in NSOs, environmental ministries and agencies, as well as other producers of environment statistics.

The FDES 2013 seeks to be compatible with other statistical and analytical frameworks and systems, such as the SEEA, the Driving force-Pressure-State-Impact-Response (DPSIR) framework, the SDGs, the Millennium Development Goals (MDGs) and the Sustainable Development Indicator (SDI) framework. The FDES 2013 organizes environment statistics into six components, each of which is broken down into sub-components and statistical topics. The six components are: environmental conditions and quality; the availability and use of environmental resources and related human activities; the use of the environment as a sink for residuals and related human activities; extreme events and disasters; human settlements and environmental health; and social and economic measures to protect and manage the environment. The statistical topics represent the components' quantifiable aspects and are grouped into sub-components, taking into account the types and sources of the statistics required to describe them. The FDES 2013 sets out a comprehensive – although non-exhaustive – list of statistics that can be used to measure the statistical topics: the Basic Set of Environment Statistics, or "Basic Set". The Basic Set is organized into three tiers, based on the statistics' level of relevance, availability and methodological development. The FDES 2013 is relevant to and recommended for use by countries at all stages of development. However, it particularly intended to guide the formulation of environment statistics programmes in countries that are in the early stages of developing their environment statistics systems. Indeed, it: (i) identifies the relevant scope and constituent components, sub-components and statistical topics relevant; (ii) contributes to the assessment of data requirements, sources, availability and gaps; (iii) guides the development of multi-purpose data collection processes and databases; and (iv) assists in the coordination and organization of environment statistics, in light of the inter-institutional nature of the domain.

Figure 1. The framework used in FDES 2013.





Despite adoption of a tiered approach, the number of variables and indicators in Tier 1 remains substantial (Table 1) and exceeds the target number envisaged in this report. However, the FDES approach and overview serves as an excellent starting point in selecting indicators, and in ensuring consistency and coherence with other environmental indicator frameworks.

Table 1. Overview of the number of indicators covered for each component (see Figure 1) in each FDES 2013 tier.

Component							
	1	2	3	4	5	6	Total
Tier 1	32	30	19	4	12	3	100
Tier 2	58	51	34	11	22	24	200
Tier 3	51	43	5	16	20	23	158
Total	141	124	58	31	54	50	458

The FDES 2013 explicitly refers to the widely used DPSIR framework, an analytical framework based on the causal relationship between its own components. “Driving forces” are the socioeconomic and sociocultural forces driving human activities, which increase or mitigate pressures on the environment. “Pressures” are the stresses that human activities exert on the environment. The “State”, or state of the environment, is the condition of the environment. “Impacts” are the effects of environmental degradation. “Responses” refer to the society’s responses to the environmental situation.

Although the framework is widely used, experience has shown that it is often difficult to distinguish between the effects of human and natural stressors on the environment, and even more challenging to link a particular stressor to a specific impact. Nevertheless, the DPSIR framework facilitates consistent handling of information and thus guides users in collecting pieces of information and minimizing unintended gaps in assessment and analysis. As such, it is useful for grouping and reporting existing data and indicators. The FDES does not apply the causal sequence assumed in the DPSIR framework; however, the FDES’s statistical topics can be rearranged in accordance with the logic of the DPSIR framework.

2.3. The System of Environmental-Economic Accounting (SEEA)

The SEEA (UN, 2014) is an accounting system that describes and quantifies the interactions between the economy and the environment. Central to the SEEA is a “systems” approach to organizing environmental and economic information that covers, as completely as possible, the stocks and flows that are relevant to the analysis of environmental and economic issues. It applies the accounting concepts, structures, rules and principles of the System of National Accounts, or SNA (SNA, 2009). In practice, environmental-economic accounting includes the physical and monetary statistics for the compilation of supply and use tables, functional accounts (such as environmental protection expenditure accounts), and asset accounts for natural resources.

The SEEA’s Central Framework (SEEA-CF) is the core section that establishes how the link between the economy and the environment, in terms of stocks and flows, is quantified. Another section that is important for the purposes of this this report is SEEA Agriculture. The United Nations Statistical Commission, at its 43rd session in 2012, adopted the SEEA-CF as the initial version of the international standard for environmental-economic accounting, thus making it a widely accepted standard. The SEEA for Agriculture, Forestry and Fisheries (SEEA Agriculture) is a statistical system for organizing data to enable the description and analysis of the relationships between the environment and the economic activities of agriculture, forestry and fisheries. This is of particular relevance to this report because these activities form the basis for many livelihoods in the rural area and depend directly on the environment and its resources, while also entailing a strong impact upon them.

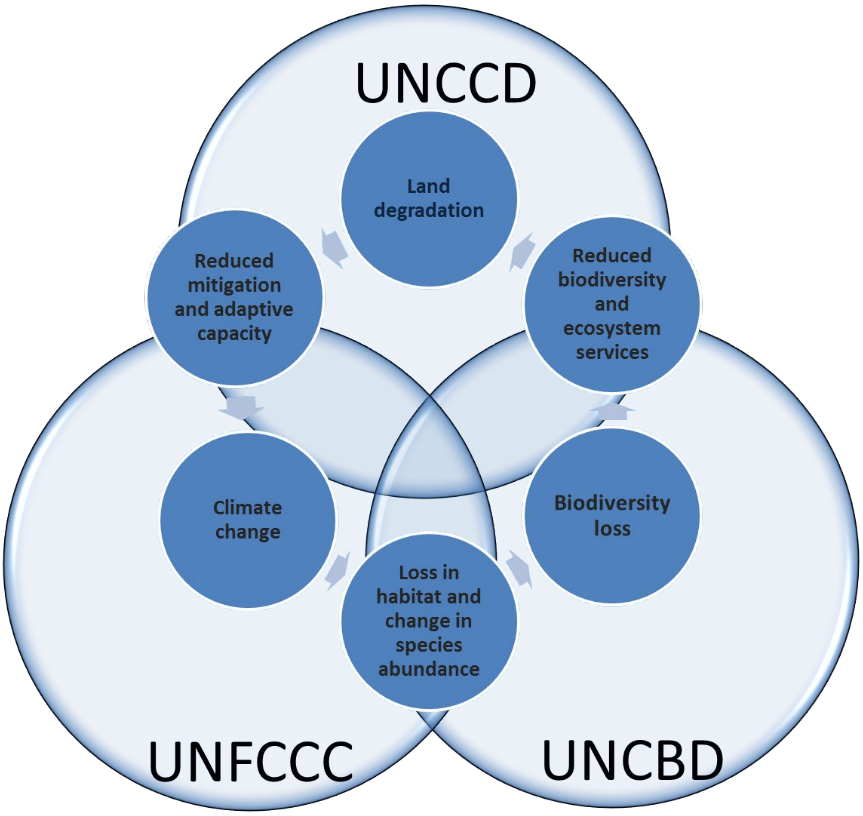
SEEA Agriculture is a single tool for harmonizing and aligning the data from various agencies within a national statistical system. The data include information drawn from surveys and censuses, administrative sources and – increasingly – Geospatial Information Systems (GIS). The SEEA Agriculture is broad, and requires a large amount of data for its implementation.

SEEA Agriculture is an explicitly linked with the GSARS initiative. The main focus of GSARS is the development and implementation of approaches to the collection and use of statistics relevant to agriculture and rural issues, elements with which SEEA Agriculture is aligned. As stated in SEEA (2016), *"the potential for complementarity between improving the coverage and quality of agricultural statistics and implementing the SEEA Agriculture is evident in the similarity of the types of data encompassed by the two frameworks"*. In particular, the complementarity consists in the fact that GSARS is intended to provide more and better data, while SEEA Agriculture should create a framework for integrating various data sources and assessing data gaps. GSARS should aim to develop a Master Sampling Frame (MSF) as the basis for the collection of country-level agricultural statistics; this MSF should then support the implementation of the SEEA Agriculture. While this appears to be clear on paper, in practice, the comprehensiveness of the SEEA approach may collide with the aim of GSARS to define minimum indicator sets that can be collected by national statistical bureaus of varying technical capacities and financial resources.

2.4. Indicator approaches established in UN conventions

Within our focus on environmental indicators, three UN conventions are of specific interest, also because they have defined indicators to be monitored and have developed approaches towards their quantification. These conventions are the UNFCCC, the United Nations Convention to Combat Desertification (UNCCD) and the UNCBD (see Figure 2). These three conventions were established at the Earth Summit, held in Rio de Janeiro (Brazil) in 1992, and are also known as the Rio Conventions.

Figure 2. The relationships between the UNCCD, the UNFCCC and the UNCBD; figure adapted from UNCCD (2015).



Each of these conventions has developed, or is in an advanced stage of developing, a core indicator set that countries should quantify. The indicator approaches used in each convention will be described briefly below.

2.4.1. The United Nations Convention to Combat Desertification

The UNCCD links the environment and development to sustainable land management. It specifically addresses the arid, semi-arid and dry sub-humid areas, known as the drylands, where some of the most vulnerable ecosystems and peoples may be found. Through strategic operational aims for science, technology and knowledge , the UNCCD seeks to become a global authority on scientific and technical knowledge pertaining to desertification/land degradation and the mitigation of the effects of drought. This will achieved by national monitoring and vulnerability assessments of biophysical and socioeconomic trends identifiable in affected countries. Core activities include setting a baseline based on the new and existing data, and gradually harmonizing relevant scientific approaches. Most importantly, with regard to this report, the UNCCD is the convention that has advanced the most on formulating a minimum set of indicators, which are now 11 in total (Berry et al, 2009).

2.4.2. The Convention on Biological Diversity

The CBD has three main objectives: 1) the conservation of biological diversity; 2) the sustainable use of the components of biological diversity; and 3) the fair and equitable sharing of the benefits arising from the utilization of genetic resources. In the last objective, factors such as food security and nutrition are important, and there is an explicit link to rural livelihoods. The CBD has worked together with the Biodiversity Indicator Partnership, or BIP (see BIP, 2011). In the CBD's indicator guidance report, it is stated that its overall aim is to "assist in the production of successful biodiversity indicators at the national level. By 'successful' [the CBD] mean[s] indicators that are actually used to support policy and decision making, whether this be in reports on progress towards targets, analysis of important issues, or in education and the news media". The indicators should be quantified on a regular basis, so that they can be used to track changes over time. Although a basic description of the indicators to be tracked is available, and the guidance report provides examples of successful indicators, the work on turning these into a systematic, harmonized indicator set is still under way. This is all the more true for minimum indicators that should and can be quantified by all countries relatively easily.

2.4.3. The United Nations Framework Convention on Climate Change

The oldest active Rio convention, the UNFCCC establishes a framework for action aimed at stabilizing atmospheric concentrations of GHGs to avoid "dangerous anthropogenic interference" with the climate system. Controlled gases include methane, nitrous oxide and, in particular, carbon dioxide. Parties to the UNFCCC submit national GHG inventories to the Climate Change secretariat, in accordance with the reporting requirements adopted under the UNFCCC itself. The GHG data reported contain estimates for direct GHGs, such as carbon dioxide, methane and nitrous oxide, as well as for indirect GHGs such as sulphur dioxide, mono-nitrogen oxides, carbon monoxide and non-methane volatile organic compounds (NMVOCs). A series of strict data definitions has been established, as well as tiered protocols for quantifying the emission estimates. Definitions and methodologies, including relevant methodological publications of the Intergovernmental Panel on Climate Change (IPCC), may be found at http://www.ipcc.ch/.

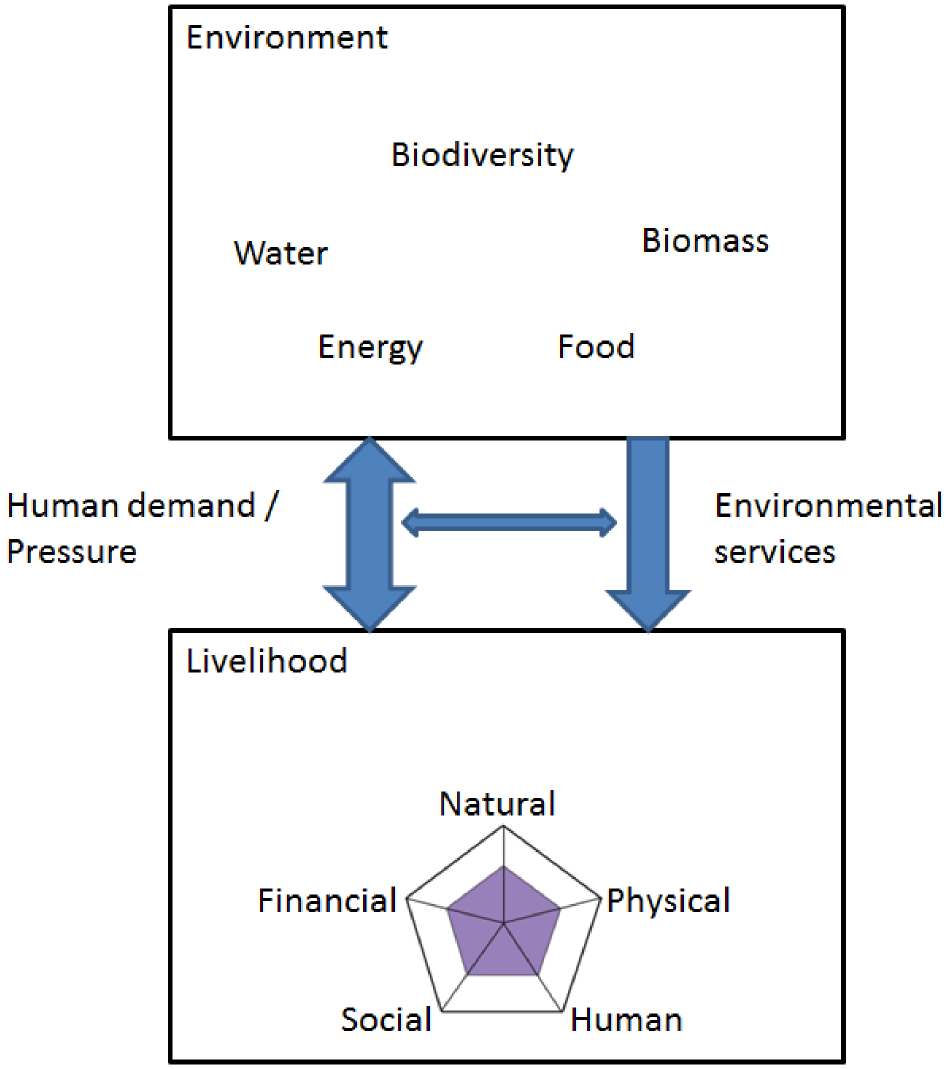
2.5. New developments in collecting environmental indicators having rural livelihood as a key entry point

These efforts clearly focused on quantifying the state of (and changes to) the key aspects of the environment. However, not all of these activities and frameworks explicitly take the livelihood perspective into account, a perspective that is necessary for the purposes of this report. Therefore, subsections 2.5.1.–2.5.4. provide a brief overview of several new developments that expressly apply a livelihood perspective when examining environmental indicators or indicators of environmental sustainability that have been presented recently in the scientific literature.

2.5.1. The Environmental Livelihood Security (ELS) framework

The Environmental Livelihood Security (ELS) framework (see Figure 3) combines methodologies that quantify sustainable livelihoods approaches and "nexus" approaches, which focus on the environment's supply of food, water and energy. The framework was created by Biggs et al. (2014) to balance natural resource supply and human demand on the environment, and thus promote sustainability. The ELS framework seeks to ensure that livelihoods are explicitly accounted for within the water-energy-food nexus. The framework is adaptable to a range of spatial scales and institutional levels, to ensure accurate monitoring of SDG progress and enable subnational accounting for spatial disparities in meeting SDG targets – an area in which MDGs have been critiqued as being deficient. Although the ELS framework is yet to be attached to a detailed indicator approach, its generic overview of the aspects to be taken into account (see Biggs et al., 2015) makes it easier to gain an overall overview of the system's performance in indicator selection exercises, and to bear in mind a few key performance indicators. The ELS framework thus functions similarly to the five-capital approach in livelihood analyses: the five-capital approach is also flexible in terms of the indicators used (in other words, there is no harmonization); however, its users are unlikely to overlook key performance aspects of the system of interest.

Figure 3. The conceptual framework for investigating ELS.



Source: adapted from Biggs et al., 2015.

2.5.2. Vital Signs

Vital Signs (www.vitalsigns.org) aims to collect and integrate data on agriculture, the environment and human well-being across several African nations. Vital Signs seeks to provide data and diagnostic tools to better inform agricultural decisions and monitor outcomes, to guide sustainable agricultural development and ensure healthy and resilient ecosystems and livelihoods. The initiative takes the form of a partnership, led by Conservation International (CI) in collaboration with the Earth Institute (EI), Columbia University, and South Africa's Council for Scientific and Industrial Research (CSIR); it is funded by the Bill & Melinda Gates Foundation and the MacArthur

Foundation. Vital Signs strives to systematically define and work across scales (a core problem when integrating livelihood data and environmental data): from the household level back to the plot scale, and again upwards to landscape, regional and global levels.

The monitoring system developed by the project is designed such that each decision support indicator is related, in a systematic and harmonized manner, to a connected set of analytical outputs and a set of georeferenced measurements. This related set of metrics, analytical outputs and indicators is called a "thread". These threads should then be combined to obtain an overall view of the state of the combined human-environment system, although precisely how that integration will happen is as yet unclear. For the purposes of this report, the most interesting section is Vital Signs' final set of indicators (see http://vitalsigns.org/indicators), in combination with the metrics supporting them (http://vitalsigns.org/sites/default/files/VS_Indices%20Metrics%20Chart_A4.pdf). Although – as usual – the quality and representativeness of individual indicators may be discussed, the approach is valuable method in that it seeks to formalize the monitoring of combined human-environment systems in a harmonized way. In addition, some indicators are of direct importance for the minimum indicator set proposed in this report.

2.5.3. The Natural Resource Integrity Assessment (NaRIA)

The Natural Resource Integrity Assessment (NaRIA) scorecard approach (Barrios and Mortimer, 2014) is another example of a rapid assessment of factors that are important, from an environmental perspective, in rural households focusing on farmers. The purpose of the NaRIA scorecard is to provide a rapid assessment of the Natural Resource Integrity (NRI) status of rural livelihoods, focusing on farms. The assessment involves farm-walks and on-site conversations with farmers. The NaRIA scorecard is simple to use and allows for a rapid and quantitative visual estimation of the NRI status of each study farm. After combining results for the five indicators in each of six NRI status assessment dimensions (landscape context, soil erosion, soil organic matter content, soil nutrient availability, soil biological activity, incidence of pests, weeds and diseases), an overall farm assessment can be generated. The landscape aspect of NaRIA appears to be relevant to the subject of this report.

Starting with a broad examination of the landscape context, NaRIA aims to trace a general picture of the challenges and opportunities in the areas surrounding the study farms; these general overviews can also be used for other rural households. Their elements are the relative level of connectivity between natural vegetation patches, and of conservation of the riparian forest; these are also important indicators of land use intensification, which ultimately affects the status of and potential for management of natural resources. The turbidity of surface water may provide a rapid indication of the relative amount of sediment transported as a result of upstream soil erosion processes in action (transparent water indicates no erosion; a murky color shows erosion). The visual presence of gullies indicates that long-term soil erosion processes have been occurring and require urgent attention. The colour of surface water may indicate excessive richness in particular nutrients (for example, a greenish colour is generally due to profuse algal growth resulting from eutrophication). An awareness of the amounts of inputs generally being used by farmers may also signal potential pollution problems before they become visible.

2.5.4. The Rural Household Multiple Indicator Survey (RHoMIS)

A new tool that also aims to simplify and harmonize data collection efforts to derive minimum sets of performance indicators is the Rural Household Multiple Indicator Survey (RHoMIS). In their work, Hammond et al. (2016) noted the lack of standardization of performance indicators in rural livelihoods (from agronomic, food security and environmental perspectives), which has led to the development of a wide array of tools and ad hoc indicators. This lack of harmonization and standardization strongly limits the possibility to perform comparisons across sites and draw general conclusions on the relationships and trade-offs between livelihood characteristics on one hand, and trade-offs and synergies between environmental indicators and other indicators (such as nutrition, food security and poverty) on the other. RHoMIS is a household survey tool designed to rapidly characterize a series of standardized indicators across the spectrum of agricultural production and market integration, socioeconomic and environmental conditions, food security, poverty and GHG emissions. The tool is relatively weak on environmental indicators (although GHG emissions and carbon and nutrient balances can be assessed); however, its lean data approach and its focus on livelihood are useful for the Global Strategy's objectives.

3

The Minimum Environmental Indicator Set

3.1. Type of data

Data to calculate the values of environment indicators are collected with different techniques, and are measured at different spatial and temporal scales and levels of integration. Typically, the environmental consequences of human actions are visible at a larger spatial scale and a longer time scale than those at which the human decisions were actually taken; the farm livelihood may be the onlyan exception to this rule. It is difficult to standardize the monitoring of data at landscape level, if only due to the divergent definitions of the term "landscape" itself. With regard to collection techniques, the FDES (2016) distinguishes five different sources: (i) statistical surveys; (ii) administrative records of government and non-government agencies responsible for natural resources, as well as other ministries and authorities; (iii) remote sensing and thematic mapping (e.g. satellite imaging and mapping of land use and land cover, water bodies or forest cover); (iv) monitoring systems (e.g., field-monitoring stations for water quality, air pollution or climate); (v) scientific research and special projects undertaken to fulfil domestic or international demand.

The quantification of environmental indicators relies considerably on data collected by means of direct measurements. For this purpose, most developed countries have established agencies that are primarily responsible for monitoring the state of the environment and any changes occurring thereto. Usually, two types of data are produced to track indicators: (i) measured data (obtained by observation) and (ii) calculated data (derived using estimates and modelling). Measured data can be further divided into (i) empirical observations and field measurements; and ii) remotely sensed information. This report focuses on the development of a minimum indicator set based on directly observed characteristics in the field and on publicly available processed data sources. It is assumed that the remote sensing and GIS departments of organizations such as FAO will be capable of generating the core information and data products necessary for larger-scale environmental indicators such as land use and plant cover, and of making these data available to national statistical bureaus.

3.2. What is a minimum indicator set?

The exercise described in this report seeks to define a minimum indicator set that can help to characterize the state of the environment in relation to agricultural and other rural households. At the outset of this exercise, a target number of five or six indicators was established.

The approach adopted for this exercise connects to recent developments in targeted information collection, such as the Lean Data approach (www.acumen.org). Acumen focuses on developing tools for assessing the impact of social enterprises. These enterprises, often cash- and time-constrained, face a conundrum when it comes to measuring social performance. Traditional measurement tools – whether inherited from international development or impact investing – are either too costly, because they were designed for large-scale aid projects or focus on typical business metrics that fail to reach the heart of impact. The Lean Data approach applies lean experimentation principles to the collection and use of social performance data. It uses low-cost technology to communicate directly with end customers, obtaining high-quality data quickly and efficiently. Today, similar approaches are implemented in rural surveys (Hammond et al., 2016).

To formulate this minimum indicator, the following (generic) criteria were applied:

1. Relevance – especially to the achievement of rural policy objectives;
2. Methodological soundness – and acceptance as a meaningful indicator among the scientific community;
3. Measurability – quantifying the indicator should be relatively straightforward;
4. Parsimony – or avoiding duplication: the minimum indicator set should capture a range of aspects of the natural environment, and not provide multiple measurements of a single manifestation of the same process;
5. Ease of communication – this too is significant, in relation to rural policies and their effectiveness: clarity and unambiguity of results and quantification of outcomes is essential when using indicators in a policy arena.

A series of context-specific criteria also play an important role. To assure the cost efficiency of data collection methods, it is essential to achieve substantial overlap with existing indicators and monitoring arrangements and agreements. With regard to the agreements, the five most relevant ones are the SEEA, the FDES, the UN's CBD, the UNCCD and the UNFCCC. It is necessary to ensure the following aspects:

1) the relevance of the indicators – data are collected within or as a consequence of the GSARS initiative and match the indicators used in worldwide agreements;

2) reference to other data collection efforts – alignment with other data collection efforts will facilitate expanding upon them, and thus enhance information availability and the capacities of national statistical bureaus.

To provide a comprehensive picture of the state of the natural environment, the indicators should cover the key environmental compartments: land, water and air (FDES, 2016). The integral nature of such an indicator set reduces the likelihood of omitting an essential element of environmental degradation, even though a minimum set is being used. As discussed above, the third criterion is the relevance of the indicators for rural livelihoods. The indicators should be capable of effectively measuring the impact of human activities on the environment, while also providing key information on the environment's capacity to provide services that are essential to human well-being.

3.3. The minimum environmental indicator set: the livelihood level

Taking into account the criteria listed in the previous section, the final set of indicators chosen was the following:

1. Sustainability of biomass extraction (compartment: land)
2. Environmental health (compartment: air and water)
3. Water availability and quality (compartment: water)
4. Land degradation (compartment: land)
5. Biodiversity (compartment: land, water and air)

This final set covers all compartments (land, air, and water), coincides with SDG 6 on clean water and SDG 15 on land, overlaps with SDG 7 on energy, and assesses a wide range of aspects relating to the natural environment.

Table 2 lists the overall indicators, describes the sub-indicators of which they consist, the key information required for their calculation and their consistency with the indicator frameworks listed in Section 2 above. This consistency evidences a reliance upon of existing experience with the quantification of these indicators. In addition, it ensures that the indicators can be quantified with relative ease and that the information required can be collected efficiently, especially because a large proportion of this information can be reused for indicator activities engaged in within other UN-led global efforts. Furthermore, in many cases, these indicators are driven by decisions made by rural livelihoods (which and how much biomass to use, how much water to use for which purposes, the intensity of land use and use of common land resources that are often biodiversity hotspots). Therefore, they comply with the criteria formulated earlier and enable an assessment of the efficiency of rural policies (see also Section 5 below).

Table 2. Overview of the final minimum indicator set, the relevant information needs and the relationship with other indicator frameworks (for an explanation of the framework abbreviations, see "Acronyms and Abbreviations" section above).

Indicator	Sub-indicators	Available in which indicator frameworks
Sustainability of biomass extraction	Annual production of woody biomass; Annual harvest of woody biomass; Primary fuel for cooking; Primary fuel for light; Types of fuel purchased in the last year; Percentage of income allocated to fuel purchases	FDES, SEEA, some overlap with SDG Goal 7
Environmental health	Waterborne diseases; (airborne) vector diseases	FDES
Water Availability and Quality	Water Availability; Water Quality	FDES, NEEA, SDG Goal 6
Land degradation	Land cover trend over last 10 years; land cover in protected areas versus non-protected areas; extent of land areas in different months with bare soil; erosion risk maps; on-the-ground measurement of the extent of degraded or eroded land.	FDES, NEEA, UNCCD
Biodiversity	Extent of protected areas; number of red list species in a country; number of red-list species in protected areas; ratio of number of red-list species in main animal categories within protected area to total number of red-list species; area, number and diversity of ecosystems protected.	IUCN, UNCBD, FDES, SDG Goal 15

These environmental indicators are important in the interaction between rural livelihoods and their environment: they are strongly affected by the decisions made by rural livelihoods, but also influence rural livelihoods in turn. For example, for many households, biomass extraction is a key strategy when collecting fuel for cooking. Environmental health, here defined with a focus on diseases, clearly has remarkable effects on livelihoods, and water availability and quality. The effects of land degradation and biodiversity on the well-being of livelihoods is indirect; for example, it is achieved through the collection of wild foods, firewood (see also Indicator 1) or even ecotourism. As these indicators of the state of the natural environment are affected by the presence and densities of rural livelihoods, they may also be influenced by rural policies.

4

From Concepts to Practice: What to Measure?

The five indicators ensure that an overall quantitative picture of the state of the environment can be given, thereby ensuring that the risk of omitting key environmental changes is minimized. The precise method with which these five indicators are quantified, and the specific weights of the individual sub-indicators that contribute to the indicator's overall value may differ from country to country, depending on the different policy emphases. For each of the overall indicators, sub-indicators are defined; in addition, for each overall indicator, two sub-indicators that should be prioritized in terms of quantification are noted. These two sub-indicators are identified on the basis of their importance and the ease with which they may be quantified (i.e. whether the underlying data are already available, whether costly field campaigns are required, etc.).

4.1. Sustainability of biomass extraction (with a focus on fuelwood)

The definition of this indicator follows that used in the Vital Signs project, where it is called the "fuelwood efficiency" indicator. The Vital Signs project includes seven sub-indicators, of which the following six directly contribute to the indicator of sustainability of biomass extraction:

a. Annual production of woody biomass
b. Annual harvest of woody biomass
c. Primary fuel for cooking
d. Primary fuel for light
e. Types of fuel purchased in the last year
f. Percentage of income allocated to fuel purchases

Detailed information on these six sub-indicators may be found in Table 3. The two priority sub-indicators, emphasized in bold text, are Annual production of woody biomass and Annual harvest of woody biomass, the core indicators in assessing the sustainability of current woody biomass use.

Table 3. Sustainability of biomass extraction (with a focus on fuelwood) indicator: sub-indicators, information needs and data sources.

N.B. Bold text denotes the two sub-indicators that should be given high priority in terms of quantification.

Sub-indicator	Formula for computing indicator	Variables needed	Reference area	Frequency	Data source	Data collection instruments
Annual production of woody biomass	Production measured / time	Combination of remotely sensed information on biomass changes and targeted field campaigns	Landscape	Yearly	Remote sensed information: FAO	Field campaign measuring biomass value
Annual harvest of woody biomass	Total woody biomass harvested / community	Amount of woody biomass harvested by rural households	Household / community	Yearly	-	Household surveys
Primary fuel for cooking	-	Ordered scale of sources for fuel	Household / community	Yearly	-	Household surveys
Primary fuel for light	-	Ordered scale of sources for light	Household / community	Yearly	-	Household surveys
Types of fuel purchased in the last year		Ordered scale of purchased sources for fuel	Household / community	Yearly	-	Household surveys
Percentage of income allocated to fuel purchases	100%*amount of money spend on fuel purchase / total income	Amount of money spent on fuel purchases and total income	Household / community	Yearly	-	Household surveys

4.2. Environmental health

Environmental health can be defined in many different ways. However, in this case, the focus lies fully on the aspects of the environment relating to human health, in that this indicator consists of two core sub-indicators: *the occurrence of water* and *airborne diseases*. The relevant pathogens may be viruses, bacteria, or fungi. Many common infections spread by airborne transmission, including tuberculosis, influenza and smallpox. Waterborne diseases are caused by pathogenic microorganisms and most commonly transmitted through contaminated fresh water.

Therefore, this sub-indicator is related to Indicator 4.3. However, as stated above, it focuses specifically on human health. The category of waterborne diseases also includes water-related insect-borne diseases (e.g. malaria and yellow fever). The incidence of these diseases can be measured through standard health surveys at the level of individual household members. The occurrence of these diseases may be expressed as a total number of occurrences, or – more commonly – as a density value (occurrence per 1,000 individuals). Detailed information on the sub-indicators and the two priority sub-indicators is available in Table 4. The two prioritized sub-indicators are persistent incidences of diarrhea and pneumonia, as these are two of the leading causes of death of young children (respectively, 19 and 18 per cent of such deaths) worldwide.

Table 4. Environmental health indicator: sub-indicators, information needs and data sources.

N.B. Bold text denotes the two sub-indicators that should be given high priority in terms of quantification.

Sub-indicator	Formula for computing indicator	Variables needed	Reference area	Frequency	Data source	Data collection instruments
Airborne diseases: tuberculosis	Occurrence per 1,000 individuals	Disease incidence at household level	Community	Yearly	DHS health surveys	Household surveys
Airborne diseases: influenza	Occurrence per 1,000 individuals	Disease incidence at household level	Community	Yearly	DHS health surveys	Household surveys
Airborne (or related) diseases: pneumonia	Occurrence per 1,000 individuals	Disease incidence at household level	Community	Yearly	DHS health surveys	Household surveys
Waterborne or water-related insect diseases: persistent diarrhea (at least 14 days)	Occurrence per 1,000 individuals	Disease incidence at household level	Community	Yearly	DHS health surveys	Household surveys
Waterborne or water-related insect diseases: malaria	Occurrence per 1,000 individuals	Disease incidence at household level	Community	Yearly	DHS health surveys	Household surveys
Waterborne or water-related insect diseases: yellow fever	Occurrence per 1,000 individuals	Disease incidence at household level	Community	Yearly	DHS health surveys	Household surveys

4.3. Water availability and quality

This indicator consists of two sub-indicators, *availability* and *quality*. The availability must be quantified in terms of supply (rainfall and river discharge) and of demand (therefore, at the level of rural households, information must be collected on water withdrawal, and on the incidence and severity of water shortages, in the context of domestic and agricultural use). Water quality may be quantified through a water sampling protocol, in which the water quality of open water bodies is assessed through measurements of N and P content, pH and faecal coliform. In addition, water quality assessments may be performed on samples of the water collected by rural households for domestic use.

Detailed information on the sub-indicators and the two priority sub-indicators (in bold text) is given in Table 5. The two prioritized sub-indicators are annual rainfall and incidence of water shortages at household level.

Table 5. Water availability and quality indicator: sub-indicators, information needs and data sources. N.B. Bold text denotes the two sub-indicators that should be given high priority in terms of quantification.

Sub-indicator	Formula for computing indicator	Variables needed	Reference area	Frequency	Data source	Data collection instruments
Water availability: rainfall	Annual rainfall (mm)	Precipitation	Field level	Daily	Remotely sensed information, e.g. CHIRPS datasets[1]	Field-based collection
Water availability: river discharge	Total annual discharge in m^3	Daily river discharge	Landscape	Continuous	The Global River Discharge (RivDIS) Project, a global source available only for most important river systems[2]	River gauges
Water use for domestic needs	Total amount of water used per household	Annual water use estimate	Household	Yearly	-	Household surveys
Amount of water used for irrigation	Total amount of water used for irrigation	Annual water use estimate	Household	Yearly	-	Household surveys
Incidence of water shortages in household	Total number of days per year with water shortage	Annual water use estimate	Household	Yearly	-	Household surveys
Water quality, nutrients, pH and faecal coliform	In open water bodies: N, P and faecal coliform concentration; pH level	In open water bodies: N, P and faecal coliform concentration; pH level	Landscape	Monthly	-	Field campaigns

[1] http://chg.geog.ucsb.edu/data/chirps/.
[2] https://daac.ornl.gov/RIVDIS/rivdis.shtml.

4.4. Land degradation

For this indicator, information based on spatial land use and cover must be collated (e.g. spatial products developed by FAO). The core sub-indicators are the following:

a. the tree cover trend over the past 10 years; the area of land where tree cover is decreasing, the area of land where tree cover is increasing ("greening"), and relative values of these compared to the total land area of the country of interest;
b. the same trends as under (a), and, in addition, distinguishing between trends in protected areas and trends in non-protected areas.
c. To quantify degradation risk, it is important to categorize and quantify the extent and amount of (in months) of land areas having bare soil.
d. If available for the country of interest, erosion risk maps may also be used to quantify the extent (in terms of area) of the various erosion risk classes.
e. It is important to supplement these sub-indicators, often based on remote sensing data, with on-the-ground measurement of the extent of degraded or eroded land. In this regard, the NaRIA guidelines may be followed, particularly with regard to their quantification of soil erosion on the basis of five qualitative queries: proportion of area with slope greater than 15 per cent, proportion of exposed soil, visual presence of erosion, visual evidence of subsoil or exposed roots, and presence of perennial plant cover on farm (trees, pastures). These can be used in household-level surveys.

Detailed information on the sub-indicators and the two priority sub-indicators (in bold text) are given in Table 6. The two prioritized sub-indicators are the extent and time length in months of land areas with bare soil and the tree cover trend in the last 10 years.

Table 6. Land degradation indicator: sub-indicators, information needs and data sources.

N.B. Bold text denotes the two sub-indicators that should be given high priority in terms of quantification.

Sub-indicator	Formula for computing indicator	Variables needed	Reference area	Frequency	Data source	Data collection instruments
Tree cover trend over the past 10 years	Change in tree cover per year	Tree cover estimates over time	Landscape	Yearly	FAO	Field-based collection
Tree cover trend over the past 10 years in protected and unprotected areas	Change in tree cover per year, separated by land class	Tree cover estimates over time	Landscape	Yearly	FAO	Field-based collection
The extent and amount of time (in months) of land areas with bare soil	12 total land areas with 1, 2, 3, etc. months of bare soil	Bare soil estimates	Landscape	Monthly/Yearly	FAO	Remote sensing
Integrated erosion risk maps	Existing data tools	-	Landscape	Yearly	FAO	-
The extent of degraded or eroded land	Summation of score of proportion of area with slope greater than 15%, proportion of exposed soil, visual presence of erosion, visual evidence of subsoil or exposed roots, and presence of perennial plant cover on farm (trees and pastures)	Household-level information on perception of degradation and erosion (e.g. NaRIA approach)	Household	Yearly	-	Household surveys

4.5. Biodiversity

This indicator makes use of existing spatial products developed especially by the IUCN (e.g. the IUCN Red List of Threatened Species) and FAO . On the basis of the existing information, the following minimum set of key sub-indicators may be defined:

a. Extent of protected areas – how much of the land area in a specific country is protected; this may be quantified as an absolute number (land area, ha) and as a relative value (percentage of the total land area within a country).
b. Number of red-list species in a country – using the red list data sets that are publicly available through the IUCN, a quantitative assessment can be made of how many red list species occur in a country.
c. Number of red-list species in protected areas – combining the information on Items 1 and 2 above, the number of red-list species falling under some sort of protection may be quantified.
d. Ratio of number of red-list species of main animal categories within the protected area and the total number of red-list species – previous sub-indicators supplied absolute numbers, which however could differ greatly between countries, depending on the countries' diversity of ecosystems. If the ratio is also used, it is possible to generate better insight on the relative vulnerabilities of existing red-list species, upon the assumption that creating protected areas is an effective measure to protect species.
e. Area, number and diversity of ecosystems protected – the extent of the protected areas (sub-indicator 1) only quantifies the protected areas' total size, and not their diversity in terms of habitats of endangered species. This sub-indicator adds key information to supplement sub-indicator 1.

Detailed information on the sub-indicators and the two priority sub-indicators (highlighted in bold characters) can be found in Table 7. The two prioritized sub-indicators are the extent of protected areas and the ratio of number red list species of main animal categories within protected area and total number of red list species.

Table 7. Biodiversity indicator: sub-indicators, information needs and data sources.

N.B. Bold text denotes the two sub-indicators that should be given high priority in terms of quantification.

Sub-indicator	Formula for computing indicator	Variables needed	Reference area	Frequency	Data source	Data collection instruments
Extent of protected areas	Total land area in protected land use class; can also be divided by country's total land area	Extent of protected areas	Landscape	Yearly	FAO	Spatial data products
Number of red-list species in a country	Sum over main animal categories	Red-list species distribution of main animal species	Landscape	Yearly	IUCN	Spatial data products
Number of red-list species in protected areas	Sum over main animals categories within protected land class	Extent of protected areas and red-list species distribution of main animal species	Landscape	Yearly	IUCN / FAO	Spatial data products
Ratio of number of red-list species of main animal categories within protected area and total number of red-list species	Number of red-list species within protected area divided by total number of red-list species	Red-list species distribution of main animal species	Landscape	Yearly	IUCN / FAO	Spatial data products
Area, number and diversity of ecosystems protected	Total area, number and diversity of ecosystems counted in protected area class	Protected areas map, ecosystem distribution map	Landscape	Yearly	FAO	Remote sensing, land use classification

5

Policy Relevance of the Indicator Set

One of the criteria followed when selecting the minimum indicator set was whether the policy options were capable of influencing the indicators. As stated in FDES 2016,

"environment statistics support evidence-based policy making by making it possible to identify environmental policy issues and quantify the measures and impacts of policy initiatives objectively. They strengthen assessments through quantitative metrics, making analyses more robust through the use of timely and comparable data."

The indicator set selected in this report seeks to quantify the consequences of human activities for the direct environment of rural livelihoods, focusing on the use of non-renewable and renewable resources for energy production, land use, and the discharge or reuse of residuals into the environment from production and consumption processes. These human activities may be the focus for policy development if they lead to unwanted environmental consequences. Environmental protection and the management of environmental resources may be advocated for, facilitated, supported or mandated by different policies, economic measures, instruments and actions. As per FDES 2016, these interventions strive to:

1) limit environmentally harmful effects;
2) manage environmental resources; and
3) restore the state of the environment.

Therefore, these interventions seek to ensure that the environment can continue to provide sustainable support to human society.

As stated above, the five indicators may be affected deeply by the decisions made by rural livelihoods. Therefore, rural livelihoods are one of the key entry points, if rural policy is to influence the state of the environment as quantified through these five indicators. These livelihoods are not an easy entry point for policies, as is the case generally with non-point and nonsingle-point sources of pollution, and adverse land use change. Still, it is possible to define several pathways through which these indicators may be influenced by policy interventions.

For example, biomass extraction can be influenced by policies that focus on small-scale electricity generation or subsidies to alternative energy sources. Several indicators may be affected by land use policies and policies for the protection of vulnerable pieces of land. Supporting land-use intensification may help to lift the burden of vulnerable land resources (the land “sparing” hypothesis), while investments in land restoration may also be enhanced by specific policies. Water availability and quality may be influenced by policies concentrating on the use of water in open water bodies, while water quality could be the focus of policies oriented towards pollution reduction. Many challenges in the formulation and execution of these policies remain to be solved; however, the indicator set chosen in this report is at least capable of quantifying the effects of the steps taken in this regard.

References

Barrios, E. & Mortimer, P.E. 2014. Natural Resource Integrity Assessment (NaRIA) Score Card.
Humidtropics Project Publication. http://humidtropics.cgiar.org/.

Berry, L., Abraham, E. & Essahli, W. 2009. UNCCD Recommended Minimum set of Impact Indicators. Consultancy report. United Nations Publication: New York, USA.

Biggs, E.M., Boruff, B., Bruce, E., Duncan, J.M.A., Duce, S., Haworth, B.J., Horsley, J.,Curnow, J., Neef, A., McNeill, K., Pauli, N., Van Ogtrop, F. & Imanari, Y. 2014. Environmental Livelihood Security in South-East Asia and Oceania: a Water- Energy-Food-Livelihoods Nexus approach for Spatially Assessing Change: White Paper. International Water Management Institute Publication: Colombo.
Available at: http://www.iwmi.cgiar.org/publications/other-publication-types/environmental-livelihood-security-south-east-asia-oceania/.

Biggs, E.M., Bruce, E., Boruff, B., Duncan, J.M.A., Horsley, J.,Pauli, N., McNeil, K., Neef, A., Van Ogtrop, F., Curnow, J., Haworth, B., Duce, S. & Imanari, Y. 2015. Sustainable development and the water–energy–food nexus: A perspective on livelihoods. Environmental Science & Policy 54: 389–397.

Biodiversity Indicators Partnership. 2011. Guidance for national biodiversity indicator development and use. UNEP World Conservation Monitoring Centre Publication: Cambridge, UK.

Hammond, J., Fraval, S., van Etten, J., Gabriel Suchini, J., Mercado, L., Pagella, T., Frelat, R., Lannerstad, M., Douxchamps, S., Teufel, N., Valbuena, D. & van Wijk M. 2016. The Rural Household Multi-Indicator Survey (RHoMIS) for rapid characterisation of households to inform Climate Smart Agriculture interventions: description and applications in East Africa and Central America. Agricultural Systems.

European Commission, International Monetary Fund (IMF), Organisation for Economic Co-operation and Development (OECD), United Ntions (UN) & World Bank. 2009. System of National Accounts

2008. Joint publication of the European Commission, IMF, OECD, UN and the World Bank: New York, USA.

Vital Signs. 2015. Vital Signs Decision Support Metrics and Indices. Available at: http://vitalsigns.org/metrics-indicators. New York, 7pp.

UN. 2014. System of Environmental-Economic Accounting 2012: Central Framework. UN Publication: New York, USA.

United Nations Statistics Division (UNSD). 2016. Framework for the Development of Environment Statistics (FDES 2013). UN Publication: New York, USA.