PART VI SOLUTIONS

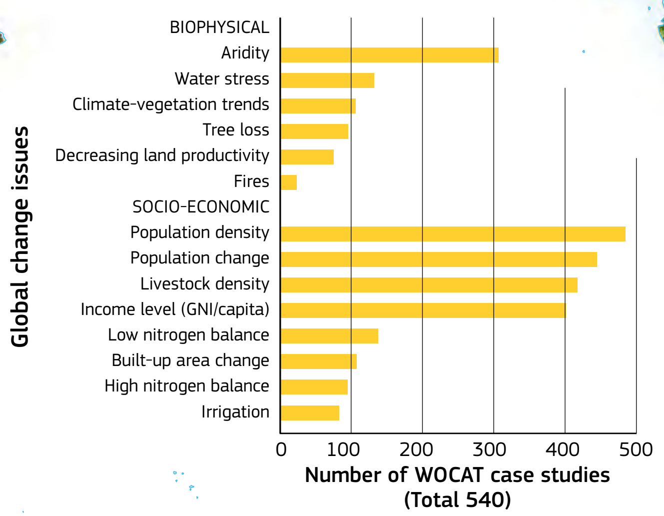
Maintaining or improving the productive capacity of land requires a move towards land degradation neutrality. This is a matter of preserving or enhancing the ability of land resources to support ecosystem functions and services. Sustainable management of soil, water and biodiversity can help close yield gaps, increase the resilience of land and thus support the people who depend on it for their livelihoods. This will come at a cost, but the cost of action or prevention is always lower than the cost of inaction.

Source: Liniger, Hanspeter.

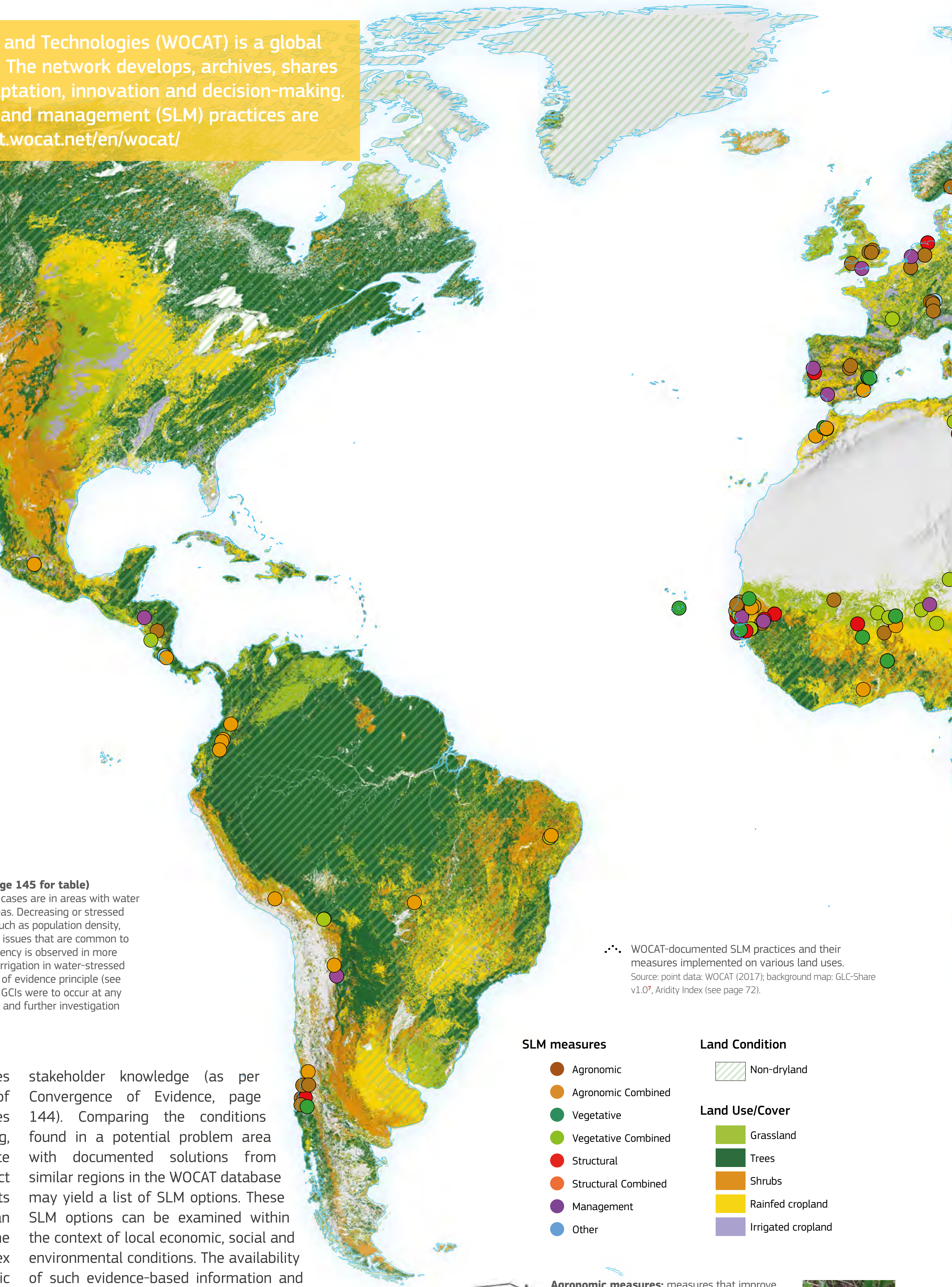
Sustainable Land Management: Current State

A growing inventory of adapted land-use practices

The World Overview of Conservation Approaches and Technologies (WOCAT) is a global network on sustainable land management (SLM). The network develops, archives, shares and disseminates SLM knowledge to support adaptation, innovation and decision-making. Methods and tools for documenting sustainable land management (SLM) practices are available via a worldwide platform at https://qcat.wocat.net/en/wocat/



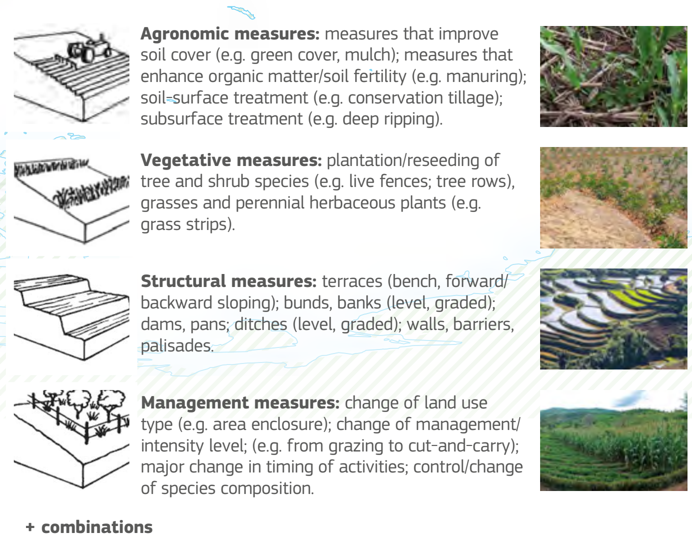
WOCAT documented SLM measures per global change issue (GCI, see page 145 for table)
Most of the documented SLM interventions are in dryland areas (57%). 25% of cases are in areas with water stress and 20% in areas with climate-vegetation trends or drought-affected areas. Decreasing or stressed productivity prevails in about one-sixth of the cases. Socio-economic variables such as population density, population change as well as livestock density and income level are outstanding issues that are common to 74-90% of the cases; (90%, 82%, 78% and 74%, respectively). Fertiliser deficiency is observed in more cases (26%) than overuse of fertilisers (18%). Expansion of built-up areas and irrigation in water-stressed areas occur in 20% and 15% of the cases, respectively. As per the convergence of evidence principle (see page 144), no GCI *by itself* is sufficient to infer land degradation) but if multiple GCIs were to occur at any location, this suggests the potential for land degradation (at least in some form) and further investigation would be warranted.
Source: WOCAT database, 2017 and WAD3-JRC, 2018.



WOCAT-documented SLM practices and their measures implemented on various land uses.
Source: point data: WOCAT (2017); background map: GLC-Share v1.0[7], Aridity Index (see page 72).

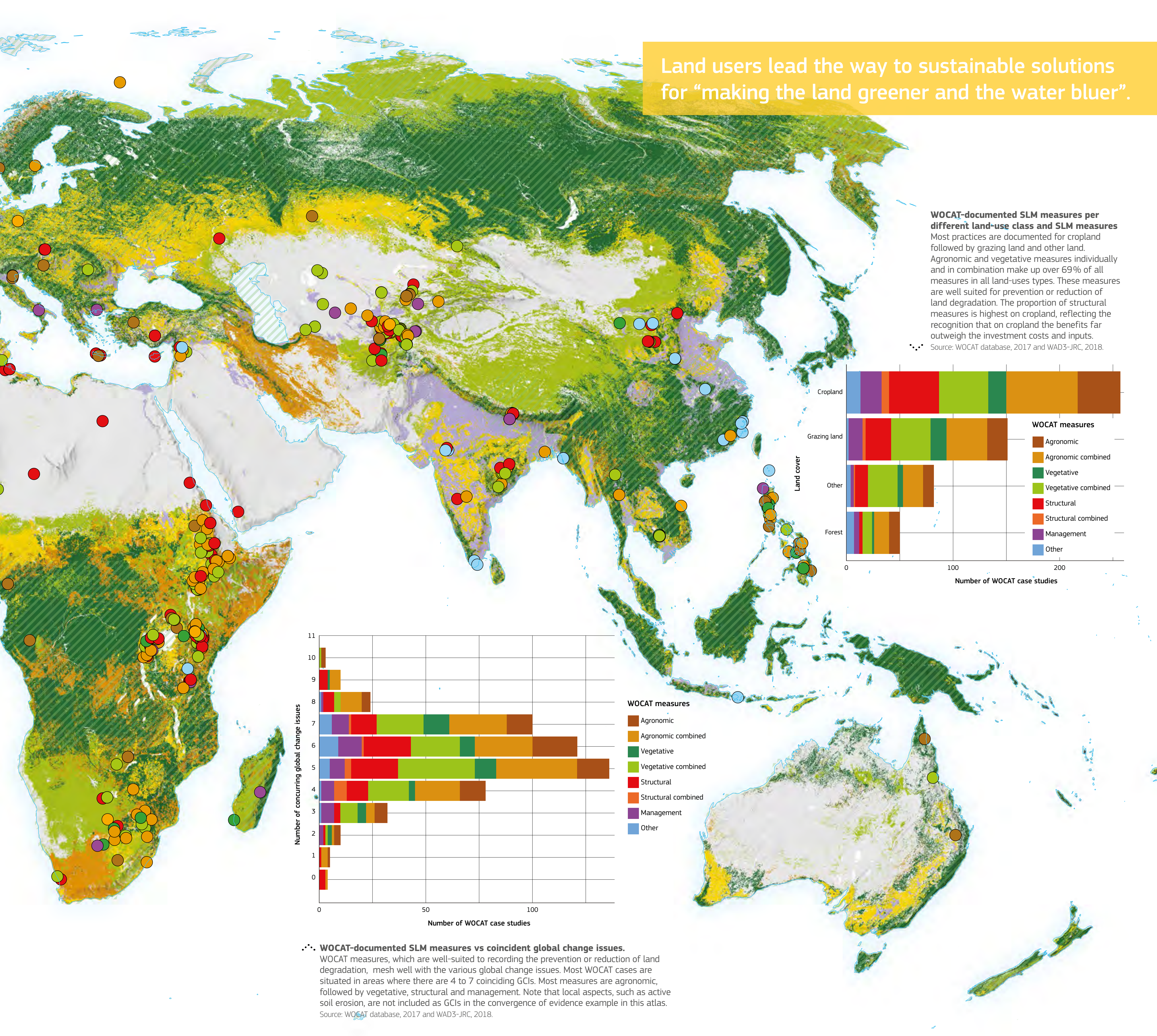
Human activities involving land use and land-use changes are widespread across the globe and are a major driver of land degradation[1, 2]. While there are many land-use practices associated with land degradation (over-cultivation, overgrazing, etc.), the existence of any these practices alone does not constitute land degradation. For example, based on simple cause-effect logic, overgrazing and primitive farming techniques by peasants and pastoralists were traditionally blamed for causing Sahelian drought and land degradation[3]. A new paradigm exposed the overly simplistic nature of this view by documenting the complex nature of non-equilibrium systems, such as abiotic versus biotic controls, short- versus long-term dynamics, and the value of local stakeholder knowledge in governing coupled human-socio-economic systems[3, 4] (see page 64 on smallholders). This led to a more integrated approach in formulating the social and institutional dimensions of land management, including the development and implementation of the adaptive practices of sustainable land management (SLM).

The World Overview of Conservation Approaches and Technologies (WOCAT) is a network that develops, archives, shares and disseminates SLM knowledge to improve human livelihoods and the environment[6]. As part of its mission, WOCAT strives to support evidence-based decision-making and influence policy making at various levels to promote wider implementation and scaling up of identified good practices, thereby contributing to global efforts to prevent, halt and reverse land degradation. Potential locations of maladapted land use practices are identified by mapping the co-occurrence of key issues related to land degradation and framing them within local contexts and stakeholder knowledge (as per Convergence of Evidence, page 144). Comparing the conditions found in a potential problem area with documented solutions from similar regions in the WOCAT database may yield a list of SLM options. These SLM options can be examined within the context of local economic, social and environmental conditions. The availability of such evidence-based information and knowledge facilitates the uptake and widespread implementation of SLM. The value of systematic collection and cataloging of geographically based SLM knowledge is gaining broad appreciation from research agencies, institutions and the global community. SLM technologies and approaches are not static but are continuously adapted in response to changing environmental conditions and human needs. However, this requires long-term monitoring of instances of implementation, adaptation, and impact of SLM. These efforts are supported and encouraged by significant advancements in information technology (cloud computing, the Internet of Things, social networking, etc.), which supports a wide array of social, economic and environmental contexts.



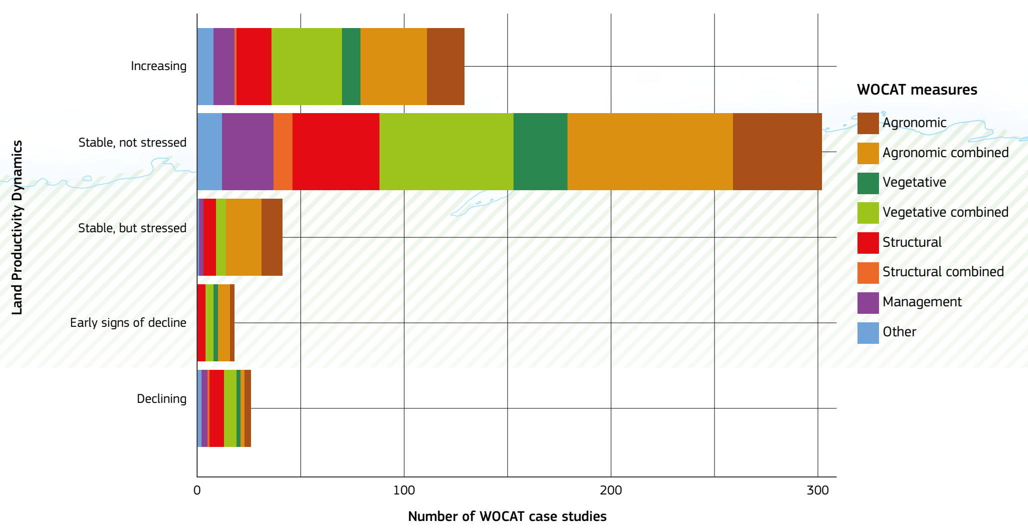
Categories of WOCAT measures inventoried in the field
SLM technologies are made up of agronomic, vegetative, structural or management measures, or most often a combination of these.
Source: Liniger and Crichley, WOCAT, 2007[6].

Land users lead the way to sustainable solutions for "making the land greener and the water bluer".



WOCAT-documented SLM measures per different land-use class and SLM measures
Most practices are documented for cropland followed by grazing land and other land. Agronomic and vegetative measures individually and in combination make up over 69% of all measures in all land-uses types. These measures are well suited for prevention or reduction of land degradation. The proportion of structural measures is highest on cropland, reflecting the recognition that on cropland the benefits far outweigh the investment costs and inputs.
Source: WOCAT database, 2017 and WAD3-JRC, 2018.

WOCAT-documented SLM measures vs coincident global change issues.
WOCAT measures, which are well-suited to recording the prevention or reduction of land degradation, mesh well with the various global change issues. Most WOCAT cases are situated in areas where there are 4 to 7 coinciding GCIs. Most measures are agronomic, followed by vegetative, structural and management. Note that local aspects, such as active soil erosion, are not included as GCIs in the convergence of evidence example in this atlas.
Source: WOCAT database, 2017 and WAD3-JRC, 2018.



WOCAT-documented measures per land productivity dynamics (see page 114)
80% of the interventions are in areas that now show stable 'not stressed' and even 'improving' land productivity. This might be proof of increasing efforts in investing in SLM and a positive impact of investments made in good land management. Only 5% of the SLM measures reported are in areas with declining land productivity and suggest that efforts are in the initial phase or not yet wide-spread.
Source: WOCAT database, 2017 and WAD3-JRC, 2018.

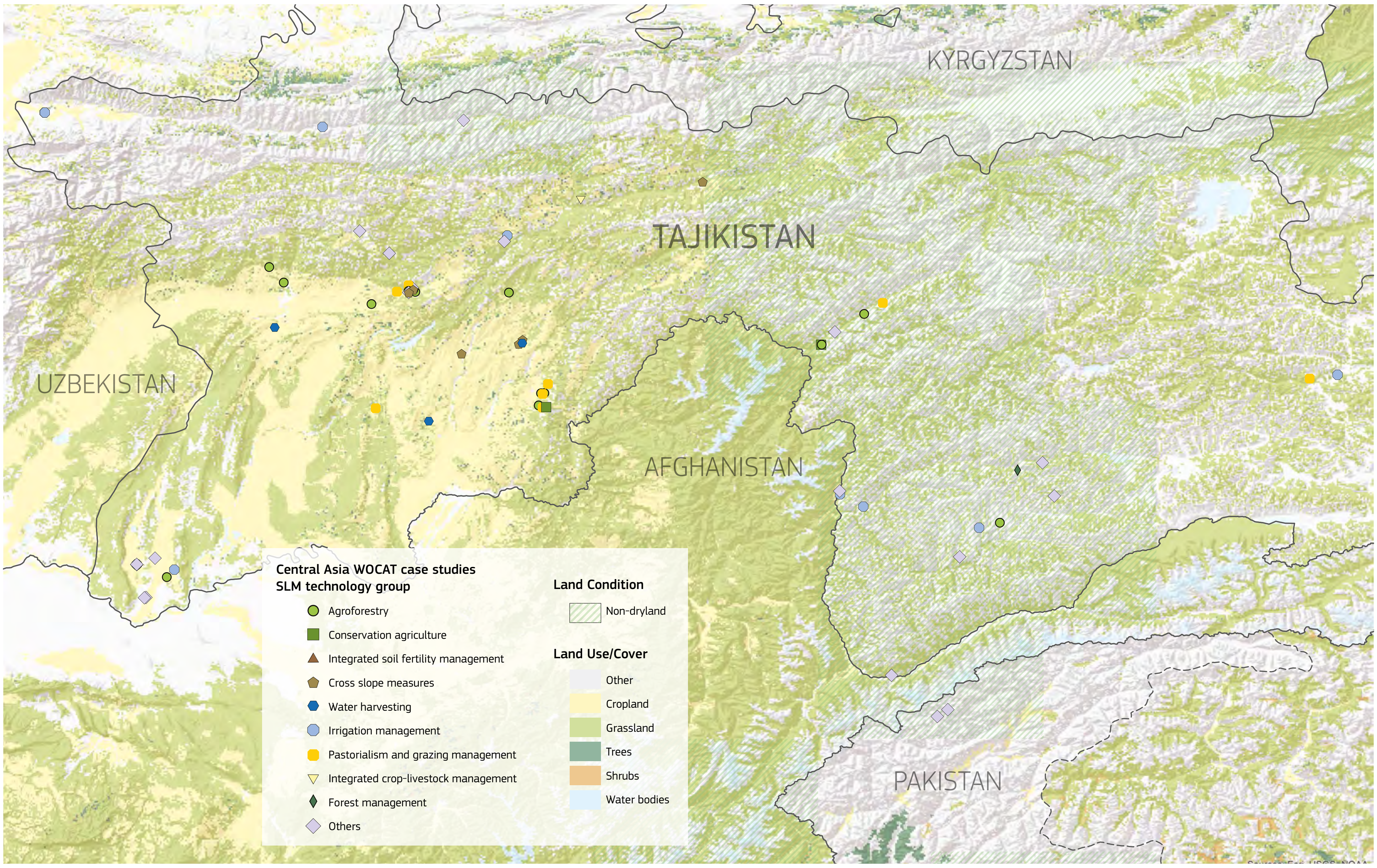
SLM practices and measures

SLM is defined as the use of land resources, including soils, water, animals and plants, for the production of goods to meet changing human needs, while ensuring the long-term productive potential of the resources and the maintenance of their environmental functions[5].

Sustainable land-management practice consists of an SLM technology and SLM approach.

An SLM technology is a physical practice on the land that controls land degradation, enhances productivity, and/or other ecosystem services. A technology consists of one or several measures, such as agronomic, vegetative, structural, and management measures (WOCAT 2016). An SLM approach includes the ways and means of support that help introduce, implement, adapt and apply SLM technologies on the ground to foster an enabling environment.

Learning from each other



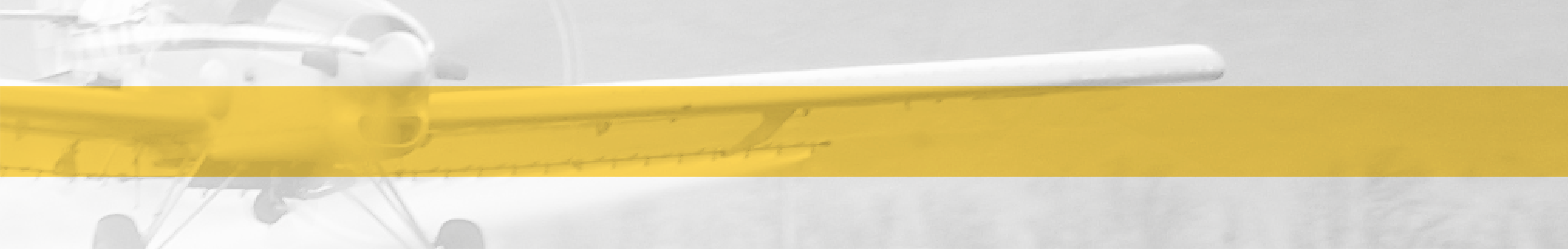
Central Asia WOCAT case studies, SLM technology group
Land use and SLM technology groups for documented practices.
Source: point data: WOCAT database (2017); background map: Esri, USGS, NOAA.

Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan) has undergone drastic political, economic and social changes during the past decades[1]. Soviet policies led to a collapse and dismantling of collective irrigated networks, overuse of water (with consequent drying of the Aral sea), land tenure insecurities and insufficient market development. The resulting land fragmentation and abandonment on marginal lands made it very difficult for land users to adopt sustainable land management (SLM) practices[2]. Hence, unsustainable agricultural practices, e.g. excessive irrigation without adequate drainage, mono-cropping, tillage on steep slopes, inadequate replenishment of soil fertility, overgrazing of pastures, and deforestation remain problematic in the region to date. Combinations of these factors contributed to severe impact on the land resources that is expressed by different types of land degradation along the agro-ecological regions: widespread salinisation in irrigated areas[2, 3], soil erosion and nutrient depletion in rain-fed areas[2, 4], decline in pasture quality in rangelands[2, 5] and soil and vegetation erosion in mountainous areas[2]. The consequent reduction in overall productivity threatens the livelihoods of millions of farmers and pastoralists in this region.

Successful prevention of and solutions to existing land degradation, including drought adaptation, require practical proven and scientifically approved technologies and approaches for sustainable land management that integrate ecological, economic, and social dimensions of land use. Many efforts have been made within the region of Central Asia to mitigate land degradation. Success stories on implementation of SLM practices, along with policy actions, have been documented. Taking into account the local and transboundary use of natural resources, the need for new arrangements and agreements emerges throughout the area. Some of these include better market access, improved land tenure for smallholders and livestock owners, and support for extension and experience exchange which can positively stimulate the uptake of SLM measures[2].

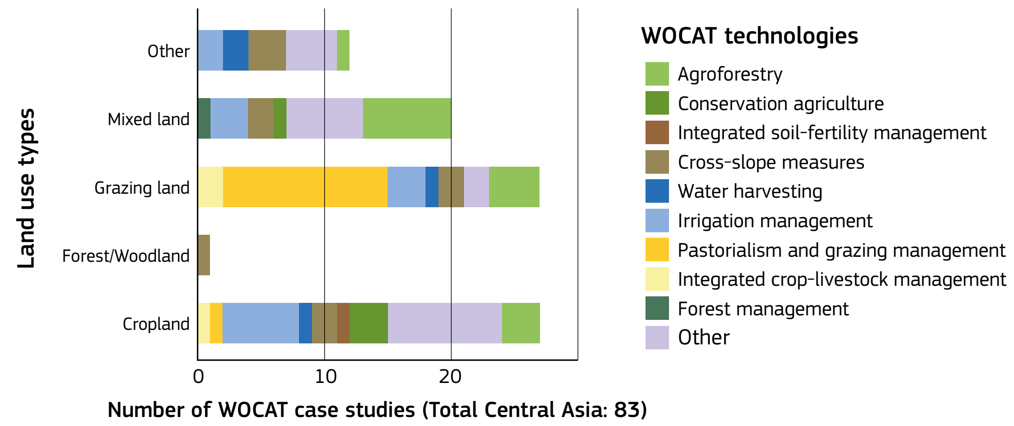
WOCAT monitored and inventoried a large number of cases where SLM practices have been implemented successfully and this database is a key knowledge base for expansion of SLM in Central Asia[6], as access to extension plays an important role in adopting SLM by rural farmers and herders[2].

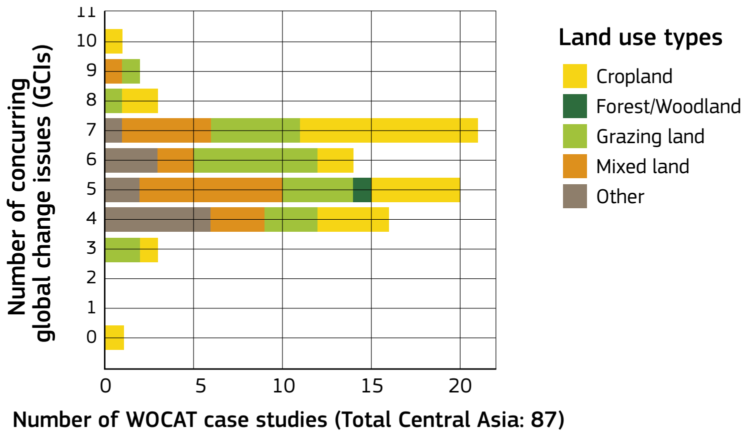
"Where the land is greener"
The mountainous areas of Central Asia face enduring threats of land degradation due to the rugged topography, exposure to heavy rains, the erodibility of the soils and high pressure on the land due to population increase. However, green and productive areas emerge and show where sustainable land management is practiced.
Source: Liniger, H., WOCAT, 2007.



Many efforts have been made to mitigate land degradation in Central Asia. Success stories on implementation of SLM practices, along with policy actions, have been documented and are ready to be upscaled.

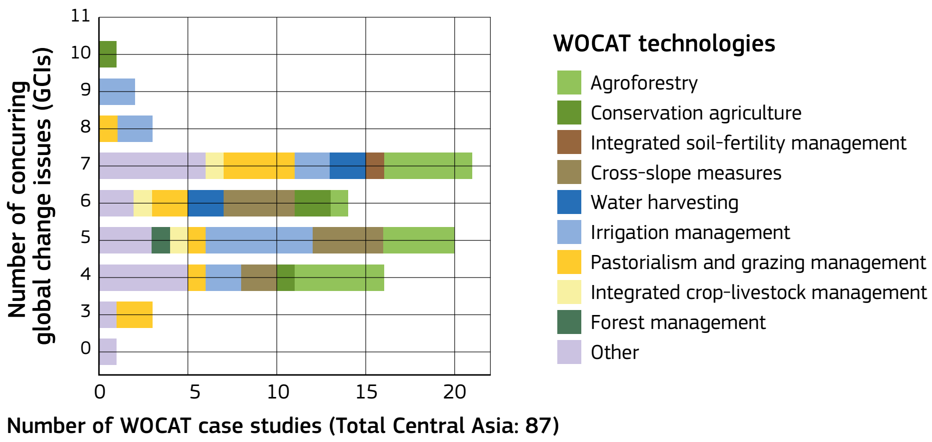
Documented SLM practices by land-use type in central Asia (WOCAT Database 2017)
Case studies cover all major land uses, but most case study intervention areas are on grazing land and cropland. These are some of the most important land uses in the area and illustrate strong dependency on both crop and livestock production. The large number of practices on mixed land illustrates the value of small-scale integrated systems producing various food, fruits, fodder, and wood products close to settlements.
There are only limited areas of forests remaining in this region, and good management practices and efforts in improved forest management are limited.
Source: WOCAT database, 2017 and WAD3-JRC, 2018.

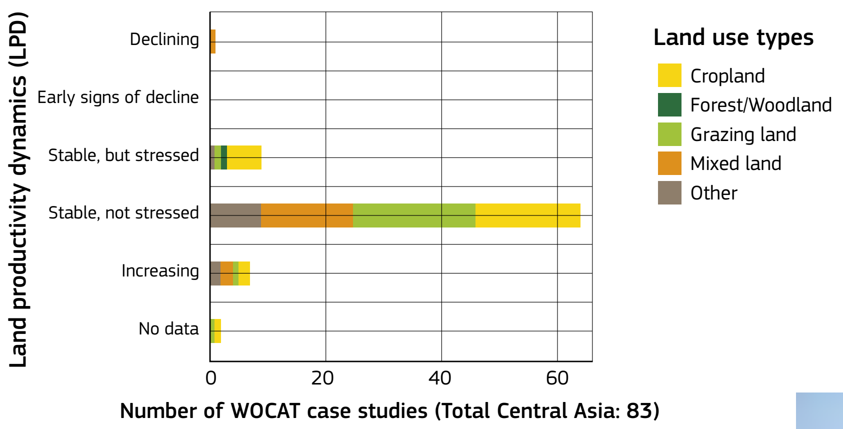




Documented SLM practices distribution in land-use types and coincident issues. (WOCAT Database 2017)
WOCAT case studies cover the whole range of coincident issues (apart from 1 and 2). Most practices coincide with areas that are impacted by 4 to 7 issues related to land degradation. The share of cropland practices seems to increase with the number of overlapping issues.
Source: WOCAT database, 2017 and WAD3-JRC, 2018.

Documented SLM practices in areas with different numbers of coincident issues (WOCAT Database 2017)
Most of the practices coincide with areas affected by 4 to 7 issues related to land degradation. In areas with 4 to 7 overlapping issues, agroforestry, water harvesting and irrigation management are strongly represented. Of all pastoralism and grazing management practices, the highest number occurs in areas affected by 7 coinciding issues. 8 to 9 coinciding issues are mostly found in irrigation areas.
SLM practices documented in the WOCAT database are within areas with several coincident issues related to land degradation. This suggests that there are valuable experiences to be promoted and shared so that they can be implemented by other land users facing similar conditions.
Source: WOCAT database, 2017 and WAD3, 2018.





Documented SLM practices per land-productivity dynamic and land-use type
Most cases are situated in areas that are "stable and not stressed", meaning some achievements have been made in that zone especially for the grazing land, the major land use in Central Asia. For areas that are "stable but stressed", the major SLM activities reported are on cropland. For the areas with increasing land productivity, there are examples for all land uses except forest. Very few forest practices are documented and only in areas that are "stable, not stressed".
Source: WOCAT database, 2017 and WAD3-JRC, 2018.

Rangelands in the Tienshan Mountains of Kyrgystan.
Source: Liniger, H., 2018.

Degraded loess soil and agroforesty system around a homestead in Faizabath, Tajikistan.
Source: Liniger, H., 2018.

Sustainable Land Management: Examples

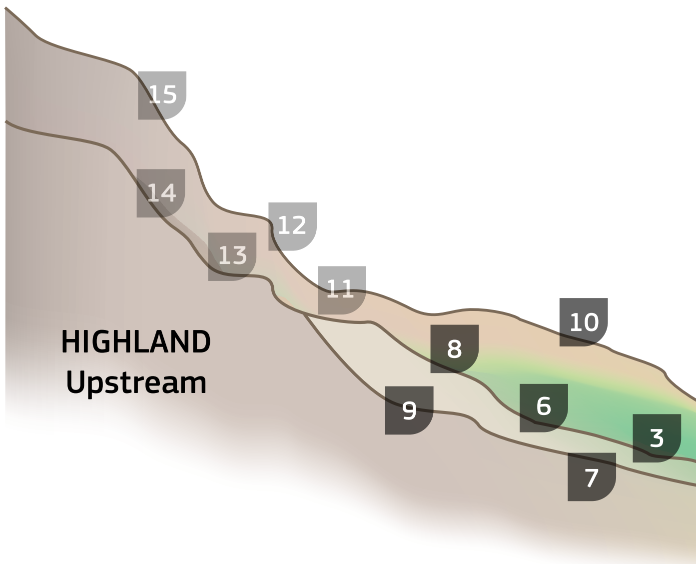
Good land management practices

Large-scale terracing in the Loess plateau of China has improved land productivity and the livelihoods of millions of land users. Implementation was driven by requirements for increased food production for a growing population and supported by downstream interests in reducing catastrophic floods and reducing sedimentation of large dams.
Source: WOCAT case studies; photo: Liniger, H.

Stone walls and forward-sloping terraces help prevent soil erosion and improve water retention on agricultural fields. However, in the hot drylands of Rajasthan, India, this is not sufficient to maintain adequate soil moisture. Other agronomic or vegetative measures that provide more permanent cover of the soils are still needed to ensure sustainable land use.
Source: WOCAT case studies; photo: Liniger, H.

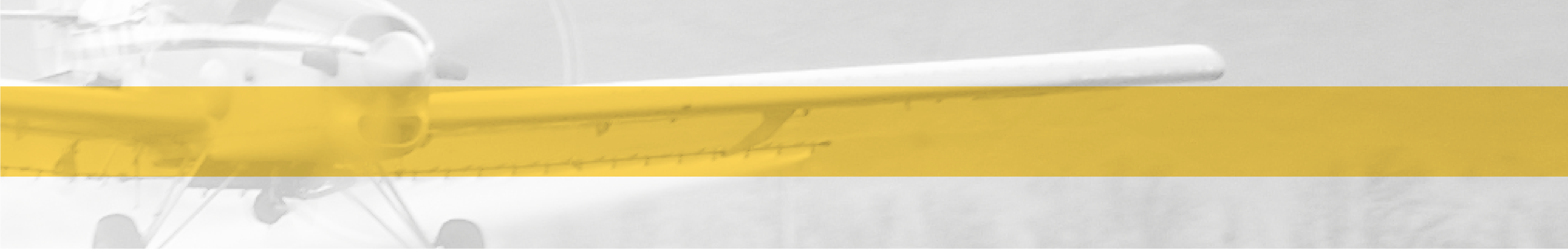
Wind farms in the Alicante area of Spain show a profitable alternative land use that taps the potential for wind generation. This allows for reforestation of degraded land. To reduce increased risk of the spread of forest fires in this wind-rich region, adaptive management is required. Removing dead wood, selective cutting of mature trees and planting fire-resistant tree species can limit the accumulation of fuels and reduce fire hazard. Also, grazing to reduce undergrowth, and the establishment and maintenance of firebreaks are necessary management options. All contribute to the success and sustainability of this complementary set of land uses.
Source: WOCAT case studies; photo: Liniger, H.

Widespread implementation of small-scale water-harvesting systems make better use of precious rainfall in drylands. Micro-basins as seen here near Mount Kenya are an effective way of maximizing rainwater retention. However, the loss of soil moisture through evaporation can only be reduced when the soil is covered. Leaving crop residues and weeds (applied as a mulch) between crop rotations is a good practice to keep permanent soil cover and reduce moisture loss.
Source: WOCAT case studies; photo: Liniger, H.



In mountainous regions in Kyrgyzstan, Central Asia, hay harvesting provides a growing economic opportunity for productive land use. Increasing numbers of livestock drive a growing demand for hay and supplementary feed as rangelands are under pressure from overuse and degradation. The shrinking availability of quality land for free ranging and the economic advantages of landless livestock production systems (see page 58) increase the attraction of and need for hay cultivation. This practice is sustainable as it follows the natural vegetative cycle and keeps the land well covered and protected.
Source: WOCAT case studies; photo: Liniger, H.

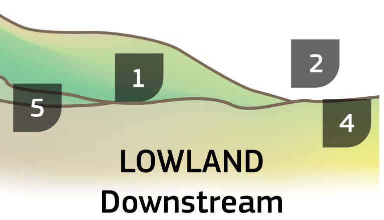
Maintaining soil fertility by applying manure while leaving crop residues to cover the soil and maintaining traditional terraces. These are good sustainable and productive land-management practices implemented on both gentle and steep slopes in Nepal.
Source: WOCAT case studies; photo: Liniger, H.



Good land management in the humid lowlands along the Meta river, a main tributary of the Orinoco, protects the riverbanks from cutting and washing away productive land and increasing the sediment loads downstream. High streamflow during the rainy season produces a large sediment load. Silt deposition can be either a blessing in terms of providing fertility to fields adjacent to streams during floods or a threat to safe navigation of river channels and storage capacity of water reservoirs along the main stem of the stream. Upstream land uses are critical because of their very large downstream effects.
Source: WOCAT case studies; photo: Liniger, H.

The straw-covered field in the mid-left of the picture is an 'anomaly' in this bird's eye view. An innovative agroforestry farmer in the Gulu region in North Uganda applied a simple, yet very productive, land-management practice by using crop residue to systematically cover the field after harvest. This provides soil cover, reducing erosion potential, improving soil fertility, soil moisture retention and water use.
It is a promising way to promote sustainable land-use-management practices when intervention projects engage innovative land users in training and extension activities.
Source: WOCAT case studies; photo: Liniger, H.

It is the goal of WOCAT to inventory and document individual initiatives as showcases for other land users. The few examples here show successful sustainable land management practices around the globe and their environmental, ecological and societal benefits.



In East Africa, semi-arid lowlands depend on water from adjacent highlands. Widely variable stream flow is tempered by well-established riparian forests. Protection of springs will continue to provide drinking water not only for livestock that sustain pastoral livelihoods but also for wildlife (Shaba Kenya rangeland, border of protected area is noticeable as a green line on the picture).
Source: WOCAT case studies; photo: Liniger, H.

A plantation of a leguminous tree species (*Caragana microphylla Lam*) used as fodder, biomass production and sand stabilisation, flourishes in the drylands of China.
The use of a special plough, known as the Vallerani System, helps create micro-catchments at small regular intervals along the plough line. The plough breaks the surface crust and creates depressions where rainwater and soil nutrients accumulate, also reducing runoff. In these micro-basins, grasses and shrubs, even trees, have a better chance of thriving. Degraded fields, catchments or larger managed areas can recover with a minimum of further input.
Similar large-scale mechanised rehabilitation of degraded land has been achieved in China. In Inner Mongolia, the plough has been used for plantations of Jojoba (*Simmondsia chinensis*) for oil production - as well as in the Sahel and the Middle East countries. (http://www.vallerani.com).
Source: WOCAT case studies; photo: Liniger, H.

Good land-management practices (cont'd)

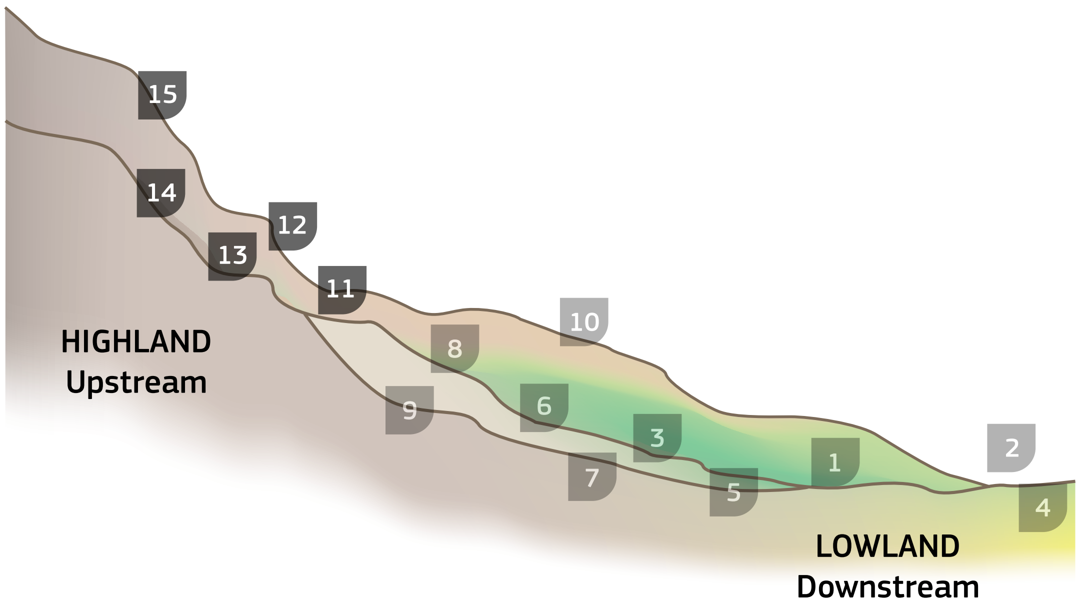
Sustainable land management also encompasses the safeguarding and protection of the fauna and flora of unique environments and ecosystems.
Biodiversity is the intrinsic ecologic value that spurs the maintenance of protected forests that are home to the gorillas in the volcano region of Northern Rwanda.
Source: WOCAT case studies; photo: Liniger, H.

Multi-story agroforestry in the Popayan region of the Colombian Andes, provides adequate coverage and soil protection to regulate water flows to downstream lowlands, while preventing local erosion and soil fertility loss. Mountain areas are crucial water sources in nearly all climates. Land-use change in tropical and subtropical mountain areas can provide productive systems. However, loss of vegetative cover may rapidly lead to erosion and soil loss, leaving these areas vulnerable. In many mountain regions of the world, multi-story agroforestry has proven to be a sustainable practice, preserving and ensuring essential ecosystem functions.
Source: WOCAT case studies; photo: Liniger, H.

Cyclones and heavy rainfall have a worsening impact on already severely degraded slopes in Haiti. Yet, around these homesteads, degraded slopes were restored by afforestation, productive agroforestry systems and home gardens. These were not destroyed during recent catastrophic storms.
The green area visible at the top of the hill up the valley illustrates the potential to restore badly degraded and heavily exposed slopes in less than 10 years.
These sustainable land-management practices reduce the risk for disasters such as landslides and floods further downstream. Community mechanisms must be established to ensure investments in productive and protective land-use practices upstream.
Source: WOCAT case studies; photo: Liniger, H.

In mountainous semi-arid environments of Tajikistan, the protection of land reduces water loss and erosion by runoff, thus reducing degradation. Implementing adaptive management practices to increase soil cover and land productivity is both protective and economically productive.
Protective land management in the upstream areas reduces risks of flooding and erosion downstream.
Source: WOCAT case studies; photo: Liniger, H.

Terracing and irrigation in this very dry environment in Morocco is challenging and requires well-adapted sustainable land-management technologies. To ensure availability of water in fields and equitable societal, sharing of this common resource, well-established and ethically functioning water users' associations are essential.
Source: WOCAT case studies; photo: Providoli I.



Promoting Solutions for Local Land Degradation

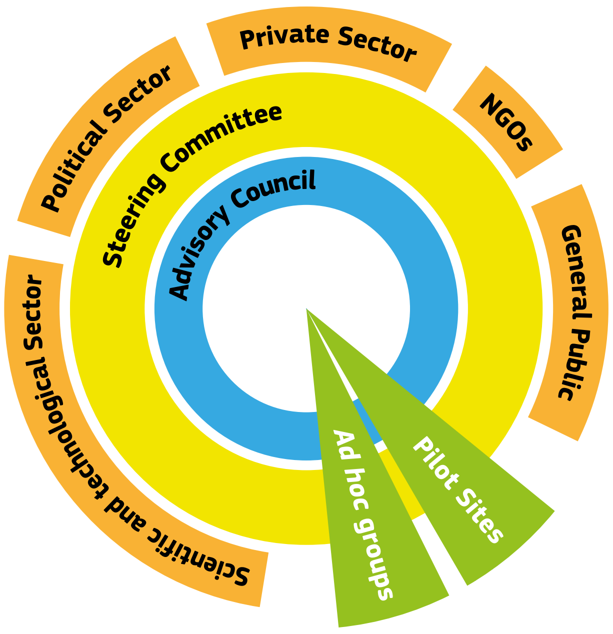
Successful partnership across political, scientific and technological sectors in Argentina

The National Observatory of Land Degradation and Desertification

Prevention and mitigation measures are proposed and promoted based on information on the status and risk of land degradation and desertification. In Argentina, the National Observatory of Land Degradation and Desertification (ONDTyD, as per its acronym in Spanish) was established in 2011 to provide such services. The observatory is a national system for land monitoring and assessing land degradation and desertification at different scales (national, regional and local). The adopted approach is holistic, interdisciplinary and participative. A network of scientific, technological and political organisations both uses and supports the observatory with data and knowledge. The observatory advises public and private decision-makers and organises awareness and education programmes.

The ONDTyD is an example of a successful partnership built across political, scientific, and technological sectors in Argentina. Currently, more than 30 institutions and 150 professionals from all over Argentina are part of the ONDTyD. Monitoring and assessment activities are executed with close links among all partners and sectors. Hence, multi-sectoral knowledge feeds directly into the policy process.

Several national workshops were launched to create networks linking the political, scientific, and technological sectors at regional and national levels, as well as non-governmental organisations working in the area. The Secretariat of Environment and Sustainable Development (SAyDS), the National Scientific and Technical Research Council (CONICET), the Argentine Institute for Arid Zone Research (IADIZA), the National Institute of Agricultural Technology (INTA), and two national universities (Center for Surveying and Assessment of Agricultural and Natural Resources, University of Córdoba and School of Agriculture, University of Buenos Aires) were all founding institutions of ONDTyD. Together, they established its organisation and internal regulation. These institutions are all part of the steering committee and work together with other agencies on the advisory council. They are in charge of compiling and reporting data at the national level and directing work on specific topics.



Steering Committee
Representatives from MAyDS (Executive), CONICET Central, IADIZA-CONICET, CREAN, INTA, FAUBA. As the highest organ, it is in charge of management and coordination.

Advisory Council
Key individuals and representatives from institutions. As the advisory organ on technical/scientific matters, it supports the functioning of the ONDTyD and provides data.

Pilot Sites
They are providers of local-level field data with the capacity to extrapolate results to the regional level.

Structure of the Observatory of Land Degradation and Desertification.
Source: Abraham, E., 2015[5].

Active dunes advancing up the mountains by wind erosion, Catamarca Province
Source: Maggi, A.

The objective of the National Observatory

The principle objective is to establish and maintain a national network for permanent bio-physical and socio-economic monitoring and assessment of land degradation in order to better inform decision-making and policy development on land-use planning and management[1]. Results of the ONDTyD are presented with general information, interactive maps, and an open-source server for sharing geospatial data on a website (www.desertificacion.gob.ar).

The activities and user-oriented output of the National Observatory:

- Implementation of the Argentine System for Monitoring and Assessing Land Degradation and Desertification at local and national levels
- Monitoring of a set of biophysical and socio-economic issues in 17 Pilot Sites
- Repository for geospatial data
- Operation of interinstitutional projects
- Compiling scientific publications and science communication
- Providing science outreach and technical training
- Proposing and promoting Sustainable Land Management proposals

Across scale monitoring methodology

Building further on experiences gained from the Land Degradation Assessment in Drylands in Argentina[2] and from the earlier system of integrated assessment of desertification[3] as well as many other projects, e.g. Patagonia[4], the participatory monitoring approach considers local, regional and national levels. The scheme highlights the importance of pilot sites in generating local contextual evidence that is needed for correct interpretation of higher-level information. Currently, fifteen pilot sites, representing almost all of Argentina's ecosystems, are networked and gather biophysical and socio-economic data. Criteria have been defined through a participatory process to ensure comparability. Issues on which local data is gathered include:

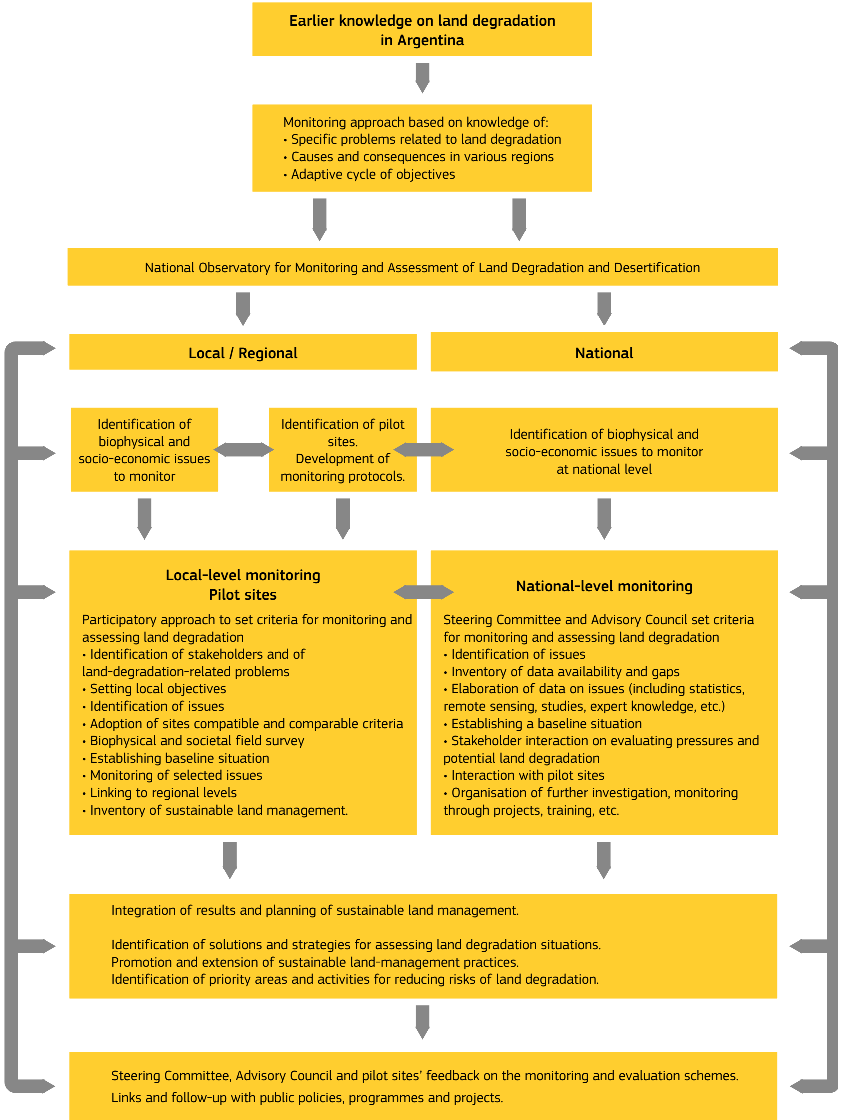
- human (e.g. education completion rates, illiteracy rates, local rates of principal illnesses),
- social (e.g. participation of herders and farmers in civil organisations, social programmes),
- physical (housing quality, forms of land ownership, household access to water), and
- financial (household income, access to government subsidies or credits).

Other topics covered include:

- State of water
- Erosion
- Soil characteristics
- Vegetation cover and composition
- Local-specific degradation processes
- Societal impact of changing conditions

Trends on biophysical data are monitored and linked with satellite data. Regular reports are compiled by members of the steering committee and advisory council and made available on the website.

On 14 July 2015, the Observatory of Land Degradation and Desertification and its work were declared a matter of national interest by the Argentine Congress.



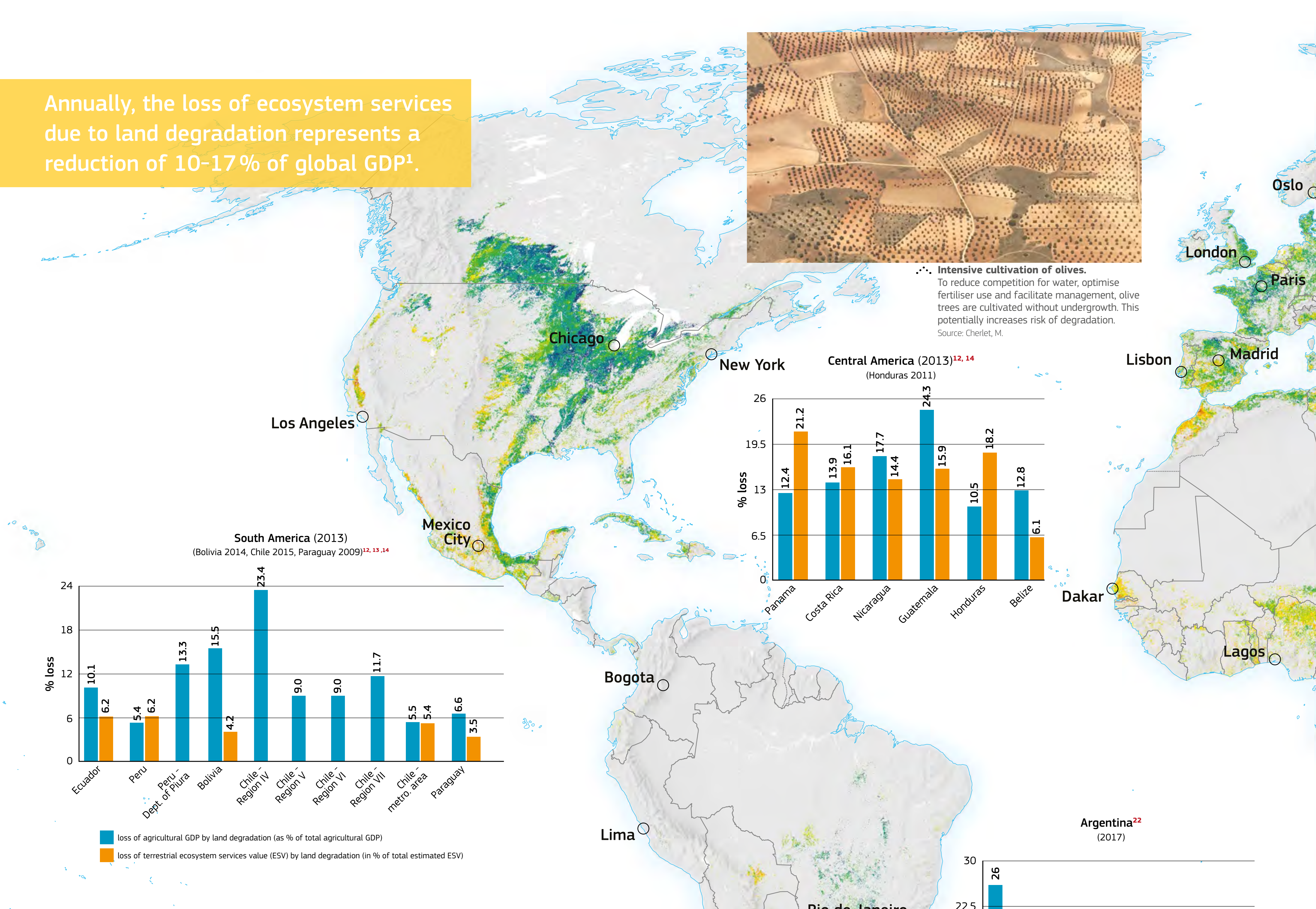
Implementation of monitoring and assessment of land degradation and desertification in Argentina.
Source: Adapted after Abraham, 2015[5].

The website of the National Observatory of Land Degradation and Desertification (www.desertificacion.gob.ar).

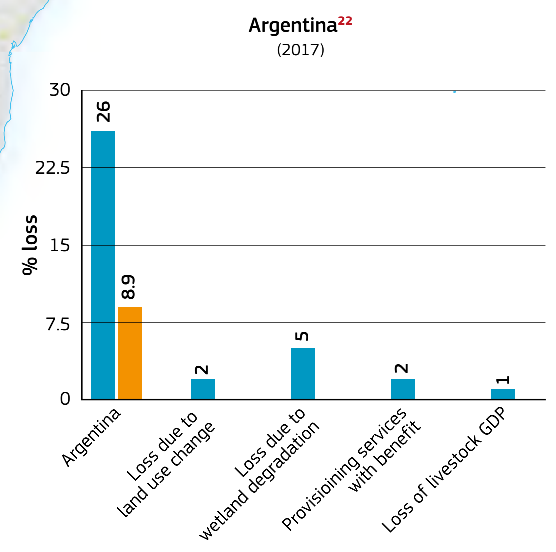
Cost of Land Degradation

Understanding economics increases awareness and prompts sustainable land management

Annually, the loss of ecosystem services due to land degradation represents a reduction of 10-17% of global GDP[1].



Intensive cultivation of olives.
To reduce competition for water, optimise fertiliser use and facilitate management, olive trees are cultivated without undergrowth. This potentially increases risk of degradation.
Source: Cherlet, M.



Historically, a reduction in productivity (usually plant yield) and its subsequent economic cost, was the main criterion used to define the severity of land degradation[2]. A more robust criterion now exists that places land degradation into the context of issues that matter the most to humans – estimating the monetary value associated with a "persistent reduction of ecosystem goods and services"[3]. For example, in absolute terms the monetary value of total global ecosystem goods and services – the terrestrial ecosystem services value (ESV) which includes food, feed, water availability, timber, air and water purification, soil formation, storage of carbon, flood mitigation and pollination – was recently estimated to be $125-145 trillion US$/year while losses due to land degradation ranged from $4.3–20.2 trillion US$/year[4]. The Economics of Land Degradation (ELD) Initiative, which is a global initiative that promotes an awareness of the economic consequences of land degradation, and the value of sustainable land management (SLM), estimates that the value of ecosystem services lost due to land degradation is equivalent to 10-17% of global GDP[1].

Monetary valuations of ecosystem goods and services such as these should nonetheless be considered as rough approximations. There are numerous reasons for this, including: (i) the lack of a universally accepted pricing system[5]; (ii) the lack of cost–benefit economic analyses at local scales and in data-poor areas[6]; (iii) many physical or environmental linkages that support or maintain ecosystem functions are difficult to quantify and thus remain 'hidden'[7]; and (iv) most ecosystem services are interdependent, interactive, and function on long time scales, which makes their economic valuation extremely challenging[8]. In spite of these shortcomings, the monetary valuation of ecosystem services has many benefits, from raising awareness to supporting decision-makers who are considering the economic benefits of SLM[9,10]. Econometric data at the local scale has the potential to impart insights into the cost-benefits of alternative strategies (and their trade-offs) as well as the monetary value of adopting a specific land-management practice[6].

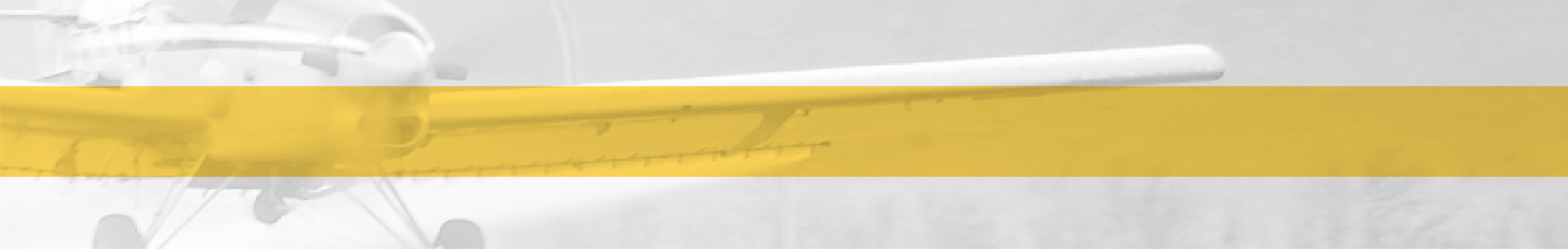
Case study: Ecosystem services and economics in Botswana rangelands[11]

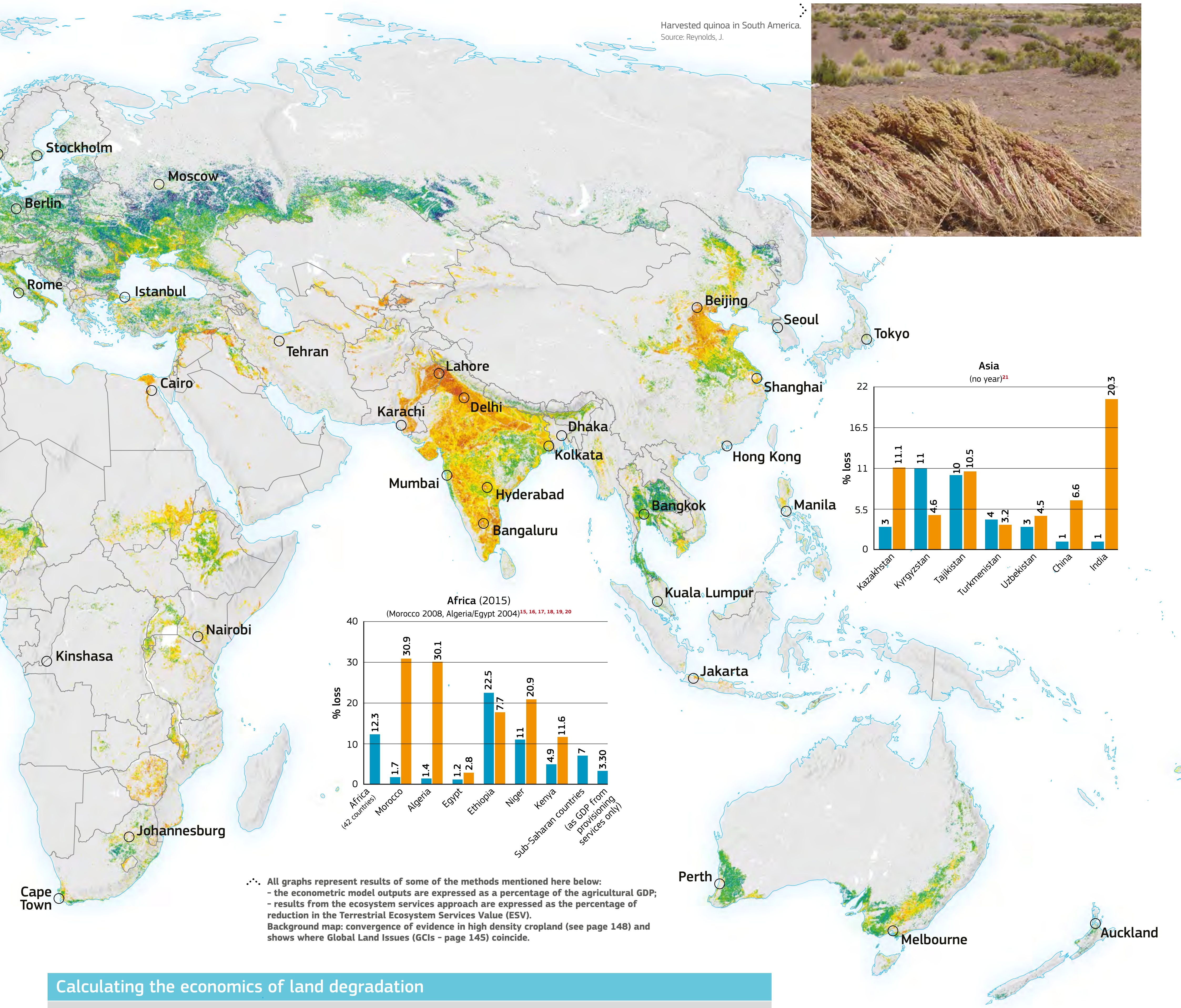
In rangelands of southern Botswana, ecosystem services provide local inhabitants with food, fuel, construction material, groundwater, genetic diversity, climate regulation, recreation and spiritual inspiration. In a report prepared by the ELD Initiative, four land uses – communal grazing, private cattle ranching, private game ranching and protected areas (WMAs, Wildlife Management Areas) – were ranked according to their abilities to deliver these ecosystem services.

Quinoa field in Bolivia.
Source: Reynolds, J.

Communal livestock grazing was found to deliver the widest range of ecosystem services, mainly via commercial food production, wild food production, fuel, construction material, climate regulation and spiritual values; WMAs delivered the next widest range of ecosystem services, followed by private cattle ranches and private game ranches.

While cattle production provides the largest financial returns to private cattle ranchers, its negative consequences in terms of land degradation affect all users of communal rangelands. Hence, costs and benefits are not distributed fairly and policy incentives that support the livestock sector – especially those linked to fencing and borehole drilling – result in an overemphasis on commercial food production, at the expense of other services. Veld products, construction material and fuel wood remain undervalued due to a lack of markets, while access to these ecosystem services is negatively affected by policy support for fencing and borehole drilling. The ELD report concludes that there is a need for policy reform that can support livelihood diversification – and hence SLM – and highlights the need for investment to explore new and potential market opportunities for veld products and carbon trading.





Harvested quinoa in South America.
Source: Reynolds, J.

All graphs represent results of some of the methods mentioned here below:
– the econometric model outputs are expressed as a percentage of the agricultural GDP;
– results from the ecosystem services approach are expressed as the percentage of reduction in the Terrestrial Ecosystem Services Value (ESV).
Background map: convergence of evidence in high density cropland (see page 148) and shows where Global Land Issues (GCIs – page 145) coincide.

Calculating the economics of land degradation

International organisations, such as the Organisation for Economic Co-operation and Development (OECD) and the United Nations Convention to Combat Desertification (UNCCD), initiated programmes to investigate and test different pragmatic approaches to estimate the costs of land degradation. In 2005, the OECD highlighted the cost of inaction as a key consideration for decision-making and resource allocation in combating desertification and land degradation. In April 2013, the UNCCD held the second Scientific Conference to analyse, discuss and build on experiences, research and methodologies used in different contexts and places worldwide. More recently, the Economics of Land Degradation (ELD)[1] developed an holistic framework for the consideration of the economic values of land in political decision-making processes and the benefits derived from the sustainable management of land and soil on a global and local scale.

Currently applied methods to estimate the cost of land degradation illustrate the diversity of views and approaches:

- i Replacement cost method, which counts the value of nutrients needed to add to the land, in order to recover the lost fertility.
- ii Methods based on the loss of net erosion and other associated losses related to water and biodiversity.
- iii Econometrical models, where the cost of land degradation is obtained by calculating the difference in cultivation output between affected and non-affected lands. These models calculate production and yield functions of the most important crops in affected and non-affected lands, as well as data from affected areas compared with optimal economic frontiers of production. Value differences in crop produce between non-degraded and degraded land drive the estimation of economic loss of degradation.
- iv Methods that consider the Total Economic Value (TEV) of land estimate the economic loss by comparing the economic benefits derived from adopting sustainable land-management practices with the costs of these practices.
- v The ecological economics approach[2], based on the estimated Total Terrestrial Ecosystem Services value at global level and its degraded fraction with results for all countries.

All methods depend heavily on the way degradation is approached and measured, which explains the large range of estimates in economic costs. As shown in WAD3, this should be viewed and estimated following stakeholders' interests which will likely yield a wide variety of spatial and numerical results which are all valid and complementary, relecting very different and local situations.

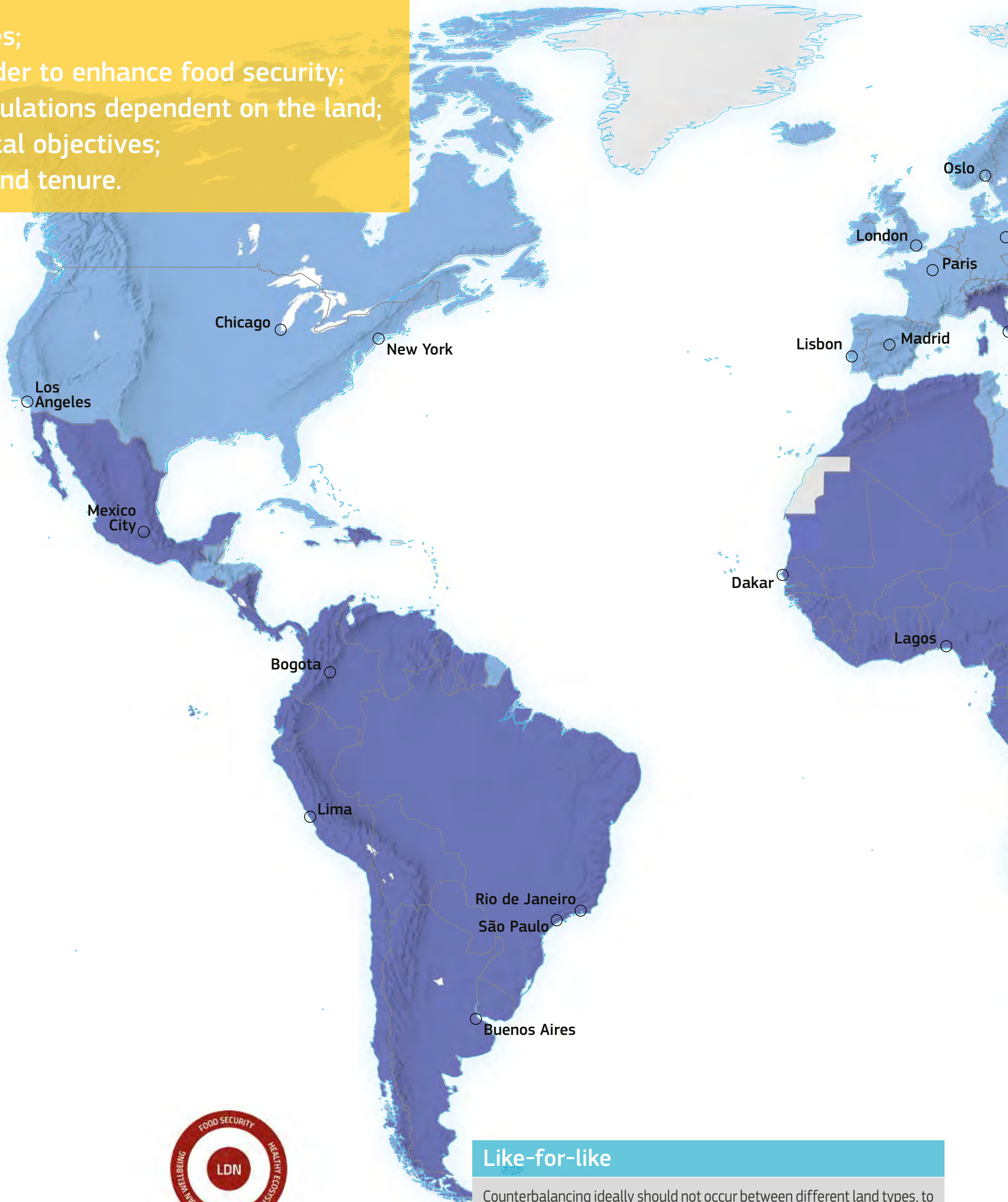
Hay stacks.
Well managed terraced fields on the Chinese Loess plateau minimise the risk of degradation.
Source: Cherlet, M.

Land Degradation Neutrality

A scientific conceptual framework

The objectives of LDN are to:

- Maintain or improve ecosystem services;
- Maintain or improve productivity, in order to enhance food security;
- Increase resilience of the land and populations dependent on the land;
- Seek synergies with other environmental objectives;
- Reinforce responsible governance of land tenure.



Introduction

Achieving Land Degradation Neutrality (LDN) is the new paradigm, introduced to halt the ongoing loss of healthy land as a result of unsustainable management and land conversion. Defined as "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"[1], the goal of LDN is to maintain the land resource base so that it can continue to supply ecosystem services while enhancing the resilience of the communities that depend on the land.

While the scope of the United Nations Convention to Combat Desertification (UNCCD) is limited to drylands, the LDN conceptual framework is intended to be applicable across all land types, so it can be used by countries according to their individual circumstances. The LDN conceptual framework is designed to apply to all land uses (i.e. land managed for production – e.g. agriculture, forestry, for conservation – e.g. protected areas and also land occupied by human settlements and infrastructure) and all types of land degradation.

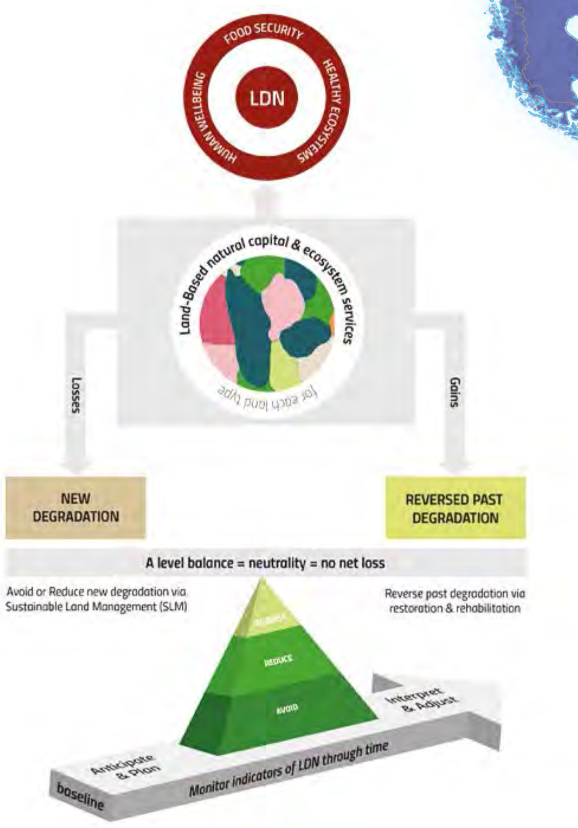
To achieve LDN countries will need to assess the cumulative effect of land use decisions and then undertake measures to restore degraded land so as to compensate anticipated losses – what the policy refers to as a counterbalance. Linking LDN objectives with existing land-use planning mechanisms will facilitate the implementation of LDN. Countries should consider the social, economic as well as environmental outcomes of alternative options when planning LDN measures and should engage relevant stakeholders.

Overview of the conceptual framework

The Scientific Conceptual Framework for Land Degradation Neutrality[2] provides a scientific foundation for planning, implementing and monitoring LDN. It was developed by a group of experts led by the Science-Policy Interface (SPI) of the UNCCD and has been reviewed by technical experts and policymakers. By defining the LDN concept in operational terms, the framework is designed to create a bridge between the vision and implementation. It articulates the scientific basis for the vision and logic of LDN and, based on this, presents a strategy for achieving LDN, an approach to monitoring LDN status and guidance on interpreting the results of monitoring.

Integrated land use planning and the counterbalancing mechanism

Achieving LDN will require monitoring land use where degradation is anticipated (so that cumulative negative impacts can be estimated), followed by interventions designed to avoid, reduce or reverse land degradation, with the intent of achieving neutrality at national scales. Therefore, the conceptual framework introduces a new approach in which land-degradation management is coupled with land-use planning. Decision-makers are encouraged to consider the cumulative effects on the health and productivity of a nation's land resources caused by the collective impact of their individual decisions. LDN thus promotes integrated land use planning, with a long-term planning horizon including consideration of the likely impacts of climate change. The counterbalancing mechanism requires implementation of interventions that will deliver gains in land-based natural capital equal to or greater than anticipated losses due to degradation elsewhere.

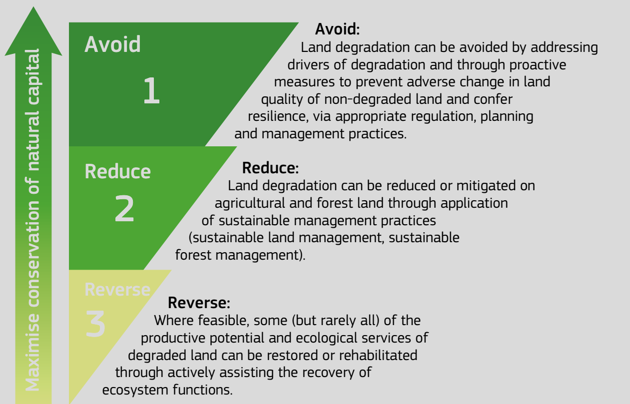


Schematic of the scientific conceptual framework for land degradation neutrality. Envisaged new land degradation needs to be counterbalanced by restoring already degraded land so that on balance the area degraded remains the same or decreases. This is done per land type on a like-for-like basis.
Source: Orr B., 2017[2].

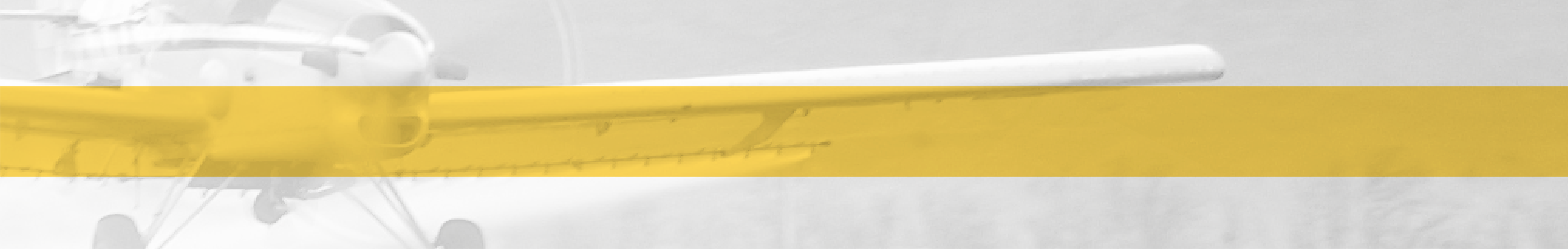
Like-for-like

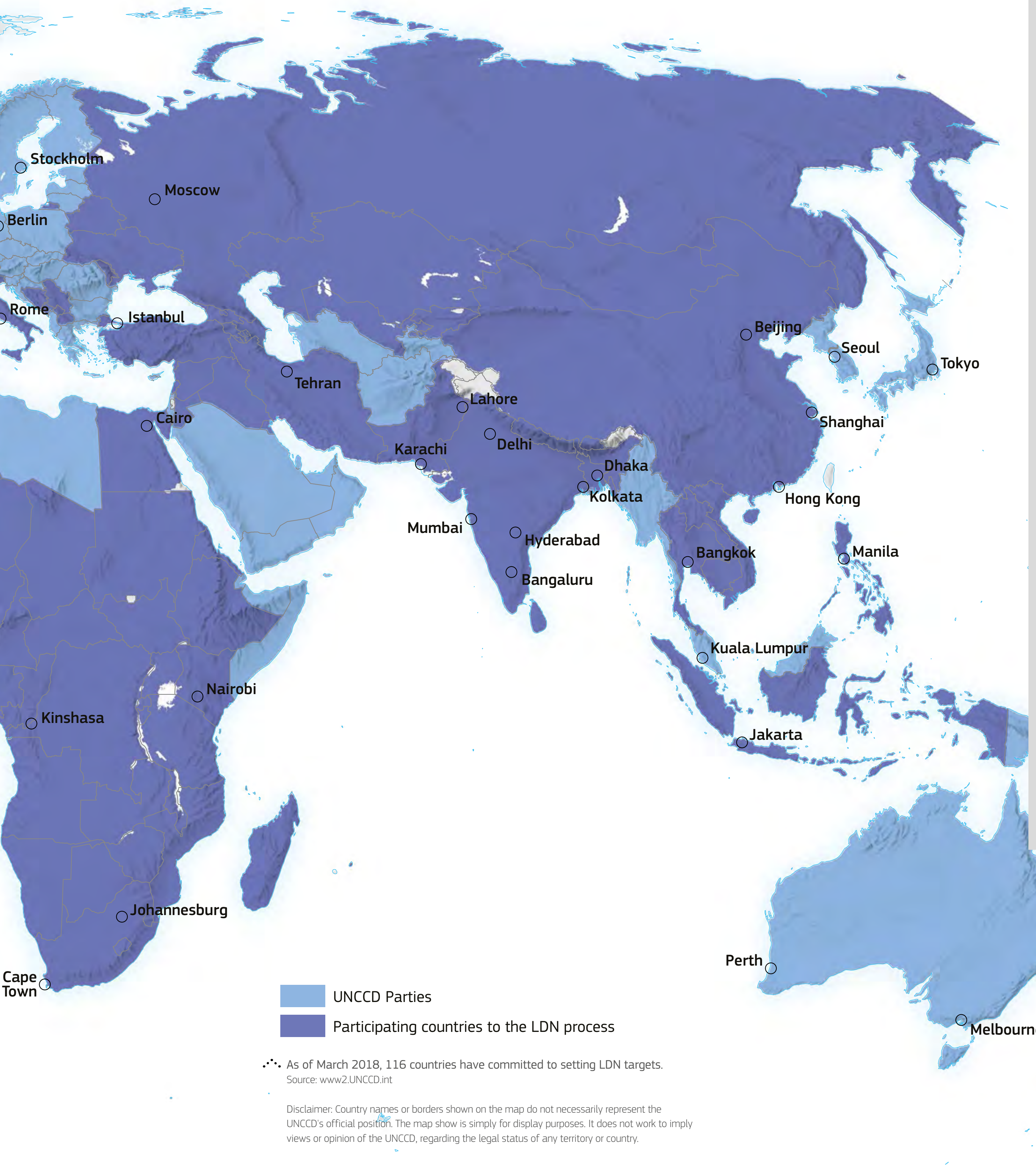
Counterbalancing ideally should not occur between different land types, to ensure "like for like", when assessing and managing the counterbalancing between losses and gains. In other words, a gain in one land type cannot counterbalance a loss in a different land type. Counterbalancing losses in land types managed for conservation with gains in land types managed for production should be avoided.

LDN activities should seek to deliver 'win-win' outcomes, whereby land restoration and rehabilitation contribute to broader environmental goals and more sustainable livelihoods.



The LDN response hierarchy encourages broad adoption of measures to avoid and reduce land degradation, combined with localised action to reverse degradation, to achieve LDN across each land type. It acknowledges that preventing degradation is typically easier and more cost effective than reversing degradation.
Source: Orr B., 2017[2].





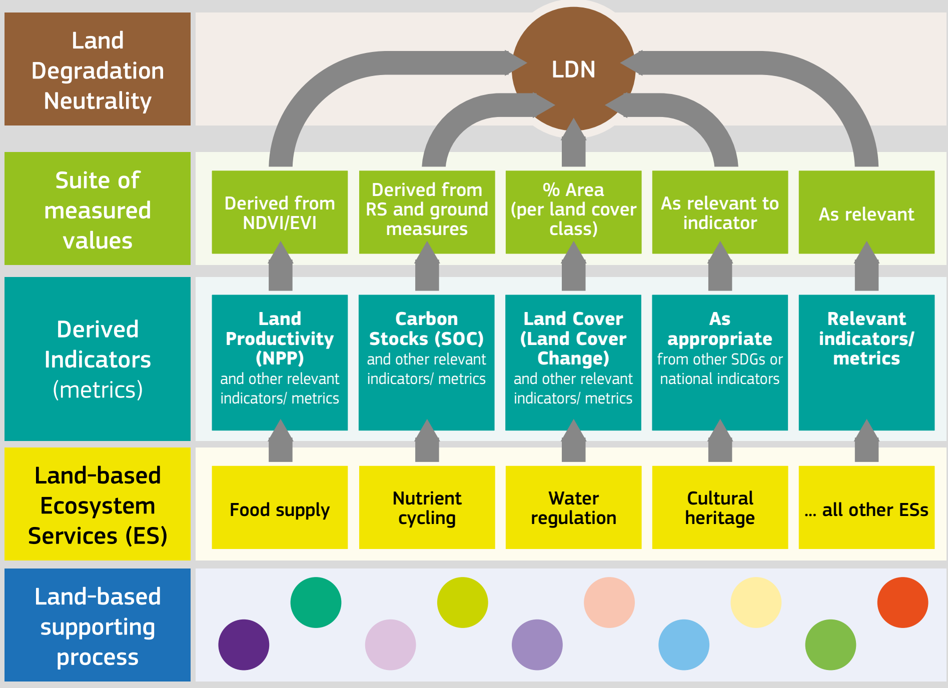
As of March 2018, 116 countries have committed to setting LDN targets.
Source: www2.UNCCD.int

Disclaimer: Country names or borders shown on the map do not necessarily represent the UNCCD's official position. The map show is simply for display purposes. It does not work to imply views or opinion of the UNCCD, regarding the legal status of any territory or country.

The principles for governing LDN:

1. Maintain or enhance land-based natural capital.
2. Protect the rights of land users.
3. Respect national sovereignty.
4. For neutrality, the LDN target equals (is the same as) the baseline.
5. Neutrality is the minimum objective: countries may elect to set a more ambitious target.
6. Integrate planning and implementation of LDN into existing land-use planning processes.
7. Counterbalance anticipated losses in land-based natural capital with interventions to reverse degradation, to achieve neutrality.
8. Manage counterbalancing at the same scale as land-use planning.
9. Counterbalance "like for like" (within the same land type).
10. Balance economic, social and environmental sustainability.
11. Base land-use decisions on multi-variable assessments, considering land potential, land condition, resilience, social, cultural and economic factors.
12. Apply the response hierarchy in devising interventions for LDN: Avoid > Reduce > Reverse land degradation.
13. Apply a participatory process: include stakeholders, especially land users, in designing, implementing and monitoring interventions to achieve LDN.
14. Reinforce responsible governance: protect human rights, including tenure rights; develop a review mechanism; and ensure accountability and transparency.
15. Monitor using the three UNCCD land-based global indicators: land cover, land productivity and carbon stocks.
16. Use additional national and sub-national indicators to aid interpretation and to fill gaps for ecosystem services not covered by the three global indicators.
17. Use the "one-out, all-out" approach to interpret the result of these three global indicators.
18. Apply local knowledge and data to validate and interpret monitoring data.
19. Apply a continuous learning approach: anticipate, plan, track, interpret, review, adjust, create the next plan.

Monitoring LDN



Monitoring LDN achievement of neutrality will quantify the balance between the area of gains (significant positive changes in LDN indicators=improvements) and area of losses (significant negative changes in LDN indicators=degradation), within each land type across the landscape. The LDN indicators specify what to measure, while the metrics state how each of the indicators is assessed. Indicators for LDN were selected to reflect the land-based ecosystem services the LDN seeks to support. The relationship between ecosystem services, indicators and metrics is illustrated in the figure adjacent.

Selection of indicators based on ecosystem services to be monitored.
Source: Orr B., 2017[2].

LDN can help achieve multiple global development and environmental goals

Achieving LDN can have major benefits for both society and the environment. The Sustainable Development Goal 15 (SDG 15) "Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss" includes the specific target (15.3) to "combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods and strive to achieve a land degradation-neutral world". Achieving this goal will be a catalyst to many other SDG goals relating to poverty, hunger, water, fuel and climate. LDN, however, also cuts across all three of the Rio conventions, as in addition to its obvious links to the Convention to Combat Desertification, it will also help maintain biodiversity as well as reduce the rate of climate change through the sequestering of carbon[3].