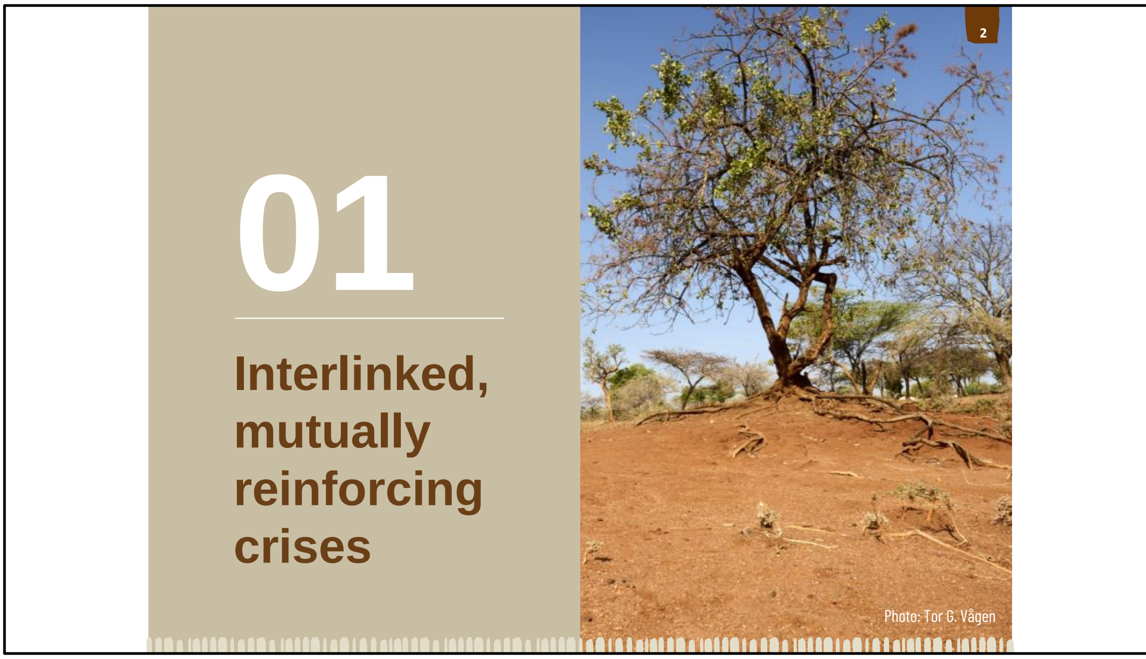
Soil and Water Conservation

to support the restoration activities in Somalia and the establishing of EMGs

OASIS Training-of-Trainers Online-Course,
22 August 2024, Aida Bargués-Tobella, SLU

Funded by the European Union



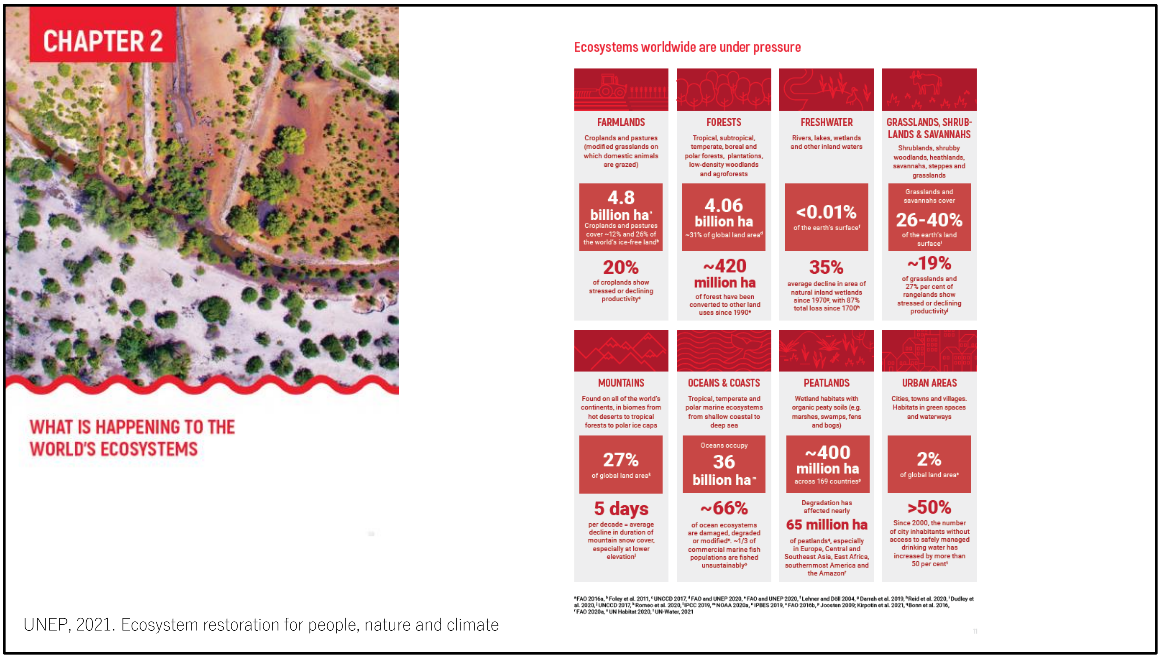
Climate change, land degradation, and biodiversity loss are among our time's most pressing planetary crises and a threat to life on Earth and human wellbeing.

Land degradation is defined as the many human-caused processes that drive the decline or loss in biodiversity, ecosystem functions or ecosystem services in any terrestrial and associated aquatic ecosystem (IPBES, 2018).

Soil erosion is the most critical and widespread form of land degradation globally

The main direct drivers of land degradation and associated biodiversity loss are expansion of crop and grazing lands into native vegetation,unsustainable agricultural and forestry practices, climate change, and, in specific areas, urban expansion, infrastructure development and extractive industry

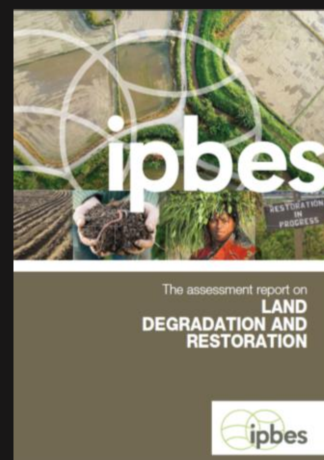
IPBES – intergovernmental science-policy platform on biodiversity and ecosystem services



We are degrading our ecosystems in serious ways. From farmlands to forests, from mountains to oceans, our diverse ecosystems – both natural and modified – are being damaged faster than they can recover. This means they are losing their integrity, their biodiversity and their ability to provide essential services.

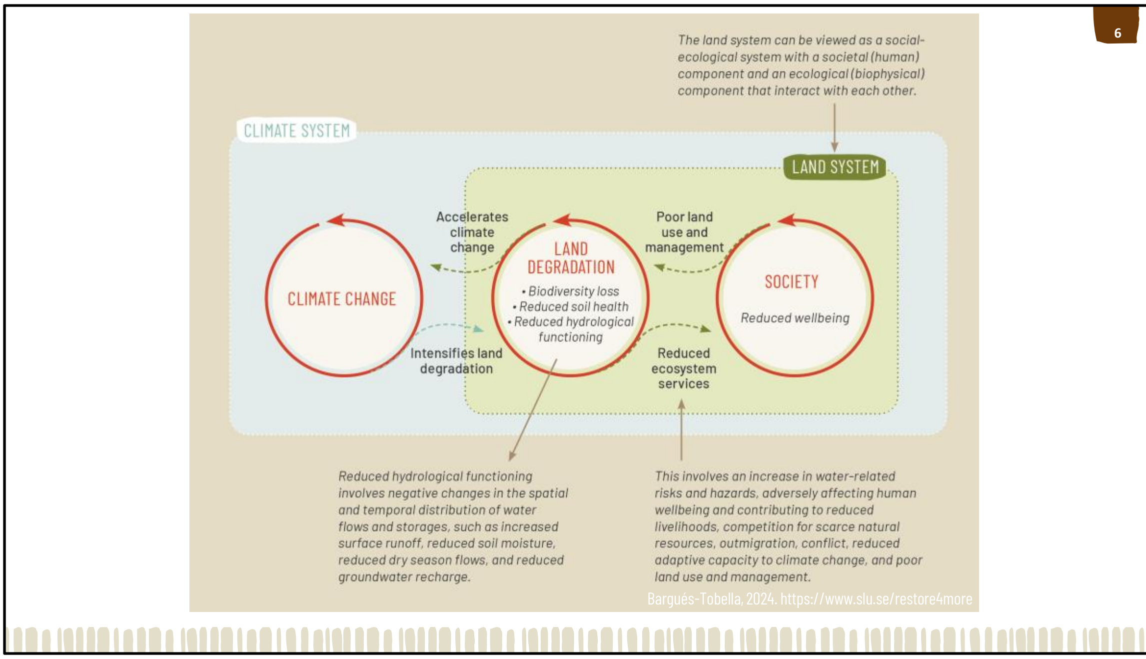
Impacts of land degradation

- Land degradation contributes to the loss of ecosystem services
- It decreases resilience to other stresses
- It increases health risks
- It increases vulnerability, including to socio-economic instability
- It can result in environmental outmigration, more conflict (over e.g., water, food and land) and lower economic growth



IPBES, 2018. The assessment report on land degradation and restoration

Therefore it is critical that we avoid degradation as a first action



These crises are deeply interwoven and mutually reinforcing: climate change is a principal driver of land degradation and biodiversity loss, while land degradation and biodiversity loss further accelerate climate change.

Land and climate are tightly coupled through complex two-way interactions across temporal and spatial scales. Climate change and land degradation act as threat multipliers, with mutually reinforcing positive feedbacks between land degradation and climate change leading to an accelerated downward spiral

In the drylands of East Africa…

- Millions rely on livestock-based livelihoods
- High aridity levels and unpredictable and variable rainfall constrain livelihoods
- Land degradation is widespread
- Ongoing climate change and socioeconomic changes exacerbate the situation
- Disproportionately negative impacts on disadvantaged social groups

IPBES, 2019; Gang et al., 2014; Robinson et al., 2011; Lickley & Solomon, 2018.

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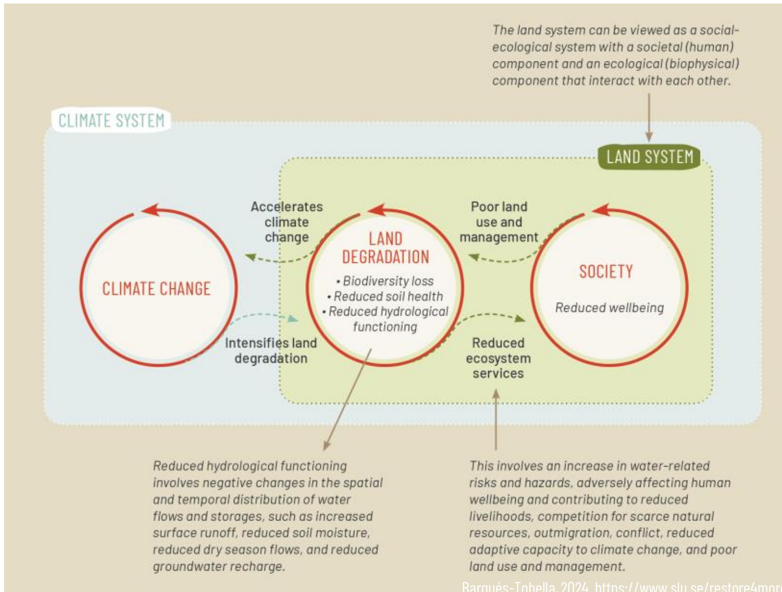
But rangelands and the livelihoods of the people they support are severely threatened by the compounding effects of land degradation, water insecurity, biodiversity loss, and climate change.

In the drylands of East Africa, where millions rely on livestock-based livelihoods, high aridity levels and unpredictable and variable rainfall **place significant constraints on water security and livelihood opportunities**. Land degradation is widespread and **reduces fundamental ecosystem functions and services**. Ongoing climate change and socioeconomic changes, including rapid population growth, further exacerbate the situation, with disproportionately negative impacts on disadvantaged social groups such as pastoralists.

In East Africa,most of these drylands are rangelands that support pastoralist communities and where these challenges are
particularly acute. Restoring degraded rangelands is critical to address these interlinked crises and enhance

human wellbeing. However, significant knowledge gaps limit effective rangeland restoration at scale



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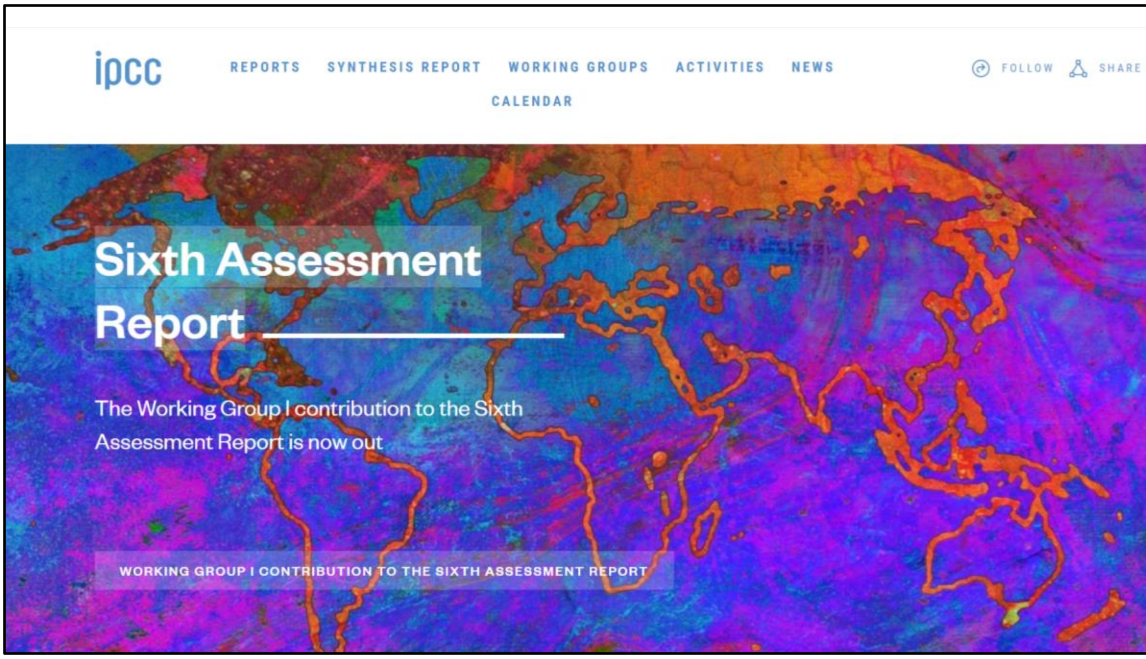
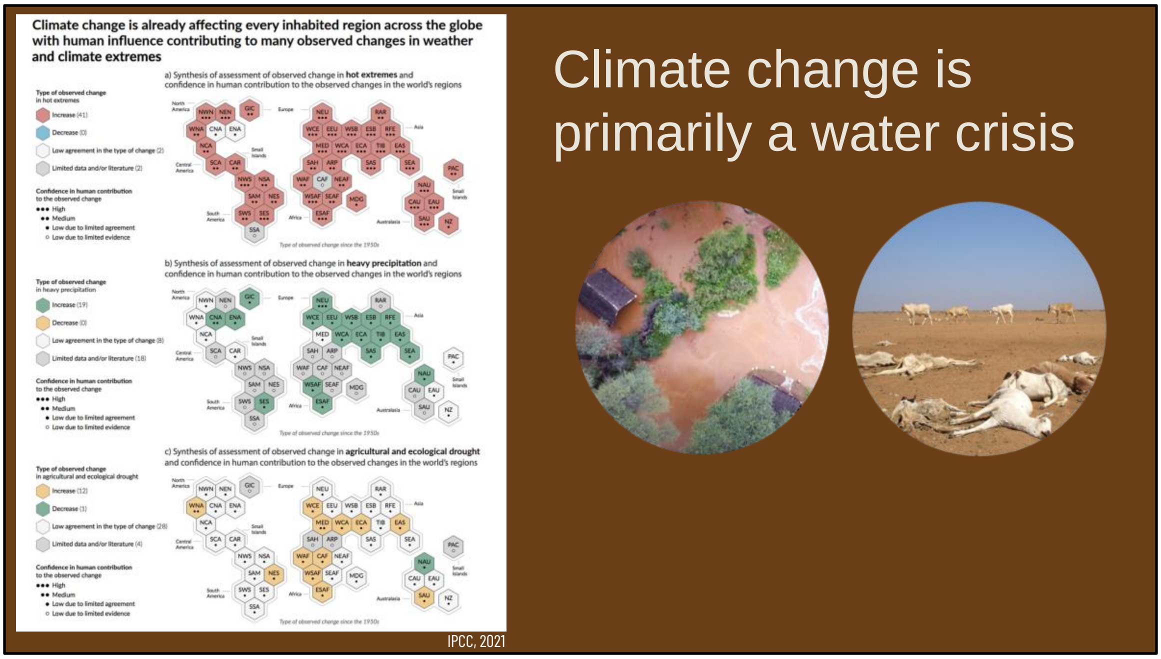


Understanding these links is particularly urgent under climate change, as it will likely increase the frequency and intensity of heavy precipitation and droughts

IPCC's sixth assessment report from 2021, which for the first time included a dedicated chapter to extreme weather and climate events.

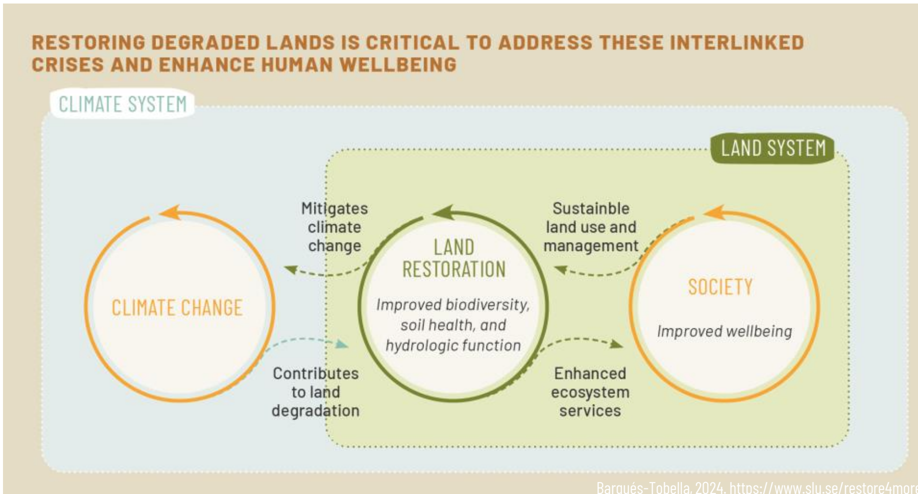
Among its key conclusions is that it is an "established fact" that human-caused greenhouse gas emissions have "led to an increased frequency and/or intensity of some weather and climate extremes since pre-industrial times".



Climate change is primarily a water crisis. Global warming is increasing the frequency and intensity of extreme weather and climate events, including droughts and heavy precipitation

With an increase in the frequency and intensity of extreme weather and climate events, more intense rainfall can exacerbate soil erosion and result in greater peak flows and increased flood risk, jeopardizing water and food security and constraining adaptive capacity to climate change. Concurrent increases in the frequency and severity of meteorological droughts can further exacerbate water security and land degradation

New research shows that rapid shifts from severe drought to heavy rains **are becoming more common with climate change**


RESTORING DEGRADED LANDS IS CRITICAL TO ADDRESS THESE INTERLINKED CRISES AND ENHANCE HUMAN WELLBEING
CLIMATE SYSTEM
LAND SYSTEM
CLIMATE CHANGE
Mitigates climate change
Contributes to land degradation
LAND RESTORATION
Improved biodiversity, soil health, and hydrologic function
Sustainble land use and management
Enhanced ecosystem services
SOCIETY
Improved wellbeing
Bargués-Tobella, 2024. https://www.slu.se/restore4more

The restoration of degraded ecosystems is a global priority as reflected by the growing number of restoration initiatives such as the UN Decade on Ecosystem Restoration (2021-30) or the Bonn Challenge. Governments all over the world, including in Africa, have committed to restoring hundreds of millions of hectares of degraded land under these and related initiatives, including AFR100 and the Great Green Wall.

Moving from restoration commitments to action in drylands requires shifting the focus to rangelands

Ecosystem restoration initiatives and efforts have been largely dominated by forest restoration, while other ecosystems have received much less attention. While forests play a critical role in achieving the SDGs, in countries such as Kenya, where drylands make up over 80% of the country, achieving the restoration target of 5.1 million ha by 2030 implies restoring rangelands and farmlands, together with pastoralists and farmers.

Restoration interventions should aim to restore multiple functions and generate a range of ecosystem services that benefit multiple stakeholder groups, from the local to the global level. Unfortunately, many restoration attempts in drylands have failed to do this, compromising water security, biodiversity, and local livelihoods. Such failures are often the result of a lack of understanding of the biodiversity-water-climate nexus. Improving this understanding is critical to ensure quality restoration outcomes that benefit both the environment and local people's livelihoods and that are sustainable in the long term.

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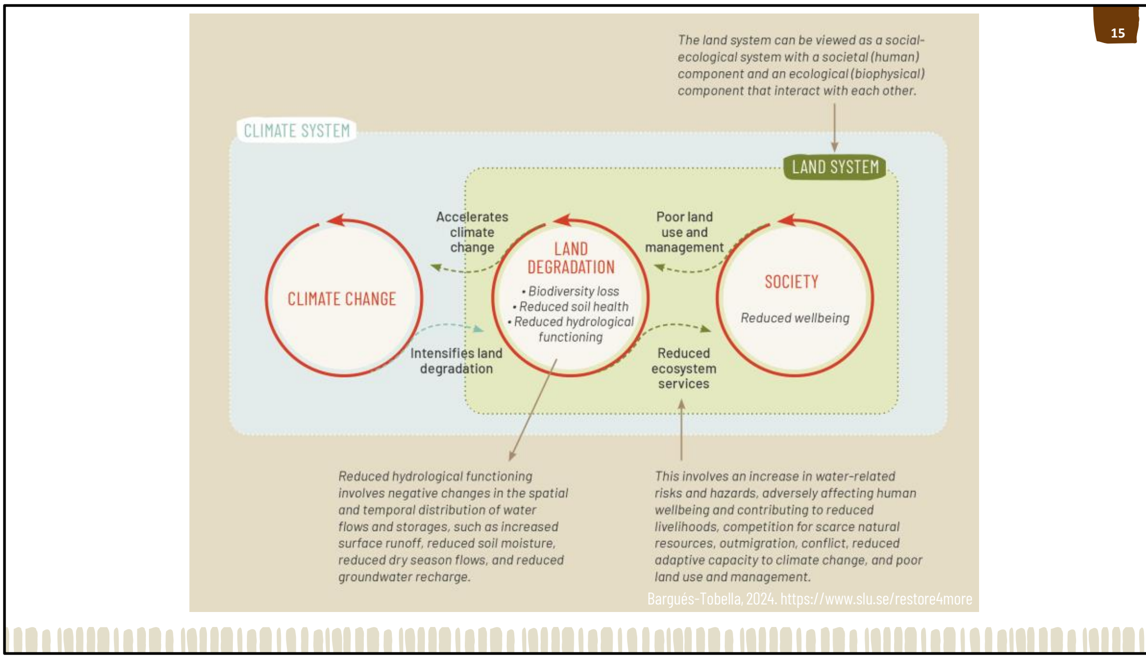
Water plays a central role in the climate-biodiversity crises, simultaneously being part of the challenge and the solution

02

Making sense of land degradation


Photo: Aida Bargués-Tobella



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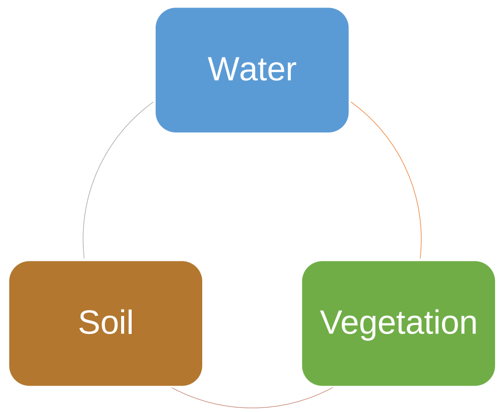
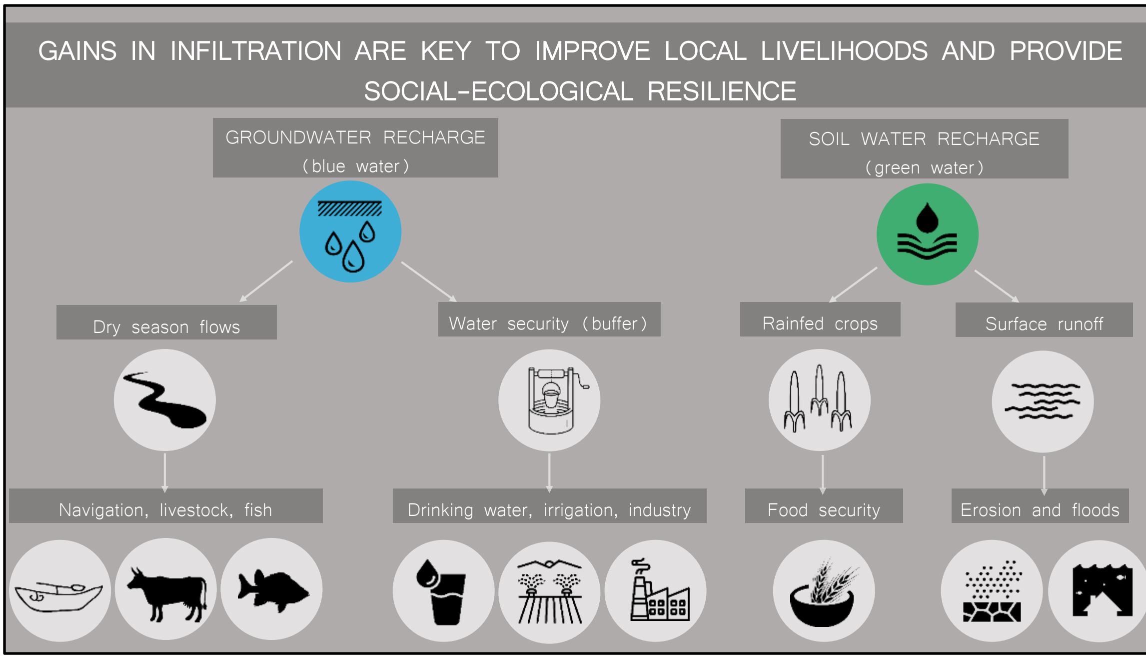

Water
Soil
Vegetation



Groundwater stores sustain baseflows and dry season flows in streams and other aquatic ecosystems

If managed in a sustainable way, groundwater provides a reliable source of fresh water that can serve as a buffer in times of surface water scarcity.

03

Preventing and reversing land degradation through Soil and Water Conservation (SWC) technologies

Some useful definitions

Sustainable Land Management (SLM): 'the use of land resources, including soils, water, animals and plants, for the production of goods to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and ensuring their environmental functions'.
Soil and Water Conservation (SWC): 'activities at the local level which maintain or enhance the productive capacity of the land in areas affected by, or prone to, degradation'.
SWC Technologies: 'agronomic, vegetative, structural and/or management measures that prevent and control land degradation and enhance productivity in the field'.
SWC Approaches: 'ways and means of support that help introduce, implement, adapt and apply SWC technologies on the ground'.

Measures, Technologies, Case Studies and Groups (as defined by WOCAT)

SWC **measures** fall into 4 categories: agronomic (eg mulching), vegetative (eg contour grass strips), structural (eg check dams) or management measures (eg resting of land).

Measures are components of SWC **technologies.** For instance, a terracing system is a technology which typically comprises structural measures – the terrace riser, bed and a drainage ditch – combined with other measures, such as grass on the risers for stabilisation and fodder (a vegetative measure), or contour ploughing (an agronomic measure).

Source: WOCAT, 2007. *Where the land is greener*

Agronomic measures: related to soil management, soil cover, and crop mixtures and rotations
Vegetative measures: use of perennial vegetation to improve ground cover
Structural: Physical barriers to prevent movement of sediments/eroded soil
Management: involve a fundamental change in land use

Groups of SWC technologies

1. Conservation agriculture
2. Manuring/composting
3. Vegetative strips/cover
4. Agroforestry
5. Water harvesting
6. Gully rehabilitation
7. Terraces
8. Grazing land management

Source: WOCAT, 2007. *Where the land is greener*

Table 2: Case studies/ technologies by group

Climatic zone: arid, semi-arid, subhumid, humid
Land use type: annual crops, perennial crops, grazing land, forest, mixed, other[1]
Degradation type: water erosion, wind erosion, chemical deterioration, physical deterioration, vegetation degrad., water degradation
Conservation measure: agronomic, vegetative, structural, management
Intervention type: prevention, mitigation, rehabilitation

Group / Case study/ technology	Country
1 Conservation agriculture	
No-till technology	Morocco
Conservation agriculture	UK
Small-scale conservation tillage	Kenya
No-till with controlled traffic	Australia
Green cane trash blanket	Australia
2 Manuring/ composting	
Vermiculture	Nicaragua
Composting/ planting pits	Burkina Faso
Improved trash lines	Uganda
3 Vegetative strips/ cover	
Natural vegetative strips	Philippines
Green cover in vineyards	Switzerland
Vetiver grass lines	South Africa
4 Agroforestry	
Shelterbelts	P.R. China
Grevillea agroforestry system	Kenya
Poplar trees for bio-drainage	Kyrgyzstan
Multi-storey cropping	Philippines
Intensive agroforestry system	Colombia
Shade-grown coffee	Costa Rica
Conversion of grazing land	Tajikistan
Orchard-based agroforestry	Tajikistan
5 Water harvesting	
Sunken streambed structure	India
Planting pits and stone lines	Niger
Furrow-enhanced runoff harvesting	Syria
6 Gully rehabilitation	
Check dams from stem cuttings	Nicaragua
Gully control and catchment protection	Bolivia
Landslip and stream bank stabilisation	Nepal
7 Terraces	
Stone wall bench terraces	Syria
Rehabilitation of ancient terraces	Peru
Traditional stone wall terraces	South Africa
Fanya juu terraces	Kenya
Small level bench terraces	Thailand
Orchard terraces with bahia grass cover	PR China
Zhuanglang loess terraces	PR China
Rainfed paddy rice terraces	Philippines
Traditional irrigated rice terraces	Nepal
8 Grazing land management	
Ecograze	Australia
Restoration of degraded rangeland	South Africa
Improved grazing land management	Ethiopia
Area closure for rehabilitation	Ethiopia
9 Other technologies	
Pepsee micro-irrigation system	India
Sand dune stabilisation	Niger
Forest catchment treatment	India
Strip mine rehabilitation	South Africa

[1] other land use types: eg wasteland, degraded land

Land use type: before SWC technology was implemented / after SWC technology was implemented
Degradation type: main degradation type addressed / minor degradation type addressed
Conservation measure: main conservation measure / supportive / optional SWC measure

Combinations: Often these measures are implemented together

1. Conservation agriculture

- Mainly agronomic measures
- Incorporation of 3 basic principles:
  - Minimum soil disturbance
  - Some degree of permanent soil cover
  - Crop rotation

Small-scale conservation tillage
Kenya – *ConTill / Kupiga tindo*

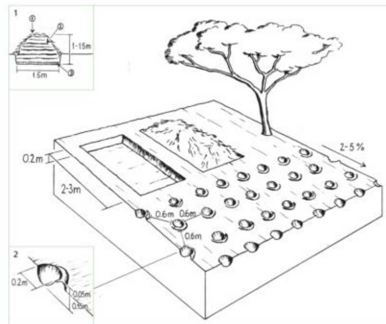
Source: WOCAT, 2007. *Where the land is greener*

The form of conservation agriculture described in this case study involves the use of ox-drawn ploughs, modified to rip the soil. (here to a depth of 10 cm).
The aim of ripping is to increase water infiltration and reduce runoff. In contrast to conventional tillage, the soil is not inverted, thus leaving a certain amount of crop residue on the surface. As a result, the soil is less exposed and not so vulnerable to the impact of splash and sheet erosion, and water loss through evaporation and runoff.

2. Manuring / composting

- Mainly agronomic measures
- Organic manures and composts are intented to:
  - Improve soil fertility
  - Enhance soil structure
  - Improve water infiltration and percolation

The earthworms or red wrigglers convert organic matter to fertile compost
Photo: © GIZ/Abinet Shiferaw (Hammer branding)



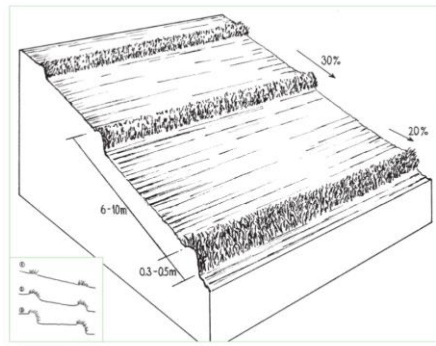
Technical drawing
Overview of compost making and *zai* planting pits within a field. Tree shade helps to conserve moisture in the compost pits.
Insert 1: Cross section of compost pit: protective straw (1); successive layers of compost (2), clay layer at the bottom (3).
Insert 2: Detailed view of *zai* planting pit.

Source: WOCAT, 2007. *Where the land is greener*

Layers of animal dung, crop residues, and ash, and covered with straw. Watered.

3. Vegetation strips /cover

- Mainly vegetative measures
- Involve the use of perennial grasses, shrubs or trees
- Benefits of ground cover by vegetation



Technical drawing
Spacing of natural vegetative strips depends on the slope. The insert shows the evolution of terraces over time through tillage and soil erosion, leading to accumulation of sediment behind the strips (steps 1–3).

Source: WOCAT, 2007. *Where the land is greener*

Natural vegetative strips (NVS) are narrow live barriers comprising naturally occurring grasses and herbs. Contour lines are laid out with an A-frame or through the ‘cow's back method’ (a cow is used to walk across the slope: it tends to follow the contour and this is confirmed when its back is seen to be level). The contours are then pegged to serve as an initial guide to ploughing. The 0.3–0.5 m wide strips are left unploughed to allow vegetation to establish.

4. Agroforestry

- Vegetative and agronomic measures mainly
- Trees are deliberatly grown in association with agricultural crops, pastures or livestock

Photo: Patrice Savadogo

Photo: Aida Bargués-Tobella

Photos: Aida Bargués-Tobella

5. Water harvesting

- Structural measures mainly
- Collection and concentration of rainfall runoff for crop production or for improving the performance of grass and trees in drylands where moisture deficit is the primary limiting factor.

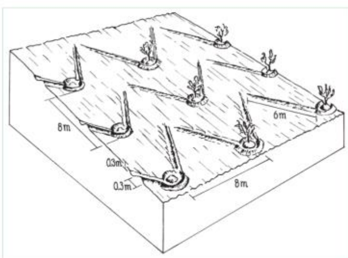
Half moons

Photos: Justdiggit

Half moons


Photo: Aida Bargués-Tobella

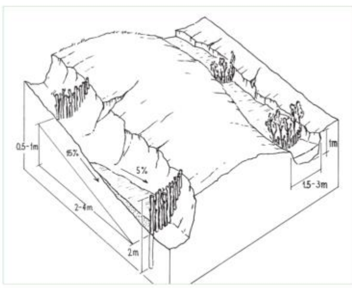
Zaï pits



Technical drawing
V-shaped micro-catchments which harvest water for the olive trees: the furrows up-and-down slope help channel the runoff to the olives.

6. Gully control

- Structural and vegetative measures mainly
- Measures that address gully erosoion
- Usually structural barriers stabilized with permament vegetation

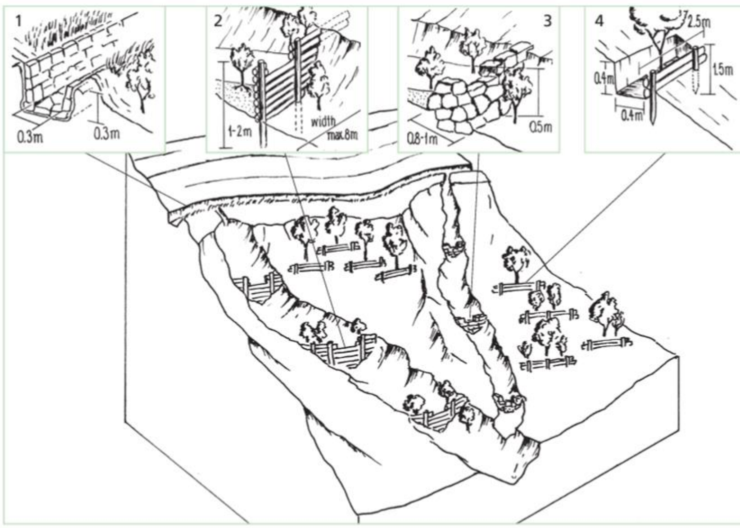


Technical drawing
Stem cuttings planted in gullies to form living check dams: recently planted (left) and cuttings that have begun to take root and sprout, resulting in the gully becoming filled with trapped sediment (right).

Source: WOCAT, 2007. *Where the land is greener*

Photo: Stephen Mureithi

The dams retard runoff and thus retain eroded sediment. Spacing between dams depends on the gradient of the gully bed. For example on a 15% slope it is recommended to build a dam every 4 meters (see spacing under establishment activities). Between dams, the gully gradually fills up with eroded soil, the speed of the runoff is further reduced and agricultural land that has been divided by the gully is reconnected. Large and deep gullies may change over time into a sequence of narrow fertile terraces where crops can be grown.

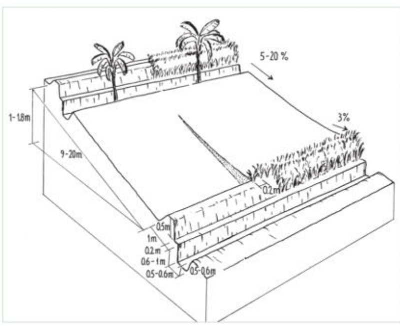


Technical drawing:
Gully control and catchment protection: an overview of the integrated measures.
Insert 1: Stone-lined cut-off drain with grass-covered bund and live barriers.
Insert 2: Wooden check dam: note that trees are established to further stabilise the gully (as for stone check dams).
Insert 3: Stone check dam.
Insert 4: *Biotrampa:* staggered structures which collect moisture and sediment for tree planting.

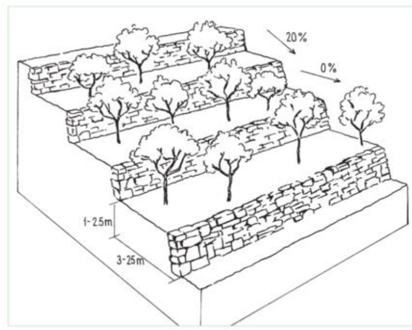
Source: WOCAT, 2007. *Where the land is greener*

7. Terraces

- Structural, but usually combined with agronomic and vegetative measures
- Many types of terraces



Technical drawing
Fanja juu terraces: newly constructed (left) and mature (right) with bananas planted below the bund and fodder grass on the riser: note leveling occurs over time (right).



Technical drawing
Stone wall risers constructed in ancient times: these hold back the earth for production of fruit trees on the level benches.

Source: WOCAT, 2007. *Where the land is greener*

This intervention aims to reduce soil erosion by breaking down long slopes into smaller sections. Thus, the speed of runoff will decrease, and water can infiltrate.

Fanya juu (‘throw it upwards’ in Kiswahili) terraces comprise embankments (bunds), which are constructed by digging ditches and heaping the soil on the upper sides to form the bunds. A small ledge or ‘berm’ is left between the ditch and the bund to prevent soil sliding back. In semi-arid areas, fanya juu terraces are normally constructed on the contour to hold rainfall where it falls.

Photo: Greener Land

8. Grazing land management

- Management practices with associated vegetative and agronomic measures
- Related to changing control and regulation of grazing pressure
- Initial reduction of grazing intensity through fencing, followed either by rotational grazing, or ’cut-and-carry’ of ofdder, and vegetation improvement.

Combining SWC technologies in Livestock Cafés

drylands transform

RESTORE 4MORE

drylands transform

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Combining SWC technologies in Livestock Cafés

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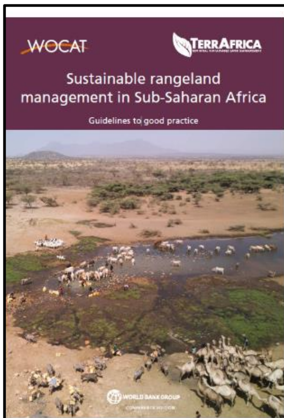
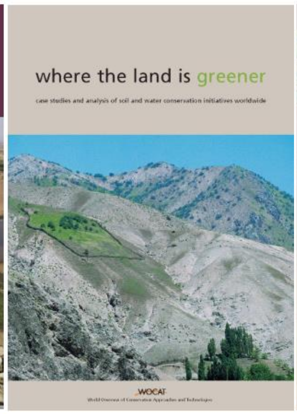
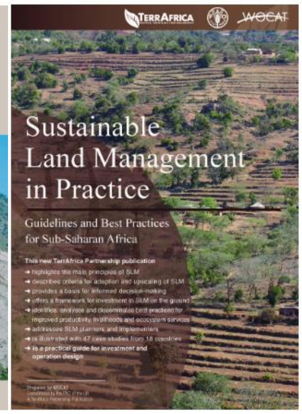
WOCAT

World Overview of Conservation Approaches and Technologies







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World Overview of Conservation Approaches and Technologies

Thank you.

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