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PARTICIPATORY RANGELAND AND GRASSLAND ASSESSMENT (PRAGA) METHODOLOGY

First edition





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Abbreviations and acronyms

AA	Ayil Almak
CBD	Convention on Biological Diversity
DPSIR	Driving force-Pressure-State-Impact-Response Framework
EO	Earth Observation
FAO	Food and Agriculture Organization of the United Nations
GIS	geographic information systems
IUCN	International Union for Conservation of Nature
LADA	land degradation assessment in drylands
LAI	leaf area index
LD	land degradation
LDN	land degradation neutrality
NDVI	normalized difference vegetation index
NPP	net primary production
ODK	Open Data Kit
PAs	protected areas
PET	potential evapotranspiration
PRAGA	participatory rangeland and grassland assessment
RS	remote sensing
SDG	Sustainable Development Goals
SLM	sustainable land management
SOC	soil organic carbon
UNCCD	United Nations Convention to Combat Desertification
WWF	World Wildlife Fund


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Preamble

This participatory grassland and rangeland assessment (PRAGA) methodology was developed for the assessment of rangelands and grasslands in selected project countries. It was developed through the project “Participatory assessment of land degradation and sustainable land management in grassland and pastoral systems”, financed by the Global Environment Facility (GEF) and executed by the Food and Agriculture Organization of the United Nations (FAO) and the International Union for Conservation of Nature (IUCN). The methodology was piloted in five countries – Burkina Faso, Kenya, Kyrgyzstan, Niger and Uruguay – to test its effectiveness and value. Necessary revisions were made to the methodology, based on lessons learned from its application.

This document contains background information on global grasslands and rangelands and describes the need and the guiding principle for rangeland health assessments and practical guidance on how to conduct cost-effective assessment. It is divided into two parts:

- Part I: Background information on grasslands and rangelands
- Part II: Guidance for the preparation, assessment and monitoring of grasslands and rangelands at the local level

The methodology was designed with enough flexibility to adapt to specific contexts and countries along the nine steps laid out in the document.

Part I
BACKGROUND INFORMATION ON GRASSLANDS AND RANGELANDS

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1 Introduction

1.1 Grassland and rangeland assessment and monitoring

Global rangelands are expansive and have been estimated to cover anywhere from 18 percent to 80 percent of the planet's terrestrial surface (Lund, 2007) and between two thirds and three quarters of all drylands (MEA, 2005; Neely *et al*., 2009). A recent analysis, based on the World Wildlife Fund's (WWF) terrestrial ecoregions, estimates that 54 percent of all land is rangeland, including 100 percent of all drylands (ILRI *et al*., 2021). Rangelands include grasslands, shrublands, savannahs, open woodlands, most deserts, tundra (arctic and alpine), meadows and riparian ecosystems. Grasslands and savannahs are the most widespread biomes within rangelands. The composition, structure, productivity, and diversity of these ecosystems are governed by a combination of climate, geography, topography, and geology, including soil development. In addition, rangelands are used by a large number of vertebrate and invertebrate herbivores, including a diverse combination of domestic or native ungulates (Kauffman and Pyke, 2001).

The above estimates may illustrate the global importance of rangelands, but they also highlight the huge variance in understanding their true extent. Grasslands and rangelands, depending on how they are defined and measured, cover between one third and one half of the Earth's land surface, making them one of the most important "land systems" on Earth (Figure 1). Referring to them by such an unconventional term as "land systems", however, underlines an important challenge in understanding rangelands.

ILRI *et al.* (2021) produced a world map of rangelands (Figure 1) based on WWF's terrestrial ecoregions.

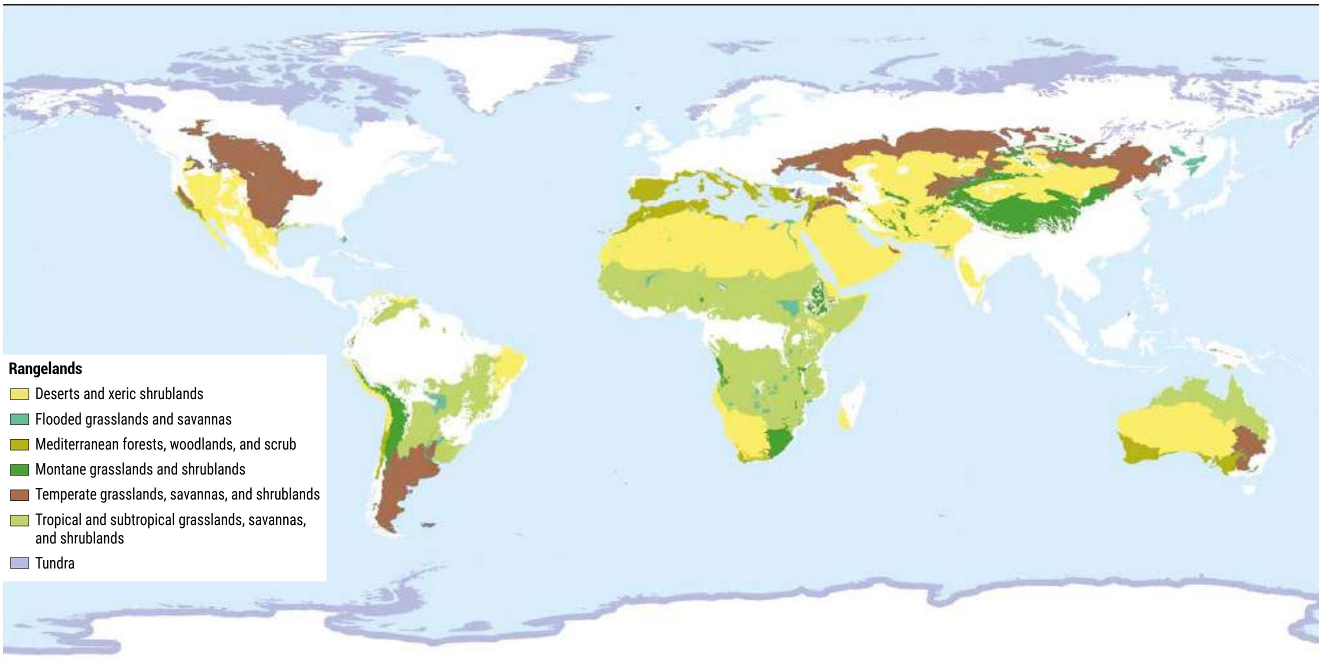
Box 1. **The complexity of defining rangelands**

The term rangeland can be used as both an ecological and social system. For example, Faber-Langendoen *et al*. (2012) place grasslands and rangelands into two natural formation classes: i) shrubland and grassland; and ii) desert and semi-desert. The shrubland and grassland class includes “grasslands, shrublands, open tree savannahs, marshes, bogs and fens dominated by broadly mesomorphic (including scleromorphic) shrub and herb growth forms (including broad-leaved, needle-leaved, and sclerophyllous shrubs, and forb and graminoid herbs) with an irregular horizontal canopy structure, mesomorphic trees typically <10 percent cover, and tropical to boreal and subalpine climates and wet to dry substrate conditions” (ibid.). The desert and semi-desert class (xeromorphic woodland, scrub and grassland vegetation) includes “tundra, alpine and tropical high montane habitats dominated by cryomorphic growth forms (including dwarf-shrubs, associated herbs, lichens and mosses) with low height and open to closed canopy” (ibid.).

Besides purely ecological descriptions, rangelands are often defined in terms of the ranging animals after which they are labelled: “land carrying nature or semi-natural vegetation which provides habitat suitable for herds of wild or domestic ungulates” (Pratt, Greenway and Gwynne, 1966). On another level, the term rangeland refers to the management unit – a sociopolitical construct, which may contain a great diversity of other ecosystem elements and areas suitable for other uses like cultivation. Some of these elements may not be classified as rangeland ecosystems; for example, oases ecosystems, wetlands, riparian forests, woodland patches, areas of “rich patch” vegetation, and higher altitude forests. Yet these resources within rangeland landscapes are often critical – sometimes seasonally essential – to the functioning of the rangeland management units and the associated livelihoods.

A factor in this knowledge gap stems from the lack of an international organization responsible for assessments and reporting on rangelands (Lund, 2007). A recent effort at standardization defined **rangelands** as “land on which the indigenous vegetation (climax or subclimax) is predominantly grasses, grass-like plants, forbs or shrubs that are grazed or have the potential to be grazed, and which is used as a natural ecosystem for the production of grazing livestock and wildlife” (Allen *et al*., 2011). This definition excludes some artificial pasturelands that would be classified as grasslands, so the overlap between the two terms – rangeland and grassland – is imperfect.

Figure 1. Map of world rangelands



Source: ILRI, IUCN, FAO, WWF, UNEP and ILC. 2021. *Rangelands Atlas.* Nairobi Kenya: ILRI.

The term **grassland** "bridges pastureland and rangeland and may be either a natural or an imposed ecosystem. Grassland has evolved to imply broad interpretation for lands committed to a forage use" (Allen *et al*., 2011). This does not mean that rangelands can be subsumed within grasslands, but there is significant overlap between the two. The same source states that "the vegetation of grassland in this context is broadly interpreted to include grasses, legumes and other forbs, and at times woody species may be present" (ibid.).

The lack of consensus over how to define this important part of our natural heritage – as a biome, an ecosystem, or a system – contributes to **major gaps in assessment and monitoring**, and an overall lack of evidence to support sustainable management or conservation. Pastoral lands are particularly poorly monitored and unsubstantiated assumptions of degradation are widespread (Behnke, Scoones and Kerven, 1993; Niamir-Fuller, 1999).

Assessment and monitoring of rangelands can be carried out for a number of reasons, including to guide livestock grazing practices and subsidiary rangeland uses, to guide management of non-pastoral rangeland uses and values, and to track sustainability of land uses as the basis of public policy (Smith and Novelly, 1997). Assessment and monitoring can help improve understanding of the **state and trends in rangeland health** and for this reason they are needed at different scales, according to the requirements of different users. The detail and frequency of information that is used by herders or rural landholders to guide their management on a day-to-day basis may be different from that required by national authorities to guide investment priorities or policymaking.

1.2 The need for a bespoke grassland and rangeland assessment framework

The project "Participatory assessment of land degradation and sustainable land management in grassland and pastoral areas" is funded by the FAO-GEF and implemented in five pilot countries: Burkina Faso, Kenya, Kyrgyzstan, Niger and Uruguay. The objective of the project is to strengthen the capacity of local and national stakeholders in pastoral areas comprising of grasslands and rangelands to **assess land degradation (LD) and make informed decisions to promote sustainable land management (SLM) in a way that preserves the diverse ecosystem goods and services provided by rangelands and grasslands.**

Given the aforementioned knowledge gaps in assessment and monitoring of these ecosystems, the project team has designed a bespoke methodological framework for the participatory assessment and monitoring of LD of pastoral areas and grasslands. The framework, called PRAGA (participatory rangeland and grassland assessment), has been developed to address the weakness in assessment of grasslands and rangelands. It builds on IUCN's participatory assessment methodologies and experiences from FAO's work on LD assessment (e.g. Bunning, S. *et.al*, 2016).

The methodology is designed to assess **rangeland health** according to the **management objectives** of local land users, based on a combination of scientific and local knowledge. It has been developed to support improved targeting of policies and investment, particularly for pastoralists and landholders. The findings of the assessment and monitoring process will also identify SLM best practices that can feed into policy processes. The project worked with national partners in each pilot country to ensure co-knowledge creation and institutionalization of the methodology.

The goal of this document is to provide a structured guide to aid rangeland assessment in consultation with relevant sectors of the community, through i) identifying lands for assessment; ii) determining the management objectives against which rangeland health should be assessed; and iii) identifying suitable indicators. The specific steps in the methodology are elaborated in Section 2. However, many elements of the methodology remain as areas of learning and questions for further examination are provided in the final section and in Annex 1, to help inform subsequent editions.

1.3 Guiding principles

The PRAGA methodology is designed to support decision-making in pastoral landscapes, which can be highly diverse and include natural resources that could be classified in other ways. The terms rangelands and grasslands are therefore used in combination to maintain the widest possible interpretation.

The methodology is informed by the land degradation assessment in drylands (LADA) "manual for local level assessment of LD and sustainable land management", a useful resource for fieldwork. Some specific modifications have been introduced to strengthen the **participation** of local communities, to **reduce costs** of data collection and analysis, and to strike a balance between locally determined and globally-comparable **indicators**.

1.3.1 Multi-functionality

Given the complexity of rangelands and grassland characterization and use (see Section 1.1), the methodology was tested in both relatively homogeneous landscapes in five countries, with common widespread species as well as those that are highly heterogeneous, with an array of vegetation types including areas that have been deliberately converted to other land uses (e.g. agriculture, conservation areas). Standardization requires harmonizing with sufficient flexibility for the methodology to be adapted to different societies, economies, and ecologies, while retaining core elements that allow comparison between locations.

1.3.2 Cost effectiveness

The methodology discusses the challenge of balancing the need for national or global comparison with the need for local ownership. This also has implications for the scale and cost of assessment, which are discussed later.

Therefore, a principle that guides this methodology is to identify the minimum **indicator set** required for reliable, cost-effective assessment, rather than a maximum set to satisfy the diverse interests of multiple actors. Cost-effectiveness is a vital criterion if the methodology is to be widely adopted, particularly in developing countries where assessments are so urgently needed.

Countries with greater resources, or with the capacity to effectively analyse larger data sets are not limited to the minimum data set presented in the methodology. Countries with established methods, or specific requirements, can adapt and enrich the methodology when resources permit.

1.3.3 Participation

Although the essence of participation is to ensure that the views of the community are taken into consideration, participation is a term that is overused in development aid discourse. Participatory development approaches were popularized in response to the perceived failures of more top-down approaches. Therefore, supporting citizens as they participate in planning and development processes is thought to have a number of benefits. Participation not only helps to achieve better decisions but also helps ensure that decisions are more likely to be implemented and enforced by all actors. Participation may also contribute to empowerment of citizens and fulfilment of their basic human rights. The level of participation could range from simply providing basic information to involvement of stakeholders in planning process and even working together. Figure 2 shows that the level of participation also determines the number of people that can be involved. Where large numbers of stakeholders are involved it can be challenging to maintain high levels of interaction, and greater reliance may be placed on the role of selected representatives. When the aim is to simply inform the community, then the number of people involved can be larger than when the aim of participation is joint planning or agreeing on specific issues (i.e. empowerment).

The right to participate in critical decision-making is an important element of good governance and is established in international law (e.g. the United Nations Convention to Combat Desertification [UNCCD]), the Convention on Biological Diversity (CBD), human rights law (International Covenant on Civil and Political Rights), and soft law commitments such as the United Nations Declaration on the Rights of Indigenous Peoples. Effective participatory approaches should be full, meaningful and effective. “Full” implies the inclusion of all relevant actors, including marginalized groups, within a safe space for different opinions to be voiced. “Meaningful” implies that participants understand the purpose and objective of the decision-making process and their role in it, and that the process is legitimate and accountable. “Effective” means that participation can genuinely influence decisions, that participants have access to information, and that the process is fair and transparent

Figure 2. Levels of participation

Source: Regional Environmental Center. 1996. Awakening participation: building capacity for public participation in environmental decision-making. In: *Policy Documentation Center* [online]. [Cited 26 April 2021]. http://pdc.ceu.hu/archive/00002419

In the context of **land management**, participation of relevant stakeholders in the development of the methodology is essential to build trust with land managers (landowners and land users), to draw on local knowledge, to help negotiate the incorporation of science and local knowledge in the methodology, and to contribute more generally to empowerment of rangeland managers. The method is not primarily designed for devolved use by pastoral communities and landholders, and a significant role is anticipated from rangelands experts and extension agents in government, along with other stakeholders.

A number of steps of the PRAGA methodology require stakeholder involvement: mapping of the target landscape, indicator identification, fieldwork and validation of the assessment. Different stakeholders will be involved at each stage, and they will be engaged in different ways, as discussed under respective steps in the following section.

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2 Assessment framework

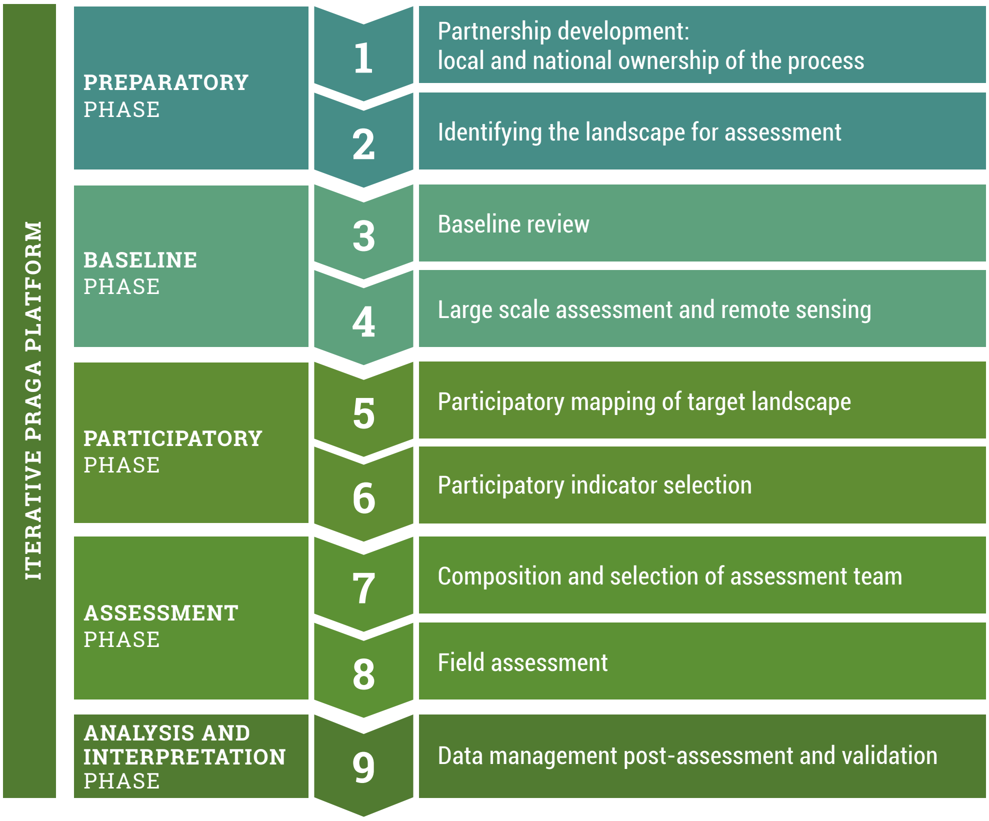
The need to get the rangeland assessment process right compels us to distinguish between the common terms used in the assessment. In this methodology, the term assessment means a critical evaluation of information on a state or a process at a particular time, and in a specific location for purposes of guiding decisions. The term "monitoring" implies repeated collection of data to track changes over time, and for grasslands and rangelands this requires data to be collected periodically over several years at least (Vogt *et al.,* 2011).

This methodology is primarily designed to conduct assessments supported by a limited number of core, representative indicators of rangeland/grassland health, in order to make it more cost-effective, both in terms of the volume of data collected and the amount of analysis needed. Moreover, the framework adopts the good practice of 'collect once, use many times', and thus it fosters the use of environmental and socioeconomic indicators for reporting adopted by the three Rio Conventions.

2.1 Foundations

The assessment methodology adopts a stepwise approach consisting of preparatory phase (Steps 1 and 2); baseline phase (Steps 3 and 4); participatory phase (5 and 6), assessment phase (7 and 8), analysis and interpretation (9). It is important to note that, although steps appear linear, their implementation is iterative and they are connected in nonlinear manner. The relationships of different steps are described in the subsequent sections of this report.

Figure 3. Summary of PRAGA methodology



Where resources permit, additional assessment is included to define indicators and procedures to establish a **monitoring system**. Monitoring is the systematic observation of key rangeland/grassland health and condition and hence, it relies on indicators that can be systematically assessed. Monitoring and indicator selection should be goal-oriented, where the purpose and expectations are identified, shared with stakeholders and boundaries and timeframes are consultatively established. Indicators are signals of or proxies for rangeland health and ecosystem function.

Essential to the success of a monitoring system is that indicators be specific, measurable, achievable, relevant and time-bound (SMART) and limited to a core set of indicators that can be measured on a repetitive basis. Ideally, monitoring could be carried out on the basis of the same indicators used in the assessment, but a more practical option may be to monitor a narrower indicator set on a frequent (e.g. annual) basis, punctuated with less frequent assessments either on a multiyear timescale, or when a more detailed insight is needed.

The PRAGA methodology is designed to:

1. Inform medium- and long-term decision-making by rangeland stakeholders, and to guide collaborative actions between local government, pastoralists (communal land users, private landholders, estancieros, etc.) and pastoral communities. Agreeing on management objectives is therefore crucial as a first step in the assessment methodology.
2. Identify trends in rangeland health in order to guide management planning, such as prioritizing areas for rehabilitation or areas that can support more intensive use.
3. Inform public planning as well as collective action by pastoralists/landholders and therefore combine locally determined indicators with standardized indicators that governments can use to compare rangeland health among sites.

PRAGA does not attempt to answer all questions that may be of relevance to rangelands management in all contexts. This is a conscious choice to make the methodology cost-effective and therefore more suitable for scaling up and institutionalizing. The methodology relies on a few carefully selected indicators to inform planning for sustainable range management and investment, rather than a comprehensive measurement of *all* parameters associated with rangeland health and ecosystem functions. However, there is considerable scope within the analysis of data to examine links between multiple drivers and pressures, between rangeland health and the delivery of ecosystem services, and between grassland and rangeland health and the resilience of people and ecosystems, to inform and evaluate policy.

Step 1. Partnership development

Aim

Engagement of key stakeholders (e.g. public institutions, communities and relevant third parties) to foster ownership of the methodology, and leadership of implementation.

Identification of key stakeholders

Systematic identification of stakeholders/key partners at national and local level that are to be involved in the participatory rangeland assessment is very important. Therefore, before commencing the process of rangeland assessment, the first step is to identify key stakeholders through an iterative process. Sequencing the dialogue from national to landscape and then to the local level has proven valuable for defining target areas for assessment and relevant stakeholders.

The national inception workshop is the right point to begin the preliminary discussion to expand the list of stakeholders and to define the wider stakeholder groups (e.g. through snowball sampling).

The sequencing of national workshops with local level ones yielded interesting lessons for deepening stakeholder identification, refining discussions on the landscape for assessment, understanding of land-use types, as well as crude refinement of local indicators across the five countries where PRAGA was tested. However, measures need to be taken to avoid the participants in the preliminary meeting from excluding certain stakeholders from subsequent steps.

Some countries with established traditions of rangeland monitoring and with already established multistakeholder fora could provide a good entry point. For example, stakeholder committees established under the UNCCD national action programmes or for national target setting for land degradation neutrality among others.

At the national level, key stakeholders may include different ministries. However, in some countries the institutional mandates overlap or responsibility for rangelands is divided between ministries hence a thorough understanding of this institutional setting is required to ensure that no key stakeholders are overlooked. Other stakeholders include government departments responsible for field and remote sensing data collection, such as the Office of Statistics and remote sensing agencies. Partnership development involves understanding existing institutional arrangements and working relations as well as convening meeting at different levels.

The local inception meeting at different pilot sites will review the identified stakeholders and expand the list with other crucial local level stakeholders and define their specific roles and responsibilities in field assessment and subsequent dialogues. This will further enrich the stakeholders for inclusion in field assessment, subsequent consultations and revision of landscape indicators.

National inception meetings

National inception meetings should be led by the government institution responsible for grassland and rangeland assessment. Participants should include, among others, all project partners, representatives from other key ministries and government institutions, academia and/or research centres, representatives from international organizations and NGOs working in the same field, and where possible, representatives from the targeted communities (if the field sites are already identified by this stage).

The national inception meeting is to be organized to ensure:

- support from the key line ministries/departments responsible for rangeland and grasslands;
- identification of existing relevant grassland assessments (current or past);
- identification of related initiatives which this assessment can contribute to or benefit from;
- identification of policy and investment processes into which assessment findings can be fed;
- site selection;
- identification and agreement of grassland management objectives (driven by end users, site selected);
- consensus on the overall approach to implementing the assessment, including use of remote sensing data and data management/ownership;
- agreement on access to existing data;
- assessment team structure and identification of national participants;
- agreement on the terms of reference for the baseline assessment and the process for selecting the assessor (expert or partner institution); and
- agreement on roles and responsibilities for mobilizing stakeholders at field level, organization of logistics and timing of the field assessment.

Local inception process

The local inception process may include preliminary visits to the field by key project partners, primarily to ensure engagement and acceptance of the assessment by local stakeholders. This may be combined with the baseline data collection process elaborated below. Further meetings with key partners at the local level will be held later on and back-to-back with the participatory mapping and indicator selection workshops (Steps 5 and 6). The local inception process should occur after the baseline assessment has been conducted (or is underway); ideally within 1–3 months of the national workshop.

The local inception process is designed to:

1. ensure local engagement and acceptance of the assessment, at both government and community levels;
2. ensure free access to the field to conduct the assessments;
3. identify local data and past assessments that can inform the current assessment;
4. identify relevant local stakeholders, including related initiatives, to involve in the participatory workshops; and
5. ensure subsequent participatory workshops are informed by local expertise and are supported by key informants and stakeholders.

National and local debriefing

Debriefing of project partners is an important step immediately after conducting the fieldwork (Step 8), prior to developing the assessment report. This is a brief and informal activity, but it is required to maintain transparency and to ensure relevant stakeholders remain engaged in the assessment process and develop a sense of ownership of the assessment outcomes. During these debriefings, initial observations can be shared with government stakeholders and their first feedback on the findings can be gathered.

Step 2. Identifying the landscape for assessment

Aim

Agree on an area for assessment that is of the appropriate geographic or administrative scale, where ecosystems and land use can practically be determined, and take other relevant questions into consideration for application of the methodology.

Defining the system

Although the landscape targeted for assessment will usually be broadly agreed during, or before, the national inception meeting, the actual identification of the relevant landscape should be discussed and agreed upon during the national workshops and further refined with project stakeholders during subsequent local-level project meetings.

The rationale for selecting a specific landscape will be agreed through discussions with project implementing partners, national government agencies in charge of livestock and rangeland management, geographic information systems (GIS) and remote sensing departments and local community representatives.

There are diverse reasons for prioritizing a given landscape. This usually stems from several interrelated factors including: the importance of a given landscape for grazing, the ease of accessibility, state of security, previous experience/contacts in the region, organized herder/producer groups, especially with contacts on the ground, representation of landscape heterogeneity and degradation gradient. Site identification of assessment landscape should also be informed by a detailed review of landscape level data for example, from existing remote sensing maps and related rangeland studies, where they exist. The rationale behind site selection should be recorded and preliminary knowledge of the site, from those making the selection, should be noted. Figure 4 provides guidance on how to characterize the agreed site for assessment, focusing on the system description, preliminary assessment, description of the system governance, and multistakeholder engagement (covered in Step 1).

Figure 4. Defining the system

System description: socioecological

Scope, scale and desirable future system; pressures and threats;
governance and social interactions
[including land tenure, agroecosystem potential and function]

↓

Characterizing the system
(either as biophysical or socioeconomic)

Alternative "regimes"; system resilience: need for adaptation or system transformation

Source: adapted from O'Connell, D., Walker, B., Abel, N., Grigg, N., Cowie, A. and Durón, G., 2015. *An Introduction to the Resilience, Adaptation Pathways and Transformation Assessment (RAPTA) Framework.* Scientific and Technical Advisory Panel of the Global Environment Facility.

Scale of assessment

Scale may be influenced by the degree of heterogeneity of the landscape. Highly heterogeneous landscapes may require assessment at a large scale (i.e. more detail), while more homogeneous landscapes can be assessed on a smaller geographic scale (i.e. less detail). Scale is also influenced by the intended use of the assessment and by administrative considerations in each country.

A rough guide is to use the methodology to assess at the highest local level (subnational – e.g. catchment, sub-catchment, province, district, etc.) by pastoralists and local authorities. The methodology is designed to inform local level decision-making and therefore its geographic scale of use should be guided by the scale of decision-making of local authorities. This is likely to be determined by the size of administrative zones in each country as well as the size of the country. The methodology has been developed for assessments covering areas of between 5 000 and 20 000 km^2.

Data and information collection (e.g. census, surveys) often occur within administrative units and the assessment may be carried out within agreed administrative boundaries, risking that some landscape features, such as watersheds, may not be fully included. The baseline review, detailed later in the methodology, should identify where transboundary resources are a significant feature (e.g. in pastoral systems that manage larger landscapes), and how to deal with them. The geographic scale of the assessment should balance cost effectiveness and details of output information. This is context specific and therefore scale is not rigidly fixed, but basic principles are provided to guide the setting of scale. The tool is not designed to support day-to-day management of livestock and therefore is not adapted for highly-localized assessments.

Ecosystem and land use

The approach is designed for use in rangeland landscapes – in a broad sense – including grasslands, shrublands, woodlands and associated riparian and other wetland areas. It is expected that many grasslands are managed ecosystems and therefore semi-natural and the methodology is designed for this context. In many grassland ecosystems it can be expected to find areas that have been converted to other uses (cropping, artificial grasslands, urban development, and infrastructure). These could pose problems for site selection, particularly in the case of highly transformed landscapes. The methodology builds on good practice of other approaches for non-grasslands and hence it is considered robust enough to cope with such forms of “land-use change”, though this should be taken into consideration during site selection.

Similarly, the methodology has been particularly designed with communal rangelands in mind, though it should be suitable for landscapes with a range of tenure types, including private lands such as ranches. Land tenure aspects should be examined as part of the baseline assessment, see Step 3 in the methodology.

To be useful for large-scale planning, assessments should ideally be applied at the landscape management scale used by the resident population. For many pastoral communities, this can include multiple ecosystems and multiple administrative areas. Application of the methodology should also be guided by pragmatism and may be more practical on a scale determined by administrative boundaries, considering the significant increase in stakeholders with the addition of each administrative zone. This is particularly true in the case of pastoral systems that span international boundaries.

Site selection should be guided by the end users, but assessment should also be informed by an understanding of transboundary resource use (e.g. joint village land use plans or participatory village land use plans), since local management decisions affect, and will be affected by, decisions made in other locations. Governments are also expected to use existing data on LD to influence site selection. For example, the methodology may be used to improve the assessment of areas that have been targeted for action in national LDN targets.

Access and consent

Access to the field for data collection needs to be considered. Physical constraints to access – such as the lack of roads – should not deter assessment. It is important to avoid bias that comes from only assessing easily-accessible sites, since those sites are likely to be used and managed differently. However, security constraints need to be taken into consideration.

A thorough understanding of local ownership and rights, including seasonal rights, should inform site selection in communal lands. Bias at this stage of selection could be construed as recognizing the rights of one claimant over another and it is important to avoid aggravating conflict. The methodology should be guided by the principle of Free, Prior and Informed Consent and it is vital to ensure appropriate representation of diverse groups in the participatory process outlined below.

Timing of assessment

Local key informants should provide guidance on seasonal and other factors to determine the best time for assessment. Timing should be influenced by seasonality of the growing season, seasonality of access to the field, seasonal availability of the community or landholders, timing of religious holidays and timing of key political or other events.

From the five countries where the methodology was piloted, some insightful lessons were gained on the consideration for assessment time. In Kenya, the field assessment, was conducted at the beginning of the dry season (July/August), when the status of vegetation is thought to be less influenced by the previous wet season (unless it is a drought year) and seasonal grazing impact was moderate. In Kyrgyzstan, assessment was conducted in summer to capture changes in pasture condition during the period of growth and accessibility to all pasture types is possible. In Burkina Faso and Niger, season (avoiding dry season), site accessibility and availability of communities to participate in the field assessment in different season were the main considerations. The months of October and November were considered the most suitable as these are the tail-end of rainy season. In Uruguay, the floristic surveying was performed twice (initial and final surveys), between the months of September and the end of November, as a way of determining the evolution of the pasture.

Step 3. Baseline review

Aim

Gather relevant, available data from secondary sources and local informants to provide the context of the assessment landscape as well as available environmental and socioeconomic data.

The baseline phase is informed by the preparatory phase and supports identification of the required database for the assessment objectives, as agreed by national stakeholders. The preparatory stage is also important in identifying where the data is, who owns it and how it is acquired. Choices of baseline data can be broad. So, careful selection needs to be made on the data to constitute the baseline and ensure it is directly linked to the assessment area. The data should inform indicator selection and help in overall interpretation of field results/analysis, and so on.

Tools

The baseline may be compiled using a combination of documented information and key informant interviews. Documented information can include, official as well as unofficial records (e.g. local census data, NGO reports). The quality of such information should be assessed to guide users on its reliability and adequacy for the intended scale and objective of the assessment.

Key informants should include a balance between community members and government staff. Key informant interviews could also include group interviews and focus group exercises, for example to give preliminary insights into local ecological knowledge and management responses, and the full extent of the landscape under assessment.

Context and background information

The baseline review should include key information to guide implementation of the assessment, such as:

- data on climate, ecology and biodiversity of the site
- climate change projections
- topography and landscape features
- primary and secondary uses of rangelands
- social and political context
- land tenure/rights arrangements

Environmental data

This includes maps of agro-climatic zones in assessment areas (aridity index), maps of mean annual potential transpiration (PET), mean annual rainfall maps and trends, projected mean annual temperatures, elevation across the study area, maps of perennial and seasonal rivers and water points across assessment landscape, forage condition index, annual normalized difference vegetation index (NDVI), net primary production (NPP), mean annual leaf area index (LAI), land and cover change. Other factors to assess include qualitative changes in LD across the assessment landscape, proportion of land showing signs of LD, map of LD, total area (km) that has changed between different degradation categories in a specified time period, among others.

Other environmental data to collect include:

- existing assessments of rangeland health and LD (including those derived from satellite imagery such as trends in net primary productivity);
- soil map / geomorphology maps / agroecological zoning maps / land suitability (FAO) or land capability (United States Department of Agriculture) maps;
- hydrography;
- data on water resources and other natural resources;
- biodiversity assessments, including relevant Redlist data;
- significant environmental hazards, including urban areas, mining, and so on;
- meteorological data for example, temperature, rainfall trends; and
- satellite images, aerial photographs.

Socioeconomic data

Socioeconomic data is required primarily to help interpret land degradation analysis, including the impacts of LD on people as well as the drivers and pressures behind land degradation.

Data on land tenure can also be captured in the assessment area – different tenure systems confer different levels of protection to landscapes considered for assessment under PRAGA and thus the need for analysis of the land tenure is an important parameter for understanding degradation (extent of communal lands, gazetted protected areas, and map of protected areas).

Gathering of socioeconomic data through field surveys can be costly and therefore this methodology relies on secondary data sets (i.e. existing data). A breadth of socioeconomic data may be available in some cases, whereas in other cases data may be relatively scarce. As already mentioned in Step 1, involving the Bureau of Statistics, and identifying other key sources of such data, is critical to developing a thorough baseline. As far as possible, it is recommended to use the five UNCCD impact indicators as the minimum-standard for cross-comparability between sites but recognizing that these five indicators alone are inadequate for thorough analysis. UNCCD reports tend to provide statistics at the national level whereas the baseline requires the same data from subnational level. This data is available at subnational level in many countries and, while it may be insufficient on its own, it has the advantage of being tracked over time and providing a low-cost option for ongoing impact monitoring.

The five UNCCD (PRAIS) impact indicators include:

- water availability per capita;
- change in land use;
- proportion of the population living above the poverty line;
- childhood malnutrition or food consumption or calorie intake; and
- Human Development Index.

In addition, the baseline assessment should include data on poverty and food security, the diversity of livelihoods, and – considering the emphasis on pastoral livelihoods – data on livestock production and marketing. Useful variables to that end are:

- livestock mortality rates;
- livestock productivity data;
- livestock reproduction rates;
- distribution of water resources (availability and access);
- livestock commodity prices;
- price trends for key commodities consumed by herders;
- infrastructure – roads and town centres; and
- trends in human population, human population density and distribution for the study area, livestock and wildlife population and crop diversity.

These variables can be used as indicators of state and impact of current grasslands and rangelands management, as well as to identify responses that can address pressures and drivers of the current status (Step 9 of the methodology). For example, livestock commodity prices can guide options for action (responses); distribution of water resources can serve for assessing pressures on the state of grasslands as well as in supporting responses to address land degradation of grasslands (e.g. related to carrying capacity of the land).

Beyond the scope of indicators considered in the baseline assessment, there is a need for careful consideration on how the baseline data is integrated in the assessment and analysis to influence other PRAGA steps. Except for Uruguay – which used the Driving force-Pressure-State-Impact-Response Framework (DPSIR) and PRAGA framework in the initial workshops to help the team appreciate the national and subnational level dynamics of a wide scope of indicators that influence degradation – in other pilot countries the bulk of baseline data was not effectively used. Most of the available secondary data was generated at national level and was not specific to the assessment area. In some of the pilot countries, it was difficult for the PRAGA team to have confidence in the baseline data generated through a separate study. The PRAGA team need to be fully involved in the generation of the baseline to have its full integration across all steps, not just in the final analysis.

Stakeholder analysis

The stakeholder analysis in the baseline study is an elaboration of the stakeholder analysis in Step 1, providing deeper insights into relationships and decision-making power at the local level. Stakeholder analysis should identify the different resource user groups in the target area, including occasional or seasonal users, and should examine different land management practices and resource dependencies. It should also examine who is affected by different forms and severity of LD and which groups are adopting sustainable land management practices. Issues to be examined could include the following:

- overview of land use and land management by ethnic or socioeconomic groups in the target area;
- details on resource use and responsibilities, disaggregated for example by gender, age, and so on;
- identification of temporary, seasonal and occasional resource users from outside the assessment area;
- sociopolitical context, including relationships between resource user groups;
- marginalized groups in the area such as women and their roles in range land management;
- public institutions with a role or responsibility over rangeland natural resources management;
- community institutions governing natural resources;
- other stakeholders, including private investors, which might not be closely involved in rangeland activities;
- impacts of land degradation on different stakeholder groups; and
- impact of different stakeholder groups on LD or the use of SLM options.

The stakeholder analysis may be informed by published and grey literature and by key informant interviews. However, considering the sensitivity of the task and the risk of manipulation by those with privilege, it is also recommended to cross-examine details through focus group sessions. The interest–influence matrix can be used to differentiate stakeholders by their power and interests relevant to the problem addressed (Figure 5)

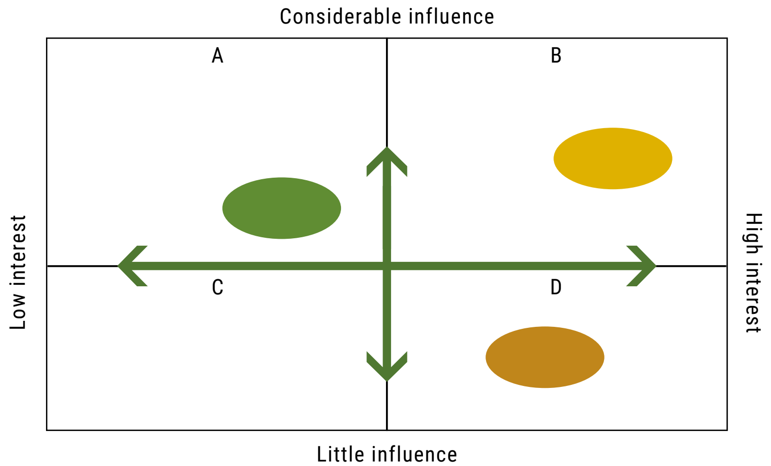
The stakeholder matrix tool can also be used to assess the resources and interest, or who has influence over the project. Figure 5 shows an example of how stakeholders (represented by oval shaped colours) are differentiated by their power and interest relating to the problem the project addresses. The stakeholders identified in different quadrants (A, B, C, D) could be addressed differently by project activities (Zimmermann and Maennling, 2007).

Policy and strategies overview

To assist in analysis of results, it is helpful to have an overview of the prevailing policy environment, including the level of implementation of established policies and inventory of current development and land use plans (at national, province or district level, and/or sectoral). Policies and plans to compile should be from:

- institutions that play a role in LD (positively or negatively) and institutions that play a role in sustainable land management;
- policies that may have an impact on LD or on adoption of SLM practices; and
- institutional mechanisms for integrated action or coordination of LD related work.

Figure 5. Interest–influence matrix for stakeholder analysis



Source: adapted from Zimmermann, A. & Maennling, C. 2007. *Mainstreaming Participation: Multi-stakeholder management: Tools for Stakeholder Analysis: 10 Building Blocks for Designing Participatory Systems of Cooperation.* Promoting Participatory Development in German Development Cooperation. Eschborn, Germany: Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ). http://www.fsnnetwork.org/sites/default/files/en-svmp-instrumente-akteuersanalyse.pdf

Step 4. Landscape-scale assessments and remote sensing

Aim

To provide a landscape-scale overview of the target area, and to inform the selection (number and location) of field validation sites (e.g. assessment plots and/or transects).

What is a landscape-scale assessment?

Landscape-scale assessments can be carried out using existing datasets to provide a rapid overview of the state and trends of specific indicators of LD or grassland/ rangeland health. Landscape-scale data can include topographic maps, climate data, and indicators of land productivity (discussed below under remote sensing). Due to their scale, these assessments are often crude and may require ground truthing. Ground truthing is used to calibrate or validate large scale assessment and helps to improve the interpretation and analysis of landscape condition and health, including trends.

Landscape-scale assessments will be guided in the first instance by the availability of data and expertise in each country. If established approaches to assessment of rangeland conditions or LD already exist, they can be used as the basis for the methodology and tailored as needed to respond to the grassland management objectives (to be set in Step 1).

Pastoralist communities have elaborate systems of rangeland classification that form the basis for rangeland assessment and monitoring of change including decision-making at the land-use scale. Participatory rangeland assessment needs to consolidate the local ecological knowledge of landscape units as the basis for assessment. This will allow identification of community indicators for landscape assessment to be integrated in the assessment framework.

Countries that have established landscape-scale assessment procedures should use this data as a priority. In addition, all countries are encouraged to include the three standard indicators of LDN, as outlined by the UNCCD and discussed in detail below. Other data, such as the Redlist of Ecosystems, Collect Earth, and Group on Earth Observations and its Global Agricultural Monitoring (GEOGLAM) Rangeland and Pasture Productivity (RAPP), which have established datasets in some countries, can also be included for the assessment, and can also be ground-truthed through this methodology. The assessment report should include metadata information of the datasets used, including field validation and calibration of remote sensing products and/or data quality statement.

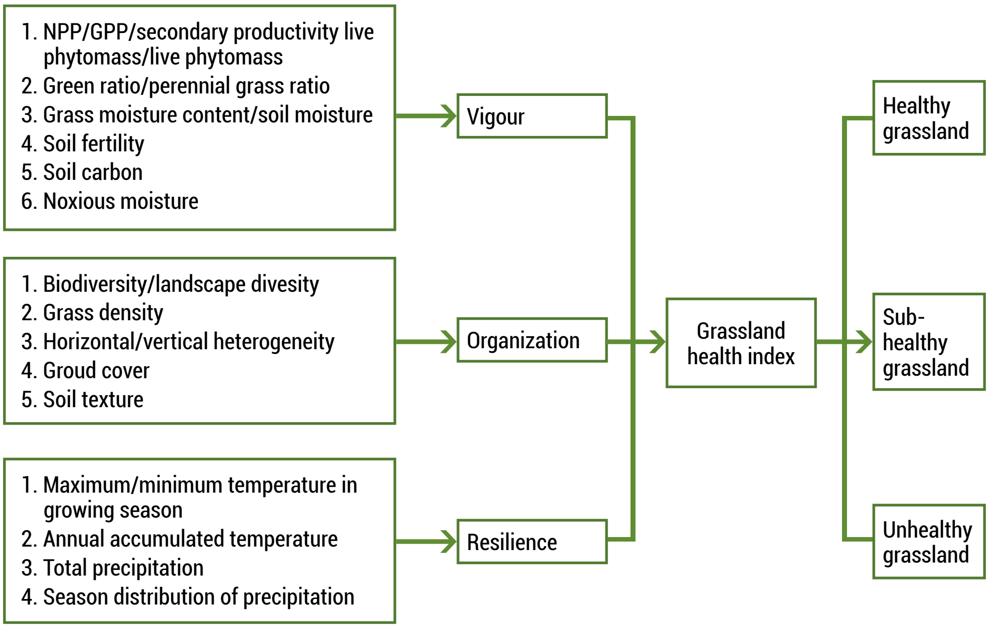
Remote sensing and its role in landscape-scale assessment processes

Remote sensing is the science of obtaining information about an area of land from a distance, typically from aircraft or satellites.

Images collected from aircraft or satellites and transformed to produce maps of features of the surface of the Earth are commonly referred to as Earth Observation (EO) data. They are one of the most widely used sources of information and are used globally for mapping, monitoring and modelling environments and their changes over time. However, an intrinsic component of high-quality remote sensing or EO data is the explicit link between the satellite or airborne image data and corresponding sampled ground measurements used for producing mapped products (e.g. biomass, ground cover, LAI). This involves the calibration of sensors, application of mapping algorithms, and validation of the products (e.g. net primary productivity, land cover classes, vegetation cover percentage). In some cases, this is referred to as “ground truthing” or field validation.

Images from satellites or aircraft reveal surface features and their changes (multitemporal images are acquired). However, local *in situ* observations are needed

Figure 6. Framework for grassland health assessment



Source: Xu, Dandan & Guo, Xulin. 2015. Some Insights on Grassland Health Assessment Based on Remote Sensing. *Sensors*. 15. 3070-3089. 10.3390/s150203070.

to provide the correct interpretation of the "signal" shown in the images and/or to make quantities/estimations from the digital numbers the images provide (e.g. through statistical correlation or models). Care must therefore be taken in interpreting the data and "ground-truthing" is often required to determine what the remote sensing analysis is really telling us. For example, if remote sensing data shows that NPP has increased over time, is that increase due to greater coverage of palatable or unpalatable species? Does it show an increase in the distribution of pasture species or bush encroachment?

An appropriate sampling strategy for field observations/validation is as important as the actual collection of data from the field. Step 5 describes the framework for field sampling.

This methodology enables the use of satellite-derived products such as NPP trends[1] (see Box 5), or spectral indices[2] that measure the amount of green vegetation and support land-use/land cover classifications. The current status of the

Box 2. Net primary productivity estimates for grasslands and rangelands

- **Assessing ecosystem functions**
- **Estimating crop yields or stocking rates of livestock**
- **Monitoring changes in productivity over time**
- **Monitoring vegetation health**
- **Assessing carbon budget and effects of climate change**

Specific examples of rangeland applications: Hunt and Miyake (2006) compared remotely sensed estimates of NPP with GIS-based estimates from soil surveys to determine if either approach would be suitable for **estimating stocking rates of livestock** at a state-wide scale in Wyoming. Reeves et al., (2001) described the applicability of productivity estimates from MODIS data for **monitoring rangeland health**; and Wessels et al., (2003) used remotely sensed measures of NPP to evaluate the **extent of land degradation** in southern Africa.

Source: Landscape Toolbox.

[1] NPP is an important component of the global carbon budget and is used as an indicator of ecosystem function. NPP can be directly assessed by measuring plant traits or harvesting plant material on the ground, but **across large areas remotely sensed images** can be used to estimate NPP. NPP is often calculated as a product of fPAR (fraction of photosynthetically active radiation) and light use efficiency (also called radiation use efficiency). Common inputs to NPP models include land cover, phenology, surface meteorology, and (LAI). http://wiki.landscapetoolbox.org/doku.php/remote_sensing_methods:net_primary_productivity

[2] Vegetation indices are dimensionless, radiometric measures that indicate the relative abundance and activity of green vegetation including (LAI) percentage green cover, chlorophyll contents, green biomass, and adsorbed photosynthetically active radiation (APAR). A vegetation index (e.g. NDVI, EVI, etc) should be coupled to some specific measurable biophysical parameter such as biomass, LAI, or APAR (that are collected in the field), as part of the validation effort and quality control of the remote sensing-derived product (e.g. net primary productivity).

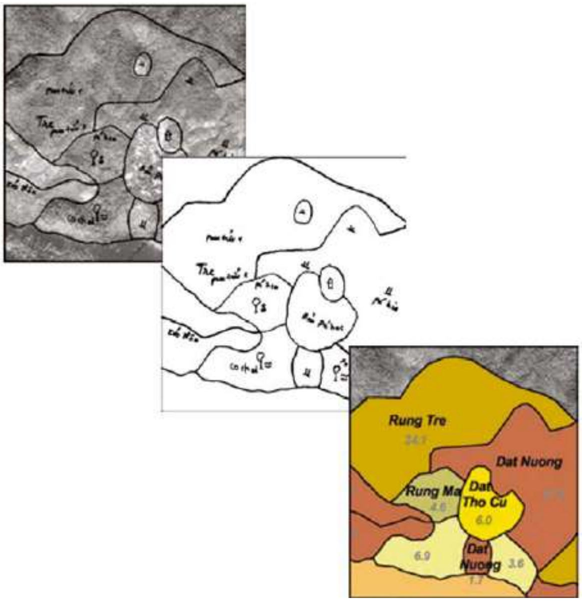
grass includes aspects such as sward height, biomass, quality, phenological stage, productivity level, species composition. The advantage of using remote sensing is that it provides data on a large scale and over an increasingly long time frame (e.g. satellites like Landsat have been operating since early 1970s), at relatively low cost. The data from many satellites (e.g. Landsat, C-BERS, Copernicus Sentinel, TERRA-MODIS) are freely available and the technical skills to use the data are increasingly widespread (See Annex 3, for satellite sensors, their characteristics and web links).

The aim of using remote sensing data in this methodology is to provide an overview of possible "hotspots" and "bright spots" in the targeted landscape: areas where NPP or greenness and/or vegetation cover has declined and areas where NPP has increased. The on-site assessment will validate this data (i.e. ground truthing) by using local indicators to evaluate changes that are occurring on the ground.

At what stage should landscape-scale assessments be introduced?

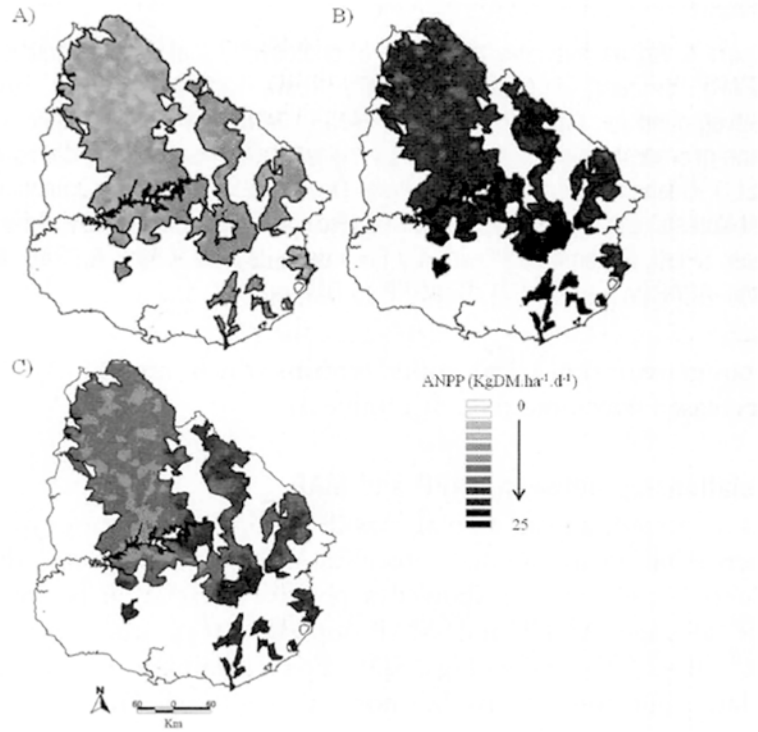
Elements of landscape-scale assessment can be introduced to support various steps of the methodology. A satellite image (e.g. a poster of a Google Earth image) can be used as a base map to support participatory dialogue and landscape mapping by participants (Figure 8).

Figure 7. Participatory village mapping using remote sensing image as a base map



Source: Müller, D., & Wode , B. (2003). *Manual on participatory village mapping using photomaps. Trainer Guide*, Second draft. http://www.iapad.org/wp-content/uploads/2015/07/participatory_mapping_using_photomaps_ver2.pdf

Figure 8. Map showing seasonal and spatial variability in aboveground NPP production (ANPP; kg DM ha^{-1} d^{-1}) of Uruguayan grasslands. A, autumn; B, spring; C, summer.



Temporal series of EVI images from the MODIS sensor on-board the EOS Terra satellite were used to estimate ANPP.

Source: Guido, A., Díaz Varela, R., Baldassini, P., & Paruelo, J. Spatial and Temporal Variability in Aboveground Net Primary Production of Uruguayan Grasslands. *Rangeland Ecology & Management*, Volume 67, Issue 1, 2014, Pages 30–38, http://dx.doi.org/10.2111/REM-D-12-00125.1

As well as a more advanced landscape-scale assessment, based on GIS spatial analysis of remote sensing derived products, and other ancillary data such as slope, topography, precipitation, temperature, soils, land use, and so on can be introduced in Step 4 (to guide field assessment) and Step 9 (post-assessment and validation).

If elaborated landscape scale assessments (Figure 8) showing variations in aboveground NPP are introduced prematurely in a participatory dialogue (Step 5), they may distort the way local knowledge is revealed. After participants have classified the landscape according to their own rationale, landscape-scale assessment maps derived from remote sensing (e.g. bright and hotspots) can be used to examine relationships between zones identified by participants and hotpots and bright spots defined remotely.

PRAGA supports the analysis of remote sensing data at both the landscape and the national level. Although only the targeted landscapes will be ground truthed, it may be possible to extrapolate information from this to the national scale. Figure 9 provides an overview of the different remote sensing techniques (satellite, UAV, aircraft based) and their potential scope and limitations for grasslands and rangelands assessments.

Figure 9. An overview of remote sensing-based grassland/pasture approaches and their limitations

Overview of grassland monitoring			
Approach/ Technology	Satellite	Aerial (UAV)	Fixed cameras (or ground based traditional methods)
Supporting tools	GPS and GIS tools to incorporate auxiliary data.		
Target properties	• Biomass • growth rate • vegatation structure and composition • vegetation type • stocking rate • change in vegetation cover • identification of low performing areas • vegetation status, ...		
Management scale	National/global	Local/farm/ field	Site specific
Advantages	Large scale coverage	Flexible acquisition planning	Cheap and easy to operate
Limitations	Long revisit time, cloud cover	Operationally expensive	Small-scale application, site specific
Output	• Yield map • precipitation map • soil type maps • land use land cover maps • quantitative analysis depending on the target properties.		
DSS and modeling	Use of available information (data) for the development of intelligent decision support system and models.		
Variability detection scale	• Inter-and intra region • inter-and intra field (for high resolution data)	Inter- and intra-field	Inter-field
Management strategy	• Evaluation • assessment • planning • profitabilty ...		

Source: Ali, I., Cawkwell, F., Dwyer, E., Barrett, B., & Green, S., 2016. Satellite remote sensing of grasslands: from observation to management. *Journal of Plant Ecology*, 9, 649–671. doi:10.1093/jpe/rtw005

Selection of indicators for landscape-scale (remote sensing) assessment

The selection of remote sensing indicators will be determined according to the baseline study, expert opinion, and the availability of existing data. Highly sophisticated and costly mapping is not required for this assessment methodology. However, it is important to identify the data that can give practical insights into land health and factors influencing degradation, based on the context.

Some common examples of ancillary data that can provide indicators useful for the grassland assessment include the following:

Topographic maps, landform maps, hydrological maps can be useful for identifying physical features that are often used by local users to classify their land. For example, some communities will map areas of high versus low altitude to differentiate between grazing areas, or they may map rivers or wetlands that are of strategic importance. Other commonly used physical features include steep versus flat areas, hilltops, foot slopes, floodplains and riparian areas.

Climate maps can be useful for identifying seasonally restricted areas that are managed as distinct resource zones by pastoralists. This could include, for example, dry season and wet season areas or drought refuges, where pastoralists identify specific types of degradation or specific management requirements.

Politico-administrative maps are often useful for delineating resource zones and identify population concentrations, particularly in countries where administrative boundaries have a significant impact on grazing patterns.

Infrastructure maps may be informative in countries where heavy infrastructure (such as rail or roads) or strategic infrastructure (such as water points or dams) may have a significant influence on resource management.

To ensure comparability between countries and within countries, and to contribute to reporting on international commitments, it is recommended to include established indicators[3] of LDN as follows:

1. land use and land cover change;
2. land productivity; and
3. carbon stocks above and below ground.

Importantly, there needs to be agreement on 'what is wanted/needed' from remote sensing (i.e. variable(s)/indicators). Each country then identifies the 'method/technique' they prefer to use to achieve such variable/indicator.

[3] The Inter-Agency and Expert Group on SDG indicators established tier 3 indicators used to derive the indicator for monitoring and reporting, that is, vegetative land cover, land productivity dynamics and trends in above and below ground carbon stocks.

Step 5. Participatory mapping of target landscape

Aim

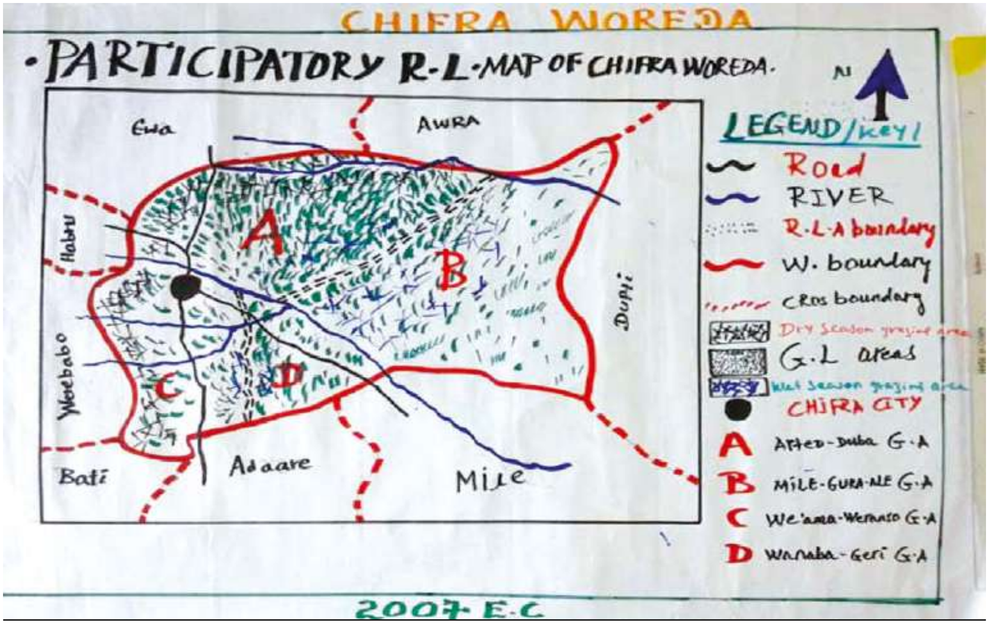
Local stakeholders map the target landscape to identify distinct zones for assessment through a participatory process.

Rationale for the participatory approach

Participatory mapping is key to understanding and visualizing rangeland priority resources, different land uses (Figures 10 and 11), the resource conditions, utilization strategies, and issues related to rangeland resource uses. The purpose is to provide the community with a meaningful participation space and an opportunity to contribute to the processes that influence rangeland management decisions. The participatory approach outlined in this methodology is guided by the following principles:

- to ensure that the assessment is guided by a set objectives and goals defined by the land users;
- to identify **indicators that reflect local management strategies and objectives**;
- to capture local knowledge in the identification of assessment sites;

Figure 10. Participatory rangeland map of Chifra Woreda (Ethiopia) after discussions on rangeland use planning



Source: Bormann, U., Flintan, F., & Gebremeskel, T. 2016. *Woreda (district) participatory land use planning in pastoral areas of Ethiopia: development, piloting and opportunities for scaling-up*. https://cgspace.cgiar.org/bitstream/handle/10568/107387/GebreMeskel_345_ID5581.pdf?sequence=1&isAllowed=y

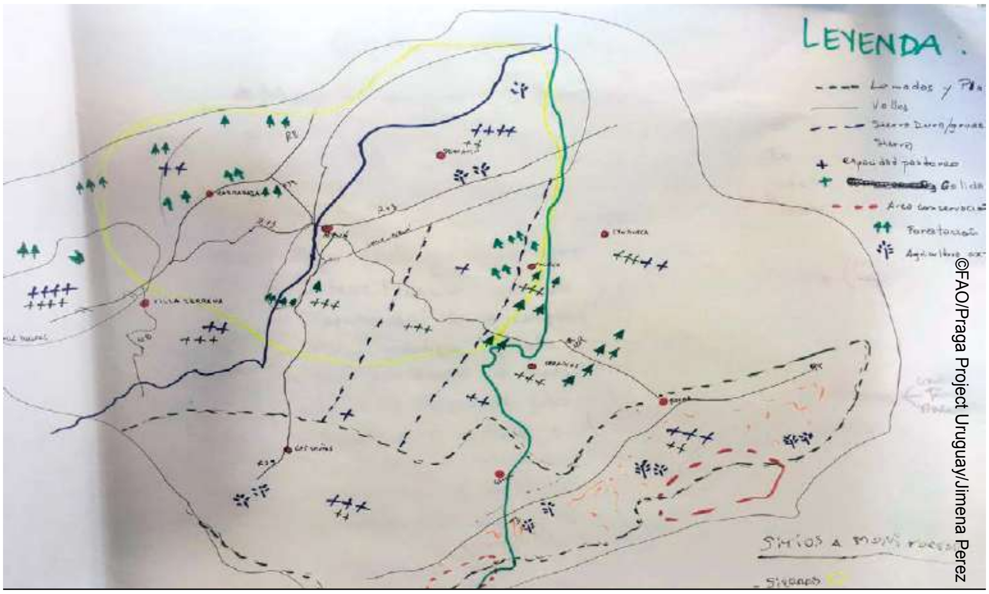
- to strengthen the acceptance of the findings by different stakeholders, and in particular, the local land users;
- to ensure that assessment results are used to influence relevant decisions by both communities and government; and
- to strengthen the sense of entitlement and rights over rangeland resources (particularly on communal lands).

Given the diversity in landscapes and seasons, community members are better placed to lead this process. Community members are the custodians and main users of the land. Therefore, they are better informed of the complexities of their landscapes, respecting established land use plans for the area from relevant government authorities. Community members or representatives will also lead in defining the management objectives of different resource zones in the landscape. Other stakeholders are engaged according to the interest–influence matrix (Figure 5).

Selection of participants

The selection of a manageable number of participants should be guided by the baseline stakeholder analysis (Step 3) and should endeavour to include all major stakeholder groups identified in the influence–interest matrix. Stakeholders should reflect a good social balance, not only between men and women but also between youths and elders and any other social classes. Participants should include principal

Figure 11. Participatory map with community (Uruguay) showing degraded and non-degraded areas



land-user groups as well as representatives from key government ministries, such as agriculture, environment, and water. Given the scale of assessment, relatively few participants will be involved and therefore the selection should try to ensure a combination of authentic community representatives and community opinion leaders on rangeland management matters. Elected representatives may fulfil the first criterion but are less likely fulfil the second. Community opinion leaders on rangeland management are usually recognized as the most knowledgeable members on this subject and are therefore better identified through peer reference.

It is important that the process of participant selection is done gradually and after a few days in the field, building trusting relationships that lead to genuine local participation. There is need to ensure representation of women in the team, as this may not be obvious among communities in which women have minor roles in decision-making.

Geographic representation should be attempted, for example including rangeland users from each sublocation (e.g. smaller administrative zones) within the target area. At the same time, the number of participants should be influenced by practical considerations; participatory exercises work best with group of approximately 8–10 and each group needs a facilitator. Assuming 3–4 groups, the overall number of participants is typically around 25–35.

Participatory landscape mapping

The participatory mapping exercise is carried out to classify the landscape into sub-areas for further assessment. To avoid confusion the following terms are used in this methodology. However, care should be taken over how these terms are translated into local languages:

1. **Landscape:** the overall area to be assessed, which is also the highest geographical unit selected for assessment from which the rest are classified (selection criteria discussed above).
2. **Zone:** locations within the landscape identified according to locally determined characteristics (e.g. land use/land cover, soils, landforms, transhumance activities). A zone is similar to the concept of land units used in ecology[4] or FAO's land mapping units.[5]

[4] The **land unit**, as an expression of landscape as a system, is an ecologically *homogeneous tract of land at the scale at issue.* A land unit survey aims at mapping such land units. This is done by simultaneously using characteristics of the most obvious (mappable) land attributes: landform, soil and vegetation (including human alteration of these three). The land unit is the basis of the map legend but may be expressed via these three land attributes (Zonneveld, 1989).

[5] A **land mapping** unit is a mapped area of land with specified characteristics. Their degree of homogeneity or of internal variation varies with the scale and intensity of the study.

3. **Plot:** locations within each zone where measurements will be carried out on the ground.

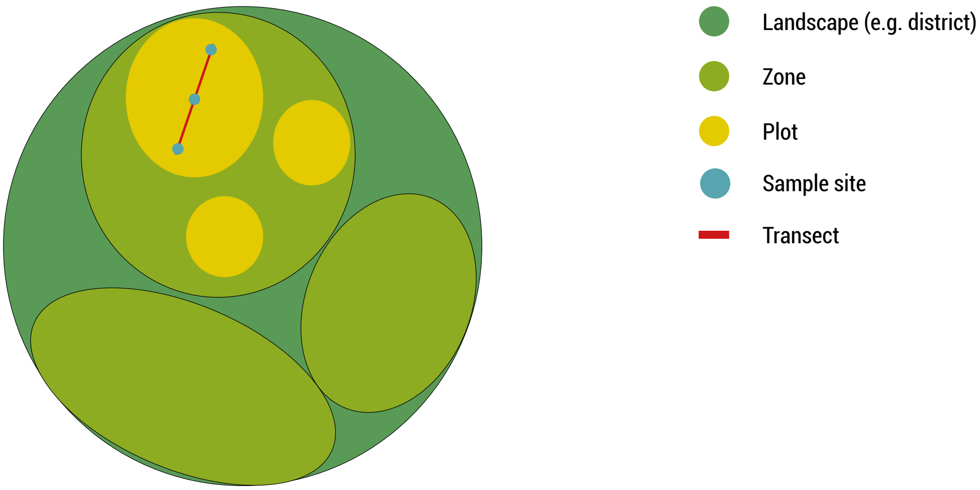
Landscape, zone and plots/transects are interconnected as shown in Figure 12. This figure shows the synergy and complementarity of using remotely sensed images and field observations. This terminology is to simplify the methodology, but the terminology varies by country. Additionally, countries may have established assessment methodologies which vary from this classification that can be adopted, for exampling substituting sentinel sites/plots for transects.

There are different ways to represent the classification of landscape units. The landscape can be an administrative or biophysical unit, and it is the first ‘stratum’ for the hierarchy of classification. The hierarchy of units is a simple way to demonstrate landscape classification, as illustrated in Figure 12.

Participatory identification of criteria for defining zones

The criteria for defining zones may differ from place to place according to the context. Even within the same country there may be different ways of classifying landscapes, for example according to the management objectives of different pastoral communities. The number of zones identified within the landscape has implications for the time required to conduct the assessment. Two to four distinct zones can generate a reasonable number of assessment sites.

Figure 12. Hierarchy of units for assessment



Source: FAO and IUCN, PRAGA Project.

Common criteria for classification include:

- seasonal use: for example wet season/dry season or winter/summer pastures;
- topography: for example differentiating between plains and hills;
- state of degradation: although this can introduce bias, highly degraded areas may need to be disaggregated from less degraded areas;
- grazing management areas/ grazing capacity and intensity;
- pasture quality and status (including productivity);
- transhumance areas: trace corridors of seasonal movement of herds. In mountainous areas and there is an annual cycle of livestock migration to the higher elevation pastures in warm seasons and return to lower altitudes for the rest of the year (Ali *et al.*, 2016); and
- conservation areas.

Participatory mapping considerations

Mapping can be carried out as part of broader participatory planning exercises or can be exclusively for the sake of rangeland assessment. The success of participatory exercises depends on the skill of the facilitator in:

- explaining the objective of the exercise and ensuring that participants fully understand the task and their role in it;
- sharing of responsibilities and input between participants;
- maintaining a frank exchange of views and ensuring that all participants contribute their views;
- managing and resolving disagreements;
- reacting to responses and provoking relevant, leading questions;
- keeping the discussion focused on the issue at hand; and
- maintaining common understanding in each task.

Main steps in the mapping exercise

1. Explain the exercise clearly: what is the aim, how will it be accomplished.
2. Establish ground rules: ensuring everybody’s view is heard, making collective decisions, and so on.
3. Develop preliminary base maps – Google Earth Imagery, historical topographic maps, and spatial data on infrastructure and administrative units. This will help the local communities easily locate the various land units against settlements and water points. Use of topographic and real time Google map with community will guide the laying of the transect and prior identification of sampling point collaboratively.

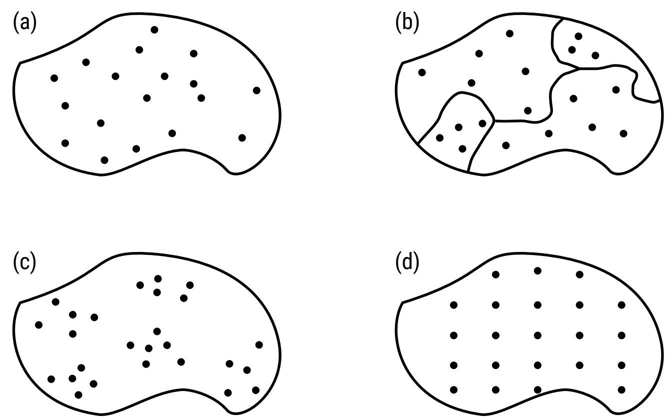
4. Where Internet connection allows, information can be captured directly through on-screen digitization over Google Earth images or on paper maps which can be digitized using ArcGIS.
5. Community members can describe their cultural landscape and natural resource governance models, including local landscape classification systems based on a combination of location, soils, vegetation, terrain and patterns of use.
6. Community landscape classification through herders' mental maps can divide the landscape into "macro" and "micro" landscapes. This characterization is helpful in identification of appropriate sampling scale and capture the within-landscape variability and small-scale heterogeneity that is crucial to the decision-making.
7. Discuss the **landscape** that is under assessment: ensure all participants agree on the scale of assessment, discuss key resources in the landscape, and ensure participants are considering the landscape at the appropriate scale.
8. Agree on how to classify the landscape (i.e. identify zones), how to differentiate between large areas that are distinct from each other, how and why these zones are different, for example, through differentiating grazing units from vegetation and livestock grazing suitability perspective.
9. Herders' mental maps are useful in: i) highlighting the overall heterogeneity of the assessment landscape; and ii) providing an important framework for laying out the sample transects/land units were mapped based on their uses, topographies, soil structure and dominant forage species.
10. Community members also detailed the degree of LD, and the factors influencing degradation, in each of the micro landscape zones.
11. Estimate the boundaries for any known degradation hotspots and add details of the type of degradation (e.g. soil erosion, soil salinization, invasive species).
12. During the analysis, provide remote sensing maps to compare with participatory mapping in order to contrast bright and hotspots derived from remote sensing products (e.g. NPP trends, changes in NDVI over time).
13. Identify the proposed location of **plots and/or transects** within the identified zones, considering the ease of access, how representative those areas are, and whether all key areas are included. This step includes identifying existing field plots (e.g. from ongoing projects or monitoring activities) and incorporating them into the sampling pattern.
14. Agree on the timing of the field assessment number of sample sites; and the size and spacing of sample sites (whether plots and/or transects).

Steps 1 and 2 may be carried out in the full group as part of a general introduction. Smaller groups are formed for the mapping exercises from Step 3 onwards in order to obtain group-specific perceptions. Groups should be selected to ensure that different stakeholders have space to share their experiences. Depending on the context, this may mean ensuring separate groups for women participants, or separate groups for different ethnic groups, or it may require that all groups include a balance of different stakeholder groups. Each group should present their mapping to the wider group at the end of the exercise. However, at this stage differences between the maps can be informative and the aim is not to negotiate for one "definitive" map. Differences between the maps should be discussed and differences in perceptions or priorities need to be recorded for further analysis.

Plots or transects are usually defined to give location and distribution of assessment sites across each zone. The number and location of plots may be influenced by the relative diversity of the landscape as well as the size of individual zones (see Figure 13). The number of plots is also determined by practical questions: number of teams conducting the assessment, number of vehicles, distances and road access, security and so on. The number of plots in each zone is typically between three and six, but this is not a fixed rule.

Figure 13. Examples of sampling pattern configurations for field observations

(a) random within a landscape (b) stratified, covering all the pre-defined zones c) clustered and (d) systematic*



* Participatory mapping using remote sensing images: a toolkit - http://pgis-tk-en.cta.int/m11/u03.html

Step 6. Participatory indicator selection

Aim

Participants in the mapping workshop agree on adequate and feasible number of indicators for field assessment of rangeland status.

Adequacy and feasibility

In the context of this methodology, an **adequate** set of indicators is one that can provide a thorough assessment of rangeland status. It is also a set of indicators that is accepted by the stakeholders and therefore should include indicators that are informed by local knowledge and local management objectives and are also scientifically robust.

Feasibility, in this methodology, refers particularly to the cost and logistical implications of the indicators. The methodology is designed to be widely adopted by governments and therefore the set of indicators should be limited by costs and time of acquisition. This includes the cost of gathering data as well as the cost of analysing the data. Complex indicators requiring highly specialized skills for analysis may also be considered unfeasible for the aims of the methodology. The overall target of the participatory indicator selection step is to ensure that the minimum set of indicators is included for a reliable assessment that fulfils the needs for which it was designed.

Framework for indicators

The following framework for indicator categories is proposed as a way of selecting indicators for a comprehensive assessment. Three domains of biophysical indicators are identified that are considered essential for a robust assessment of rangeland condition health: soil, hydrology and biota (Table 1). Each domain can be further divided into quantitative and qualitative indicators: for example, change in quantity of soil (e.g. physical erosion) and change in soil quality (e.g. decline in soil carbon which can be a proxy indicator for a management objective related to soil productivity/food security). In most cases, it is considered necessary to include at least one indicator in each subdomain. Following the guidance in the previous paragraph, it is important not to over-populate a given subdomain with indicators. For example, there is often a tendency to gather exhaustive data on certain families of plant under the biota domain, whereas careful selection of key indicators may be more manageable and informative.

Leaving biotic indicators open paves the way for an expanded list of indicators. For example, in some instances, many indicators are selected to make the methodology cumbersome and expensive. Giving community a bigger role in selecting indicators is useful for them to select locally suitable indicators such as: proportion of palatable species, presence/absence of ecto-parasites as proxy to assess macro landscape health, and other locally specific multidimensional measure. From the pilot countries, it was observed that change in soil organic carbon (SOC) requires more detailed analysis and could not be easily estimated in the field by the participants so it does not fit well in the PRAGA framework.

Furthermore, it is important to note that at the landscape scale communities might use composite indicators rather than any of the above indicators discretely. For example, change in landscape 'grazing potential' is associated with both soil and plant species. In defining indicators with communities, it is important to establish if there are other important criteria they use for assessing and monitoring land degradation. Depending on the situation, the field data sheet can be re-designed to capture additional priority community-defined indicators.

Socioeconomic indicators are not included in Table 1 as they are costly to incorporate as part of the field assessment. Socioeconomic data should be gathered from secondary sources as part of the baseline assessment (Step 2).

Table 1. Framework of indicators for grassland assessment

INDICATOR DOMAIN	DESCRIPTION
Soil	▪ Physical degradation processes (soil surface loss, bare ground, wind and water erosion) ▪ Biological/chemical soil changes, including soil organic carbon
Hydrology	▪ Total water retained in the system (e.g. aquifers, soil moisture and proxies such as well depth, recharge rates, time required to water stock etc.) ▪ Water quality e.g. turbidity, salinity, chemical content etc.
Biota	▪ Total vegetation (e.g. biomass, proportion of vegetation cover, net primary productivity) ▪ Type of vegetation (e.g. species richness, palatable species, high value species, and invasive plants, etc.)

The main stakeholders to engage in this phase are the community and the technical experts. This is to ensure a blend of local and indigenous knowledge with scientific knowledge to ensure that indicators are both locally accepted and scientifically robust. In many communities, a number of locally-recognized experts can be found, and it is important to ensure that these local experts are identified in a consultative process.

Indicator selection process

1. Explain the exercise clearly: what do we mean by “indicators”, what is the aim of the exercise, how will it be accomplished.
2. Explain the framework of indicators for grassland assessment using examples.
3. Based on participatory maps, draw out the management objectives for the land and how each area is distinguished from the other.
4. Understanding of the change over time (e.g. vegetation), what do herders assess and how? How different parts of the landscape changed in status (this information can be further corroborated with land cover change analysis established under Step 4).
5. List indicators in each of the indicator domain (see Table 1) and discuss how each indicator would be measured.
6. Agree on how indicators are to be interpreted (in most cases this is simple, but more time may be spent on certain indicators that are perceived differently).
7. Inquire if there are indicators not captured in the indicator domains in Table 1 (composite or otherwise).
8. If the number of indicators in a category is very long, attempt to prioritize.

Steps 1–3 can be carried out in the main group. In the case of Step 3, this is recapping on the previous mapping exercise. After all steps are completed, each group should present back to the full group and any discrepancies between groups should be examined further.

Creation of data sheets

Indicators identified during the participatory exercise will be entered into the blank data sheets (Annex 2). These will be printed for use during the data collection exercises, which will be launched after the participatory workshops. Data sheets can be completed in digital form (iPad or similar) or using hard copies.

A number of indicators are included as they are already established as requirements for monitoring land degradation, including key indicators required in national reporting processes for the UNCCD. To encourage free thinking on indicator systems that satisfy the agreed grassland/rangeland management objectives, it is recommended to present these pre-determined indicators to participants after the group work. These can be presented along with details of other fields in the data sheets as follows:

1. Basic plot and site information:
   a) plot name, description, ID number, site ID number, geo-reference (GPS reference).
   b) topography: slope (extent and shape) and aspect, landform types.
   c) local history: main use of natural resources, known historical trends.
   d) management practices: tree-felling, pasture cutting or grazing, contour management, restoration, removal of invasive species.
2. Vegetation indicators: for example type of predominant plant cover, extent of plant cover (proportion of bare soil), availability or non-availability of palatable species.
3. Soil indicators: for example visual assessment of degradation, visual assessment of soil quality and type, pH, water infiltration, SOC estimation (at 10 cm depth).
4. Water availability indicators: for example known changes in local water supply or quality (e.g. depth of groundwater), frequency of flooding or drought.
5. Other indicators used by the community, unique to the landscape (composite).

Step 7. Composition and selection of assessment team

Aim

Establish an assessment team that combines the necessary skills and representation.

Size of assessment team

The size of the team will be determined by the resources available for field assessment. Costs of logistics and access to vehicles, and to some extent, the scale of the landscape under assessment and ease of access to assessment sites also influence the size of the team. Importantly, prior to the assessment, the team should have more detailed training before conducting the assessment. Field assessments can be conducted by small teams (3–4 members) each with a vehicle suited to the terrain. A rapid field evaluation could be conducted in 4–5 days, typically using three or more assessment teams. 1–2 days will be used to clarify indicators (taken from the participatory workshops) and to field-test them. Where possible, each team should consist of a combination of community representative, government staff and another resource person. Efforts should be made to ensure women participate in the field assessment, particularly community representatives in order to ensure the knowledge of women rangeland users is captured in the assessment.

Skills

Overall, it is important to ensure a balance between community and non-community rangeland experts in order to maintain the interface between local/indigenous knowledge and science. Experts from the scientific community should be selected for their knowledge of rangeland science, botany and ecology. Similarly, community participants in the field assessment should be identified according to local recognition of their expertise and knowledge. At a minimum, the key skills/profiles should be included in the overall assessment team, for example, one botanist, one community representative with good grasp of environmental history of the landscape, one local government representative, one international participant, a soil scientist and one GIS expert. The lead stakeholders in the assessment team are the technical experts and local government staff, with support from community members.

Representation

In addition to the key skills, the assessment team also needs to represent key stakeholder groups, while recognizing that the small size of the assessment team makes balanced representation challenging. Community leaders should be part of the assessment team to ensure acceptance by communities in the field. Key government stakeholders also need to be represented (see the section below on partnerships). This includes both local and national government representatives. Achieving the perfect balance of skills and representation may be unfeasible considering limitations on resources and time and in each case, the assessment leaders will need to use their judgement to ensure a reasonable cross section within the team.

Training of the assessment team

The assessment team should be trained for a day in implementing the assessment methodology. This can be done with all participants at one of the assessment sites to initiate the data collection process (i.e. day of the full assessment in Step 8). The training includes a short overview of the challenges for grassland assessment, including features of rangeland ecology, methodological challenges, data gathering, field observations, and respecting local and indigenous knowledge and local resource rights.

The assessment team will be trained in site identification and selecting plots or transects. They will also be trained in the measurement of indicators agreed to during the participatory workshop and will be shown how to complete the data sheets.

In addition to developing a shared understanding of the participatory framework, team training is necessary to remove language barriers associated with background in professional training. Thus, the training is important to facilitate dialogue to enable knowledge sharing and to capture the voices of each of the participating stakeholders in the assessment process. Otherwise, the most influential team members will dominate the assessment process, making it less participatory.

Step 8. Field assessment

Aim

Measure the agreed indicators in all the identified zones, plots or transects.

Agreement over maps for field assessment

The assessment team will review the maps generated through the participatory exercises to agree on the most suitable map for conducting the assessment and to agree on precise location of plots and/or transects. The GIS expert can produce the field maps that will guide sampling in the field afterwards. In this step, the assessment team will plan the sampling, dividing assessors between plots or zones (as appropriate) and ensuring adequate time and access to the field.

The leadership of knowledgeable herders is useful during field assessment – mostly in placing sampling points, guiding overall laying of transects and actual assessment, because they fully understand and verify conditions on the ground during the participatory assessment. However, in a country with stronger tradition of monitoring rangelands and with established bodies responsible for pasture monitoring, it is important to rely on such established groups to form assessment teams. For example, in Kyrgyzstan, field assessment teams were selected from established pasture committee members.

Fieldwork

For each patch where assessment data is recorded, observations will cover the immediately visible vicinity. If following transects this can be driven in a more-or-less straight line, depending on topography, with individual measurements taken at pre-agreed spaces – this may be several hundred metres depending on the scale of the landscape. The starting point, distances and direction of transects should be predetermined to avoid bias, although flexibility is often exercised in the field due to physical constraints. Typically, at least three separate transects will be driven in each plot, but this will be determined by the number of assessors/vehicles, and the size and number of plots. Some countries have established approaches or monitoring sites where the fieldwork can be conducted. In these cases, pre-identified monitoring plots may be used. However, it is important to ensure that plots are representative of the landscape and zone that has been identified by participants in Steps 5 and 6.

Rapid validation of selected indicators

The assessment team typically will make a short (half-day) test of the indicators and data sheets to ensure that the indicators are realistic, the mapping has been effective, and to identify discrepancies in the way teams fill the data forms. This may be combined with the on-site training outlined in Step 7. After the rapid validation, the assessment team reconvenes to compare experiences, to review indicators and to revise the assessment approach for the remaining days of the full assessment.

Specific tools for key indicators

As far as possible, the assessment should be conducted *in situ* based on simple tools and visual assessment. All teams will carry GPS-enabled cameras to capture visual images. Additional tools will be included where specifically required by the partners and where the required capacity and equipment is already in place.

Step 9. Data management, post-assessment and validation

Aim

Ensure all data is systematically stored, analysed, and easily retrievable, and the assessment reports are improved and endorsed by key stakeholders, including local communities.

Data gathering and storage

Online data capture tools – such as Open Data Kit and Kobotoolboxes – on a smartphone/tablet facilitate data collection, optimize travel time, reduce errors, and streamline data access and management. However, the ideal solution may differ between countries and agreement over data storage and access should be reached during country inception processes. Further options for data storage include:

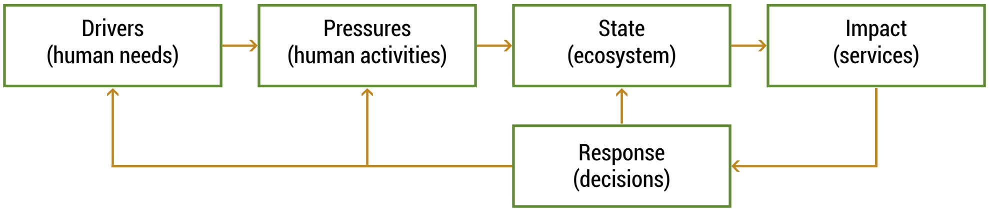
- outsourcing of data management to a third party;
- strategic partnership with an institution that can provide data management (e.g. GEOGLAM or Digital Data Cube model from Australia); and
- building on existing data storage options (e.g. Google Earth Engine, UNEP Live, FAO databases etc.).

Data analysis

Analysis of data generated in PRAGA would require an appropriate analytical framework. The DPSIR for example, is a causal framework, describing the interactions between society and the environment. The analysis will combine baseline data with field assessment to provide an overview of the five components in DPSIR (Figure 14). The choice of analytical framework will however depend on the type of data generated in the assessment or available secondary data. The analysis will also integrate and contrast field assessments with the remote sensing data to identify differences and propose explanations for the discrepancies, always considering the management objectives of the land. Relationships between the components will be proposed and this will provide the basis for a draft assessment report. The assessment report will be reviewed by partners and local participants, as far as costs permit, through a series of feedback workshops.

Data will be presented according to the landscape and zones (i.e. land units) as identified by participants. The assessment polygons will be digitized to present the assessment information with indicators or groups of indicators presented as

Figure 14. DPSIR framework

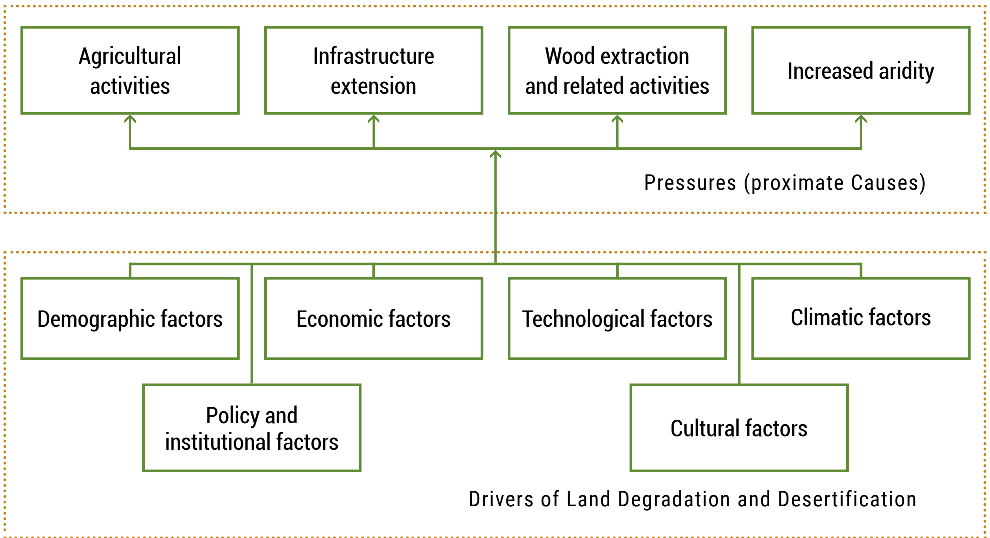


Source: modified from Bunning, S., McDonagh, J., Rioux, J., Nachtergaele, F., Biancalani, R. and Woodfine, A.C., 2016. *Land degradation assessment in drylands (LADA Project)*. https://www.fao.org/publications/card/en/c/40875549-ecc8-4388-b944-26edc9b58272/

appropriate to report on the findings. This will include indicators of drivers and pressures where they are available. Additionally, the assessment will attempt to extrapolate from the landscape assessment to the national level to indicate the level of confidence that planners should have in larger scale remote sensing analyses.

The analysis will examine factors behind degradation or the absence of degradation and, where possible, will link rangeland health to management practices, governance arrangements, and other likely drivers of change. The assessment will also estimate the impact of the current state of rangelands on key development indicators (see Figure 15).

Figure 15. Categories of drivers and pressures of land degradation

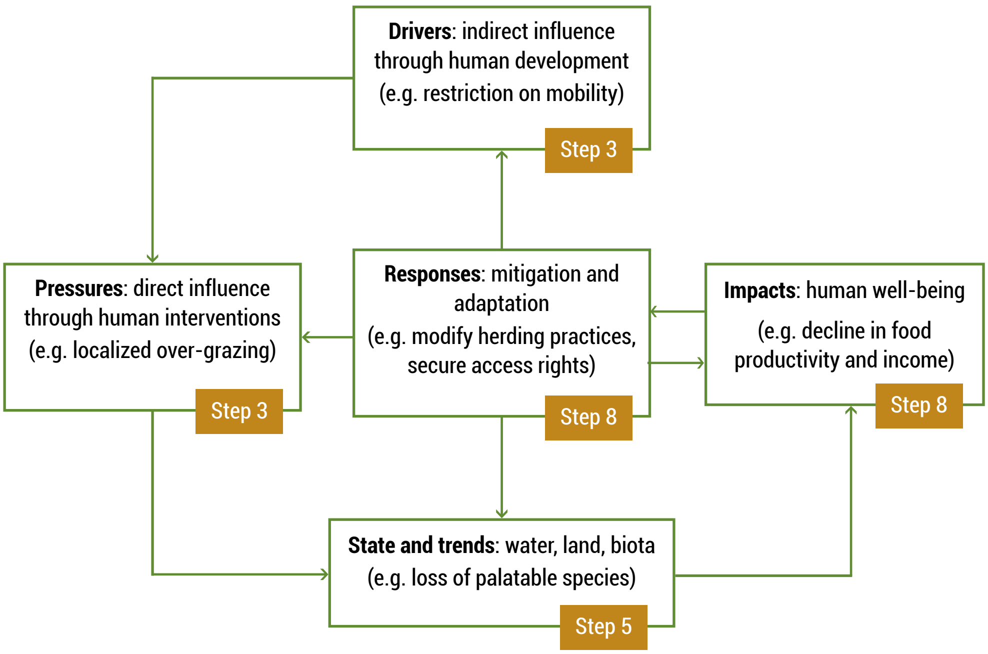


Source: modified from Geist, H.J. & Lambin, E.F. 2004. Dynamic Causal Patterns of Desertification. *BioScience*, Volume 54, Issue 9, Pp. 817-829.

The analysis should provide options for SLM that address the findings, including responses to drivers and pressures where appropriate. These response options will be discussed in detail during the validation workshops to either reach consensus or to identify areas of disagreement, which will inform follow-up work. The assessment report will therefore conclude with recommendations for policy and investment that have been developed jointly by key stakeholders.

The analysis will also look at the effectiveness of different indicators that were used, and the complementarity between local and scientific knowledge. It will examine the relative merits of participatory assessment and remote sensing technologies to provide relevant data and information, and it will propose ways to use and interpret

Figure 16. Example of using the DPSIR framework for analysis for steps in the PRAGA methodology



Step 3	What is happening to the grasslands/rangelands and why?
Step 5	What are the consequences for the landscape and its landholders/residents?
Step 8	What is being done and how effective is it?

Source: modified from Bunning, S., McDonagh, J., Rioux, J., Nachtergaele, F., Biancalani, R. and Woodfine, A.C., 2016. *Land degradation assessment in drylands (LADA Project).* https://www.fao.org/publications/card/en/c/40875549-ecc8-4388-b944-26edc9b58272/

remote sensing data in future. The analysis will consider the suitability of different indicators for long-term monitoring at the appropriate scale and with suitable frequency and will produce a costed monitoring plan for future adoption by partners.

Additionally, the analysis will examine the relevance of the assessment for reporting against different environment and development goals, including the Aichi Targets and the SDGs (e.g. LDN). A number of questions relating to the overall methodology will be evaluated during the analysis phase (see Annex 1).

Structure of assessment report

A draft assessment report will be prepared for the validation workshop, but responses and recommendations will be extensively modified based on the consultations. The structure of the report can be modified according to local requirements, but the following key sections should be included:

1. local context and characterization of the study area, including physical, biological, social, and economic features;
2. state and trends of land resources, degradation and restoration processes and land use changes (biota, soil, water);
3. drivers and pressures;
4. impact of land use and management (e.g. degradation or restoration on ecosystems) on ecosystem services, and human well-being;
5. responses to current state (e.g. LD or restoration) and how it is affecting decisions; and
6. recommendations (i.e. options for action) to land users, policymakers, and other stakeholders, and overall conclusions.

Each analysis report should provide: i) a short and concise summary for decision-makers; and; ii) a summary of findings to assist reporting against national and international indicators.

Validation workshops

The validation stage involves the review, revision and acceptance of assessment reports by key stakeholders including the local community. This involves holding validation workshops at national and local level to share results from the assessment. Participation at this stage involves all the main stakeholders but since the aim of these validation exercises is to influence policy and planning, national government and local government should form the main stakeholders. Communities play an important role in validation, ensuring that the drivers and pressures behind degradation are correctly attributed, and that they approve of the recommendations. Donor agencies and NGOs working on the project site or on similar issues can also be involved at this stage.

Validation workshops should be held at both national and subnational levels, to share results and finalize analyses with stakeholders at each level. At local level, this means reporting back to the original participants as far as possible. The validation workshops will remind participants of the assessment process, mapping exercises, and indicators that were selected. They will present results using the DPSIR framework and feedback on the findings will be elicited from participants. They will also discuss the relative merits of local and scientific knowledge for monitoring rangeland status and other observations on the methodology.

The envisioning exercise with participants aims to understand what they want done and asks what the current or planned development plans are. Land use planning is essential to make recommendations on future land use for climate change adaptation, sustainable land management practices and select investments that address land degradation.

The validation process can be carried out in conjunction with a broader national and local consultation process to influence policy and planning. The workshops therefore can include discussions for prioritizing responses to the assessment results, and on how to scale-up and sustain the monitoring process. This can include the development of investment options and resource mobilization plans to respond to the assessment findings. The feedback workshops will discuss options for systematic monitoring and will make recommendations for institutionalizing monitoring and for scaling up the assessment methodology countrywide.

Learning

The final step in the PRAGA methodology is to document lessons from the assessment in order to adapt and strengthen the methodology. The lessons will also extend beyond the methodology itself and include lessons on broader issues of grassland and rangeland health and pastoral knowledge. Examples of questions that have been posed through the development of this methodology are provided in Annex 1. These questions are for guidance, and new questions are expected to emerge from application of the methodology in different rangeland contexts.

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ANNEX 1

Learning from the methodology

During the validation process, the facilitators will also examine a number of questions that the methodology aims to address. These questions for experience-based learning include the following:

- Defining grasslands and rangelands. Should we focus on ecological (natural) grasslands or current grasslands? For example, do we exclude grasslands that have been converted to other uses like crop farming or settlements? Do we include non-native grasslands such as forests that have been converted to pasture? Are established definitions useful, such as global maps of ecosystems?
- What is an appropriate scale on which to monitor? Do we assess grasslands landscapes, in which patches may have been lost to other uses, and therefore assess the overall landscape health? Or do we focus on more distinct grassland ecosystems? Are different scales required in the same landscape – for example large homogenous areas vs. smaller and more diverse areas? How do different stakeholders interpret scale differently?
- How do we select sites and plots for assessment? Do we deliberately identify degraded areas for assessment or does this introduce bias? Keeping in mind the need to be cost effective, what is an appropriate level of granularity for decision-making at different scales? Do we include protected areas and other places where pastoralists are denied access?
- What is the best season in which to carry out grassland assessment?
- What is unique about grasslands that render existing indicators unsuitable? How do we account for non-equilibrium systems and shifting baselines? How do we determine competing management objectives and the desirable state against which health is measured?

- Are the indicators of grassland health any different from those used under LADA, or do we address the uniqueness of grasslands through the way we interpret those indicators? Does interpretation of indicators relate to management objectives?
- What is the difference between monitoring and assessment in relation to our approach? Are the indicators the same? How do monitoring and assessment needs relate to national reporting requirements? What is an appropriate level of detail/data at different levels? How does this impact on the cost effectiveness of the methodology?
- What are suitable indicators of SLM in grasslands? How are these different from indicators used in assessment of grassland status? How does the methodology assess land use and land management? How do indicators of sustainable management differ according to management objectives or social perspectives? What does this tell us about sustainability – for example, can an area be ecologically degraded but still support a large population? Who defines what is sustainable? Can we identify tipping points (linked to collapse and transformation) in grassland ecosystems? Does local knowledge help?
- How do we link local (community) indicators, based on an entirely different epistemology with scientifically-derived indicators? What is the extent of either mismatch or agreement over indicators and assessment?
- What are the minimum globally-comparable indicators? How does the methodology contribute to monitoring key global indicators (e.g. SDG 15.3)? What are the implications of globally-comparable indicators for local participation?
- How do we measure soil organic carbon (a key indicator)? Do local users have their own indicators, i.e. based on livestock behaviour, soil colour, biotic indicators, and so on?
- How do we respect FPIC in grassland assessment? How do we respect community rights over information, government rights over information, and overall data access vs. risk of misuse? How do we ensure that local users agree to the assessment? To whom does FPIC apply in each landscape?

ANNEX 2

Sample data sheet

Name of assessor/team	Date of assessment:
SITE IDENTITY	
Site name	Plot ID (name or reference)
Site geo-reference (GPS reference)	
SITE DESCRIPTION	
Slope (flat, gentle, medium, steep, sharp)	Shape (convex, concave, straight)
Aspect (N,S,E,W)	
Predominant land use (grazing, browsing, cropping, forestry, protected area)	
Management practices	
Historical changes or trends in land use	
Distance of water from nearest settlement	
SOIL INDICATORS	
Soil texture (clay, silt, sand)	Soil structure (tillage pan, aggregate size distribution)
Surface crust	Soil colour
Soil life (i.e. earthworms and other biota)	Roots
Visible organic litters	
Observable salinity	Soil carbon
Soil erosion by type (e.g. sheet, gulley etc.)	
Indicator of soil erosion (e.g. root exposure, pedestals)	
Soil moisture content	
Other indicators:	

WATER INDICATORS	
Groundwater level	Water availability
Water turbidity	Salinity
Surface water colour	
Other indicators:	
VEGETATION/BIODIVERSITY	
Land cover type (bare ground, grass, woodland, savannah, shrub, tree, crop/tillage, settlement/ infrastructure) ▪ visual images required	
Extent of ground cover (e.g. score 1–5) – areas that is visible from the standpoint	
Vegetation quality score in relation to land use in section 1 (1–5)	
Vegetation diversity (1–5)	
Other biodiversity indicators (qualify this with group, as positive or negative)	
Desirable and undesirable species	

ANNEX 3

Data sources

List of open access, global datasets that could be used in support of the landscape scale assessments.

PRODUCT	INDICATOR	WEBSITE
FAO Land cover maps	Land use and land cover	http://www.fao.org/geonetwork/srv/en/metadata.show?uuid=ba4526fd-cdbf-4028-a1bd-5a559c4bff38&currTab=distribution
MODIS indices	Vegetation greenness, LAI, NPP	https://modis.gsfc.nasa.gov/data/dataprod/
FAO global land cover		http://www.glcn.org/databases/lc_glcshare_en.jsp
The Joint Research Centre of the European Commission's LPD dataset	NDVI, LPD data	https://wad.jrc.ec.europa.eu/landproductivity
NASA Vegetation Indices	Density of plant growth	https://earthobservatory.nasa.gov/Features/MeasuringVegetation/
FAO global soil partnership and ISRIC updated Harmonized World Soil Database (HWSD)	Soil quality, terrain, land cover	http://www.fao.org/soils-portal/soil-survey/soil-maps-and-databases/harmonized-world-soil-database-v12/en/
Landsat, the Brazilian C-BERS	Several environmental and water monitoring and land uses	https://earth.esa.int/web/eoportal/satellite-missions/c-missions/cbers-3-4


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Satellite sensor types

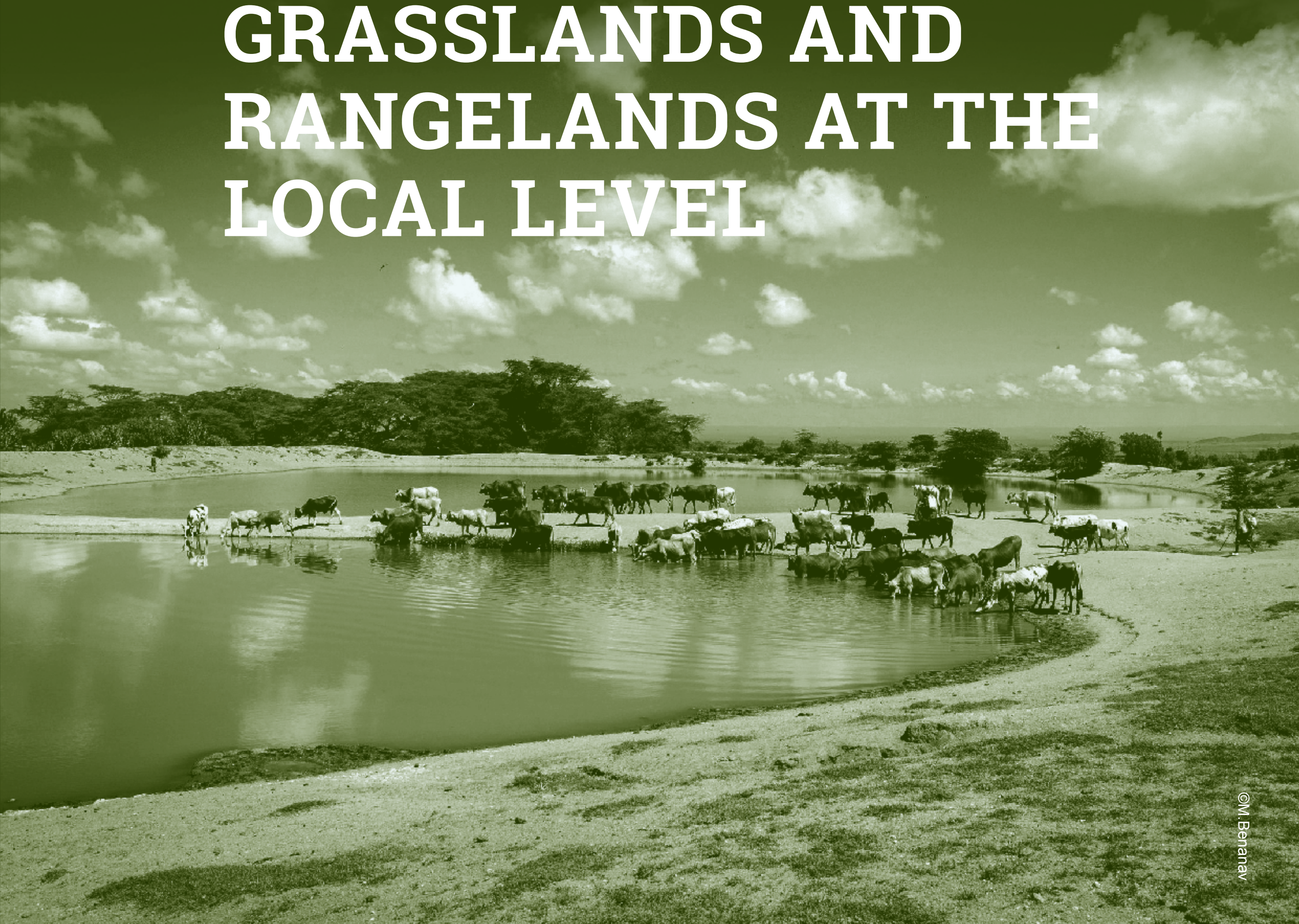
NAME	ABBREVIATION	RESOLUTION (M)	AVAILABILITY	RETURN INTERVAL	TYPE*	PLATFORM
Moderate-resolution imaging spectroradiometer	MODIS	250,500,1000	2000 to present	Daily	M	Satellite
Airborne visible/infrared imaging spectrometer	AVIRIS	5,20	1998 to present	On demand	H	Aircraft
Advanced spaceborne thermal emission and reflection radiometer	ASTER	15,30,90	2000 to present	On demand	M	Satellite
Landsat thematic mapper 5	TM5	30,60	1984 to 2013	16 days	M	Satellite
Landsat enhanced thematic mapper 7	TM7	15,30,60	1995 to 2003	16 days	P,M	Satellite
Landsat data continuity mission (Landsat 8)	LDCM	15,30,100	2013 to present	16 days	P,M	Satellite
Satellite pour l'observation de la terre 5	SPOT5	2.5,10	2002 to present	1 to 4 days	P,M	Satellite
Satellite pour l'observation de la terre 1-4	SPOT1-4	20	1986 to present	1 to 4 days	P,M	Satellite
Satellite pour l'observation de la terre vegetation	SPOT vegetation	1150	1998 to present	daily	M	Satellite
Rapideye	RapidEye	5	2008 to present	Daily	M	Satellite
Quickbird	Quickbird	0.8,2.5	2001 to present	1 to 3.5 days	P,M	Satellite
Orbview-2	OrbView-2	1100	1997 to present	Daily	M	Satellite

NAME	ABBREVIATION	RESOLUTION (M)	AVAILABILITY	RETURN INTERVAL	TYPE*	PLATFORM
Multi-angle imaging spectroradiometer	MISR	275	2000 to present	9 days	M	Satellite
Medium resolution imaging spectrometer	ENVISAT-MERIS	300	2002 to present	3 days	M	Satellite
Landsat multispectral scanner	MSS	80	1972 to 1997	18 days	M	Satellite
Ikonos	IKONOS	0.9,4	2001 to present	3 days	P,M	Satellite
Geoeye-1	GeoEye-1	.41,1.65	2008 to present	3 days	P,M	Satellite
Formosat-2	FORMOSAT-2	2,8	2004 to present	Daily	P,M	Satellite
Colour-infrared aerial photography	CIR	1	variable	On demand	M	Aircraft
Colour aerial photography	Photo	1	variable	On demand	C	Aircraft
Worldview-1	Worldview-1	0.5	2007 to present	1.7 to 4.6 days	P	Satellite
Radarsat-2	Radarsat-2	3 to 100	2008 to present	On demand	R	Satellite
Radarsat-1	Radarsat-1	8 to 100	1995 to present	4 to 6 days	R	Satellite
Panchromatic aerial photography	B/W Photo	1	variable	On demand	P	Aircraft
Advanced synthetic aperture radar	ENVISAT-ASAR	30,150,1000	2002 to present	3 days	R	Satellite
Worldview-2	Worldview-2	0.42,1.8	2009 to present	1.1 days	P,M	Satellite
Light detection and ranging	LIDAR	Variable	variable	On demand	E	Aircraft
Unmanned aircraft systems	UAS, UAV	Variable	variable	On demand	C,M	Aircraft
Advanced very-high resolution radiometer	AVHRR	1.1km	1981 to present	twice daily	M	Satellite
Compact high resolution imaging spectrometer	CHRIS	18,36	2001 to present	7 days	H	Satellite
Avnir-2 - advanced visible and near infrared radiometer type 2	AVNIR-2	10	2004 to 2011	46 days	M	Satellite

*C=Colour, E=Elevation, H=Hyperspectral, M=Multispectral, P=Panchromatic, R=Synthetic Aperture Radar

Source: http://wiki.landscapetoolbox.org/doku.php/remote_sensor_types:home

Part II
GUIDANCE FOR THE PREPARATION, ASSESSMENT AND MONITORING OF GRASSLANDS AND RANGELANDS AT THE LOCAL LEVEL



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Executive summary

This section looks at lessons learned from testing draft PRAGA methodology under the project **"Participatory assessment of land degradation and sustainable land management in grassland and pastoral areas"**. The project was primarily designed to address the increasing need to monitor and reverse land degradation in dryland areas through the development of participatory rangeland assessment methodologies, by integrating sound science and local knowledge. This report distils the salient lessons from the five country reports, particularly on important feedback and lessons learned from testing the methodology. This is complemented by an additional review of relevant reports, studies and interviews with experts involved in the PRAGA development.

The first chapter of this report provides an overview of key rangeland terminology, underscores the global extent and importance of rangelands, as well as the degradation factors and the status of rangeland degradation. Further, it highlights the knowledge gaps in assessment and monitoring of rangelands and provides a case for knowledge integration. The lessons from testing draft PRAGA methodology in the five pilot countries are organized into the phases described below.

Preparatory phase

Based on experience in Kenya, it was observed that to improve relevance, ownership and to foster good collaboration, local partnership building should be established before designing the data collection protocol and subsequently consolidated through local and national level workshops. While in countries like Kyrgyzstan, with its long history of pasture monitoring and assessment, use of existing grassland platforms was very useful in rolling out PRAGA. This facilitates faster application of draft PRAGA methodology. The existence of robust history and available data for rangeland assessment and monitoring will provide a fair understanding of the status and trends in rangeland degradation.

Regarding identification of assessment landscapes, land managers emphasized that i) landscape identification should be informed by the need to understand land degradation to a meaningful detail using a rapid method, and ii) the need to consider livestock management decisions and priorities for land users, as opposed to standard assessment of degradation. Relying on land users as the guide to identify the assessment landscape, improves matching of the landscape in use with the purpose of rapid landscape assessment. This is important in resolving the long-standing challenges of selecting representative landscapes. Therefore, application of PRAGA for rangeland assessment and management in other contexts should pay special attention to the preparatory phase in order to fully capture local priorities and strategies that are fully aligned to the decision-making process.

Baseline phase

The baseline phase is informed by the preparatory phase and supports identification of the required database for the assessment objectives, which could vary from country to country. The preparatory stage is also important in identifying where the data is, who owns it and how it is acquired. In situations where rangeland monitoring baseline systems and data are well established, they should form an important basis for implementing PRAGA methodology. In particular, a strong baseline should inform careful selection of indicators to be considered during field assessment. In situations where baseline data is absent, it is important to conduct a detailed baseline survey for the assessment. Different baseline data carry different weight, and it is important to consider which data (secondary data) is useful as the foundation for PRAGA assessment in order to be focused and avoid information overload. Furthermore, due to resource and time constraints, baseline data selection should be informed by the local context and have direct implication for land degradation. In most of the PRAGA pilot countries, the baseline study and the participatory assessment was done by a different team, with a different focus. To improve its relevance and representation, baseline and PRAGA data need to be closely associated both spatially and temporally.

Participatory phase

Participatory landscape classification and indicator selection helps to answer questions on what is assessed and at what scale, why it is assessed, and feedback loop in terms of informing land user's management options. The answers to such questions vary in different land uses and social- ecological contexts. Thus, in every context, it is good practice to understand the reference framework applied by the land users to make land degradation assessment as reliable as possible. The community landscape classification was helpful in identifying appropriate sampling scales. For example, in Kenya, landscape classification into macro and micro landscapes helped to capture the within-landscape variability and small-scale heterogeneity that is crucial to the decision-making of herders according to hour, day, and week intervals. This highlights a potential divergence of purpose behind the use of rangeland health assessment, since large scale assessment to guide restoration planning requires information to track long-term changes, whereas pastoral herd management works to a short timeframe.

The mental map outlined by community members highlighted the overall heterogeneity of the assessment landscape and provided an important framework for laying out the sample transects. The community focus group discussions provided important insights into landscape structure and facilitated the identification of appropriate community members for inclusion in the field assessment teams. Overall, the community classification systems provide the link between traditional knowledge and scientific approaches to rangeland assessment, and as such, the participatory landscape maps developed are central elements of the sampling protocol outlined in the PRAGA methodology.

Regarding selection of indicators, the PRAGA approach provides enough flexibility to adapt indicators to local needs. However, it also creates a risk that in diverse study areas different indicators are chosen or different indicators are assessed differently. Countries that have been using the LDN in national reporting for global land degradation monitoring can use the context- specific participatory indicators to complement their reporting and make it more relevant. The assessment team can develop an analysis framework for the identified indicators at the local level. For example, which of the indicators are more sensitive to pressure (fast) and which of the indicators are less sensitive to change (slow, resilience).

Assessment phase

The co-opting of local expertise and land users in rapid assessment was very valuable. In Kenya, the involvement of herders – who are recognized and acknowledged by the community as knowledgeable – was useful in placing sampling points and guiding overall laying of transects because they fully understand and verify conditions on the ground during the participatory assessment. The inclusion of remote sensing experts also helped in using Google Earth, digitization of the sampling area, and geo-referencing water points, town and other infrastructure. The use of a point scale such as the continuum of "very low", "medium", "high", and "very high" levels to assess degradation generated useful data for rapid assessment and explained the level of land degradation for each micro-landscape unit. Other valuable lessons include the use of an online portal to capture data using tools such as Open Data Kit (ODK) and Kobo toolboxes on a smartphone/tablet which facilitates faster data collection, reduces errors, and streamlines data access and management. In addition, these open-source tools allow for the direct collection of GPS locations and photographs of the sampling point. However, stricter definition of the monitoring point (a certain area) could help to prevent uncertainty on the assessment point and make assessments more consistent. From lessons learned in Kyrgyzstan, the pasture borders were often not clearly recognizable and it is recommended that it would be good to load shapefiles of pastures from participatory mapping onto a smartphone/tablet in order not to lose time searching for sites or the pasture borders.

Linking field data and remote sensing data

Combining remote sensing (RS) data with information collected during the participatory field assessment yielded new insight on the relationship between RS measures of production and local knowledge. The temporal scale used in the RS methodology is long term and does not reflect very short trends in vegetation dynamics. In contrast, the degradation levels derived from local knowledge are based on perceptions of both long-term and short-term trends. For instance, the NDVI data enabled tracking of long-term trends over large areas, while local knowledge, such as grazing potential, highlighted the complex nature of rangeland health that links issues of livestock needs and a suite of landscape characteristics such as plant species composition, functional groups, water availability, soil colour and structure, and the presence of disease and ecto-parasites, and so on. As such, the overall understanding of the elements and dynamics of grazing potential and rangeland health in a pastoral landscape is improved when mean annual NDVI data for each micro-landscape is compared with local perceptions of grazing potential. The overlays of data from the field plot and the state of 'degradation' according to RS, showed both contrast and correlation of results in some countries. However, generally when data from the local participatory assessment supplements the data from RS, the local interpretation is similar to that of satellite images. Whatever the outcome, linking field and RS observations was considered valuable as a way of integrating traditional and scientific approaches in rangeland assessment.

The report is structured into five main chapters including the introduction that provides the general overview of rangelands and degradation. The second chapter provides the background of methodological challenges that hinder effective rangeland assessment. Chapter 3 provides details of lessons learned through the application of PRAGA methodology in five countries, while Chapter 4 focuses on the relevance of the results obtained in comparison with results from past studies in the region. Last, Chapter 5 ends with a conclusion and key messages.

3 Introduction

3.1 Global extent and importance of rangeland

The definition of rangelands or grasslands and their extent vary greatly and overlap with that of other land types such as forests (Lund, 2007). A clear definition is important not only to understand spatial coverage but also can be an important basis to create inventory to manage rangelands at national and international levels (Ibid). According to Briske (2017), definitions of rangelands vary and have evolved over the years. One of the working definitions by UNCCD (2011), states that rangelands are land types (not just land grazed by livestock) where grasses and shrubs dominate the natural vegetation, and the land is managed as a natural ecosystem. It generally includes land covered by grasslands, shrub lands, woodlands, wetlands, and deserts that are grazed by domestic livestock or wild animals. With this broad definition, rangeland is considered as the largest biomes on Earth and the main source of feed for traditional livestock rearing systems in many parts of the world (Lund, 2007). Depending on the socioeconomic systems in which they are embedded, the economic importance of rangelands varies significantly. For instance in parts of Africa and Central Asia, rangelands are vital for the subsistence of pastoralists, foragers, and rain-fed crop farmers (FAO, 2000; Blench and Sommer, 1999).

3.2 Degradation status of rangelands and common factors

Land degradation is a complex multidimensional global concern in rangelands, and impacts on the livelihoods of those who directly depend on them. Land degradation has implications for livelihoods, resilience, sustainable development, and biodiversity conservation. In particular, land degradation is a serious concern in areas such as rangelands and grasslands where people's livelihoods directly depend on natural resources, with sectors such as livestock production, crop farming and forestry being majorly affected. Thus, it presents challenges in its assessment, and requires use of different methodologies that are potentially subjective (Lund, 2007).

The definitions of land degradation and the indicators for its measurement differ widely. Generally, UNCCD defines land degradation as reduction or loss in arid, semi-arid, and dry sub-humid areas, of the biological or economic productivity and complexity, resulting from land uses or from a process or combination of processes, including processes arising from human activities and habitation. The context of landscape and its management objectives need to be considered to refine the definition and to select monitoring indicators. For instance, where the definition uses loss of biological and economic productivity, the definition may have different meanings, depending on the management objective. As an example, if conservation of biodiversity is the objective then conversion of the landscape to other uses such as croplands or intensive pastoral production is regarded as degradation. Similarly, based on livestock species reared, communities may have different views about the productivity of rangelands. Where a cattle keeper considers increase in wood cover as degradation, a camel keeper may see it differently. Under the communal tenure arrangement, characterized by dynamic shifts in land ownership, there is need to establishe a history of land use in order to have a deeper insight on the shift in land cover. The information from the land users at the time of assessment can be corroborated in a multistakeholder workshop and further complemented using land cover analysis from RS.

According to the UNCCD, over 20 percent of the world's vegetative land surface exhibits signs of reducing productivity (UNCCD, 2017). The impacts of land degradation on local livelihoods can be enormous depending on the context. Land degradation in the rangelands results in a decline in livestock productivity, increasing climate hazard vulnerability, displacement and increased conflict, among others. Coupled with the impacts of climate variability, degradation of rangelands destabilizes socioecological systems and affects adaptive capacity and undermines sustainable development initiatives. Quantitative assessment in Kenya estimated that between 2001 and 2009, the direct costs of land degradation due to land cover and land use changes was likely to exceed USD 1.3 billion annually (Wellington *et al.,* 2015).

There is growing global recognition of the challenge posed by the impact of land degradation. This has led to various initiatives, including the adoption of the Plan of Action to Combat Desertification (PACD) by United Nations Conference on Desertification (UNCOD) in the late 70s, where the international community continued to make efforts to include land degradation prevention and mitigation in the global development agenda. Similarly, following the Earth Summit Conference in Rio in 1994, the United Nations developed an integrated approach, which led to the adoption of the Convention to Combat Desertification (UNCCD). Later in 2015, under the SDGs, LDN was entrenched in the global development agenda through Goal 15. Further, in COP12 of 2015, new road map for addressing land degradation that included a conceptual framework for LDN was adopted (Cowie *et al.,* 2018).

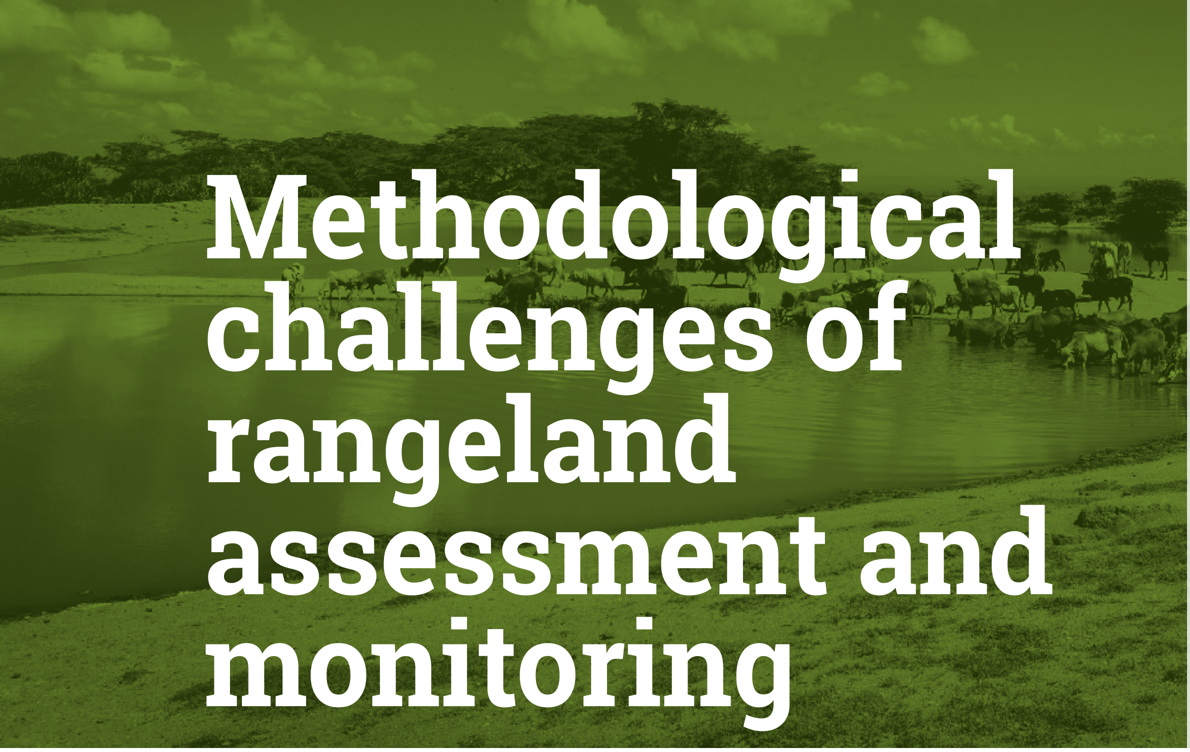
The LDN initiative fronts a shift in the paradigm of how causes, effects, and response to land degradation and on how to implement sustainable land management systems. The approach aims to balance the anticipated future loss of productive land with the restoration efforts of degraded land through effective land use planning in order to reverse, reduce, and avoid land degradation. However, the success of this initiative is linked to better understanding of rangeland degradation status at various scales – spatial and temporal – and also across the heterogeneous ecological and sociopolitical contexts.

3.3 Knowledge gaps in assessment and monitoring of rangelands – the need for knowledge integration

Traditionally, the debate on land degradation was mainly centred on scientific approaches and evidence that guided the selection of indicators and assessment to monitor changes over time and make recommendations for restoration. However, this approach was criticized for its lack of social aspects and use of peoples' knowledge about their land and resources. Also, given the complex nature of land degradation and desertification, the need for multiple approaches for indicator selection, assessment and monitoring the processes of change was recommended (Roba and Oba, 2009). This also followed research that brought to the fore the roles of local ecological knowledge for describing environmental change (Berkes and Folke, 1998; Berkes, 1999) and social-ecological resilience (Berkes, Colding and Folke, 2003). As a result, the importance of theoretical and methodological contributions for integrating local ecological knowledge and ecological methods was acknowledged and adopted.

The recognition of the social, ecological, economic and spatial dimensions of land degradation has been instrumental in identifying effective interventions to mitigate degradation and enhance restoration and rehabilitation measures. Furthermore, the integrated approach of rangeland assessment supports the adoption of the LDN approach. This approach relies on accurate data which is both relevant to the management objectives and provides timely information for the achievement of the envisaged sustainable land management at all levels – community, country and global. However, assessment methods that are cost- and time-effective and cater for the different management objectives, with indicators acceptable to both the local and scientific community, has been difficult to find. Thus, there is a need to explore participatory methodologies that can be used in vast areas of rangelands to enable monitoring of land degradation status.

Current approaches, such as the LDN initiative, recognize the importance and advocate for combining the traditional scientific approaches with local knowledge about landscapes, patterns of use, and degradation processes to enhance understanding and develop and promote sustainable land management practices (e.g. Cowie, *et al*., 2018, Roba and Oba, 2009).



4 Methodological challenges of rangeland assessment and monitoring

4.1 Paradigm shift in rangeland and grassland assessment

Traditionally, the assessment of land degradation relied mostly on ecological approaches, which were commonly accepted as objective and founded on scientifically verifiable data collection protocols that systematically yield verifiable data outputs. On the other hand, local knowledge of the land managers and their land degradation assessment approaches were largely disregarded and perceived as unscientific (Pierotti and Wildcat, 2000, Oba *et al.,* 2000).

However, over the years, advances in rangeland research has demonstrated that resource users have detailed knowledge and have developed elaborate methods of assessing rangeland conditions and trends. Also, local ecological knowledge used by the rangeland users worldwide displays a striking similarity in terms of the type of information collected on grazing land and analyzed to understand landscape level degradation (Fernandez-Gimenez, 2000, Oba *et al.,* 2000). This recognition has increased acceptance of integrating participatory and ecological methods to develop robust indicators that are accessible to a range of users, in order to monitor and enhance the sustainability of land management (Reed *et al.,* 2006). Furthermore, active participation of local communities has been entrenched in Rio Agenda 21 of the United Nations Conference on Environment and Development (UNCED, 1992). In addition, UNCCD (2000) places emphasis on the role of local communities to implement the articles of the Convention in order to meet national and global obligations.

Currently there are efforts to align the selection of indicators for the assessment of landscape degradation to the SDGs and the LDN frameworks. These indicators fall within two general, and overlapping thematic areas: socioeconomic and biophysical – with various components within each (Figure 17). Participatory tools such as PRAGA use a people-centred approach that covers these dimensions in order to obtain comprehensive causes and effects of land degradation, which also aims at identifying locally acceptable restoration actions that contribute to the global effort.

Figure 17. Thematic areas, primary components, and potential indicators for assessing and monitoring land degradation and its impacts

THEMATIC AREA	COMPONENT	INDICATORS
SOCIOECONOMIC	Human wellbeing	Poverty Access to safe water Malnutrition HDI
SOCIOECONOMIC	Livestock and crops	Species Production Diversity Mortality Distribution Sustainability
SOCIOECONOMIC / BIOPHYSICAL	Biodiversity	Species richness Distribution Abundance
BIOPHYSICAL	Vegetation	Species composition Structure Palatability Cover Production Invasive species
BIOPHYSICAL	Soil and water	Erosion Quantity Salinization Quality SOC Accessibility

Source: Author's elaboration.

The socioeconomic dimension of landscape assessment relies on livelihood indicators to provide insights into the impacts of land degradation on the well-being of pastoral communities. It also looks at the potential for poverty and unsustainable livelihood practices to further exacerbate land degradation and accelerate a negative feedback cycle of increased vulnerability and declining resilience. The measurement of human well-being encompasses human development and livelihood approaches. Human development is at the core of the SDGs and in line with LDN indicators. The aspects of poverty and access to water are regarded as central to its assessment. However, while socioeconomic data is considered relevant for assessing change in landscape health, there are concerns as to whether changes at the landscape scale are directly attributable to the broader socioeconomic issues.

On the other hand, biophysical components that are of interest in assessing rangeland health include vegetation, soil and water, which are regarded as the primary components to assess land degradation. In addition to this core set of components, information on biodiversity as a means of monitoring the impact of degradation on ecosystem services is important. The key biodiversity components measured include, soil biodiversity, distribution and abundance of large mammals, the species richness of IUCN red-listed species (mammals, amphibians, and reptiles) and the species richness of birds. Vegetation aspects of interest include net primary productivity, NDVI, leaf area index, rainfall use efficiency and land cover.

4.2 Participatory approaches to rangeland assessment

Over several decades, the approaches in rangeland appraisals and management were influenced by the ‘equilibrium theory’. This theory informed methodological approaches which prioritized measuring of bio-physical parameters as an outcome of interaction between livestock and vegetation, while the roles of pastoralists – who were the managers – was negated (Galaty, Aronson and Salzman, 1981). Indeed, the pastoralists were viewed as responsible for the destruction of the same environmental resources upon which their livelihoods depended. The change in perspective was realized with the proposal of the ‘non-equilibrium’ theory, which appreciated the role of mobility and the management oversight provided by these human stewards. This shift in thinking, not only brought about the appreciation of livestock mobility, but also created an appreciation for pastoralists’ perceptions of their grazing resources and the vital role they play as managers of the grazing lands. This appreciation, coupled with the already growing wider recognition of indigenous knowledge (e.g. Agrawal, 1995), improved the consideration of pastoralists' perspectives in methodological approaches aimed at understanding pastoral production and rangeland dynamics.

Participation of pastoral communities in decision-making over the use and monitoring of their environmental resources is regarded as one of the pillars of sound rangeland management. Using their own long-term experience, pastoralists have a detailed body of knowledge, which they have used to manage the rangelands for generations. Their knowledge is also regarded as measurable and comparable across communities and it is assumed that the outcomes of these bodies of knowledge can make an important contribution to the development of local policies (Oba, 2012). Considering that herders have evolved in-depth knowledge that encompasses systems of landscape classification and that they use diverse environmental features, this knowledge is appreciated (ibid) as an invaluable addition to the scientific discourse.

Therefore, the participation of local communities in assessing and monitoring land degradation makes important contributions for implementation of the UNCCD and CBD (Roba and Oba, 2008).

4.3 Participatory indicator selection for rangeland assessment

Over the past few decades, there is increased interest in integration of community indicators with that of ecological methods to develop robust assessment methods to monitor and enhance the sustainability of land management (Reed, Andrew and Baker, 2008, Roba and Oba 2009). Compared to published indicators, pastoralist knowledge has more holistic indicators that encompasses vegetation, soil, livestock, and wild animals as well as socioeconomic indicators such as income from rangeland products, expenditure on products that were formerly obtained from rangelands and distance to firewood, to mention a few (Reed, Andrew and Baker, 2008).

Usually, pastoralists link changes in livestock productivity performance indicators to ecological and anthropogenic factors in order to make decisions on herd movements (Oba, 2012). While ecologists make generalized deductions about land degradation, herders perceive rangeland degradation in relation to the specific livestock species (ibid) and production objectives. In their view, land degradation is reflected in the production performances of livestock, which is often related to the status of the soil and key forage plant species (ibid).

Therefore, a combination of the range science (i.e. ecological knowledge) and herder knowledge (i.e. anthropogenic knowledge), provides complementarity and a framework for assessing and managing the rangelands. For the process of knowledge integration to add value within the broader land degradation assessment framework, it is advisable to consider indicator identification as a multilayer process. The first layer could be at the national level for identification of degradation hotspots. The second layer is at the subregional level, where hotspots are prioritized using LDN indicators plus a few RS indicators. The third layer is at the local level where land degradation indicators are interpreted in partnership with local resource users, to give local perspective of degradation and help in the identification of drivers of change. This will help to inform local decisions including response and action on the drivers and planning for rehabilitation of degraded landscape.

4.4 RS and GIS-based observations

With advances in RS and GIS, data over large expanses and over long periods can be easily captured and organized. Of particular significance has been the use of the remotely-sensed NDVI which is used as a proxy for land degradation assessments. Besides, the NDVI recording captures important indicators, such as the effects of rainfall that is accounted for by rain-use efficiency (NDVI per unit of rainfall) and residual trends.

Land cover change is a key indicator of land degradation, and one of the three key indicators for LDN. In dryland ecosystems, land cover change is a complex process that results from various drivers and pressures. The results of land cover change and their implications for local and landscape level productivity vary according to management objectives and the perspective of landscape users. The interpretation of changes in land cover as degradation depends on the management objective of the land. For example, camel keepers desire woody-dominated landscapes while cattle keepers favour grasslands.

Remote assessment of LAI is also used as an important indicator of ecosystem structure and photosynthetic production as well as a predictor of other ecosystem properties such as evapotranspiration. In addition to other indicators such as NDVI and net primary productivity, LAI has been proposed as a potential indicator for measuring land degradation in the context of LDN. Another related assessment is rainfall use efficiency (RUE), which measures plant productivity per unit of rainfall. RUE is increasingly used as an indicator of the productive potential of rainfall in arid and semi-arid ecosystems, and may be a useful broad scale indicator of land degradation in drylands (e.g. Holm, Cridland and Roderick, 2003). Demonstrating direct links between land degradation and RS data requires ground-based verification and an appreciation of the role of processes at multiple scales.

4.5 What is the scale for conducting rangeland assessment?

The scale at which to undertake assessment of land degradation differs for pastoralists and scientists. Pastoralists assess land degradation at scales varying from patches of a few metres to hundreds of hectares, while ecologists assess degradation at ecosystem scales (Oba and Kotile 2001). Matching the scale of RS to that of pastoral communities' detailed systems of micro and macro landscape classification is a challenge. For this to be achieved, scientists need to appreciate and take into consideration the factors that pastoralist communities use to classify landscape into macro and micro levels. Some of the factors used by pastoralists for macro level classification include: altitude, vegetation, and patterns of use; while at the micro level, they classify landscape according to physical attributes and vegetation communities.

Additionally, due to the high variability of rangeland ecosystems, reconciling assessment scales used by local communities and those used by ecologists can be a daunting task. Therefore, interactive discussions before the assessment are important to reach agreement to guide the selection of the area to be assessed and where transects are placed. Overall, the scale of assessments selected need to be relevant to the management objective of the land users. This will render implementation of actions from the assessment acceptable to the local communities, thus boosting its chances of applicability and sustainability.

4.6 Why PRAGA methodology?

In order to achieve an integrated approach to rangeland and grassland rapid assessment, the PRAGA methodology was developed and piloted by FAO and IUCN. The aim is to bridge the gap between local and scientific knowledge to support effective targeting of investments and interventions for sustainable land management. The PRAGA method was developed to foster a participatory approach in assessing, monitoring rangeland degradation in a context where local ownership and engagement is respected, accountability is ensured and national, and international obligations met.

The PRAGA methodology is designed to provide additional indicators, and a more in-depth understanding of the drivers and pressures of land degradation.

This will help to inform sustainable land management decision-making as part of the overall goal of LDN in pilot countries. The PRAGA approach advances participatory approaches through engagement of all actors in the assessment process and provides participatory tools for assessing and monitoring land degradation and sustainable land management. It addresses land degradation challenges in a holistic manner (in a way that empowers local communities and strengthens their role in land use planning and management). It brings together local communities, practitioners, experts, and policymakers at local, national, and regional scales.

PRAGA aims to support the multifunctionality and complementarity of rangelands, the diverse management objectives of the various users, prevent conflict of interests among the respective actors and present results according to the viewpoints of the actors. This approach has facilitated the endorsement of the results by all players. It is vital that initial discussions are initiated with the local population, for the objectives of PRAGA to be clear to local communities. The approach has the advantage of incorporating the detailed knowledge of the communities about natural resources through collaborative indicator identification and participatory assessment and analysis. The success of the approach depends directly on engagement with the respective local and state players.

The key indicators used to assess and monitor land degradation in the PRAGA methodology is aligned to the two thematic areas: socioeconomic and biophysical. The measurement of the socioeconomic aspects of land degradation is fundamental for designing appropriate sustainable land management interventions. Although the social and ecological costs of land degradation are widely recognized, there is limited data or monitoring systems designed to track relevant indicators at the appropriate spatial and temporal scales.

To ascertain its applicability and possible constraints, the PRAGA methodology was piloted in five countries: Kenya, Burkina Faso, Kyrgyzstan, Uruguay and Niger. The selection of the countries was informed by a concern for variety in social, ecological and economic presentation in order to provide some form of global representation of rangelands and grasslands. While on the other hand, the livestock sector (and extensive livestock production) is important to all of them. In each of the countries, a rapid participatory assessment using PRAGA was conducted and the processes documented through detailed reports. The following section provides an analysis of the lessons learned from implementing the methodology.

4.6.1. The use of the DPSIR framework

The DPSIR is a causal framework for exploring various issues such as drivers, pressures affecting the socioecological system and monitoring the state of the system. The DPSIR framework was incorporated into the PRAGA methodology to make the results more comprehensive in assessing the complex socioecological system and establish a comparable framework for interpreting results. It also highlights the socioeconomic impacts of changes in system state, and explores potential societal responses and interventions. The DPSIR framework was used to analyze the linkages between the results from the baseline and the participatory assessments. This provides the foundation for further monitoring and analysis for evidence-based decision-making in support of achieving LDN and sustainability.

5 Lessons from PRAGA application

This chapter weaves together the lessons that emerged from implementation of PRAGA in five countries with different ecological characteristics, socioeconomic set-up, land ownership and history of land use. The objective is to filter key lessons that will inform the improvement of draft PRAGA method for global application in different contexts. To standardize the documentation of key lessons, learning questions were developed for each phase and applied across the five countries and the resultant lessons are drafted for different phases of PRAGA implementation in each country. The lessons are then discussed as recommendations for best practices.

5.1 Preparatory phase

5.1.1 Partnership formation

In each country, a somewhat different approach was used to build partnerships. In Kenya, partnership building during the preparatory phase started with systematic stakeholder identification of key partners at the national and local level that were to be involved in the participatory rangeland assessment. This began with a national process where important national institutions responsible for range management and monitoring, such as the Ministry of Livestock Development and the Department of Survey and Remote Sensing (DSRS) were listed. These institutions were involved in preliminary discussions to fully build on their experiences in range management and repository of aerial survey maps and other Earth observation products. The development of data tools, area Google maps and landscape context indicators were carried out at national level before selection of community members.

This was followed by local inception meetings at different pilot sites that reviewed the identified stakeholders and expanded the list with other important local level stakeholders with specific roles and responsibilities in field assessment and subsequent dialogues. This further enriched the stakeholders for inclusion in field assessments and subsequent consultations. The local inception meeting was useful for input and revision of landscape indicators that were developed based on LDN. The diverse participants, based on their knowledge, listed all relevant stakeholders/category (institutions) with their anticipated contributions, defined roles and responsibilities during the assessment.

In Kyrgyzstan, with its well-established tradition of rangeland monitoring, initial discussions and workshops directly started with prior established stakeholders in rangeland observations and management. Initial meetings were held with these stakeholders to understand the context and discuss project objectives and activities. Building on this, a stakeholder analysis was done during the project inception meeting at the national level (Bishkek) where organizations and their roles in the project were discussed. A series of inception meetings were held at local level with a total of 75 representatives of Ayil Almak (AA), pasture committees and herders from each AA. During these workshops, AA representatives and pasture committees discussed and selected AAs to be included in the project.

In Uruguay, the project was first presented to the Board of Livestock – a multistakeholder platform mandated by the Government to deliberate and advise on the country’s grasslands. Through the Board, the project’s relevance and contribution to the country (including policy implications) were deliberated by representatives from academia, Government ministries, researchers and producer organizations. The Board also endorsed the pilot sites. The composition of the assessment team considered individual interests in participating in the field sampling. A working team was formed, which integrated local actors from the workshops, technicians from the ministries that act as counterparts in the project, FAO technicians and members of the Consortium made up of the academia and farmer cooperatives – Cooperativas Agrarias Federadas. The field team was trained at the beginning of the data collection process on the first site to be assessed.

In Niger, livestock breeders, agro-breeders, representatives of livestock breeders’ associations (AREN, FENEN-DADO), representatives of traditional rulers of the respective communities: Fulani, Sonraï and Tuareg, government technical services (agriculture, animal husbandry, hydraulics, environment), local representatives and the representative of the Ministry of Agriculture and Livestock were involved in the initial meetings. Stakeholders with different management objectives discussed various land uses, and classified various types of rangelands (led by the local communities), and the magnitude and extent of the landscape to be assessed, based on a sampling exercise and transects established on a spatial map by those involved. Relevant indicators for assessing the degradation of rangelands was also discussed.

In Burkina Faso, the field evaluation was prepared through a project launch workshop followed by a stakeholder mapping workshop. The assessment was directly conducted by the pastoral resource users at the assessment sites, in collaboration with selected technicians. The field assessment preparation workshops brought together the stakeholders at the assessment zones, technical agents from agriculture, livestock and water, two pastoralist experts and a geographer. They all contributed to discussions at all stages of the process to the implementation of the methodology, and in particular, the identification, description and validation of the indicators, the sampling of assessment sites, and the actual field assessment.

5.1.2 Consolidated lessons

Based on the experience in Kenya, it is worth noting that the sequencing of national workshops with local-level workshops yielded interesting lessons for deepening stakeholder identification, refining discussions on the landscape for assessment, understanding of land-use types, as well as crude refinement of local indicators.

In Kyrgyzstan, the existence of many authorized institutions/bodies (including the Department of Pastures) with a long history of pasture monitoring and assessment, pasture committees provided representatives with a strong platform and indicators on national-level rangeland health and trends. These facilitated faster understanding of the need for pasture monitoring and application of draft PRAGA methodology. The existence of robust historical data for rangeland assessment and monitoring in AA resulted in a fair understanding of the status and trends in rangeland degradation. Furthermore, involvement of the pasture committees is an important step towards full integration of the resource users in rangeland management. To guarantee consistency, at least on a regional level, it would have been more desirable if all assessment teams of the region had started with a joint pasture assessment “training” wherever this was economically and logistically viable. This would have better calibrated expectations and results. Without such a provision, it is difficult to build a broader perspective on the status of rangelands.

In Uruguay, the composition of the team through integration and the participatory consultations was observed to be vital to achieve a product with a high level of consensus among all the participants.

The partnership building process in Niger was very detailed and included multiple stakeholders closely involved in the management of the rangeland. The involvement of multistakeholders provided a solid foundation for rangeland assessment, such as agreeing on assessment criteria, classifying the typology of rangelands and mapping their locations, building a general picture of the health status of rangelands, selecting rangeland health indicators, rangeland degradation factors and SLM practices in the area. In particular, the participation of local government actors and traditional rulers put resource users and decision-making at the centre of the assessment and facilitated endorsement of the assessment results.

5.1.3 Identifying assessment landscapes

Identification of assessment landscapes followed a specific approach in each pilot country. In Kenya, identification of the assessment landscape started during the national and local level workshops. This began with a conversation around the rationale for selecting a specific landscape over another and discussions with project implementing partners, national government agencies in charge of livestock and rangeland management, county government officials, and local community representatives. The presence of previous project work that the assessment can tap into to commence rapid assessment, including pilot areas with current or recently closed projects, was deemed important for easy access and organizing communities. Identification of the assessment landscape was also informed by a detailed review of landscape level data from existing RS maps and related rangeland studies. These were complemented by field observations, key informant interviews, and participatory community-based mapping and community led assessment. The assessment sites were selected based on: i) pressure and threats to the rangelands; ii) presence of rangeland governance challenges; and iii) the heterogeneity of the landscape to ensure the selected landscapes were representative of typical rangelands in Kenya. Further considerations to select the pilot county were based on: the ease of accessibility; previous experience of working in the area that provided fair knowledge of socioeconomic context of the area; community network and local contacts; and fair representation of rangeland in the region (pressure of use, and balance in the biome-grassland and shrubs).

In Kyrgyzstan, site selection started during the project inception meeting held in Bishkek, but this was further refined with project stakeholders during subsequent project meetings. Overall, stakeholders proposed a balanced approach, but emphasized the need for assessing summer pastures given its importance to the herders. The site selection process was based on the local knowledge of the condition of pasture. This helped the inclusion of pastures with different conditions for a complete assessment of pasture situation. Ensuring participation of local pasture users was very important at the initial workshops for the indicator selection and mental mapping of landscapes. Different evaluators selected different approaches: some chose the points randomly, whereas others selected representative sample points. Technically, both approaches have advantages, and allow users to customize the decision-making according to local practices and experience. In the field, it was evident that areas with complicated access like swamps or plots with high vegetation were less assessed. Advanced clarification of the number and the selected sample points (randomly/representatively) would help minimize the distortion, inconsistency and help in standardizing the approach.

In Niger, the land units were identified and classified based on a spatial map prepared for the purpose of the study. Various types of rangelands were demarcated on the spatial map and the maps were used by the local communities to facilitate the location of pastoral resources, human settlements, infrastructure, water points, and so on. Further, each type of rangeland was described by the communities and three transects were established to cover different types of rangelands. Such transects were drawn up taking into consideration the representativeness and accessibility of the sites to be assessed and security measures in place in the selected zones.

In Burkina Faso, site selection was based on a number of factors, including availability of interesting grazing land to conduct the evaluation exercise and areas with strong livestock production potential that are currently under pressure. Three transects with 14 evaluation points were identified at the initial workshop by local natural resource management stakeholders. However, due to insecurity, the evaluation sites were relocated from the Sahel Region to the Central Plateau. The first transect was selected to cover the two pastoral zones and taking into account the stations referred to as “highly degraded” and “not degraded” spots, while the second transect was selected for the evaluation of the “degraded” spots. A third transect was selected for the evaluation of the “slightly degraded” spots. Although this classification of landscape based on perceived degradation status by the community is informed by their deep knowledge of the current and historical rangeland status, there is a risk of bias. Furthermore, community sampling needs to include more natural and less disturbed landscape.

In Uruguay, the assessed sites were defined by integrating the indications of the PRAGA manual, the contributions of the technical experts field team and the integrated mapping exercise (with the recommendations of the participatory workshops). Participatory mapping was used to suggest areas of field study. Some areas were chosen for being "clean" grasslands because they had no erosion, low presence of exotic weed and ticks, low grazing pressure, overall good state of the livestock and potential for eco-tourism.

As a result of the collaborative process in the field validation between the actors, technical criteria were integrated with those provided by the participants in the workshops. Some of the key indicators from the participants include: depth, as an indicator of productive capacity; colour, as an indicator of organic matter content – the darker the colour the higher the content; percentage of bare soil; biomass and density of the species present; and the height of the tapestry in winter and presence of invasive exotic species.

The field assessment aimed to evaluate the sites identified as "cases" of exemplary and non-exemplary areas, and to think about their scale to the rest of the target landscape from the lessons learned. An exemplary zone is defined by the presence of a high diversity of native species in the grassland, the flora and the fauna in general and the water quality and by the identification of different landmarks that could be handled differently. Also, landscapes were selected for having a significant increasing or decreasing trend of the NDVI over a 15-year period.

5.1.4 Consolidated lessons

The five county reports indicate that every context presents different priorities for considering the basis for landscape selection. Careful analysis of these factors during the initial workshop is crucial in the selection of the assessment landscape. The choice of landscape to be evaluated using PRAGA methodology was informed by several interrelated factors that included: the importance of the landscape for grazing, ease of accessibility, state of security, previous experience/contacts in the region – especially with contacts on the ground, representation of landscape heterogeneity and degradation gradient. In all of the countries, the land managers provided crucial information in the selection process. For example, in almost all the countries, identification of assessment landscape followed the need to understand land degradation in meaningful detail using a rapid method. Furthermore, identification of assessment landscape was informed by the need to consider livestock management decisions and the priorities for the land users as opposed to standard assessment of degradation. These observations highlight the practical consideration of applying PRAGA as an important multistakeholder rapid assessment tool for decision-making, and for generating information on the trends in key indicators for assessing livestock-focused changes in rangeland health. Relying on the land users to guide the identification of the assessment landscape improves matching of the landscape in use with the purpose of rapid landscape assessment. This approach resolves a long-standing challenge of identifying a representative landscape that can make an impression of the often expansive rangeland and also helps in the selection of robust indicators. The lessons learned from the pilot countries also clarify practical challenges faced by resource users in terms of spatial and temporal barriers for sustainable resource use. Thus, any country that opts to introduce PRAGA as a tool for rangeland assessment and management, must pay special attention to the preparatory phase in order to fully capture local priorities and strategies that inform decision-making.

5.2 Baseline phase

The baseline survey in PRAGA application is a crucial step for detailed analysis of the context of landscape assessment. Broader baseline data considered across the five countries can be placed into two categories:

a) Information useful for interpretation of the findings, including:
   1. **Ecological context data:** These included the map of agro-climatic zones in assessment area (aridity index), maps of mean annual PET, mean annual rainfall maps and trends, projected mean annual temperatures, elevation across the study area, maps of perennial and seasonal rivers and water points across assessment landscapes, forage condition index for the first 6 months. These data were adequately used in Kenya and Kyrgyzstan.
   2. **Socioeconomic context:** Infrastructure maps including roads and town centres, trends in human population, human population density and distribution for the study area, livestock population and crop diversity. In both Kenya and Kyrgyzstan, these baseline data provided useful background information and helped to offer an important context for assessing land degradation, mainly based on land-use and seasonal utilization dynamics. Uruguay generated a

wide scope of socioeconomic baseline data using the combination of the DIPSIR and PRAGA framework in a series of community workshops.

3. **Types of land tenure in the area:** The extent and nature of land degradation in the area is influenced by the history of land use and management. Different tenure systems confer different levels of protection to landscapes considered for assessment under PRAGA and this is an important parameter for understanding degradation. In Kenya, the baseline described the extent of communal lands, gazetted protected areas (PAs), the map of PAs in the assessment landscape, and the proportion of the counties under different types of PAs. In Kyrgyzstan, the baseline includes land-use type, and management practices in pasture management efforts. In Uruguay, where approximately 51 percent of land was under private ownership, baseline data on land tenure systems was important in elucidating the sources of pressure on grazing land – which was estimated at two percent.
4. **Wildlife data:** Diversity and distribution of wildlife is a direct indicator of landscape health. The baseline in Kenya and Kyrgyzstan made use of abundance and distribution of species of terrestrial mammals, amphibians, reptiles and birds. While floral and faunal diversity is an important indicator for landscape health, it does not appear as a priority for the land users, since it does not contribute directly to their production interest.

b) Information that is required to complete rangeland assessment, including:

1. **Vegetation data:** Annual NDVI, net primary production (NPP), mean annual LAI; land cover change – other factors assessed included qualitative changes in land degradation across the assessment landscape, proportion of land showing signs of land degradation, map of land degradation, total area (in kms) that has changed between different degradation categories in a specified time period.
2. **Soil data map** such as SOC and relative area of different levels of SOC, temporal trends in SOC.
3. **Water data:** The baseline assessment developed a map of a) distance to river and water points, and b) proportion of land in 5 and 10 km bands for Isiolo and Garissa counties in Kenya. In Kyrgyzstan, water resources were mapped to indicate many lakes, streams and ephemeral wetlands which are fairly well distributed. Most of the Oblast population can find water for stock and crop irrigation in normal seasons.

5.2.1 Consolidated lessons baseline data

Countries with a well-established system of rangeland monitoring baseline information form an important basis for implementing PRAGA methodology. In particular, a strong baseline will inform careful selection of indicators to be considered in PRAGA assessments. In countries that lack baselines, it is necessary to run a preliminary list of the broad categories of baseline data listed available above, and make a strategic choice to build the background context and inform the field assessment. However, care should be taken to ensure that unnecessary or redundant baseline details are not generated. While the different baseline data carry different weight, the more baseline data is available, the better is the understanding of complex interacting variables across spatial and temporal scales. A rich baseline is important for creating a reference point for monitoring change. It is important that the baseline data is analyzed to demonstrate causes and linkages among the compounding variables and its overall relevance for understanding land degradation across the country and cascaded to the local level. Therefore, due to resource and time constraints, baseline data selection should be informed by the local context and have a direct implication for land degradation. Another important criterion is the technical and resources capacity of the assessment team in different countries. The baseline data used should not only be relevant but also simple to use by assessment teams. In most of the PRAGA pilot countries, the baseline study and the participatory assessment was done by a different team, with a different focus. To improve their relevance and representation, baseline and PRAGA data need to be closely associated in both spatial and temporal sense.

5.3 Participatory phase

5.3.1 Participatory landscape mapping

In Kenya, preliminary base maps were developed from Google Earth Imagery, historical topographic maps, and spatial data on infrastructure and administrative units; local stakeholders including local community members, administration officials, and local experts were engaged in landscape mapping. The mapping exercise was preceded by plenary presentations about the project goals and objectives, as well as detailed discussions on the focal landscapes, patterns of use, and understanding of local knowledge.

Community members described their cultural landscape and natural resource governance models, including local landscape classification systems based on a combination of location, soils, vegetation, terrain and patterns of use. Landscape levels (macro and micro), water points, roads and pattern of use was captured directly through on screen digitization over Google Earth images or on paper maps which were later digitized using ArcGIS. During the participatory mapping exercise, potential field sampling points were identified to capture the range of variability in the assessment landscape. Micro-landscapes capture the within-landscape variability and small-scale heterogeneity that is crucial to the decision-making of herders at the scales of hours, days, and weeks. Micro-landscape units were described using composite indicators that included soil (colour, texture, rocky, salinity), vegetation (grasses, trees, shrubs), grazing suitability (livestock species, season), presence of ecto-parasites (ticks, tsetse flies).

At the participatory mapping stage, potential field sampling points were identified to capture the range of variability in the assessment landscapes. Community members also detailed the degree of degradation, and the factors influencing degradation, in each of the micro landscape zones. At the macro level, local pastoralists in two pilot sites had a similar basis for landscape classification into two zones: Badhaa (forest/high altitude areas) and Gamojii/Ghabib (lowlands/low altitude areas). Macro-landscapes are classified based on broader climatic and vegetative characteristics – both of which are susceptible to broad scale shifts in climate patterns and human-induced land cover change.

In Kyrgyzstan, participants used a topological map, and information transferred to a digital format used to create pasture evaluation results overlain with PRAGA field plots. Communities divided pasture plots into grazing use according to seasonality of use. The categories were winter pastures, spring and autumn pastures, and summer pastures. To further the tasks of "pasture evaluations", the participants divided the pasture units into three categories, ranking each on a scale of "good", "moderate" and "bad" according to the participants' knowledge of their productivity, health and resilience.

In Niger, base maps were prepared by the assessment team to help the local communities easily locate the various land units against settlements and water points. Land units (*leydii*) were mapped based on their uses, topographies, soil structure and dominant forage species. This classification was made at two levels: the first level was land-use where the local communities distinguished between two types of land: crop farms (n'guesse'n) and rangelands (laade'n). The second level was rangeland re-classified into meadowlands, riparian belts, lowlands, sand dunes, glaze terrain rangelands and rocky terrain. However, rocky terrain rangelands were not assessed due to access difficulty and rampant insecurity in the area.

In Burkina Faso, participatory mapping was based on satellite images and topographic sheets. A video projector was used to visualize the sentinel images for the communities to draw the boundaries of the landscape on paper. Four typologies were selected, based on the geomorphology. These include classifications such as “very degraded” landscape units, “degraded” landscape units, “slightly degraded” landscape units and “not degraded” landscape units.

5.3.2 Consolidated lessons for participatory mapping

In Kenya, the mental map created by community members highlighted the overall heterogeneity of the assessment landscape and provided an important framework for laying out the sample transects. Community focus group discussions provided important insights into landscape structure and facilitated the identification of appropriate community members for inclusion in the field assessment teams. Group discussions and key informant interviews provided rich details on the history of the landscape, land use and cover change, and other background information which was recorded by team members as field notes and compiled for reference at the end of the assessment.

The community landscape classification into macro and micro landscapes in Kenya was helpful in identifying appropriate sampling scales. The landscape classification system, or landscape typology, recognized by the pastoral communities in pilot sites is a powerful framework for managing natural resources across a diverse range of users and livestock types and in the face of increasing climate variability. Micro-landscapes helped capture the within-landscape variability and small-scale heterogeneity that is crucial to the decision-making of herders at hour, day and week intervals. Local classification systems provide the link between traditional knowledge and scientific approaches to rangeland assessment, and as such, these participatory landscape maps are central elements of the sampling protocol outlined in the PRAGA methodology. Whether participatory mapping is done using virtual Google Earth map or a printed topological map, it is important that communities /participants get adequate orientation to help match what is on the map with the physical features on the ground, and clear enough to provoke their mental map of the landscape.

Similarly, in Kyrgyzstan, consultations and participatory processes with local land users proved to be an accurate, low-cost option for assessment and have the added advantage of putting decision-making capacity and ownership in the hands of land users from an early stage and provided clear, evidence-based decision-making opportunities for policymakers. The participatory element of the PRAGA approach clearly provided means for identifying the complexity at work in the area and laid the groundwork for the introduction of improved practices, due to its participatory nature and respect for traditional information and knowledge

In Niger, the approach led to georeferencing the participatory map with results from RS at the national level, boosting the possibility for comparative analysis between satellites. At the local level, the producers were committed to support the methodology, through genuine dialogue between the producers and the technicians. The approach considered the interest of all the stakeholders. At the national level, the methodology helped in the appreciation of local knowledge, innovative multistakeholder and better perception of the causes of pasture degradation, as well as full involvement and ownership by the actors. This evaluation method makes it possible to create monitoring cells in different zones on the state and dynamics of grazing resources. The method is based on simple and precise indicators allowing a good description of the environment.

Participatory landscape classification and determination of degradation is central to the PRAGA methodology. It helps to answer the questions on what is assessed and at what scale, why it is assessed and provides a feedback loop in terms of informing land user's management options. The answers to these questions vary in different land uses and social ecological contexts.

Thus in every context, a good practice is to understand the reference framework applied by the land users to make land degradation assessment as reliable as possible. For example, it is important to remember that as is the case in ecological assessment, community assessment and monitoring of change in rangeland is based on an established threshold, which is different for different landscape. Every landscape is monitored on the basis of its unique characteristics and environmental history. Participatory approaches therefore rely largely on the community's knowledge of the inherent landscape characteristics, history of use and production objective.

5.4 Indicator domain

Soil indicators emerged as a key consideration for determination of land degradation across the five pilot countries. Soil is an important variable as it informs landscape classification, season of use and degradability. Key soil characteristics include soil type for understanding landscape typology, soil erosion, salinization, organic litter, colour, structure and soil life. In Kenya, local land users observed that soil is an important indicator for determining grazing potential, with "warmer" soil considered important for livestock production and an indicator of healthy rangeland. In Kyrgyzstan, use of soil as an indicator for landscape change was less common. While in Niger, the proportion of bare soil, erosion crust, erosion gully/ravine, and other signs of erosion including depleted woody lands, pedestals, diverse crusts, and so on are used as key indicators of land degradation. In Niger, herders used soil colour as an attribute of ecosystem health – black soil is characteristic of soils rich in organic matter. While soil was an important indicator used by communities across in the five countries, SOC was not the main consideration for determining degradation. In Uruguay, soil depth was considered as an indicator of productive capacity, while colour was associated with organic matter content where the darker the colour, the higher the content of organic matter. Furthermore, the percentage of bare soil was used as indicator of land degradation.

Hydrology (water indicator) was not an important indicator as earlier envisaged in the draft PRAGA methodology. In Kenya, the preselected indicator of drying of shallow wells is considered a misleading indicator as in some areas, which were indicated as experiencing no drying of wells, were likely to be areas with no potential for shallow wells at all. As such, drying of wells and recharge rates did not work well to provide an indication of rangeland condition. Similarly, estimation of distance to water at the plot level may be an important determinant of plot level dynamics but is less useful as an overall indicator to interpret micro-landscape dynamics. Likewise, in Kyrgyzstan, use of water as an indicator for land degradation did not feature strongly. While in Niger, the physical distance between water points and pastoralist camps, and between rangeland and pastoralist camps is an essential underlying factor of different grazing pressure. In Uruguay, nine qualities that include dissolved oxygen, thermos-tolerant coliforms, pH, biochemical oxygen demand, total nitrogen, total phosphorus, temperature deviation, turbidity and total solids was used in the assessment. These assessments were made possible in Uruguay due to ease of access to research stations and high technical capacities of the livestock producers.

The biotic indicators including dominant land cover types, vegetation cover/bare ground, biotic disturbances, and the presence/absence of ecto-parasites came out strongly in different pilot countries as a factor of macro landscape health. In

Kenya, communities considered grazing potential as an essential indicator for locally specific multidimensional measure of the quality of land for pastoralism. Although the local and species-specific nature of grazing potential limits its utility as a comparative regional or continental measure, this locally useful characteristic makes it very useful as an integrated indicator and management tool. Presence of ecto-parasites was highlighted by local communities in the assessment landscape as an important component of a site’s grazing potential, and an important factor in determining landscape level grazing pressure. In Kyrgyzstan, the stakeholders also came up with indicators of pasture status and productivity. Local communities strongly defined vegetation indicators. They listed grass indicators such as ratio of palatable versus non-palatable species, average grass height, evidence of grass seed head formation/germination. Herders’ perceptions of the pasture state are also correlated with altitude. They believe that as the altitude increases, the pasture condition improve. This can be explained by the fact that, for herders, vegetation palatability is the main indicator, so it is possible that the indicator of perception of the state of pasture by herders and the indicator of the palatability of pasture plants have a similar trend. Likewise, in Niger, proportion of palatable species, proportion of plant cover, primary production, plant families and their distribution (phyto-sociological surveys), invasive species; plant vigour; signs of biota activity in the soil (algae crust, termite activity, termite mound, anthills, termites, and earthworms, and so on were listed by the land users.

In Uruguay, replacement of grassland landscapes by other land cover such as cropland and forests was considered as a biotic indicator. Previously, the loss of natural fields was considered negative when replaced by crops, artificial areas and bare surfaces, but deemed positive (no land degradation exists) when these are replaced by natural forests or artificial plantations and by wetlands. This lack of distinction led to the assumption that replacement of natural fields by forestry plantations is positive, although this is an important threat to ecosystem conservation and more so to biodiversity.

Table 2. List of local indicators used in the five pilot countries

INDICATOR	WHAT IS ASSESSED	COUNTRY WHERE IT IS USED	COMMENTS
Soil	Looseness, colour and “temperature” as proxy for presence/absence of organic matter, soil depth, change in the grazing potential, soil life, erosion crust, erosion gully/ravine	Kenya, Niger, Burkina Faso, Uruguay	Local assessment of soil characteristics complements expert assessment
Vegetation	Extent of bare ground, presence/ absence of key fodder species, balance of palatable and unpalatable species, replacement of grass landscape by other vegetation	All countries	Qualitative assessment of vegetation complements the RS estimate of productivity
Water	Distance of water sources from grazing field and settlement	Niger and Burkina Faso	Areas around water points are considered a compromised zone in ecological studies

5.4.1 Consolidated lessons

The PRAGA approach provided the required flexibility to strongly adapt indicators to local needs. However, it also causes a risk that in diverse study areas different indicators are chosen or are assessed differently. This makes a global comparison of the field data challenging. From the five countries, we have learned that while changes in the characteristics of vegetation and soil are common indicators across the countries, interpretation differs from place to place. Community- specific assessment and monitoring of change can help to complement LDN indicators already used in national level reporting. At local level, the assessment team can develop an analysis framework for the identified indicators. For example, which indicators are more sensitive to pressure (fast) and which indicators are less sensitive to change (slow, resilient).

5.5 Assessment phase

5.5.1 Field assessment

In each country, field assessments were executed by multiple teams, made up of members from the project implementing partners, local communities, local administrators, technical experts, and government scientists. These different team members played different but complementary roles. In Kenya, local expertise included herders who are recognized by the community as knowledgeable and have also participated in a previous project implemented in the area by IUCN. They were useful in placing sampling points and guiding the overall laying of transects because they fully understand and verify conditions on the ground during the participatory assessment. Community participants were identified through local references and were engaged in the local inception meeting to agree on the purpose and learn about the tools. Teams were given an introductory training session on the sampling protocol with all teams participating in data collection at the first few sites on the first day to ensure consistency. A short (half-day) test of the indicators and data sheets was undertaken to ensure that the indicators were realistic, the mapping was effective, and to identify any discrepancies in the way the assessment team fill out the data forms. RS experts helped in plotting Google Earth, digitization of sampling area, and geo-referencing of water points, town and other infrastructure.

On the ground, transects and sampling points were collaboratively identified based on landscape variability at macro and micro scales. The GPS coordinates for the start and end of each transect were recorded. The characteristics of the sites, including vegetation structure, physical disturbances on the vegetation and soil was recorded. A walk-through was done on the area to be included, closely visiting as many of the patches containing observable characteristics that are within 200 m of the start point, and taking GPS records at 200 m intervals. During the rapid assessment, the level of land degradation for each micro-landscape zone was identified using a five point scale ranging from "very low" to "very high". Zones where participating community members did not provide information on their levels of degradation were labelled as "unclassified". All indicators were incorporated into an online data capture tool using ODK **https://opendatakit.org** to facilitate data collection, reduce errors, and streamline data access and management. In addition, this open source tool allows data to be entered directly into an online form at the sampling point. A combination of drop-down menus and open-ended questions reduces data entry errors while ensuring response flexibility. One team member takes the lead to record the GPS location, enter data, and capture representative photographs of the sample site, soil, and dominant vegetation types. Data was recorded into the mobile device following discussions between team members, and detailed notes were captured in the ODK data collection tool, and by individual participants. All data is synched with a remote server when mobile network is available. Uploaded data was accessed through the ODK online interface and downloaded in MS Excel format (.xlsx). The average time spent on a transect is about 10–15 minutes. At the end of each day of data collection, the assessment team would gather to review the day's work, capture and clarify information collected during the fieldwork, and plan the next day's sampling work. This was considered an important session to review experiences, clarify questions, and discuss next steps. Once the traversing of transects is completed, review of the data collection is done to ensure that all relevant fields have been completed.

In Kyrgyzstan, the stronger tradition of monitoring rangelands and established bodies responsible for monitoring of pastures provided sound baseline and facilitated the formation of the assessment team. The Kyrgyzstan field assessment team was selected from already established Pasture Committee members. In addition, CAMP Alatoo experts, a member from Kyrgyz National Agrarian University and another member from Kyrgyz Pasture and Livestock Institute were co-opted into the team. In order to determine the monitoring points and the main indicators for the assessment of pastures in Ayil Almaks, participants were involved in defining land degradation, its indicators and representative areas selected for field assessments. Based on data obtained during the workshops, Camp Alatoo experts prepared assessment sheets for each region separately, taking into account the specifics of the region. The flexibility in the indicator domains allows countries to collect both qualitative and quantitative information. For example, in Kyrgyzstan quantitative data such as percentage of bare soil, ground cover percentage, and so on under soil domain was captured. However, after exchanges with the local herders and pasture committees and use of maps, it took some time to find the selected pastures. The pasture borders were often not clearly recognizable. If possible, it would be good to load shapefiles of pastures on a phone/tablet in order not to lose time searching for sites and the pasture borders. Stricter definition of the monitoring point could help to prevent this uncertainty and make assessments more consistent. Online questionnaires (Kobo toolboxes) on a smartphone/tablet was very helpful and made the data collection quicker.

In Niger, the main actors who participated in the assessment were livestock breeders, agro-breeders, representatives of livestock breeders' associations (AREN, FENEN-DADO), representatives of traditional rulers of the respective communities: Fulani, Sonraï and Tuareg, government technical services (agriculture, animal husbandry, hydraulics, environment), local representatives and the representative of the Ministry of Agriculture and Livestock. Identification and classification of land units/rangelands by the community were based on a demarcated spatial map. Based on the spatial map, the communities established three transect lines in a way to have each transect line cover different types of rangelands. To jointly assess local indicators and record plant species occurring on the survey plots, a linear method of aligned quadrat points – the Braun-Blanquet abundance dominance method – was used. The actual field assessment consisted of first simulating data collection with the field assessment tools in the first two plots. A group of three persons were used for biomass collection to estimate primary production, another group of three persons assessed the indicators using a linear survey form and a three-member group assessed the biomass.

In Burkina Faso, the team of evaluators consisted of six field agents from the technical services of the Livestock, Environment and Agriculture Departments, six land users including, three livestock breeders and three farmers. In addition to these evaluators, there was an official from BUNASOL and another from the Direction Générale des Ressources en Eau (DGRE). Before commencing the field assessment, the team of consultants provided practical training to the evaluators in Mogtédo with a view to familiarizing them with the evaluation tool. Topographical sheets were used to optimize travel time to reach the two sites using the GPS receiver and to enable the consultants to remain in an observer role during data collection. The topographic map with visible indication of geographical features such as rivers, lakes, mountains, roads and human settlement patterns was important in locating the assessment sites across the vast rangeland. Without this visual aid, it would have been very hard to transfer the 'mental map' of the expansive grazing area to sketch the map and facilitate team discussion. In addition, the topographic map had a grid reference to enable geo-referencing and locating the sites during field assessment.

The main criteria used to choose land users were essentially based on their experience in the evaluation areas. Among others, they had to be from the evaluation zone, have solid knowledge and experience of the area, and be volunteers. One representative for each main activity (livestock, agriculture, gravel collectors, charcoal burner) was needed to form the assessment team. The assessment was based on three transects that made it possible to cover most of the stations representative of the landscape. In terms of timing, the evaluation took place at the beginning of the dry season in November. This period is more appropriate for conducting the participatory pasture evaluation work due to the availability of producers after farm work. It is a period when the state of herbaceous and woody vegetation is conducive to carrying out description work of pastures such as identification of plant species, soil cover, non-agricultural works carried out on rangelands, and water and the impact of the various factors on the soil. When the evaluation is carried out late in the dry season, describing the indicators becomes difficult. When it takes place in the rainy season, problems of site accessibility and the availability of producers who are busy with their farm work can be major constraints. In Burkina Faso and Niger, the period from October to November is therefore considered most suitable time to describe biophysical and climatic indicators.

In Uruguay, the inter-institutional technical team was trained on the methodological frameworks that guide the assessment and on landscape classifications based on indicators and other sources of information agreed upon in the previous consultation phases of the project.

The training also focused on the process of consultation with the stakeholders and on the field assessments which would be carried out in the later stages of the project, by means of the field surveying methodology and the map provided by the actors. A consultative workshop was also held with the team to explain and practice the use of the selected methodologies to make a participatory assessment of the grasslands (DPSIR Matrix and PRAGA); identify the main problems faced by the pilot site; define (identify and prioritize) the indicators that will be used for the development of the assessment in order to standardize concepts; make a map of the pilot site to identify in a participatory manner at least two good management practices associated with sustainable grasslands management.

Despite the high percentage of threatened grasslands in the areas, conservation policies only consider four percent of the grasslands to be under regulated conservation zones, either as protected areas or as natural rural land. Notwithstanding significant advances being made regarding the knowledge, protection and management of natural grasses, they are still insufficient to ensure the long-term conservation of the natural grassland. In this sense, it is important to continue exploring and developing new tools and policies that support rural producers and promote the sustainable exploitation of the natural field.

Information found in published papers and in public databases complemented the information collected through participatory processes. This made it possible to carry out the assessment activity at the pilot site scale using remote-sensing. The assessment of the vegetation was performed at the specific representative sites covering different categories of the pasture, for example, dense/sparse; increasing/decreasing.

In each site, the most representative classes are determined, and in them, the cover/abundance of the main functional groups and species considered as of particular agronomic interest (general characterization) through the step point methodology. This sampling at general level was conducted with the presence of local stakeholders and producers, since many of the species and groups were considered as indicators of pasture wellness or pasture degradation (healthy herbs, uncovered land, height, etc.). The floristic surveying was performed twice (initial and final surveys), between the months of September and the end of November, as a way of determining the evolution of the pasture.

It is important to note that timing of the participatory field assessment is a factor in the application of the PRAGA. Across the five pilot countries, serious consideration was given to the timing of the assessment (Table 3).

Table 3. Time consideration for field assessment in the five pilot countries

TIMING OF FIELD ASSESSMENT
Across all the five pilot countries, the timing of participatory field assessment was given serious consideration to reduce the effects of seasonal variation on the status of rangeland. Another factor considered for timing of the participatory assessment is the availability of the local communities to participate in the assessment as per their seasonal calendar. In Kenya, the field assessment, was conducted at beginning of the dry season, (July/August), when the influence of the previous wet season was less (unless it is a drought year). In Kyrgyzstan, assessment was conducted in summer to capture changes in pasture condition during period of growth. In Burkina Faso and Niger, site accessibility and availability of communities to participate in the field assessment in the rainy season was the main consideration. October and November were considered the most suitable months. In Uruguay, the floristic surveying was performed twice (initial and final surveys), between the months of September and the end of November, as a way of determining the evolution of the pasture. As a rapid participatory methodology, the timing of field assessments is an important consideration in the five country and informs future application of PRAGA.

5.5.2 Lessons from linking field data and remote sensing data

In Kenya, combining RS data with information collected in the field during the participatory rangeland assessment yielded new insight on the relationship between RS measures of production and the local knowledge. The NDVI data enabled tracking of long-term trends over large areas, while local knowledge of grazing potential highlighted the complex nature of rangeland health that links issues of livestock needs (demand) and a suite of landscape characteristics such as plant species composition, functional groups, water availability, soil colour and structure, the presence of disease and ecto-parasites, and so on (supply).

While both approaches highlighted that there has been relatively little change in land cover in this landscape over the past 20 years, the direction of change observed differed across the landscape. For example, where land cover change had occurred, community respondents highlighted a trend away from grasslands to more woody cover types (shrublands and woodlands). The RS approach indicated a shift from woodland to grassland as the dominant transition. The high degradation patch identified by RS was within the area identified by the community as of low degradation, and the riverine area identified as highly degraded by the community was listed as medium to low by the RS. The discrepancy in the riverine area may well be due to the encroachment of an invasive species (e.g. *Prosopis juliflora*) in this area that was noted by the community, but signalling increased 'greenness' by RS techniques. The three productivity categories identified with RS had very little correlation to an index of the observed grazing potential for each micro-landscape with at least one high mean NDVI landscape (Shurr) classified as having low grazing potential, and the lower productivity landscapes ranging from very low (Omaar/Kunya) to very high grazing potential (Athaable/Kotisch and Ramaat/Ramaa) (Table 4).

Table 4. Comparison of community assessment and RS data from the five pilot Countries

OBSERVATION	COMMUNITY ASSESSMENT	REMOTE SENSING	COMMENTS
Extent in land cover change	Minimal	Minimal	Convergence: at an aggregate level, the two approaches are complementary
Land cover type transition	Grass to woody cover	From woody cover to grass cover	Divergence: need for further analysis on the cause of difference
Degradation status	Areas classified as less graded	Highly degraded patch	Divergence: possible explanation is that community assessment often focuses on the qualitative status (e.g palatability) while RS reports on the absolute NDVI value
Riverine area assessment	Degraded	High NDVI value (greenness)	Divergence: greenness is associated with invasive species. This needz thorough ground truthing

The benefits of this combined approach are clear in the context of grazing potential and a standard RS indicator of rangeland production. The overall understanding of the elements and dynamics of grazing potential and rangeland health in a pastoral landscape is improved when mean annual NDVI data for each micro-landscape is compared with local perceptions of grazing potential.

Local perceptions of grazing potential highlight the complex nature of rangeland health that links issues of livestock needs and a suite of landscape characteristics such as plant species composition, functional groups, water availability, soil colour and structure, the presence of livestock diseases and ecto-parasites.

The degradation levels derived from local knowledge are based on perceptions of both long-term and short-term trends. In addition, local knowledge incorporates a number of different variables in the evaluation of degradation which may reflect individual and dynamic management objectives, including changes in plant functional groups, changes in species composition, the prevalence of invasive species (e.g. *Prosopis juliflora*), and other indicators such as water availability and recharge rates. While a more detailed subdivision of the landscape by the local community may result in closer correspondence between the local and scientific approaches to mapping degradation, it is useful to consider these two indicators together for a more nuanced understanding of degradation and its impacts on livelihoods, biodiversity and sustainable production. In Kyrgyzstan, the overlays of data layers from the field plot and the 'degradation' state according to RS showed a contrast in the results. An example of the contrast between RS analysis and herder knowledge has shown the area surrounding the township of At-Bashi as showing improvement according to RS, yet was placed in the 'bad' category by the land users. Also in Kyrgyzstan, the positive NDVI trends were attributed to arable lands and irrigated grass. At the same time, RS was weak in differentiating palatability of species as weeds and gave positive NDVI in degraded areas. Some areas that were shown as degraded, were actually "healthy" according to local perspectives as these areas are often typified by high degrees of bare ground (these are the winter pastures).

Pastoral perspectives on the status of the pasture resources were largely in agreement with the field results. This reaffirms the importance and validity of participatory inputs in rangeland/pastureland assessments and opens the possibility of using them as a low-cost assessment approach for large or difficult-to-access areas, which are commonplace in the region.

Although there is some correlation between RS and community observations, there are also areas where the two systems of evaluation clearly differ, for example in the southern part of the Oblast in Kyrgyzstan. Here, there are many pastures which have been assessed as 'good' by pasture users yet suffer from 'degradation' according to the RS methodology used. It is important to note that of the three LDN indicators, only productivity showed temporal and spatial differences; therefore, the definition and scale of degradation is largely limited to one indicator type, productivity. It was noted that there was a discrepancy in the RS and field assessment of land degradation when it comes to spatial and temporal scaling. The RS datasets/assessment had a resolution (minimum unit) of 300 metres, that is, 90 000 square metres and a temporal range of 15 years, that is, between 2000 and 2015. The clear message is that the result reinforces the need for combined approaches to data collection.

In Niger, the various recovery classes of the respective indicators, namely their magnitude in the field cannot be readily perceived through RS. Only a field assessment with land users makes it possible to give details on biomass, particularly the nature and quality of biomass for animal feed and related productivity.

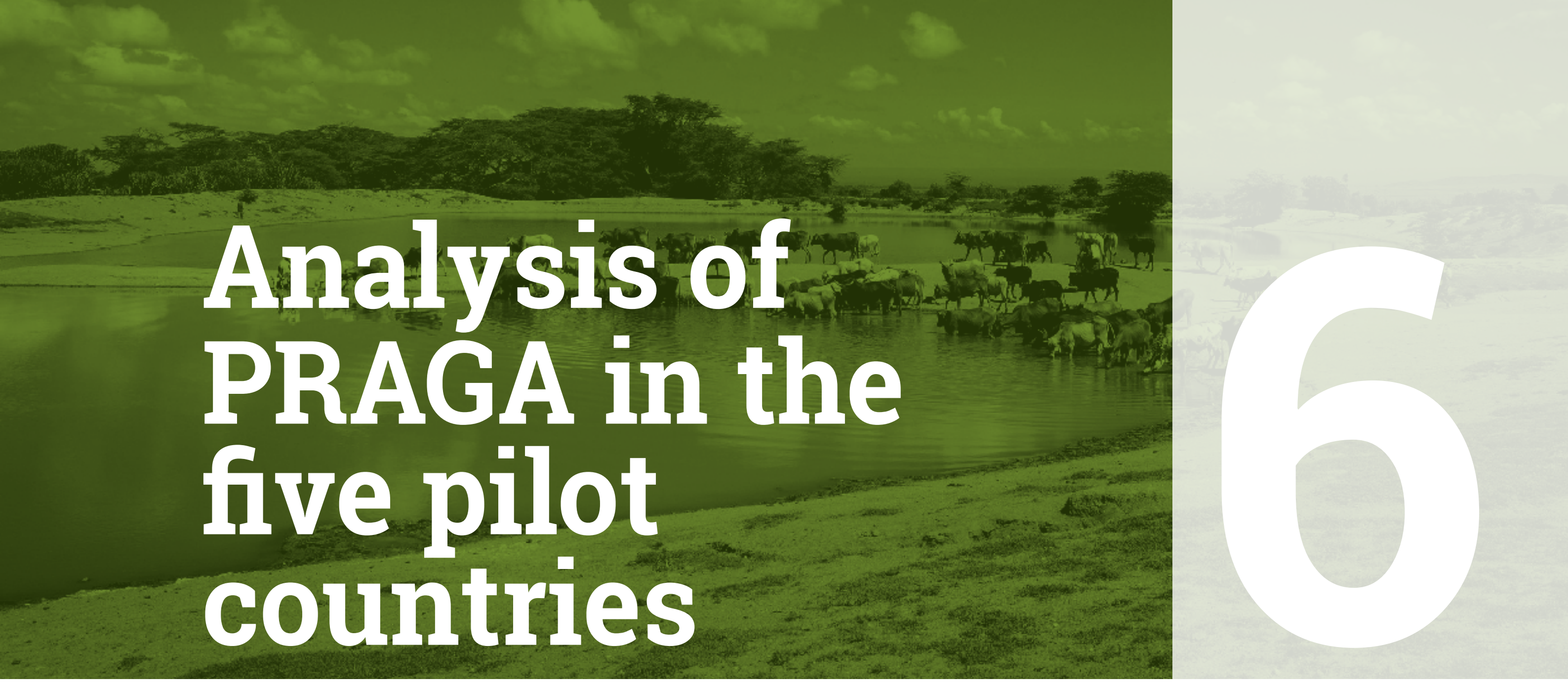
There is complementarity between the two methods, and they can be combined to develop a holistic tool for rangeland assessment. The sites infested with *Sida cordifolia* on the productivity map show a clear link with the community assessment of sharp decline in rangeland productivity due to spread of invasive species. On the other hand, erosion crust areas show a link with rangelands that are highly susceptible to erodibility; erosion ravines relate to highly degraded rangelands and bare soil to rangelands susceptible to erodibility and erosivity. These latter elements reflect a similarity between local indicators and RS indicators. Local indicators of degradation of rangelands may be used to assess the health of rangelands just like those of RS. Field assessments can cover but small surface areas because of the huge cost involved, while RS gives room for covering large areas at a lower cost.

In Burkina Faso, the field data analysis was carried out according to the vegetation-based ecosystem classification. Ecological units with the same characteristics were grouped together and their indicators were translated into observation sequences. The data from the local participatory assessment supplemented the data from RS. The local interpretation is similar to that of satellite images. In fact, it is more comprehensive, based on experience in the field. However, there was considerable discrepancy in the extent of degraded and non-degraded areas as evaluated by the RS and the participatory assessment. The difference could be due to the fact that the demarcation of different zones by the communities is not detailed enough. Nonetheless, both approaches show that more than a third of the landscape is degraded.

5.5.3 General observation from testing PRAGA methodology

In the draft PRAGA Manual (first edition), indicators concerning soil are suggested, yet typically require equipment for some degree of accuracy. To keep the methodology cost-efficient and simple, use of the selected indicators like “signs of soil erosion”, “stone cover”, seems to be very suitable. But this means that no information about actual soil state is collected (chemical/composition) and future comparisons with this baseline information would be problematic, especially for future assessments. As all measurements of field indicators are done visually, the methodology can be considered as fast and rough, with a certain degree of subjectivity, which increases with diversity and number of field teams are involved. This makes the assessment quick, cheap and does not require technical equipment or a scientific background, but it suggests that the data is collected only as estimates and not as a true scientific measurement on which to base future measurements.

Returning to the scheme with the Draft PRAGA steps, it is important to follow the steps in a nonlinear manner, with intermediary reviews and feedback mechanisms. A case in point that is considered crucial is once Step 2 (identifying the landscape for assessment) is finalized, Steps 3 (baseline review) and 4 (large scale assessment and RS) should be finalized in conjunction with or immediately before Step 5 (participatory mapping of target landscape). Thereafter, outputs from Steps 4 and 5 have to be reviewed in order to decide whether to revisit and/or change the spatial extent and location of the landscape to be assessed (Step 2) in the spirit of capturing heterogeneity and divergence of rangeland health and land degradation. This also gives the participants an insight on the indicator selection parameters/limits (Step 6) that will be investigated during the field assessment (Step 8).



6 Analysis of PRAGA in the five pilot countries

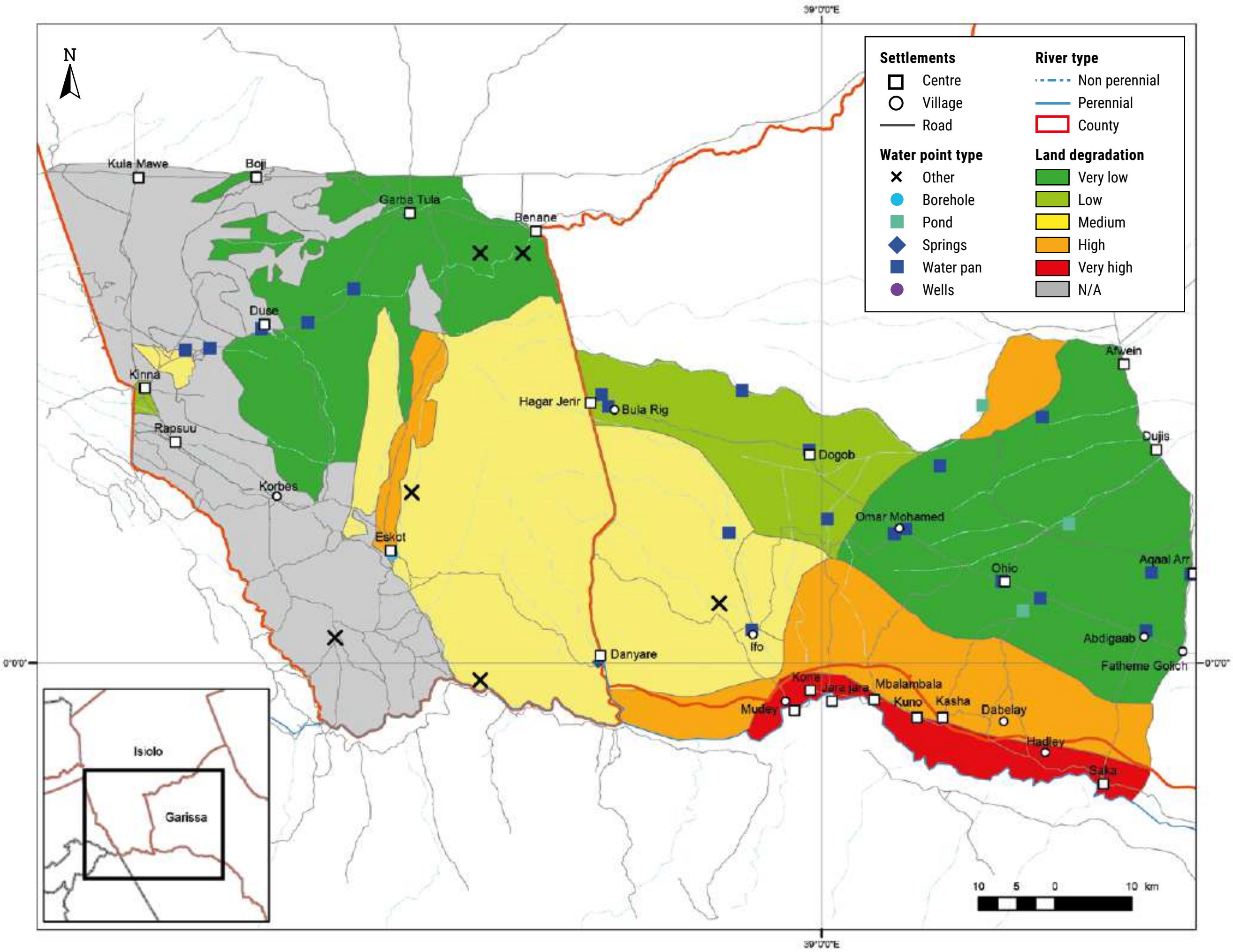
6.1 State of rangeland degradation in the pilot countries

6.1.1 Kenya

In Kenya, rapid participatory assessment and the RS techniques showed low levels of degradation in the assessed landscapes (Figures 18 and 19). In the sections that were degraded, the level of degradation was attributed to various factors that included: i) population increase; ii) changes in livestock distribution in space and time (e.g. changes in inter-annual movements, seasonal grazing patterns, and changes in daily herding patterns); iii) charcoal production and fuelwood harvesting practice; iv) spread of invasive species around settlements; and (v) weak or ineffective resource governance laws and riverine areas among others. From the DPSIR analysis framework applied in Kenya, livestock numbers and species composition are on an upward trend. Although accurate data on livestock is not readily available, there is a general increasing trend in livestock population in Kenya. In addition, infrastructure development such as roads, water, and settlements play an important role in the intensity of spatial-temporal impacts by humans.

However, there are two areas where the results diverged: the high degradation patch identified by RS was categorized by the community as of low degradation, while the riverine area identified as highly degraded by the community was categorized as medium to low degradation by the composite index in RS. The divergence around the riverine area may be due to observed encroachment of invasive species (*e.g. Prosopis juliflora*) in some areas. The community noted such unpalatable plant species during the assessment, but these patches are likely undetectable using RS techniques.

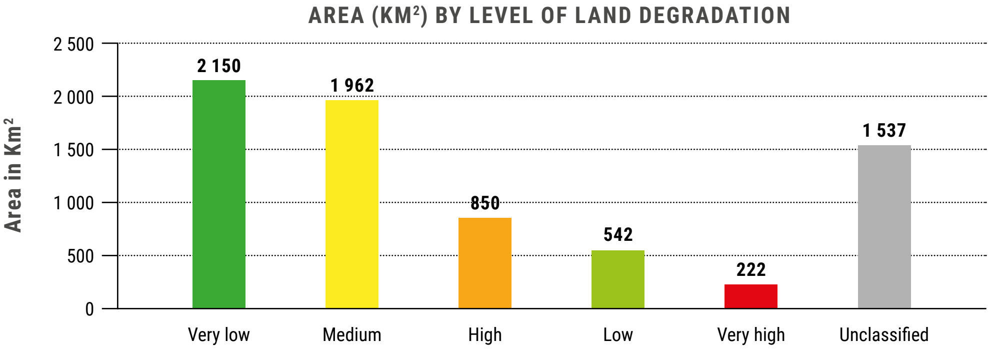
Figure 18. Area of land in the assessment landscape by degree of land degradation generated during participatory mapping process



Source: Open Street Map, World Resource Institute, PRAGA Kenya chapter field data. [Cited 15 November 2018]. Land degradation based on local knowledge and participatory Geographic Information System (GIS). Nairobi, Kenya, International Union for the Conservation of Nature (IUCN). Compiled by Mwangi P.K.

The spread of invasive species – particularly *Prosopis juliflora* – dominates the assessment landscape. While quantitative data on the extent is not available, anecdotal observation and discussions with local communities indicate that it is spreading rapidly in the riverine areas and in settlements. Sites in Niger were invaded by *Sida cordifolia* and *Calotropis procera*, which resulted in a sharp decline in land productivity, contrary to what is indicated in the literature.

Figure 19. Map of the levels of degradation in each micro landscape zone



Source: elaborated by FAO and IUCN PRAGA Project.

Similarly, the baseline and field assessment results showed slightly divergent perspectives on land cover change. Both approaches indicated that the assessment landscape has undergone minor land cover change, overall, less than two percent of the area shown on RS imagery. They deviate slightly on the direction of change with communities suggesting a trend towards woodlands and shrub lands away from grasslands. In contrast, RS data suggested a trend towards increasing grasslands. This provides insight into how the management objective by the users brings about different conclusions based on the same observations. For the scientist using RS, the increase in wood vegetation demonstrates reduced degradation, while for a pastoralist (mainly cattle keeper), the replacement of grasslands by wood species is increased degradation because it is detrimental to the livestock production objective.

The divergence and sometimes convergence in the outcome of the two approaches highlight the importance of integrating local knowledge and conventional scientific monitoring approaches. The differences may arise from spatial and temporal scale mismatches, definitional variation, or methodological errors.[1] The benefits of this combined approach are clear in the context of grazing potential, as described by the community and a standard RS indicator of rangeland production. Our understanding of the elements and dynamics of grazing potential and rangeland health in a pastoral

[1] For example, all global RS products are more effective when calibrated against local conditions.

landscape is improved when compared with mean annual NDVI data for each micro-landscape with the local interpretation of grazing potential. Local perceptions of grazing potential highlight the complex nature of rangeland health that links issues of livestock needs (demand) with a suite of landscape characteristics such as plant species composition, functional groups, water availability, soil colour and structure and the presence of disease or ecto-parasites.

In a nutshell, while the RS and local knowledge approaches used in assessing land degradation result in a similar outcome that show overall degradation as generally low in the pilot landscape, while the areas of divergence are useful in understanding the multidimensional nature of degradation. The two approaches are mismatched at scale. The temporal scale used in the RS methodology mostly reflects long-term trends in vegetation dynamics while the scale of degradation derived from local knowledge is based on perceptions of both short term and historical trends. Moreover, local knowledge incorporated composite variables in evaluation of degradation which may reflect individual and dynamic management objectives, including changes in plant functional groups, changes in species composition, the prevalence of invasive species (e.g. *Prosopis juliflora*), and other indicators such as water availability and recharge rates of shallow wells. While a more detailed subdivision of the landscape by the local community may result in closer correspondence between the local and scientific approaches to mapping land degradation hotspots, it is useful to consider these two indicators together for a more nuanced understanding of degradation and its impacts on livelihoods, biodiversity and sustainable production.

Overall, vegetation production (mean annual NDVI) appears to be declining across micro-landscapes in the assessment area. Although patterns are generally consistent across micro-landscapes, the higher productivity landscapes appear to be declining severely. This could be because of changes in species composition, changes in land cover, and/or changes in functional groups (e.g. annuals/perennials). The decline in production could be associated with over-exploitation, making this type of landscape most at risk. However, local communities did not identify any major trends in these variables so further study may be required – given the high levels of short-term vegetation production during the rainy season, prior to the field assessment. Although soil erosion in Kenyan field data showed an erosion presence of 22.9 percent of the plots sampled, the presence is highly localized and predominantly found in lowlands.

6.1.2 Kyrgyzstan

To assess overall land degradation in Kyrgyzstan, SDG indicator 15.3.1 which combines information from three sub-indicators, that is, land (vegetation) productivity, land cover and SOC change was adopted. There is significant correlation between the assessment of land degradation based on RS and the actual assessment made by the land users. The results from land cover change and SOC show insignificant levels of degradation, slightly in contrast to what was reported by the community. However, the analysis of changes in land productivity indicated a high level of degradation, which is close to the degree of degradation reported by the local land users.

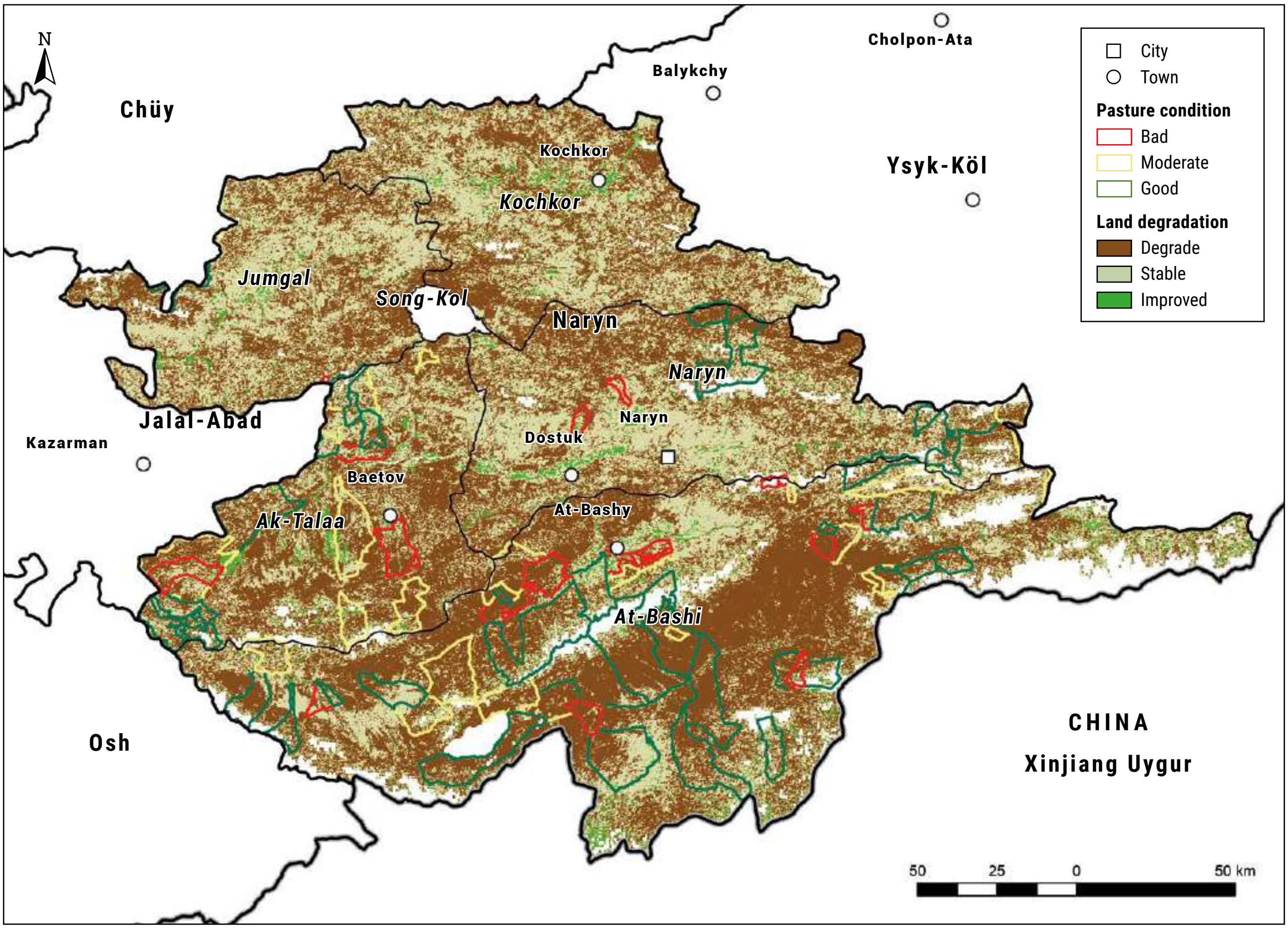
The RS results showed indication of pasture improvement while ground truthing indicated land degradation. Most of these disparities were recorded in the southern part of the Oblast (Figure 20). In this region, most of the pasture conditions were reported as 'good' by pasture users, yet noted as 'degraded' according to the RS results. However, it is worthwhile to note that of the three LDN indicators, only productivity showed temporal and spatial differences. Therefore, the definition and scale of degradation is largely limited to the indicator of land productivity. It is important to note that the temporal aspect was not applied in the field pasture condition assessment. For example, the pastureland condition 15 to 20 years ago compared to the present condition, was an important consideration that was factored in during the RS land degradation analysis.

According to recent studies (e.g. Isakov & Thorsson, 2015) the average productivity of summer pastures declined by 36 percent, from 640 kg/ha to 410 kg/ha between 1960 and 1990, while spring and autumn average pasture yields went down from 470 kg/ha to 270 kg/ha – a reduction of 43 percent. Similarly, the productivity of winter pastures declined even more drastically by 67 percent, from an average of 300 kg/ha to less than 100 kg/ha.

The study recommended observation of growth and ecological composition of isolated pasture areas that have received relatively low levels of grazing pressure. Pastures that have received prolonged periods of recovery and rest can provide important insights for management. Before these pastures are grazed, they are sampled as reference areas and compared with nearby pastures with higher grazing intensities and shorter recovery times.

Other additional observations include: i) ground cover is highest in medium altitude zones (between 2 500 and 3 300 metres above sea level) and in the lower and upper areas, this coverage decreases; ii) there is a correlation between plant palatability and altitude. Palatability dropped with the reduction in altitude. However,

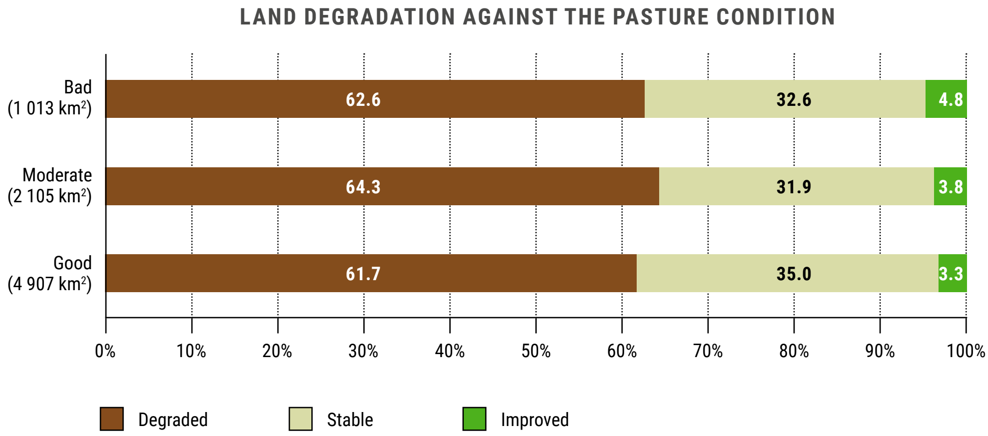
Figure 20. The distribution of pastureland condition according to local users across the land degradation status in Naryn Oblast, 2015 (2019)



Source: Global Administrative Data (GADM), Camp Alatoo field data, Trends. Earth tool, Mwangi P.K. [Cited 15 January 2020]. The distribution of pastureland condition according to local users across the land degradation status in Naryn Oblast, 2015. Rome, FAO. Compiled by Mwangi P.K. Modified to comply with UN (2020).

the extent of this reduction is worth further study; iii) evidence of seed formation and grass germination of pasture species showed a negative correlation with the altitude. In the lower zones, the number of plants with seeds is moderate; and iv) perceptions of herders on the state of the pastures are also correlated with altitude. Herders believe that as the altitude increases, the pasture condition improves. This can be explained by the fact that, for herders, vegetation palatability is the main indicator, so it is possible that the indicator of perception of the state of pasture by herders and the indicator of the palatability of pasture have a similar trend (Figure 21).

Figure 21. The percentage of improved, stable and degraded land in 2015 among the bad, moderate and good pastureland depicted by local users



Source: elaborated by FAO and IUCN PRAGA Project.

6.1.3 Niger

In Niger, the data and resultant images show that all land units in the commune are degraded – albeit at different levels – but largely from very low to medium degradation levels. These observations are based on the evidence of predominantly pantropical and paleotropical species, which are indicators of highly disturbed environment. The phytogeographic and biological spectra of Gorouol commune rangelands reveal a highly disturbed arid environment. All Gourouol rangelands show signs of erosion including gullies, ravines, alluvial deposits, carriage traces and sheet erosion, crusts, gravel crusts, structural and algae crusts, which are manifestations of erosion by rainwater runoff, and were found in glacis and lowland rangelands. Bare soils were commonly observed on slopes, followed by lowlands and dunes.

Closer examination of landscape level data showed different rangeland states.

i) In the forest gallery where rangelands contain large proportions of palatable species, the soil is deep allowing significant infiltration of water, good amount of organic matter and higher primary production. Forest gallery rangelands have less impact of livestock and are considered relatively healthy.

ii) In sandy terrain rangelands with pedestals hosting invasive species and established pastoralist settlements, there are strong positive correlations between pedestals, invasive species and pastoralist settlements, and this has a low proportion of palatable species and low primary productivity. This reveals that rangelands with deep erosion signs and large proportions of pedestals, high livestock pressure from pastoralist settlements, invaded by invasive species, that is, *Sida cordifolia* with large amounts of unpalatable biomass indicates relatively unhealthy rangelands affected by degradation.

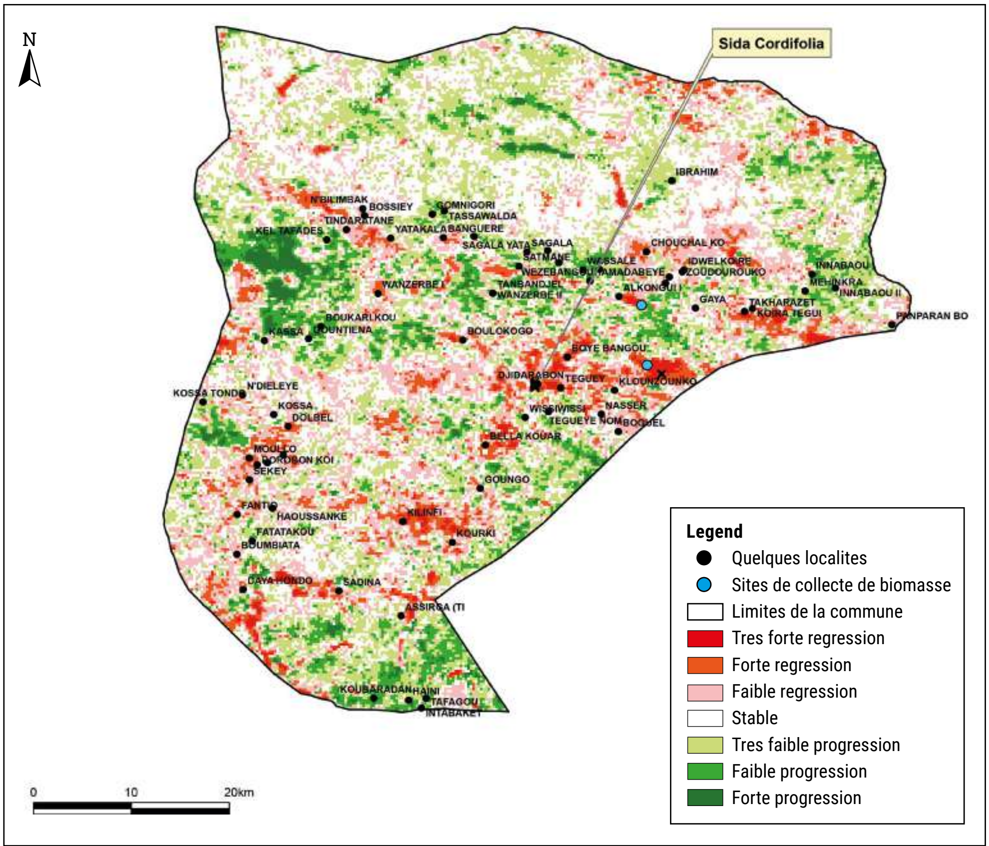
iii) On the other hand, glacis rangelands have large proportions of bare soil, evidence of soil erosion, gravel, structural and algae crust, erosion gullies and ravines. These indicators show that rangelands are susceptible to degradation and are in a very poor state of health. The emergence of erosion ravines and gullies was noted as an indicator of pastureland degradation during the participatory assessment. The spots where such indicators were observed were geo-referenced during the fieldwork. The spatial image of such spots on the degradation map matched all erosion ravine classes classed as high level of degradation.

Similarly, during the participatory assessment, the increase in areas with bare soils was recorded as an indicator of pastureland degradation. In certain areas, this corresponded to 25–50 percent of very high erosion zones and 5–25 percent of high erosion zones on the soil erosion map .Furthermore, when spots with bare soils were mapped on the soil erodibility map, the three classes of bare soil were located in the same erodibility zone on the map. The results demonstrate, in these cases, that rangelands with bare soil are susceptible to erosion and are therefore classified as unhealthy.

Other exemplary analysis based on the land degradation model advanced in East Africa, showed that non-degraded areas account for 41 percent of the total surface area of the commune. Whereas, degraded lands are at 50 percent, and highly degraded lands are estimated at 9 percent, totalling to over 59 percent of the surface area.

Invasive species such as *Sida cordifolia* were identified by the community as an indicator of rangeland degradation during the participatory assessment with local communities. Rangelands invaded by such species, when geo-referenced and the coordinates of the sites overlaid on the land productivity map, directly corresponded to spots that have declined biomass between 2003 and 2018 and areas where rangelands were regarded as unhealthy (Figure 22).

Figure 22. Productivity and presence of *Sida cordifolia*



Source: eMODIS 250 m. Land productivity according to local land users in 2019 in Gorouol commune. Compiled by IUCN, 2019

Overall, the degradation of the commune is attributed to a number of factors, namely:

i) Expanding farmlands that results in increased pressure and restricted access to forage resources and livestock water points and contributes to shrinking of rangelands. The change in land occupation and the conversion of pastoral and forest lands into farmlands led to the shrinking of rangelands. For instance, between 2000 and 2018, cultivated land areas expanded from 28 percent to over 52 percent of the surface area in the commune. In addition, overexploitation of farmlands through inappropriate agricultural techniques and absence of fallowing reduces soil fertility and facilitates the encroachment of bare surface areas and erosion in agricultural, forest and pastoral lands. Such areas are found to be susceptible to erosion. The overexploitation of farmlands through inappropriate agricultural techniques is leading to erosion of soil fertility.

ii) The land tenure arrangements encourage fragmentation and grabbing of the communal rangelands by private developers.

iii) Obstruction of livestock passage corridors with the building of infrastructure and settlements have led to a decline in pastoral resources and restrictions in livestock mobility, which increases the likelihood of degradation. The restrictions also result in recurrent damage to crop fields, thus exacerbating pastoralist–farmer conflicts.

iv) Farmer–herder conflicts are hindering previously well established mutual relationships on access and use of land and crop residues. Conflicts are also hindering livestock mobility.

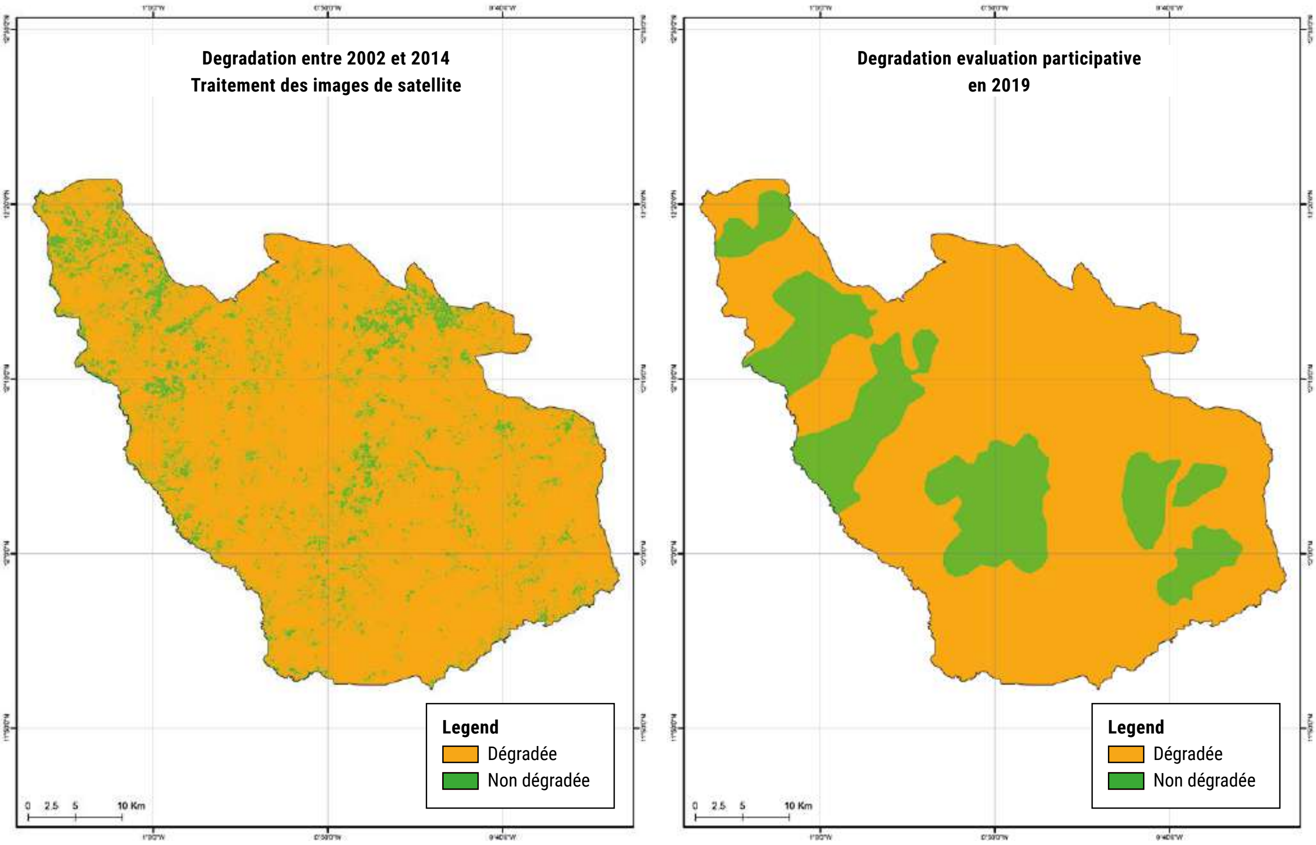
6.1.4 Burkina Faso

In Burkina Faso, the landscape assessed is largely degraded. The spatial overview of the degradation level either by using spatial data or through the participatory field assessment shows the high extent of degradation (Figure 23). Data from the participatory assessment supplemented the RS data and allowed for better harmonization of the results from technical expertise and participatory assessment on the degradation levels. Gullies are dominant features on bare soils but moderate for savannahs and farmlands. Ravines also exist and are deep in bare soils, moderate in cultivated soils and savannahs. Soil erosion is low to moderate on farms and savannahs and high on bare soils and other types of savannah.

The matrix of degradation levels based on technical tools and community analysis are shown in Table 5.

From the community assessment, 75.4 percent of the assessed landscape is degraded while 24.6 percent is not. Out of the 138 296 hectares that are degraded according to the participatory assessment, 123 994 hectares are degraded based on RS techniques (123 000 ha are consistent with the participatory approach). Out of the of the 45 168 hectares that are non-degraded according to the participatory assessment, 6 910 hectares are non-degraded based on RS techniques (6 910 ha are consistent with the participatory approach).

Figure 23. Degradation map from the diachronic analysis (a) and from participatory evaluation (b)



Source: a) Landsat. Degradation between 2002 and 2014 in Mogtedo and Boudri communes. Compiled by IUCN, 2019; b) Landsat. Degradation according to local land users in 2019 in Mogtedo and Boudri communes. Compiled by IUCN, 2019.

Table 5. Level of degradation based on community assessment and diachronic analysis

	LEVEL OF DEGRADATION BASED ON COMMUNITIES ASSESSMENT (PARTICIPATORY EVALUATION)			
Level of degradation based on spatial tools (diachronic analysis)	Degraded	Not degraded	Total (ha)	%
Degraded	123 994.8	38 258.7	162 253.5	88.4
Not degraded	14 302.1	6 910.0	21 212.1	11.6
Total (ha)	138 296.9	45 168.7	183 465.6	100
%	**75.4**	**24.6**	**100**	

Using the RS technique, it can be noted that 88.4 percent of the landscape is degraded and 11.6 percent is not. Out of the 162 253 hectares considered degraded, 123 994 hectares are consistent with the results of the participatory evaluation, whereas 38 258 hectares are not.

The degradation level based on community perception (75.4 percent) is lower than the RS result (88.4 percent). This is due to the fact that the demarcation of different zones by the communities is not detailed enough to build the picture for large-scale assessment. Nonetheless, both approaches show that more than a third of the landscape is degraded. Results of the intersection of the 2002 land use shape files with those of the 2019 degradation levels show the types of land use that are more or less affected by degradation in terms of area or percentage. This is presented in Table 6 below.

Table 6. Degradation levels in 2019 against land use types in 2002

LAND USE IN 2002	DEGRADATION LEVEL (2019)				
	Degraded		Non-degraded		Total (ha)
	Ha	%	Ha	%	
Settlement	381	0.28	0.0	0.0	381
Annual crops	69 531	50.28	21 408	47.4	90 939
Irrigated agriculture	180	0.13	0.0	0.0	180
Gallery forest	1 397	1.01	324	0.7	1 721
Agroforestry park	54 285	39.25	15 547	34.4	69 831
Tree savannah	1 207	0.87	551	1.2	1 759
Shrub savannah	7 200	5.21	5 844	12.9	13 044
Grass savannah	780	0.56	1 397	3.1	2 177
Bare soil	3 304	2.39	96	0.2	3 400
Water bodies	33	0.02	0.0	0.0	33
Total (ha)	138 297	100.00	45 169	100.0	183 466
%	75		25		100

From this table it appears that the most significant changes between 2002 and 2019 (year of the participatory landscape assessment) can be observed in the following three types of land use: annual crops, agroforestry parks and shrub savannahs. Of the 75.4 percent of degraded landscape resulting from the participatory evaluation, 50.3 percent is made up of annual crops and 39.3 percent of agroforestry areas. Shrub savannahs, potential rangeland and pastures is at third position with 5.2 percent.

6.1.5 Uruguay

In Uruguay, indicators such as the percentage of bare soil, the presence of weeds and/or invasive exotic species (farm scale), the ratio of desirable to undesirable native species and biodiversity present in general (farm scale) within the biota domain, and water quality analysis in important watercourses was used to assess the level of land degradation.

From the assessment, herbaceous coverage decreased by 7.9 percent between 2000–2015 while commercial forestry coverage increased by 64.5 percent. In addition to problems associated with such changes in land use, producers also mentioned some management problems stemming from overgrazing including soil erosion, degradation of plant cover and invasion by exotic species.

Table 7. a) Coverage in area and percentage of land degradation in southeast pilot zone and (b) for the north pilot zone.

(a)		
	AREA (KM^2)	PERCENTAGE OF TOTAL AREA
Total area	4 098	100
Improved area	508	12.40
Stable area	2 561	62.49
Degraded area	938	22.89
Area with insufficient information	91	2.22
(b)		
	AREA (KM^2)	PERCENTAGE OF TOTAL AREA
Total area	6 018	100
Improved area	1 111	18.47
Stable area	4 676	77.71
Degraded	183	3.04
Area with insufficient information	47	0.78

Sources: a) Formoso *et al.*, 2020; b) Cortés *et al*,. 2020.

For the purpose of land degradation analysis, the loss of natural fields is considered negative when replaced by crops, artificial areas and bare areas, but is considered positive (no land degradation) when these are replaced by natural forests or artificial plantations and by wetlands.

The main soil cover change at the national level in the period 2000–2015 was observed in the “shrubs, grasslands and areas of scarce vegetation” categories, which lost 13.8 percent of surface. The decrease in grassland was due to conversion into crops lands (which increased by 27.7 percent) and forests which were particularly forest plantations (with a 42.7 percent increase). At the same time, agriculture, the burning of the pastures and grazing with a permanent load of ovine, bovine and equine have led to degradation and the resulting decease in the productivity of the natural pastures.

This threat to the grasslands was acknowledged both by land users, the academia and different management institutions. It is important therefore, to highlight that the grassland areas displayed the highest decrease in surface coverage during the period 2000–2015. In the north zone, the degree of erosion was classified as “very slight” on 53 percent of its surface and “slight” for the remaining 47 percent. This information therefore suggests that anthropic erosion does not currently represent a significant problem in the zone. Given that grasslands hold unique diversity, including more than 550 grass species, 500 bird species and 100 mammal species, among others, the impact of its degradation is enormous. These changes have led to fragmentation of the landscape, loss of biodiversity, invasion of exotic species, soil erosion, and changes in the quality of water as well as in the lifestyle of the individuals living in the rural environment. The temperate grassland is however a biome with the highest risk of extinction and thus requires urgent attention.

The information provided by the National Water Directorate shows that 94 percent of water courses in Uruguay are of good quality yet some deterioration is beginning to show. Of the nine parameters that make up this index, total phosphorus (Pt) shows the greatest non-compliance and nitrogen is second, mainly due to pollution from agricultural activities.

The stakeholders who participated in the consultation process expressed the need to gather information and have resources allocated to campaigns aimed at controlling the spread of invasive species while also increasing participation of producers in various activities.

6.2 Analysis of data gaps

6.2.1 Gaps in selected indicator domains

The three domains of selected indicators are not equally applicable across the pilot countries. For example in Kenya, water indicators, based on assessment of drying of wells and of recharge rates, were not a straightforward indicator to explain land degradation. There are two reasons for this: first, this indicator is not commonly used by land users to interpret land degradation. Second, the decline in recharge rates, particularly in shallow wells is a function of numerous interacting factors, including decline in initial availability (e.g. decreased rainfall), reduced infiltration (e.g. from increased intensity of rainfall and declining vegetation cover) and decreased holding capacity (e.g. erosion-induced changes in soil structure and localized sand harvesting) – and as such is a complex indicator.

6.2.2 Discrepancies between remote sensing and participatory observations

While RS provides cost-effective landscape images that help to discern land degradation and change, the mismatch in spatial scale may cause observed divergence in patterns. In participatory mapping exercises across the pilot countries, community members were asked to identify one degradation level for the entire landscape zone, while the RS degradation index identified degradation at the level of 1 km^2. While a more detailed subdivision of the landscape by the local community may result in closer correspondence between the local and scientific approaches to mapping degradation, it is recommended that these two approaches should be considered together for a more nuanced understanding of degradation and its impacts on livelihoods, biodiversity and production systems.

In Kyrgyzstan, local perceptions (field assessment of land degradation and traditional knowledge) it was equally observed that there was a discrepancy in the RS and field assessment of land degradation, especially in terms of spatial and temporal scaling. The RS datasets/assessment had a resolution (minimum unit) of 300 metres, that is, 90 000 square metres and a temporal range of 15 years, that is, between the years 2000–2015. On the other hand, the field assessment was done as a plot unit, with data collected in summer 2019 without a temporal range assessment/reference. Comparison of the results between these two methods is difficult as it presents irreconcilable data gaps and discrepancies. The interpretation of the observations also depends on the management objective of the land users. For instance, while a conservationist might interpret vegetation cover change from grassland to woody as a restoration of degraded areas, a livestock keeper (particularly cattle herders) would view it as degradation. This underscores the importance of local feedback on RS results through participatory approaches.

6.2.3 Gaps in socioeconomic datasets

Although socioeconomic datasets provide a complementary analysis that builds the broader picture of land degradation in selected pilot sites, most useful socioeconomic data have gaps. For example, in northern Kenya, developments are not systematically mapped and documented although information on the impacts of development on pastoral livelihoods and ecosystem services – especially haphazard development of water points and human settlements and the role of food aid distribution points – reveals increasing sedentarization which undermines pastoral production systems and promotes land degradation. In addition, socioeconomic data that explain local communities' perceptions of threats are either scarce or missing. For example, there is little data on livestock numbers in the assessment landscape and no specific data was available on the extent of charcoal production and fuelwood harvesting in the pilot counties of northern Kenya. Likewise, there are disparities between official livestock census numbers and the actual head count of the existing livestock in Kyrgyzstan. This is blamed on loopholes in animal census protocols and tagging that make the census numbers differ from the actual animal head count.

In Uruguay, where extensive socioeconomic data was gathered, it was evident that there was a need to link socioeconomics and ecology. For example, as rural areas have relatively lower social services compared to urban areas, many young people are migrating from rural to urban areas depriving the rural areas of much needed labour that is important for management of the grasslands. This is in spite of the fact that overall the quality of living is better in rural areas compared to urban areas (e.g. in terms of available income versus expenditure).

6.2.4 Sampling bias in selection of monitoring sites

Other data gap results from selection bias of sampling points for assessment and for long-term monitoring. In Kyrgyzstan, the area covered in each monitoring point was not clearly defined (e.g. a circle with a defined diameter). This caused uncertainty on the observed phenomena as well as which plant species should be considered as part of monitoring points and which are closeby. A stricter definition of the monitoring point (certain area) could help to prevent this uncertainty and make assessments more consistent across landscapes.

Another aspect of sampling bias that contributes to data gaps is observed in field assessments in Kyrgyzstan. Here it was evident that areas with difficult access like swamps or high vegetation plots were less assessed, compared to easily accessible plots.

In addition, bias in choice of the season for assessment is observed to contribute to data gaps and associated inconsistencies. In Burkina Faso and Kenya, single assessments in relatively good seasons with good forage and soil cover is observed to yield different data compared to drier seasons when the soil cover declines. The high variability between seasons makes it imperative that assessments be carried out in different dry and wet seasons for data comparability and for a better understanding of the rangeland condition.

6.2.5 Potential influence on the policy

Consolidating information for establishing the land degradation baseline and establishing monitoring programmes to track change in LDN status over time is a huge challenge in terms of honouring global commitments, and more importantly, embedding the ethos of LDN into local policy and decision-making processes. Therefore, accurate, appropriate and timely information is essential for ensuring that the principles of SLM to achieve LDN are incorporated into planning processes at all levels, e.g. community, district, county, and national levels.

Assessment results can influence and strengthen existing laws and policies such as support to Pasture Law in Kyrgyzstan. Pasture Law in Kyrgyzstan continues to represent one of the most powerful pieces of legislation that exists today at a global level. The results from this study could reduce possible setbacks and gaps existing in that law and allow possible improvement to develop a stronger law as well as foster improvement in pasture management at the national level.

The results from these studies have identified land users as key stakeholders and present a good entry point for SLM interventions. The results also show that they will stand to benefit from simplified, low-cost, participatory, land-based monitoring systems for decision-making and related planning.

The results of the monitoring and evaluation process not only enable livestock producers and resource users to identify best practices of SLM and the integration of these in the policy design processes, but also help local and national authorities to outline monitoring protocols for continuous tracking of rangeland health to support informed management, investment and governance decisions.

7 Conclusion and recommendations

This review of testing PRAGA methodology in five pilot countries has identified a number of relevant lessons for this rapid rangeland assessment methodology in a context of limited costs and time, and particularly around the integration of two sets of knowledge – the scientific approach (RS) and participatory approaches with diverse land users.

- In all five countries, to a large extent, the rich landscape level understanding from the review of existing RS data and relevant rangeland studies (in selected cases) complemented the field observations, key informant interviews, and participatory community-based mapping and assessment.
- PRAGA rapid assessments build on the existing knowledge of land users but also take advantage of field assessments that make it possible to provide details on biomass, and in particular, the nature and quality of biomass for animal feed.
- The multistakeholder approach (technicians and producers) yielded innovative results on land degradation assessment. The contribution of each actor to the evaluation, and the convergence of stakeholders' perceptions on the assessment of land degradation level is an important learning point from testing PRAGA across pilot countries.
- Selection of participants for field assessments is key to generating applicable knowledge in a rapid assessment context. The transfer of their local knowledge and expertise into maps through a participatory landscape mapping process enables collective expression of herders' mental maps of the landscape.
- The applicability of the three domains of indicators "soil, biota and hydrology" was observed to be not uniform. While soil and biota were strongly considered as appropriate domains to retain in a rapid assessment, hydrology was not as important as envisaged in the draft PRAGA Manual.

- The pastoral/land users' perspectives and views on the status of the pasture resources largely conformed with results obtained from RS, with the exception of a few cases. This reaffirms the importance and validity of participatory inputs in rangeland/pastureland assessments.
- Lessons from PRAGA contribute greatly to the description of community indicators and overall participatory processes for land characterization, mapping degradation and identifying drivers of degradation.
- In pilot countries, results from testing of PRAGA methodology are grounded in robust, accessible, and applicable data which is central to targeting interventions for maximum efficiency and impacts.
- The importance of local stakeholders to establish the local "value" of land cover changes in the context of the LDN monitoring framework and is considered valuable contribution of PRAGA.

7.1 Recommendations

- To improve stakeholder engagement, relevance, ownership and to foster good collaboration, local partnership building should be established before designing the data collection protocol and subsequently deepened through local and national level workshops.
- With PRAGA, there is need for a clear and explicit meaning in the use of key terminology, including rangeland health assessment and participatory landscape mapping and participatory indicator selection.
- Selection of the baseline data in PRAGA should be informed by the context of land degradation with prioritiy given to data that has direct attribution to changes in rangeland health in areas being assessed.
- In every context, the local rangeland health assessment framework including landscape characterization and land use practice should be established at the community level to ensure the rangeland health assessment is as reliable as possible.
- In the determination of appropriate indicators for assessment of changes in rangeland health, the assessment team should develop an analysis framework for the identified indicators to understand sensitivity to pressure. This applies both to broad scale socioeconomic and landscape level assessment indicators.

- Participatory rangeland health assessment should be as inclusive as possible of local experts, relevant extension staff for range assessment and RS experts. Consultation at different stages should also aim to capture the views and perspective of women and other less represented members of the community.
- Based on the experience from the five pilot countries, timing for the field assessment needs to be decided in collaboration with local resource users for their availability and to avoid biases in indicator changes attributed to seasonal variation.
- The spatial and temporal scale advantage of the local knowledge and RS should be carefully considered to benefit from the complementary nature of the two approaches in rangeland health assessment and monitoring.

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Glossary of key terms

Assessment: a critical evaluation of information on a state or a process at a particular time and in a specific location for the purpose of guiding decisions.

Grasslands: land on which the vegetation is dominated by grasses.

Land degradation neutrality (LDN): a state whereby the amount and quality of land resources necessary to support ecosystem functions and services and enhance food security remain stable or increase within specified temporal and spatial scales and ecosystems.

Landscape: the overall area to be assessed.

Monitoring: repeated collection of data to track changes over time.

Participatory: means involving stakeholders, particularly those who have a stake in the project to have a voice, either in person or by representation.

Plot: locations within a landscape where measurements will be carried out on the ground.

Rangelands: land on which the vegetation is predominantly grasses, grass-like plants, forbs or shrubs and is managed as a natural ecosystem. Rangelands can include annual and perennial grasslands, shrub and dry woodlands, savannah, tundra, and desert. The term rangeland can also refer to the management unit – a sociopolitical construct – which may contain a great diversity of other ecosystem elements and areas suitable for other uses like cultivation. Some of these elements may not be classified as rangeland ecosystems; for example oases ecosystems, wetlands, riparian forests, woodland patches, areas of "rich patch" vegetation, and higher altitude forests (e.g. mist or alpine forests). Yet these resources within rangeland landscapes are often critical – sometimes seasonally essential – to the functioning of the rangeland management units and associated livelihoods.

Remote sensing: the science of obtaining information about objects or areas from a distance, typically from aircraft or satellites.

Resilience: the sustained ability of a community to use available natural resources to respond to, withstand, and recover from adverse situations and risks.

Scale: the spatial units of measurement.

Transect: a path along which one counts and records occurrences of the species of study (e.g. plants).

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