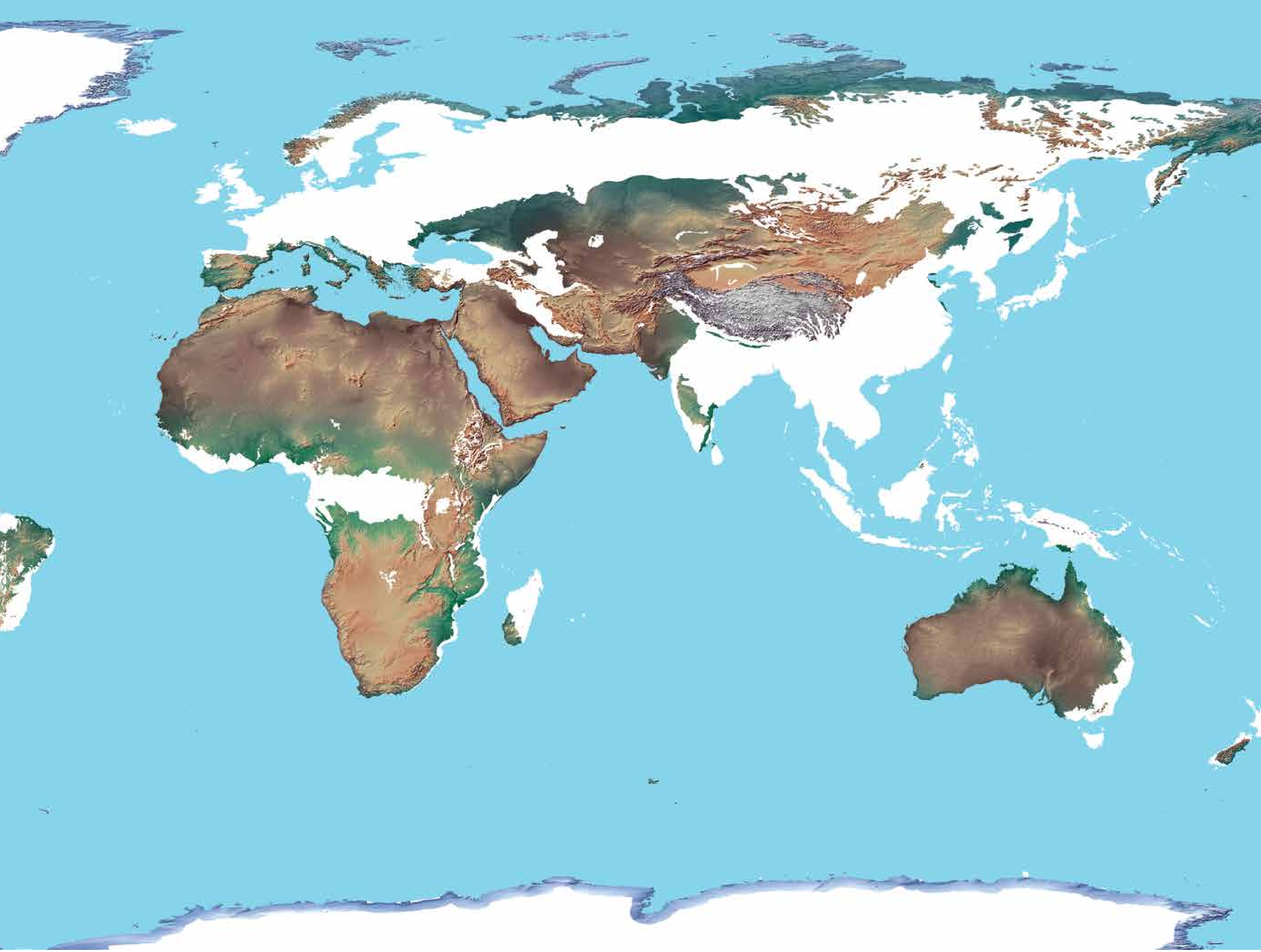

Rangelands ATLAS

INTERNATIONAL LAND COALITION

RANGELANDS INITIATIVE GLOBAL

IUCN

WWF

UN environment programme

UNITED NATIONS DECADE ON ECOSYSTEM RESTORATION 2021-2030

Food and Agriculture Organization of the United Nations

ILRI INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE

CGIAR

RangelandsAtlas

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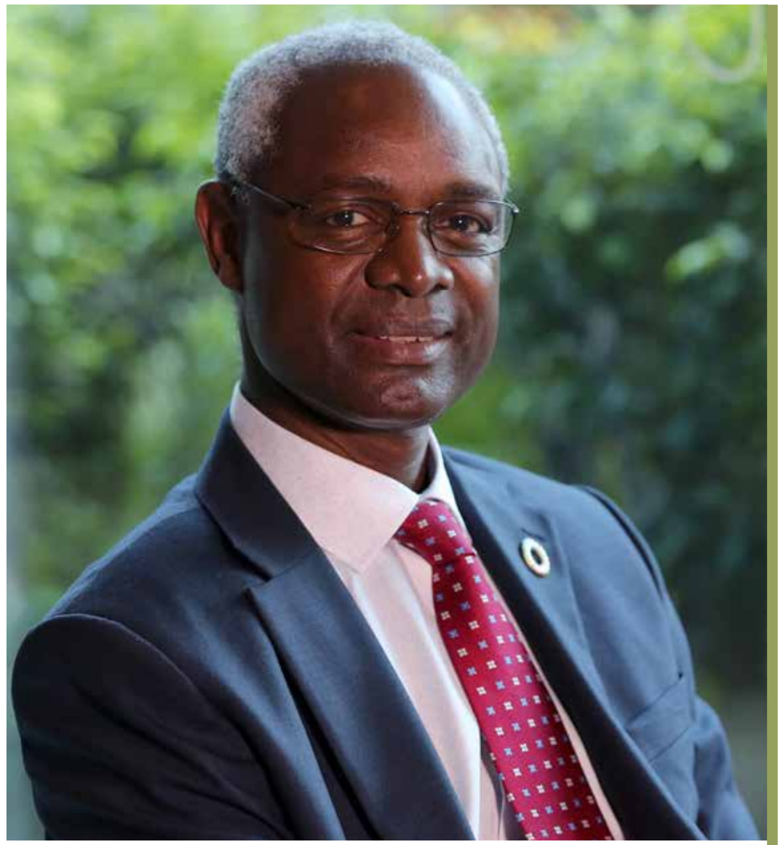


Foreword

Rangelands truly are nature's gift to humanity. We first emerged as a species from East Africa's rangelands to spread out and populate the whole planet.

Today, rangelands are home to billions of people, and provide much of the agriculture that feeds us all, wherever we live. They are vast and surprisingly diverse, covering over half of our planet's land. They are absent only from Antarctica.

But rangelands in all their forms are under intense pressure. From climate change, and from people. The problem for rangelands is the ease with which they can be put to work by humans: for agriculture, or for settlement.

Wherever rangelands are found, our unsustainable consumption and production patterns are driving land use changes, including the conversion of grasslands and savannas previously used by wildlife and for grazing livestock by pastoralists. These changes have contributed to instability in some regions, as well as the increase in the risk of pathogen spillover and new zoonotic infectious diseases.

Yet the pandemic has shown that when political will, collective action, and sustained investment come together – we can make a difference.

At the UNCCD, we fervently believe that restoring rangelands has a huge return on investment. I hope the publication of this Atlas can be a catalyst to spark significant action to restore rangelands across the world and remind us of their fundamental importance to the health of our planet.

For too long, rangelands have been neglected, receiving much less attention, investment, and advocacy than other types of ecosystems. This Atlas will play a key role in shifting the world's focus, raising awareness, helping to address significant knowledge and capacity gaps, and plugging institutional deficiencies.

Acting collectively, we must encourage, facilitate, and deliver rangeland restoration policies and investment that harness and capture indigenous knowledge to deliver meaningful local development and sustainability.

We will all benefit: Better food and water security, more locking away of our carbon emissions into soil, more biodiversity, and healthy air quality can all be delivered by the restoration of degraded rangelands.

Together, let us focus on rangelands so we can build a greener, healthier, more peaceful, and more sustainable future.

Ibrahim Thiaw

The Executive Secretary of the UN Convention to Combat Desertification (UNCCD)

Introduction

Rangelands can be described as land on which the vegetation is predominantly grasses, grass-like plants, forbs or shrubs, and often with trees that are grazed or have the potential to be grazed by livestock and wildlife. They are diverse in their vegetation driven by highly fluctuating rainfall, temperature and other climate phenomena, and habitat for a wide range of wildlife, many species of which are found nowhere else. Rangelands store vast amounts of carbon and either originate or serve as freshwater catchment areas for most of the world's largest rivers and wetlands. Rangelands are home to millions of people, from pastoralists to hunter-gatherers to ranchers to conservationists. Rangelands feed millions of people worldwide. Rangelands have significant cultural and aesthetic value too, and for many, are places of inspiration and beauty.

This *Rangelands Atlas* has been developed to document and raise awareness on the enormous environmental, economic and social value of rangelands as well as their different ecosystems. It highlights many of the changes taking place in rangelands due to climate change, land use and conversion trends, investments and other changes: of most concern is the predicted trends of climate change and biodiversity loss, which will have significant impacts on some rangeland ecosystems.

The spatial mapping of rangelands was produced by focusing on seven of the 14 global biomes categorised by WWF in their mapping of terrestrial ecoregions around the world. These seven biomes include different types of mainly dryland grasslands, savannas, shrublands and forests, together with wetter and colder biomes such as tundra. Though this mapping does not take into account actual land use and other changes that have taken place on the ground, it is a useful starting point for identifying, documenting and raising awareness on the overall characteristics of rangelands, their contribution to livestock and other food production, ecosystem services, conservation and the broader trends of change taking place.

The Atlas also highlights significant data gaps in rangelands, which have seen proportionately less investment in this regard than other land uses and ecosystems. The spatial map of rangelands is combined with other existing global datasets on different themes, to produce a mapping of that data 'for rangelands.'

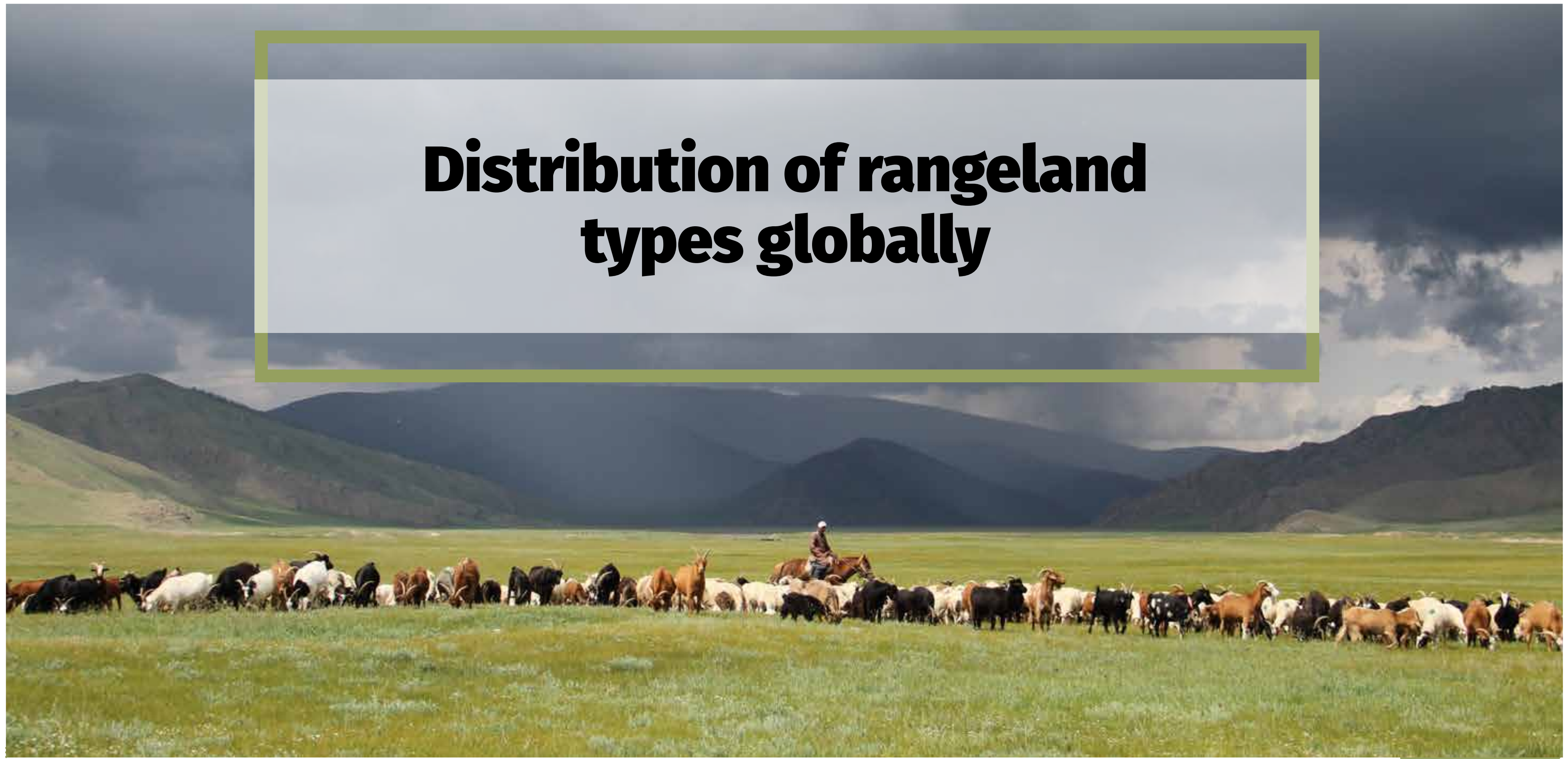
Each entry is presented with a short explanation of the map, some key figures produced from the big data that produced the map, a story from the field adding a taste of a local experience and/or perspective, and some explanation of terminologies used in the map as required. We are reliant on the accuracy of the datasets we have accessed: the data have not been verified at regional, country or local level, and therefore is only an indicator of broad and estimated figures and trends.

We would like to thank the following people who generously contributed their time to the writing of the case studies: *Yhankbai Hijaba, Enkh-Amgalan Tseelei, Claire Ogali, Leigh Ann Hurt, Marco Buemi, Aymen Frija, Mounir Louhaichi, Philippe Remy, Kathrine Ivsett Johnsen, Ol Johan Gaup, Fagouri Said, Dana Kelly, Marta Villa, Anne Gage, Clay Bolt, Kanchan Thapa, Shristi KC, Carolina Siqueira, Juliana Lopes and Brit Reichelt-Zolho. We also give significant thanks to Yasin Getahun, GIS expert at ILRI who has been working tirelessly on producing the maps over several years now, and Erika Pinto Bañuls and Carlos Doménech García of GMV Solutions for their more recent contributions.*

This Atlas is a collaborative initiative of the International Livestock Research Institute (ILRI), International Union for Conservation of Nature (IUCN), Food and Agricultural Organization (FAO) of the United Nations, World Wide Fund for Nature (WWF), the United Nations Environment Programme (UNEP), and the global Rangelands Initiative of the International Land Coalition (ILC). It reflects a strengthening, global movement to protect, restore and appropriately invest in rangelands. Join us in this journey around the world and learn about some of the different initiatives taking place!

Fiona Flintan (ILRI), Jonathan Davies (IUCN), Bora Masumbuko (IUCN), Vivian Onyango (FAO), Gregorio VelascoGil (FAO), Martina Fleckenstein (WWF), Karina Berg (WWF), Abdelkader Bensada (UNEP), and Fernando Garcia Dory (ILC Rangelands Initiative).

Distribution of rangeland types globally



Rangelands are diverse in their vegetation driven by highly fluctuating rainfall, temperature and other climate phenomena, and influenced by soils and management practices. Rangelands have many economic, ecological, social, and cultural values, and a wealth of biodiversity that supports ecosystem health.

This map has been produced using seven of fourteen biomes or rangeland types made up of terrestrial ecoregions as defined by WWF. For more information on these terrestrial ecoregions see:
https://www.worldwildlife.org/publications/terrestrial-ecoregions-of-the-world

KEY DATA

1. **Rangelands cover 54% of global terrestrial surface (148,326,000 km²) to a total of 79,509,421 km².**
2. **The largest rangeland biome is deserts and xeric shrublands covering 27,984,645 km² or 19% of global terrestrial surface.**
3. **Rangelands are made up of seven biomes or rangeland types namely: 35% deserts and xeric shrublands, 1% flooded grasslands and savannas, 4% mediterranean forests, woodlands and scrub, 6% montane grasslands and shrublands, 13% temperate grasslands, savannas and shrublands, 26% tropical and subtropical grasslands, savannas and shrublands, and 15% tundra.**

Reversing rangeland degradation through collective participatory rangeland management in Mongolia

Normally, rangelands are made up of diverse ecozones and biomes that together form productively viable natural and managed ecosystems and landscapes. In Mongolia rangelands are mainly made up of grasslands dominated by grasses, sedge and forbs, with yearly productivity variation being small. These rangelands of Mongolia comprise approximately 70% of the total national territory and are the backbone of the rural economy, providing food security for the entire nation. Livelihoods of 200,000 nomadic herder households are directly dependent on the rangeland for livestock production.

After the disbanding of Soviet cooperatives in the mid-1990s, and a transition to a market-oriented economy after 70 years of central planning, 25 million national livestock were privatised and transferred back to herder households, while the rangelands remained state property. Left unchecked for two decades, the herders, who consider security, income and status in large flocks and herds, have increased livestock numbers three-fold. The current livestock population of 67 million significantly exceeds the overall carrying capacity of the rangelands. The impact of years of overgrazing has led to rangeland degradation. According to the *National Rangeland Health Assessment Report* of 2018, 57% of Mongolia's rangeland is degraded to different degrees.

In the past 10 years or so, numerous research trials have been conducted on an array of modern technologies to identify how pastures could recover from degradation. The trials revealed that the technical rehabilitation of degraded rangelands is both difficult and costly. In addition, they found that the best method is a return to traditional rotational grazing and resting practices, regulated by a grassroots-level system of collective user controls, and supported by improvements to the legal framework, including for land-user rights.

Building on such measures through different projects and following a process of participatory rangeland management (PRM), customary collective institutions of herder households with shared rangelands have established pasture user groups (PUGs). PUG members define the boundaries of grazing areas and regulate their use based on a common rangeland management plan. These plans form the basis for the establishment of rangeland use agreements between PUGs and the local government, serving as a means to enforce and monitor implementation of the plans.

Records show that five million hectares of degraded rangelands are now being rested for a period of two to five years through contracts negotiated between the herders and local governments. Furthermore, PUGs are evolving as an institutional platform to implement not only pasture-management activities, but also to provide for the extension and marketing needs of herder communities. The project is also working through a One Health approach to improve the health of livestock, people and the land as well as preventing, controlling and monitoring livestock disease.

For more information, please see:
http://www.greenmongolia.mn
http://en.greenmongolia.mn/post/61980

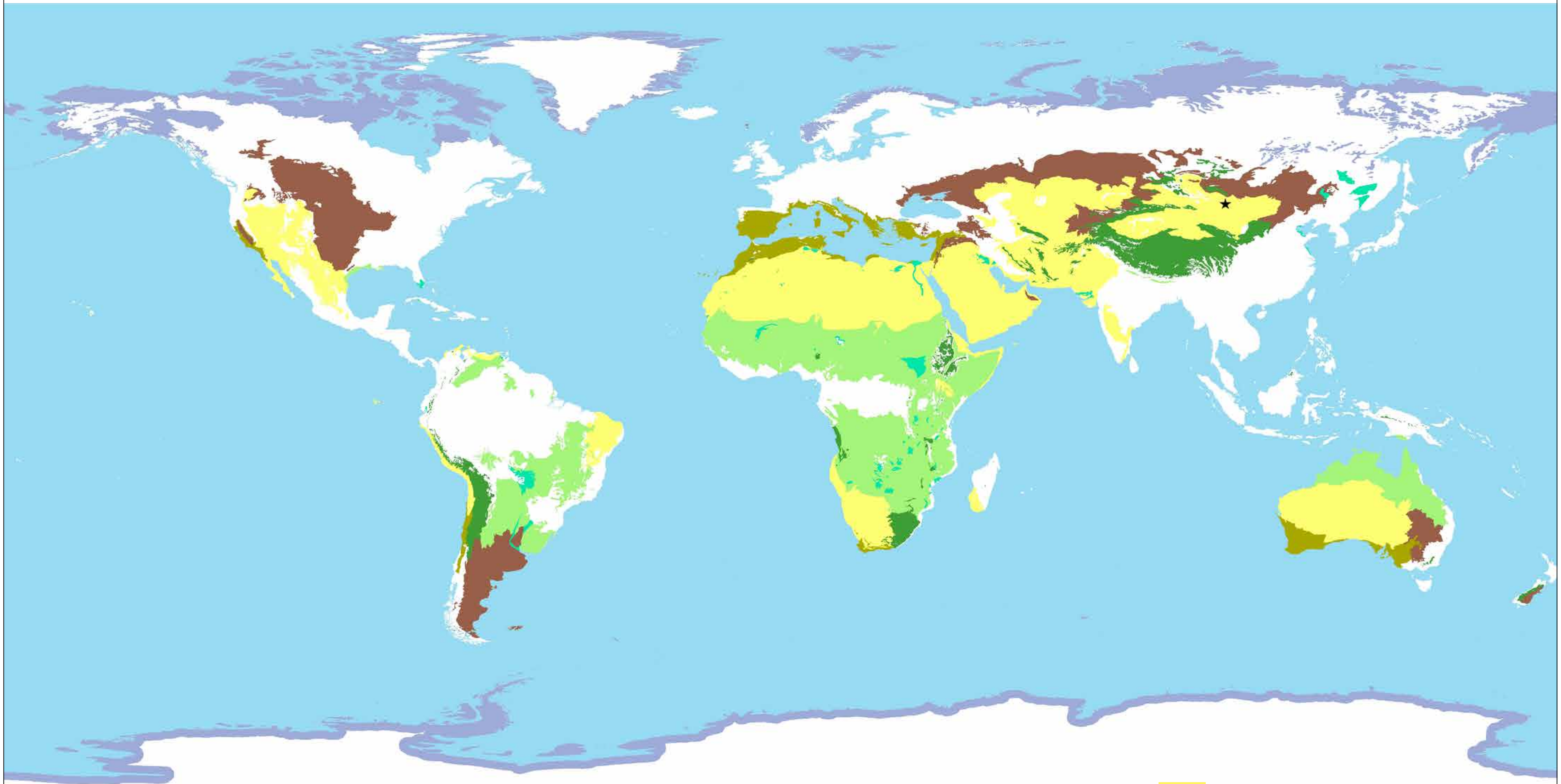
Experience of herder family:
http://en.greenmongolia.mn/post/57021

Nomadic livestock husbandry towards sustainable development presentation: http://en.greenmongolia.mn/post/57025

Implementing One Health in Mongolia's Rangelands:
https://www.youtube.com/watch?v=wfrBfD6q-4o

ILRI, 2021

Distribution of rangeland types globally

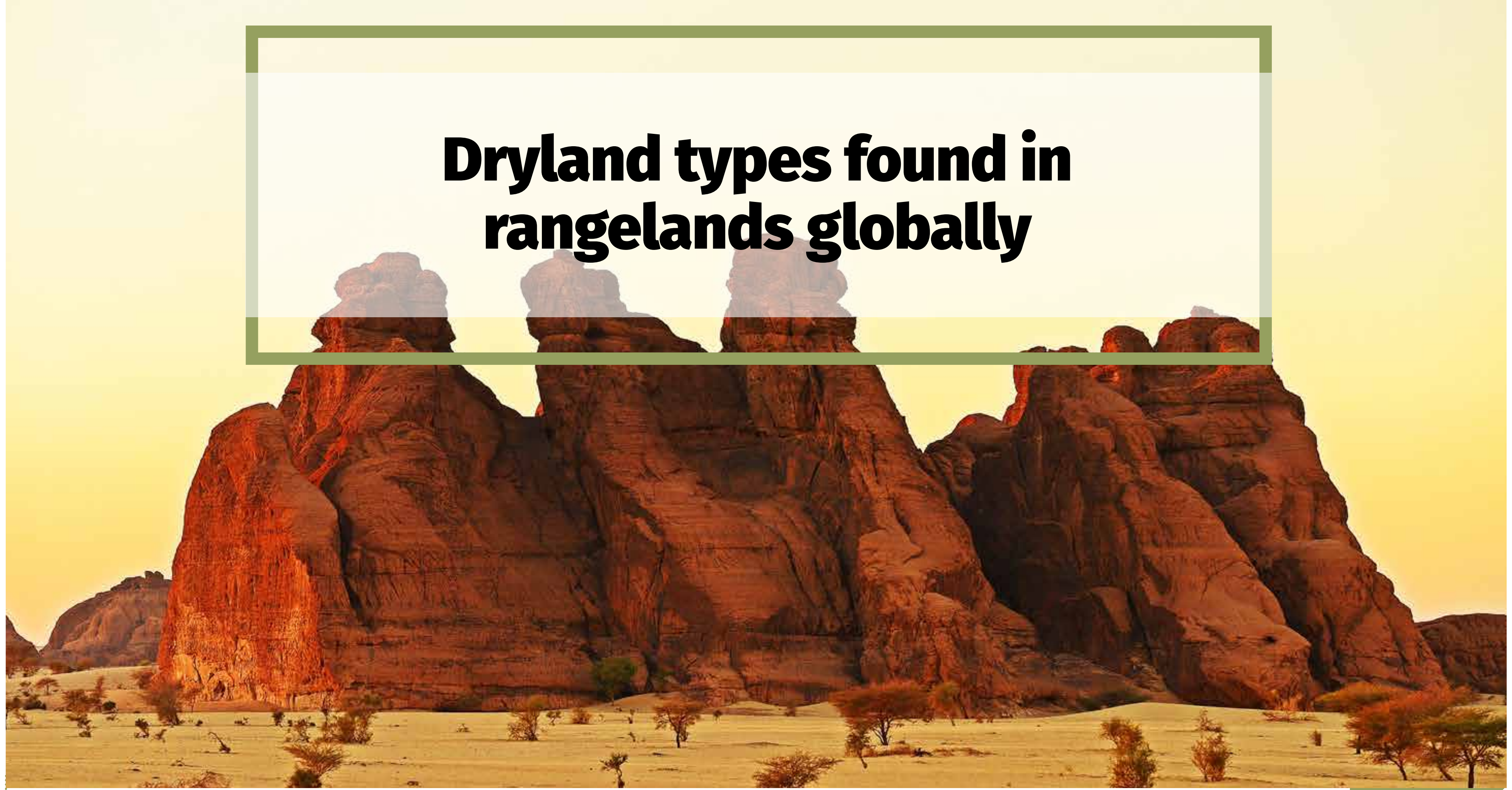


No	Rangeland types	Area km^2
1	Deserts and xeric shrublands	27,984,644.64
2	Flooded grasslands and savannas	1,096,129.62
3	Mediterranean forests, woodlands, and scrub	3,227,266.28
4	Montane grasslands and shrublands	5,203,411.00
5	Temperate grasslands, savannas, and shrublands	10,104,079.63
6	Tropical and subtropical grasslands, savannas, and shrublands	20,295,424.19
7	Tundra	11,598,465.28
	Total	**79,509,420.64**

Deserts and xeric shrublands
Flooded grasslands and savannas
Mediterranean forests, woodlands, and scrub
Montane grasslands and shrublands
Temperate grasslands, savannas, and shrublands
Tropical and subtropical grasslands, savannas, and shrublands
Tundra

Source 1: Terrestrial ecoregions of the world. Downloaded in 2021 from: https://globil-panda.opendata.arcgis.com/datasets/wwf-priority-35-ecoregions?geometry=-172.266%2C-86.819%2C172.266%2C89.233.
Original source: Olson, D. M., Dinerstein, E., Wikramanayake, E. D., Burgess, N. D., Powell, G. V. N., Underwood, E. C., D'Amico, J. A., Itoua, I., Strand, H. E., Morrison, J. C., Loucks, C. J., Allnutt, T. F., Ricketts, T. H., Kura, Y., Lamoreux, J. F., Wettengel, W. W., Hedao, P., Kassem, K. R. (2001). Terrestrial ecoregions of the world: a new map of life on Earth. Bioscience 51(11): 933-938.

Dryland types found in rangelands globally



Drylands are found mainly in tropical and temperate latitudes and account for approximately 41% (or approximately 62,000,000 km^2) of the global terrestrial area. They can be classified into four types encompassing a variety of ecosystems: arid (P/PET Precipitation/Potential evapotranspiration 0.05-0.20), semi-arid (P/PET 0.20-0.50), dry subhumid (P/PET 0.50-0.65), and others including hyper-arid lands. This map shows the coverage of dryland types in rangelands only.

KEY DATA

1. **Using the classification of rangelands outlined in Map 1, all drylands are found in rangeland areas. 78% of rangelands (approximately 62,000,000 km^2) are classified as drylands. Only around 22% or approximately 18,000,000 km^2 of rangelands are not classified as drylands.**
2. **The largest area of drylands are classified as semiarid with P/PET (Precipitation/Potential evapotranspiration) 0.20-0.50: these semiarid areas cover approximately 20,000,000 km^2 of the earth's land surface.**

Making a living in the drylands of Chad

Chad is a Sahelian country that presents a dramatic variety of geographic contrast in three zones: i) the Sudanian zone, ecologically part of the wet Congo basin and contains half the country's cultivated land, rainfall averages between 800 – 1,200 mm annually; ii) the semiarid Sahelian zone, where the main activities are pastoralism and cultivation of cereals, rainfall averages between 300 – 800 mm annually; and iii) the arid Saharan zone, rains are infrequent, with an annual average of less than 200 mm.

Mobile pastoralists in Chad's ecosystems are able to provide both food and livelihood security thus contributing to national wealth not only through the production and sale of animal-based products, but also through a high level of self-consumption which is not well assessed. However, rapid population growth, the effects of climate change, the new oil economy, and persistent conflict have brought in both opportunities and threats for Chadian pastoralists. Moreover, a lack of reliable data on the full contribution of pastoralism in Chad to regional and national economies has yet to be understood by policy actors.

A study, Pastoralist-Driven Data Management Systems, was implemented by FAO and CIRAD (Centre de Coopération Internationale en Recherche Agronomique pour le Développement) and funded by IFAD (International Fund for Agricultural Development) to assess the economic contribution of pastoralism to Chad. The study found that 54% of average gross revenue of a pastoral household is provided by livestock product sales and contributes to 11% of Chad's GDP (gross domestic product) and 24% of agricultural GDP[1]. When self-consumption is included, the contribution of the sector to the GDP rises to 27% and 61% of agriculture. Household consumption provides for subsistence needs and is crucial for overall resilience of pastoral communities, and therefore must be recognised in national economic estimates.

For more information on the study see:
The economics of pastoralism in Argentina, Chad and Mongolia. Market participation and multiple livelihood strategies in a shock-prone environment.
FAO Animal Production and Health Paper No. 182. Rome.
FAO & CIRAD co-edition (2020). https://doi.org/10.4060/cb1271en

For more information on patterns of aridity and desertification see:
The World Atlas of Desertification
https://wad.jrc.ec.europa.eu/patternsaridity

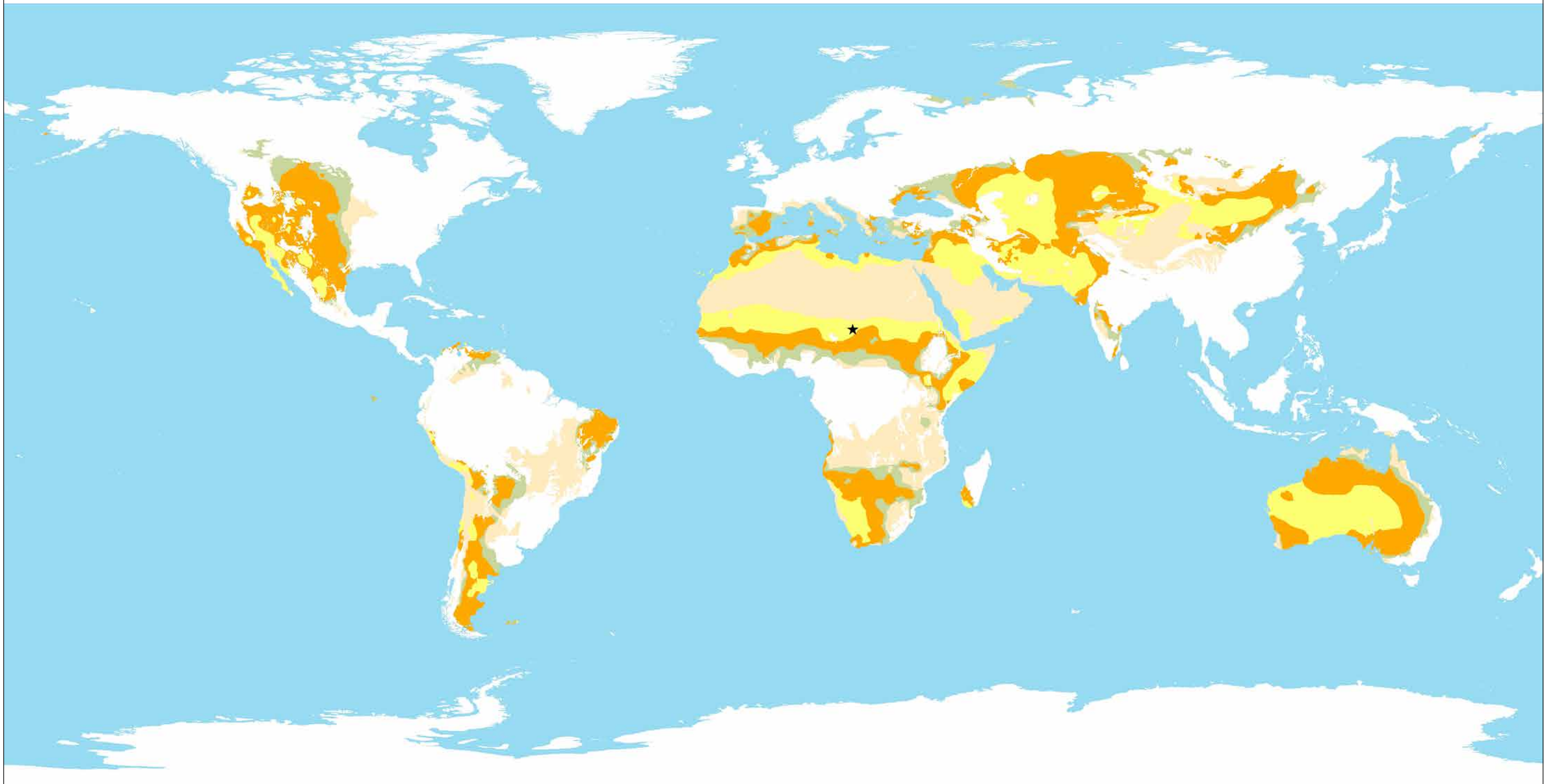
Terminologies used

Aridity is commonly quantified by comparing the long-term average of water supply or precipitation (P) to the long-term average of climatic water demand (known as potential evapotranspiration). Potential evapotranspiration (PET) is a measure of the 'drying power' of the atmosphere to remove water from land surfaces by evaporation (e.g. from the soil and plant canopy) and via plant transpiration. Consequently, if PET is greater than P, then the climate is considered to be arid. The Aridity Index (AI) is a simple but convenient numerical indicator of aridity based on long-term climatic water deficits and is calculated as the ratio P/PET. The AI is a widely used measure of dryness of the climate at a given location. Using the AI, six subtypes of arid lands or drylands are classified: Cold, hyper-arid, arid, semi-arid, dry subhumid and humid.

[1] Wane A, J. Cesaro, G. Duteurtre, I. Touré, A. Ndiaye, V. Alary, X. Juanès X, A. Ickowicz, S. Ferrari and G. Velasco (2020). The economics of pastoralism in Argentina, Chad and Mongolia. Market participation and multiple livelihood strategies in a shock-prone environment. FAO Animal Production and Health Paper No. 182. Rome. FAO & CIRAD co-edition. https://doi.org/10.4060/cb1271en

ILRI, 2021

Dryland types found in rangelands globally



Source 1: Terrestrial ecoregions of the world. Downloaded in 2021 from:
https://globil-panda.opendata.arcgis.com/datasets/wwf-priority-35-ecoregions?geometry=-172.266%2C-86.819%2C172.266%2C89.233.
Original source: Olson, D. M., Dinerstein, E., Wikramanayake, E. D., Burgess, N. D., Powell, G. V. N., Underwood, E. C., D'Amico, J. A., Itoua, I., Strand, H. E., Morrison, J. C., Loucks, C. J., Allnutt, T. F., Ricketts, T. H., Kura, Y., Lamoreux, J. F., Wettengel, W. W., Hedao, P., Kassem, K. R. 2001. Terrestrial ecoregions of the world: a new map of life on Earth. Bioscience 51(11):933-938.

Source 2: UNEP-WCMC (2007) A spatial analysis approach to the global delineation of dryland areas of relevance to the CBD Programme of Work on Dry and Subhumid Lands. Dataset based on spatial analysis between WWF terrestrial ecoregions (WWF-US, 2004) and aridity zones (CRU/UEA; UNEPGRID, 1991). Dataset checked and refined to remove many gaps, overlaps and slivers (July 2014). Downloaded in 2019 from: https://www.unep-wcmc.org/resources-and-data/world-dryland-areas-according-to-unccd-and-cbd-definitions

No	Dryland types	Area km^2
1	Arid: P/PET 0.05 - 0.20	15,194,381.53
2	Semiarid: P/PET 0.20 - 0.50	19,589,676.55
3	Dry subhumid: P/PET 0.50 - 0.65	6,743,329.52
4	Additional areas included in CBD definition	20,615,818.92
	Total	**62,143,206.52**

Arid: P/PET 0.05 - 0.20
Semiarid: P/PET 0.20 - 0.50
Dry subhumid: P/PET 0.50 - 065
Additional areas included in CBD definition

Grassland types found in rangelands globally

In its narrow sense 'grassland' can be defined as ground covered by vegetation dominated by grasses, with little or no tree cover. The map opposite has been produced from the terrestrial ecoregion and biome mapping of WWF. For more information on these terrestrial ecoregions see:
https://www.worldwildlife.org/publications/terrestrial-ecoregions-of-the-world

KEY DATA

1. **Grasslands make up 23% of global terrestrial surface (148,326,000 km^2) and 44% (34,819,964 km^2) of rangelands (79,509,421 km^2).**
2. **There are 42 types of grasslands found in rangelands.**
3. **The most prominent grassland found is the 'north sahel semi-desert scrub and grassland' covering 3,060,186 km^2. and the smallest/rarest is the 'African (Madagascar) montane grassland and shrubland' with only 1,280 km^2.**
4. **Brazilian grasslands are made up of three types – Brazilian-parana freshwater marsh, wet meadow and shrubland covering 171,429 km^2, Brazilian-parana lowland shrubland grassland and savanna covering 2,047,404 km^2 and Brazilian-parana montane shrubland and grassland covering 26,386 km^2. This totals 2,245,219 km^2 or 1.5% of global terrestrial surface.**

Keeping the grasslands of the Northern Great Plains healthy

The Northern Great Plains (NGP) is one of only four remaining intact temperate grasslands in the world. Shaped by seasonal transformations, including the migration of millions of bison kicking up dust and grass, extreme weather, rampaging rivers and racing wildfires, this unique region supports an abundance of species, including 1,595 plants, 300 birds, 95 mammals, 28 reptiles, 13 amphibians and many pollinators. More than 70% of the NGP remains intact and many of the people who call it home play a critical role in safeguarding the landscape. Together, Native American Nations, which hold unique cultural and spiritual connections to the grasslands and ranching families, own and manage 85% of the NGP remaining intact grasslands.

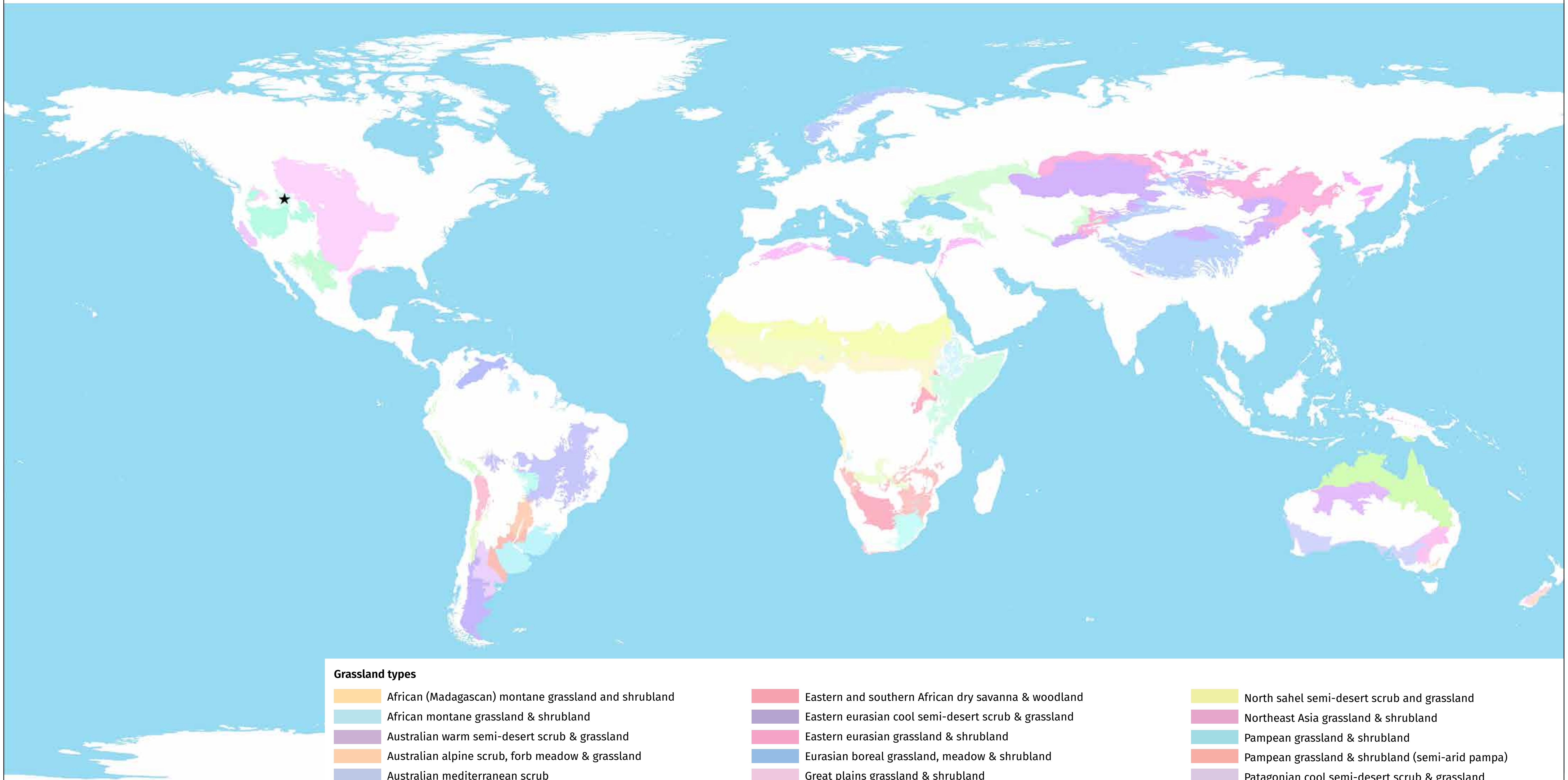
In recent years, however, the NGP grasslands have been disappearing at a faster rate than deforestation in the Amazon rainforest. The primary threat to this unique ecosystem is agriculture and, in particular, large-scale mechanised and industrial farming. When grasslands are destroyed, they emit carbon dioxide, drastically weakening the land's ability to support wildlife, stabilise the soil and provide clean water. Today, climate change has brought about a rise in extreme weather events and, along with difficult trade policies and a global pandemic, further challenges have emerged for the landscape and livelihoods that depend on it.

To ensure that the NGP grasslands remain healthy, public, private and native landowners have come together to support grasslands' management and solutions that benefit wildlife and local communities. Solutions include building community-led efforts that improve outcomes for biodiversity as well as developing financial and political incentives for landowners that support grassland conservation and discourage further clearance of native grasslands. It also entails working in partnership to restore grasslands ploughed up for growing crops, whilst improving the management and protection of the intact grasslands that remain. Finally, Native Nations and US government agencies are restoring populations of the plains' bison and critically endangered Black-footed ferret – two species central to the cultural, economic and environmental health of the region and its Indigenous communities.

For more information:
Introducing the Northern Great Plains

ILRI, 2021

Grassland types found in rangelands globally



Grassland types

- African (Madagascan) montane grassland and shrubland
- African montane grassland & shrubland
- Australian warm semi-desert scrub & grassland
- Australian alpine scrub, forb meadow & grassland
- Australian mediterranean scrub
- Australian temperate grassland & shrubland
- Australian tropical savanna
- Brazilian-parana freshwater marsh, wet meadow & shrubland
- Brazilian-parana lowland shrubland, grassland & savanna
- Brazilian-parana montane shrubland and grassland
- California grassland & meadow
- Central Asian alpine scrub, forb meadow & grassland
- Chaco freshwater marsh and shrubland
- Colombian-Venezuelan freshwater marsh, wet meadow & shrubland
- Colombian-Venezuelan lowland shrubland, grassland & savanna
- Eastern Africa xeric scrub and grassland
- Eastern and southern African dry savanna & woodland
- Eastern eurasian cool semi-desert scrub & grassland
- Eastern eurasian grassland & shrubland
- Eurasian boreal grassland, meadow & shrubland
- Great plains grassland & shrubland
- Guianan lowland shrubland, grassland & savanna
- Indomalayan montane meadow
- Mediterranean and southern andean cool semi-desert scrub & grassland
- Mediterranean basin dry grassland
- Miombo and associated broadleaf savanna
- Mopane savanna
- New Guinea montane meadow
- New Zealand alpine scrub, forb meadow & grassland
- New Zealand grassland & shrubland
- North American warm desert scrub & grassland
- North sahel semi-desert scrub and grassland
- Northeast Asia grassland & shrubland
- Pampean grassland & shrubland
- Pampean grassland & shrubland (semi-arid pampa)
- Patagonian cool semi-desert scrub & grassland
- Patagonian grassland and shrubland
- South African cape mediterranean scrub
- Southern African montane grassland
- Sudano Sahelian dry savanna
- Tropical andean cool semi-desert scrub & grassland
- Tropical andean shrubland & grassland
- West-central African mesic woodland and savanna
- Western eurasian cool semi-desert scrub & grassland
- Western eurasian grassland & shrubland
- Western north American cool semi-desert scrub & grassland

Source: Terrestrial ecoregions of the world.
Downloaded in 2021 from:
https://globil-panda.opendata.arcgis.com/datasets/wwf-priority-35-ecoregions?geometry=-172.266%2C-86.819%2C172.266%2C89.233.
Original source: Olson, D. M., Dinerstein, E., Wikramanayake, E. D., Burgess, N. D., Powell, G. V. N., Underwood, E. C., D'Amico, J. A., Itoua, I., Strand, H. E., Morrison, J. C., Loucks, C. J., Allnutt, T. F., Ricketts, T. H., Kura, Y., Lamoreux, J. F., Wettengel, W. W., Hedao, P., Kassem, K. R. 2001. Terrestrial ecoregions of the world: a new map of life on Earth. Bioscience 51(11): 933-938.

Forest cover, gain and loss in rangelands

Some rangelands can support trees and forests i.e. where soils, climate and management are suitable. This can be in the form of bush and scrub, or as large trees individual or clustered. In some rangelands, trees are purposefully managed to be part of a silvopastoral system. This set of maps are the result of time-series analysis of Landsat images characterising forest extent and change. Trees are defined as vegetation taller than five metres in height and are expressed as a percentage per output grid cell as '2,000 Percent Tree Cover'. 'Forest Cover Loss' is defined as a stand-replacement disturbance, or a change from a forest to non-forest state, during the period 2000-2019. 'Forest Cover Gain' is defined as the inverse of loss, or a non-forest to forest change entirely within the period 2000-2012. 'Forest Loss Year' is a disaggregation of total 'Forest Loss' to annual time scales.

KEY DATA

1 **In the year 2000, 20% of rangelands or 15,532,983 km² had cover of forests (as defined in the map) and 80% without. Of the rangelands covered, 11,628,796 km² or 15% had less than 50% coverage, and 5% or approximately 3,904,187 km² had more than 50% coverage. Most forest cover (a total of 11,421,459 km²) was found in tropical and subtropical grasslands, savannas and shrublands. The least amount of forest cover was found in deserts and xeric shrublands with only 482,662 km² considered to be forest cover.**

2. **According to the mapping of forest cover gain between 2000 to 2012, forest cover was gained in 0.1% or approximately 71,000 km² of rangelands. This gain was mainly found in the i) mediterranean forests, woodlands and scrub, and the ii) tropical and subtropical grasslands, savannas and shrublands biomes.**

3. **According to the mapping of forest cover loss between 2000 to 2019, forest cover was lost in approximately 1% or approximately 790,000 km² of rangelands. This loss was mainly found in the i) tropical and subtropical grasslands, savannas and shrublands (approx. 504,000 km²), ii) temperate grasslands, savannas and shrublands (360,069 km²) and iii) flooded grasslands and savannas (approximately 132,000 km²) biomes.**

An Agrosilvopastoral System in southern Spain – the case of the 'Dehesa'

'*Dehesa*' is a multi-functional agrisilvopastoral system, occupying around 2.3 million hectares in central and southern Spain and 0.7 million hectares in southern Portugal. It is known as 'montado' in Portugal. This unique landscape is a result, in part, from the clearance of Mediterranean forests and shrublands, where tree and shrub cover were reduced in favour of farming and grasslands for grazing.

Dehesa are characterised by the rearing of traditional livestock breeds at low densities and careful exploitation of evergreen oaks for acorns (eaten by pigs) and cork (still highly lucrative).

Dehesas are among the best preserved, low-intensity farming systems in Europe, wherein the integration of traditional land use and biodiversity conservation is considered exemplary land use management. In Spain, these landscapes are most common across the Andalucia region.

Women play a key role in the preservation and management of these agrisilvopastoral systems, with several extensive *dehesas* being led by them. They often combine the management and income-generation from the land with agri-tourism, conservation activities, training centres and other initiatives.

One such example is the Fundación Monte Mediterráneo and the Dehesa San Francisco, which was founded by Hans-Gerd Neglein but is run by his wife, Ernestine Lüdeke. Together, their goal is to help the *dehesa* be the 'last frontier to the desert,' hosting as many species of plants and animals as possible. Organic and sustainable management with a variety in livestock husbandry is combined with careful forestry and wildlife-enhancing activities. This work includes marketing the products and carrying out research programmes. Ernestine and her colleagues are also involved in advocacy and lobbying work, promoting the *dehesa* and pastoralism in Spain and in Europe, including organising publicity around the annual moving of livestock to summer pastures in the mountains of northern Spain.

For more information:
Dehesa farms in Spain: https://bit.ly/2Tumwq5

Fundación Monte Mediterráneo and the Dehesa San Francisco: https://bit.ly/3ibFiNw

Deforestation fronts: Drivers and responses in a changing world: https://bit.ly/3fED87e

Spanish Dehesa Federation: http://fedehesa.org/

Terminologies used

Map 1 Gain and loss: A colour composite of tree cover in green, forest loss in red, forest gain in blue.

Map 2 Gain: Defined as non-forest to forest change entirely within the study period.

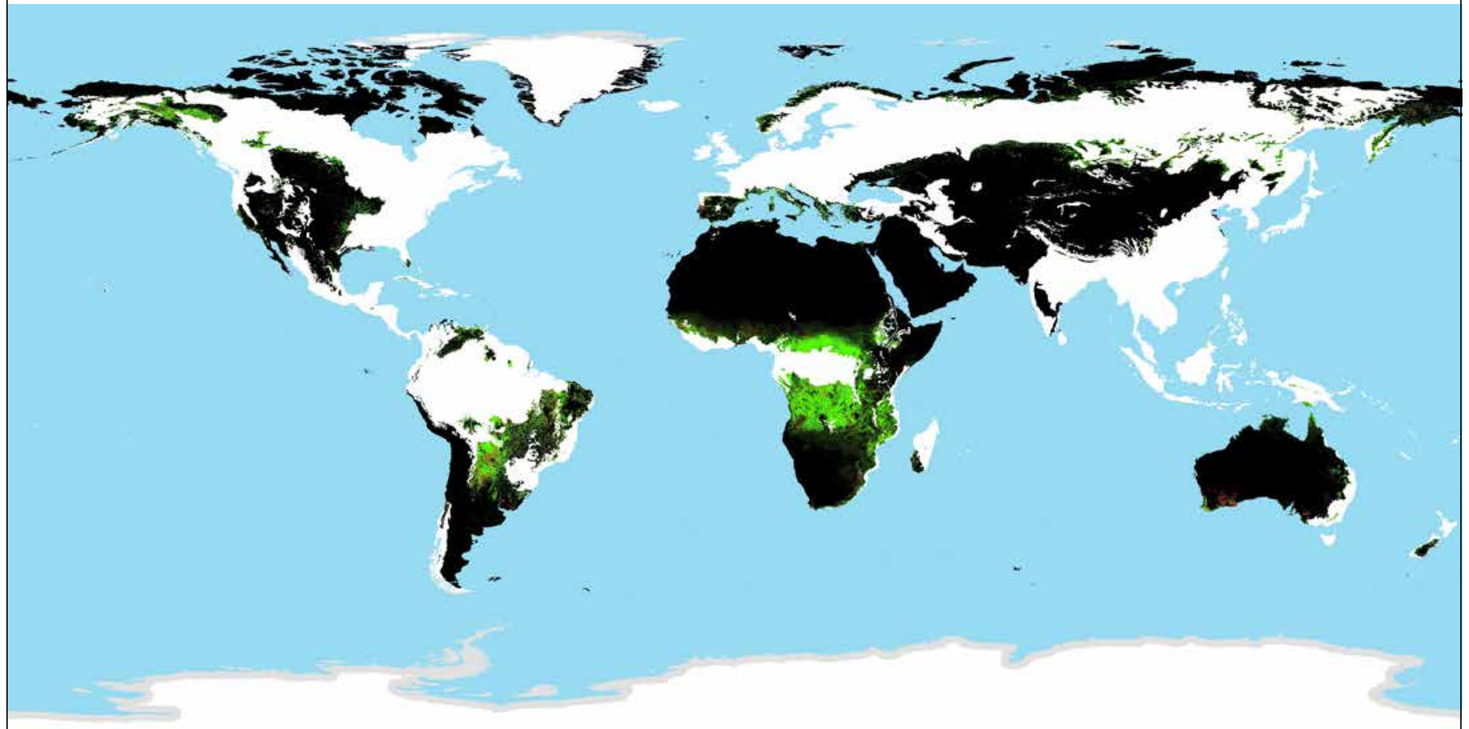
Map 3 Loss: Defined as a stand-replacement disturbance, or a change from a forest to non-forest state.

Map 4 Tree Cover 2000: Tree cover in the year 2000, defined as canopy closure for all vegetation taller than five metres in height. Encoded as a percentage per output grid cell, in the range 0-100.

Results from time-series analysis of Landsat images in characterising global forest extent. Source: https://bit.ly/34ClrPx

Forest gain (2001-2012) and loss (2001-2019) found in rangelands

ILRI, 2021



Source 1: Terrestial ecoregions of the World. World Wide Fund for Nature (WWF). Downloaded in 2021: https://globil-panda.opendata.arcgis.com/datasets/wwf-priority-35-ecoregions?geometry=-172.266%2C-86.819%2C172.266%2C89.233. Original source: Olson, D. M., Dinerstein, E., Wikramanayake, E. D., Burgess, N. D., Powell, G. V. N., Underwood, E. C., D'Amico, J. A., Itoua, I., Strand, H. E., Morrison, J. C., Loucks, C. J., Allnutt, T. F., Ricketts, T. H., Kura, Y., Lamoreux, J. F., Wettengel, W. W., Hedao, P., Kassem, K. R. 2001. Terrestrial ecoregions of the world: a new map of life on Earth. Bioscience 51(11):933-938.

Source 2: Hansen, M. C., Potapov, P. V, Moore, R., Hancher, M., Turubanova, S. A., Tyukavina, A., Thau, D., Stehman, S. V, Goetz, S. J., Loveland, T. R., Kommareddy, A., Egorov, A., Chini, L., Justice, C. O., & Townshend, J. R. G. (2013). High-Resolution Global Maps of 21st-Century Forest Cover Change. Science, 342(6160), 850 LP – 853. https://doi.org/10.1126/science.1244693. Downloaded in 2021: https://earthenginepartners.appspot.com/

No	Forest status	Area km²
1	Gain	32,841
2	Loss	741,885
3	Gain & Loss	41,114
	Total	815,840

Tree Cover & 2000

0 100

No data

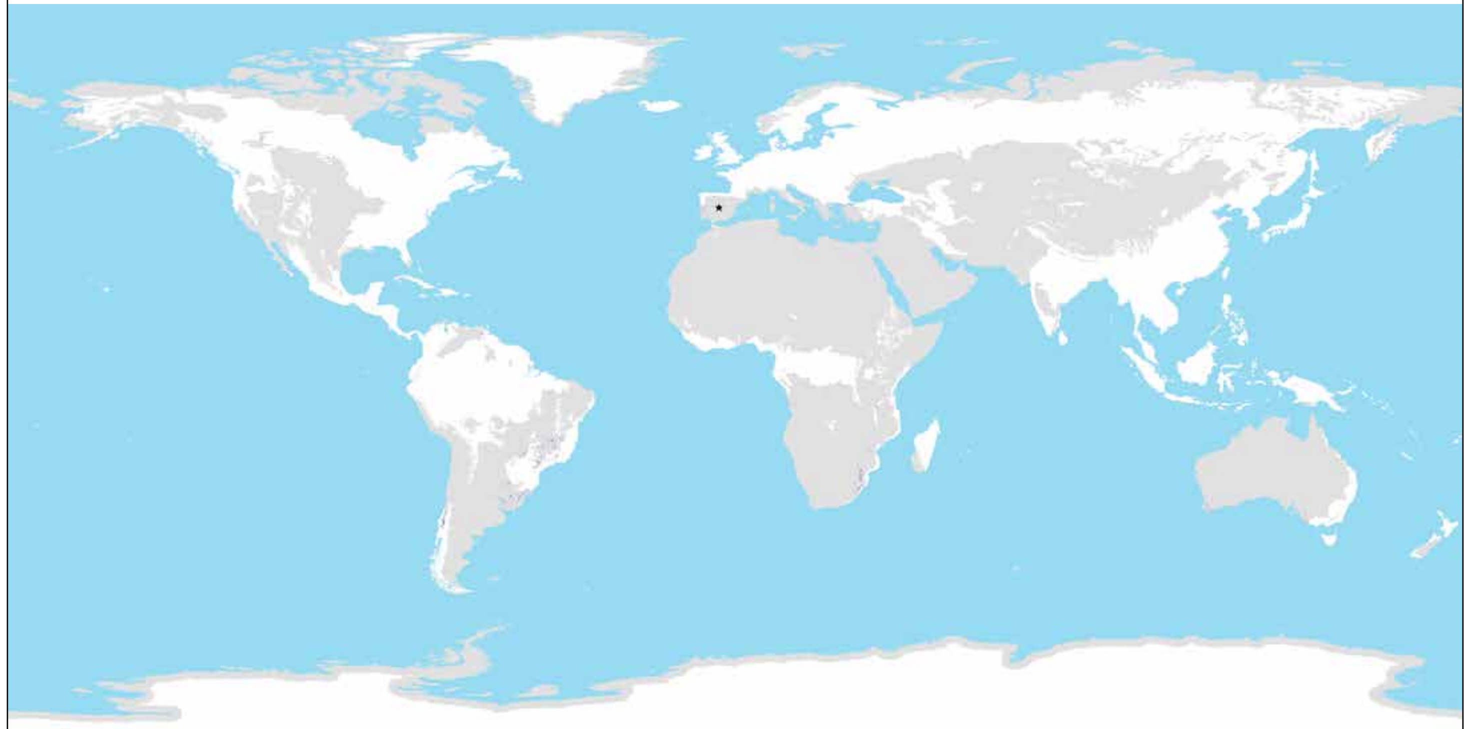
Gain

Loss

Gain & Loss

Forest gain from 2001-2012 found in rangelands

ILRI, 2021



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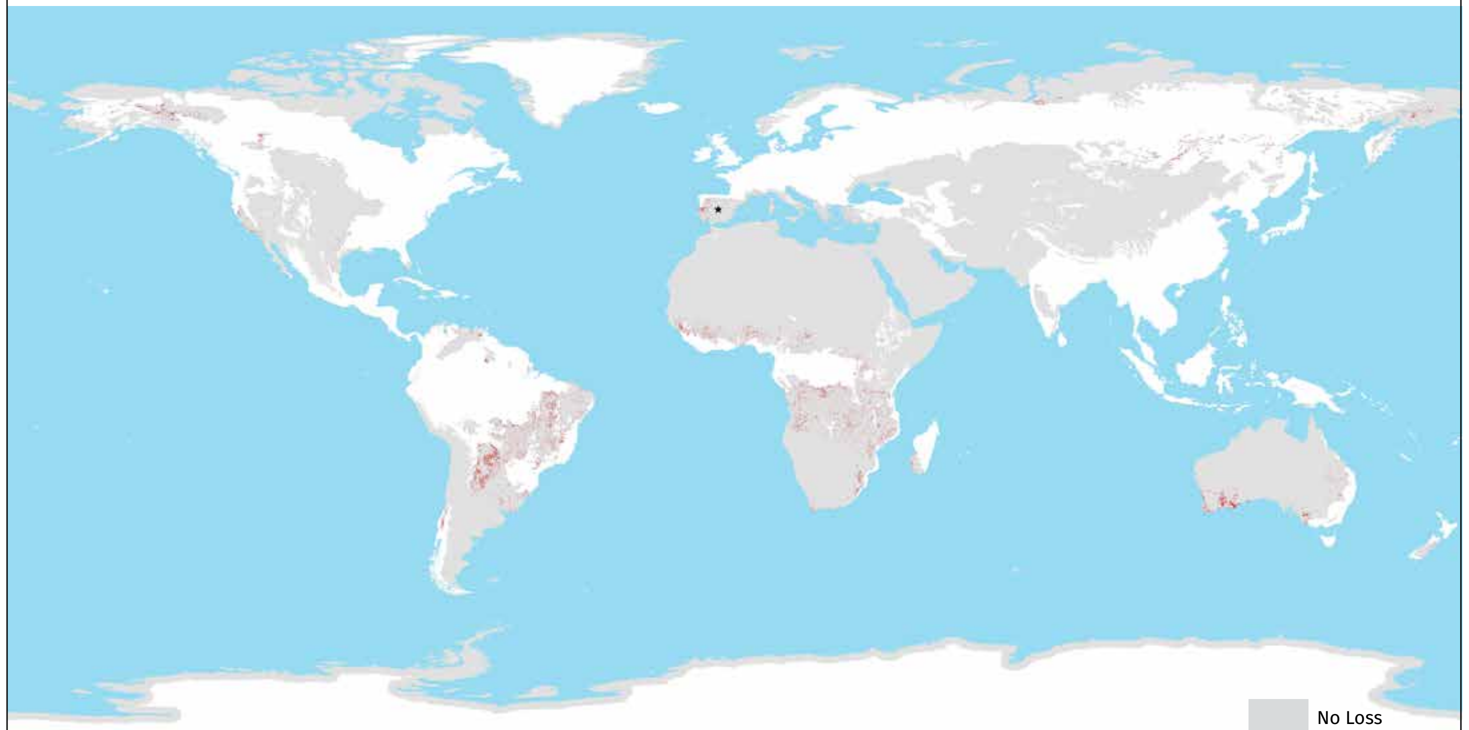
No	Gain status	Area km²
1	No Gain	79,410,855
2	Gain	71,039
	Total	79,481,894

No Gain

Gain

Forest loss from 2001 to 2019 found in rangelands

ILRI, 2021



Source 1: Terrestial ecoregions of the World. World Wide Fund for Nature (WWF). Downloaded in 2021: https://globil-panda.opendata.arcgis.com/datasets/wwf-priority-35-ecoregions?geometry=-172.266%2C-86.819%2C172.266%2C89.233. Original source: Olson, D. M., Dinerstein, E., Wikramanayake, E. D., Burgess, N. D., Powell, G. V. N., Underwood, E. C., D'Amico, J. A., Itoua, I., Strand, H. E., Morrison, J. C., Loucks, C. J., Allnutt, T. F., Ricketts, T. H., Kura, Y., Lamoreux, J. F., Wettengel, W. W., Hedao, P., Kassem, K. R. 2001. Terrestrial ecoregions of the world: a new map of life on Earth. Bioscience 51(11):933-938.

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No	Loss status	Area km²
1	No loss	78,693,675
2	Loss	786,017
	Total	79,479,692

No Loss

2001-2005

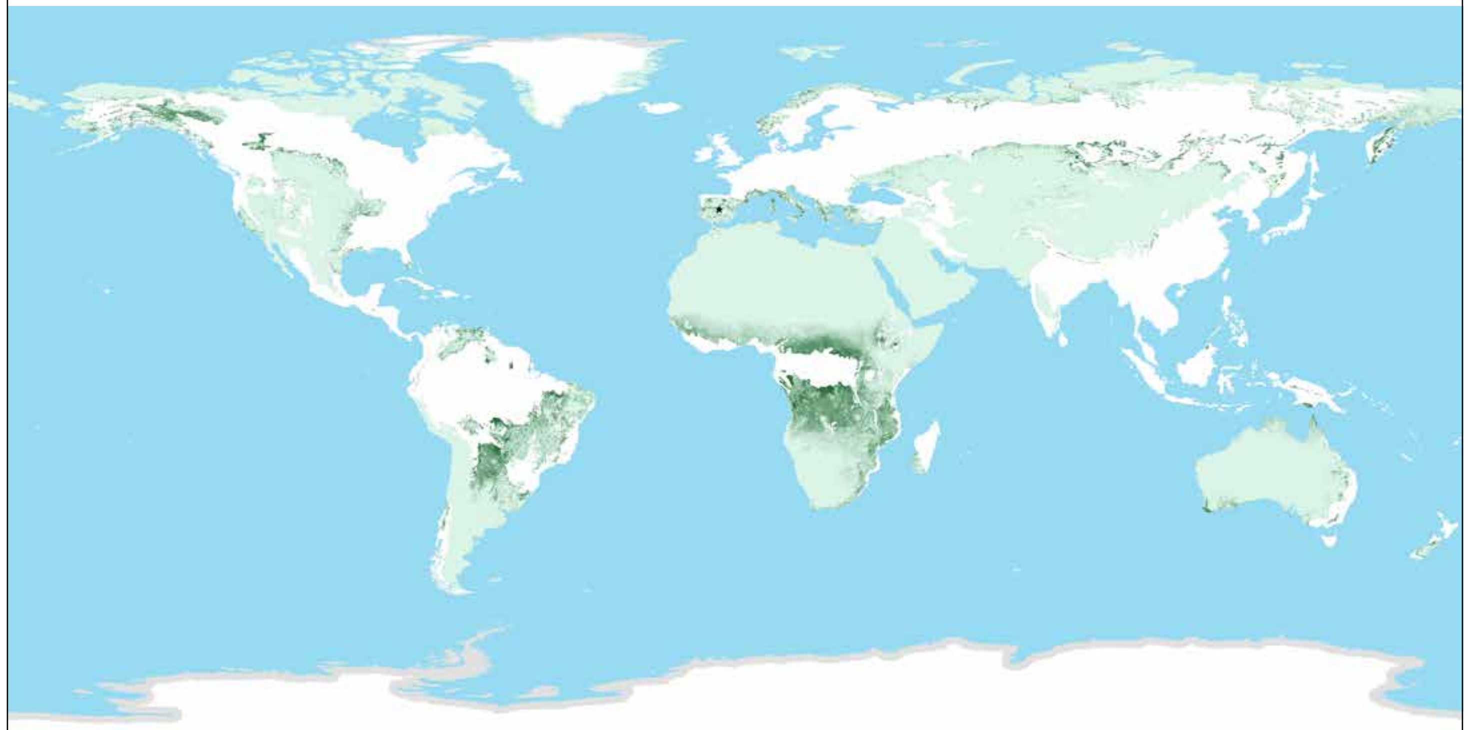
2005-2010

2010-2015

2015-2019

Tree cover in the year 2000 found in rangelands

ILRI, 2021



Source 1: Terrestial ecoregions of the World. World Wide Fund for Nature (WWF). Downloaded in 2021: https://globil-panda.opendata.arcgis.com/datasets/wwf-priority-35-ecoregions?geometry=-172.266%2C-86.819%2C172.266%2C89.233. Original source: Olson, D. M., Dinerstein, E., Wikramanayake, E. D., Burgess, N. D., Powell, G. V. N., Underwood, E. C., D'Amico, J. A., Itoua, I., Strand, H. E., Morrison, J. C., Loucks, C. J., Allnutt, T. F., Ricketts, T. H., Kura, Y., Lamoreux, J. F., Wettengel, W. W., Hedao, P., Kassem, K. R. 2001. Terrestrial ecoregions of the world: a new map of life on Earth. Bioscience 51(11):933-938.

Source 2: Hansen, M. C., Potapov, P. V, Moore, R., Hancher, M., Turubanova, S. A., Tyukavina, A., Thau, D., Stehman, S. V, Goetz, S. J., Loveland, T. R., Kommareddy, A., Egorov, A., Chini, L., Justice, C. O., & Townshend, J. R. G. (2013). High-Resolution Global Maps of 21st-Century Forest Cover Change. Science, 342(6160), 850 LP – 853. https://doi.org/10.1126/science.1244693. Downloaded in 2021: https://earthenginepartners.appspot.com/

No	Tree cover status	Area km²
1	0%	63,944,370
2	<50%	11,628,796
3	>50%	3,904,187
	Total	79,477,353

Tree Cover %

0 100

No Data

Types of ruminant livestock production systems found in rangelands

Livestock may be raised primarily for subsistence or local sales or may be raised to supply international markets with large quantities of produce. The scale, purpose and nature of livestock enterprises is known as the production system. The type of ruminant production systems is largely determined by agroecology and land use, but also influenced by capital investment, degree of specialisation and whether the animals are raised on grasslands, feedlots or as part of mixed crop-livestock farming systems. This map shows the distribution of ruminant livestock production systems in rangelands.

KEY DATA

1. **Livestock production systems in rangelands cover 66,918,559 km^2. That is 45% of global terrestrial surface. Livestock production systems cover 84% of rangelands.**
2. **46% of livestock production systems in rangelands are found in arid areas: this is land that in most cases cannot be used for growing crops. Livestock-only production systems in arid areas cover 31,058,803 km^2.**

Combining improvements in the livestock production system with rangeland management and rehabilitation: The case of Medenine in Tunisia

With nearly one-quarter of Tunisia covered by rangelands – both arid and desert areas – the country has a diverse livestock sector. Sheep are the most dominant species, with an average of 6.5 million, followed by 1.2 million goats, 401,000 dairy cattle and 234,000 other cattle, based on 2018 figures. Camelids and equines (horses, donkeys, and mules) represented 214,000. Within cattle species, dairy cattle are the most dominant, accounting for 65%[1], while Tunisian meat production generated around 16% of the national agriculture gross domestic product (GDP). Almost all rangelands in arid areas of Tunisia, where there is a mean annual rainfall of less than 200 mm, are now grazed continuously without any restriction on stocking rate. In many areas, the encroachment of agriculture, despite its limitations, has fragmented the country's rangelands and made mobility of livestock more difficult.

In the Governorate of Medenine in southern Tunisia, the International Fund for Agricultural Development (IFAD), working through the government of Tunisia and with the International Center for Agricultural Research in the Dry Areas (ICARDA), is supporting local pastoralists to improve their livestock production and rehabilitate rangelands through a project called PRODEFIL (Projet de développement agro-pastoral et des filières associées). Rangelands provide 20-60% of the feed needs of livestock, whilst also contributing to biodiversity and soil protection especially against wind erosion.

The project combines improvements in rangeland management and, more specifically, the strengthening of the local system of *Gdel* (rotation and resting). It focuses on improving productivity and building strong and inclusive value chains around the pastoral activities of the local population. In addition, it has supported new infrastructure, including the building of a slaughterhouse in Ben Guerdane. To date, a total of 19,000 hectares of rangelands have been placed under improved management, including 7,000 hectares in private land, or nearly 70% of the 29,000 hectares targeted. Resting has also allowed the reappearance of truffles and *Lazoul* (pink garlic), which are collected and sold, as well as plant cover improving by 35-85%.

At the same time, the project has supported the development of the red meat sector (sheep, goat and camelina) with the creation of 'Plateform Viande Rouge' (Red Meat Sector Platform), their by-products (wool and leather) as well as incentives for the start-up of a sector promoting camel milk to improve the income of the most vulnerable breeders. A wool collection and processing centre, and a camel milk collection and packaging centre has also been set up. Other initiatives include the establishment of a nursery for the production of fruit plants. As a result, the health and weight of the animals has improved 52%; and, the number of olive and fig trees per farm has increased from 19 to 36 or by 89%.

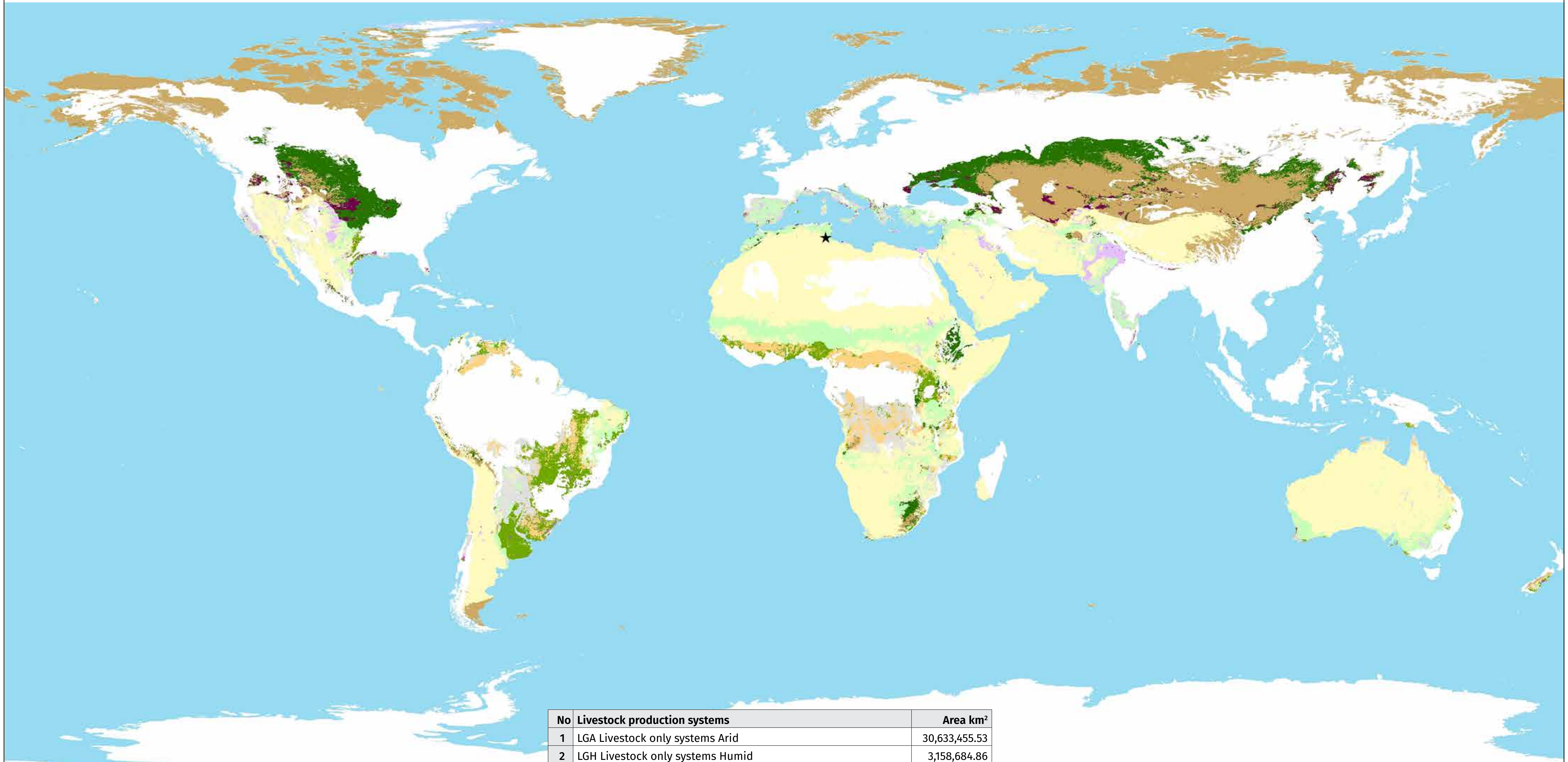
For more information about the map see:
http://www.fao.org/publications/card/en/c/aea49989-7d6f-54a5-aaae-c12fe4aef097/

For more information on the project see:
Présentation de PRODEFIL https://www.prodefilgeo.com.tn/index.php
Imen, la chamelière de Benguerdane https://ifad-un.blogspot.com/2020/10/imen-la-chameliere-de-benguerdane.html

[1] Estimation of Tunisian Greenhouse Gas Emissions from Different Livestock Species. Ammar et al (2020). *Agriculture* **2020**, 10(11), 562; https://doi.org/10.3390/agriculture10110562

ILRI, 2021

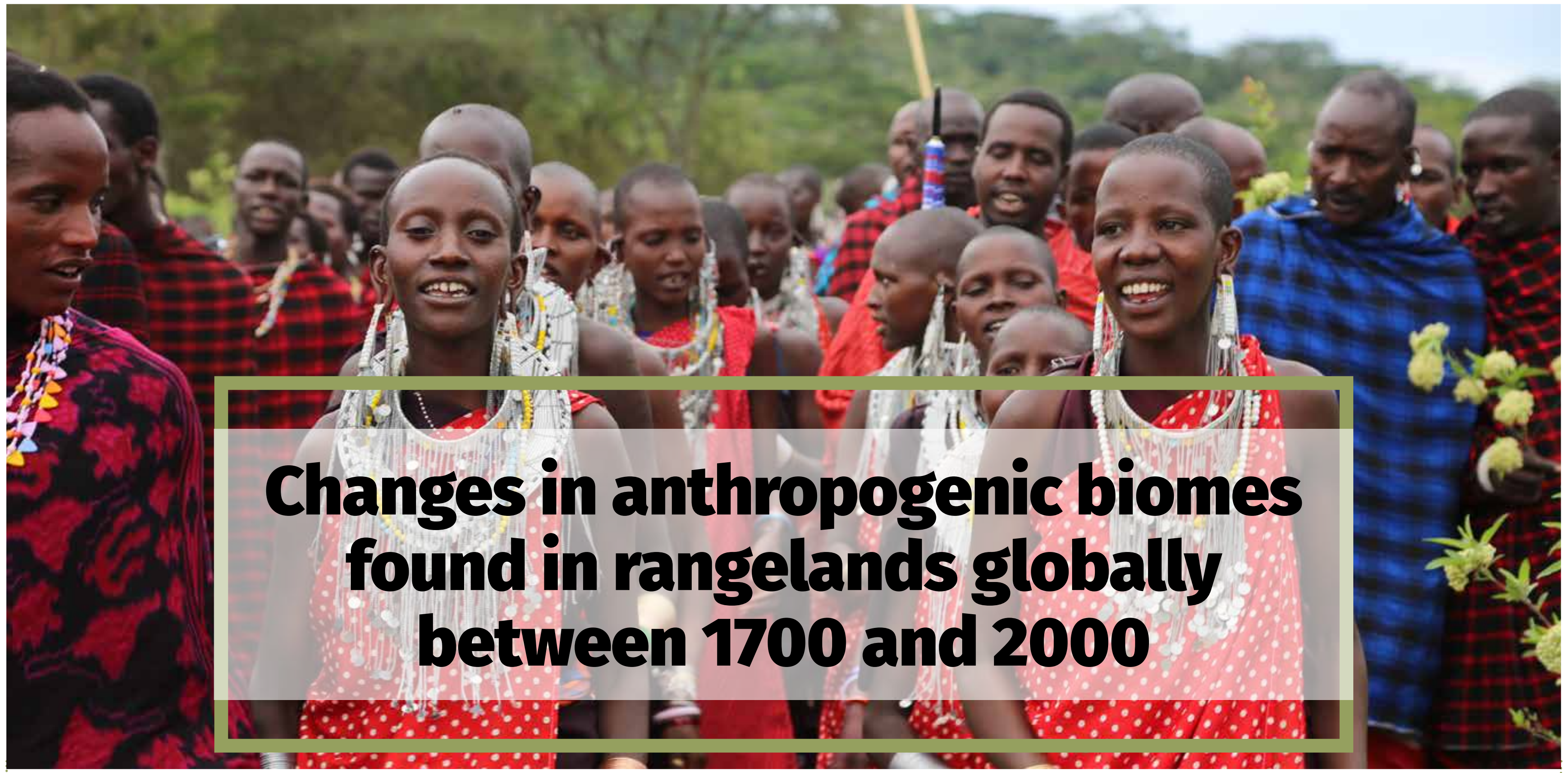
Types of ruminants production systems found in rangelands globally



No	Livestock production systems	Area km²
1	LGA Livestock only systems Arid	30,633,455.53
2	LGH Livestock only systems Humid	3,158,684.86
3	LGT Livestock only systems Temperate (and Tropical Highlands)	14,732,749.34
4	LGY Livestock only systems HyperArid	3,851,386.66
5	MIA Mixed irrigated Arid	1,387,368.44
6	MIH Mixed irrigated Humid	111,665.81
7	MIT Mixed irrigated Temperate (and Tropical Highlands)	645,490.98
8	MIY Mixed irrigated HyperArid	15,281.22
9	MRA Mixed rainfed Arid	6,891,542.54
10	MRH Mixed rainfed Humid	3,028,294.31
11	MRT Mixed rainfed Temperate (and Tropical Highlands)	4,816,717.28
12	MRY Mixed rainfed HyperArid	5,064.32
13	Tree-based systems	5,488,945.93
14	Unsuitable	53,709.54
15	Urban areas	77,119.64
	Total	**74,897,476.39**

Source 1: Terrestrial ecoregions of the world. Downloaded in 2021 from: https://globil-panda.opendata.arcgis.com/datasets/wwf-priority-35-ecoregions?geometry=-172.266%2C-86.819%2C172.266%2C89.233. Original source: Olson, D. M., Dinerstein, E., Wikramanayake, E. D., Burgess, N. D., Powell, G. V. N., Underwood, E. C., D'Amico, J. A., Itoua, I., Strand, H. E., Morrison, J. C., Loucks, C. J., Allnutt, T. F., Ricketts, T. H., Kura, Y., Lamoreux, J. F., Wettengel, W. W., Hedao, P., Kassem, K. R. 2001. Terrestrial ecoregions of the world: a new map of life on Earth. Bioscience 51(11):933-938.

Source 2: Global Livestock Production Systems 2007 v.3. FAO and ILRI. Downloaded in 2019 from: https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/WPDSZE



Changes in anthropogenic biomes found in rangelands globally between 1700 and 2000

Anthropogenic biomes, also known as 'anthromes' or 'human biomes', describe the terrestrial biosphere in its contemporary, human-altered form using global ecosystem units defined by patterns of sustained direct human interaction. Ellis and Ramankutty (2008) delineate 21 anthropogenic biomes based on population density, land use and vegetation cover. The anthropogenic biomes are grouped into six major categories – dense settlements, villages, croplands, rangeland, forested and wildlands. Between 1700 and 2000, the terrestrial biosphere made the critical transition from mostly wild to mostly anthropogenic, passing the 50% mark early in the 20th century.

For rangelands, three biomes were mapped – residential rangelands, populated rangelands and remote rangelands. Data sets are available for c. 1700, c. 1800, c. 1900, c.2000. In the map opposite we compare the c. 1700 maps and the c. 2000 maps revealing dramatic changes in the biomes with increased concentration and population growth.

KEY DATA

1. **Between 1700 and 2000, pastoral villages globally grew from 1,566 km^2 to 365,064 km^2, populated croplands grew from 287,308 km^2 to 4,010,017 km^2, populated rangelands grew from 1,101,217 km^2 to 11,209,691 km^2 and populated woodlands reduced from 7,217,694 km^2 to 1,899,952 km^2 highlighting increasing population growth and consolidation in rangelands.**
2. **Between 1700 and 2000 populated woodlands reduced from 7,217,694 km^2 to 1,899,952 km^2, remote woodlands from 4,874,260 km^2 to 586,791 km^2 and residential woodlands remained approximately the same. This highlights the infiltration and conversion of woodlands to other land uses.**
3. **Between 1700 and 2000 wild lands in rangelands reduced by more than half, with wild treeless and barren lands reducing from 30,586,608 km^2 to 14,458,293 km^2 and wild woodlands from 9,523,934 to 3,036,857 km^2 highlighting the loss of wild lands.**
4. **Between 1700 and 2000, irrigated villages increased from 10,054 km^2 to 695,705 km^2 and residential irrigated villages increased from 12,633 km^2 to 675,168 km^2 highlighting the increase in use of irrigation.**
5. **Between 1700 and 2000, remote croplands increased from 8,311 to 1,991,376 km^2, residential irrigated croplands increased from 12,633 km^2 to 675,168 km^2, residential rainfed croplands from 873,040 to 4,274,271 km^2 and rice villages from 16,365 to 146,736 km^2 highlighting the infiltration of crops into rangelands and pastoral areas – a total of 7,087,551 km^2.**

Resolving conflicts over land use in rangelands through joint village land use planning

Tanzania has a total land area of about 885,800 million km^2, of which over 74% are rangelands, mainly semi-arid with highly variable rainfall falling in one or two seasons separated by a long dry season. Pastoralism and agro-pastoralism are the predominate livelihood activities and produce the majority of Tanzania's approximately 21 million cattle, 15 million goats and six million sheep.

Throughout the centuries, Tanzania has seen significant change across its rangelands including in terms of population distribution. The government villagisation scheme, which started in the 1970s, served as a mechanism for forced consolidation of settlements and the establishment of a structured administrative government-dominated system from national to village levels. Today, there are more than 12,000 villages in Tanzania, the majority of which are found in rangelands.

Under land policy and legislation, each of these villages are expected to produce and implement a village land use plan defining key land use categories. However, strengthening administrative boundaries and categorising land use can limit mobility by creating visible and invisible boundaries along village borders, and can reduce available land for grazing particularly if the planning processes are not inclusive. In order to overcome these challenges, a process of 'joint' village land use planning has been supported by the International Livestock Research Institute (ILRI), IFAD, International Land Coalition (ILC) the government and other partners in four clusters of villages in Kiteto District, Manyara region. This process brought different village groups together, for discussion and negotiation on land use, and eventually agreement. As a result, around 2,000 km^2 of grazing land has been protected and written into the villages' land use plans.

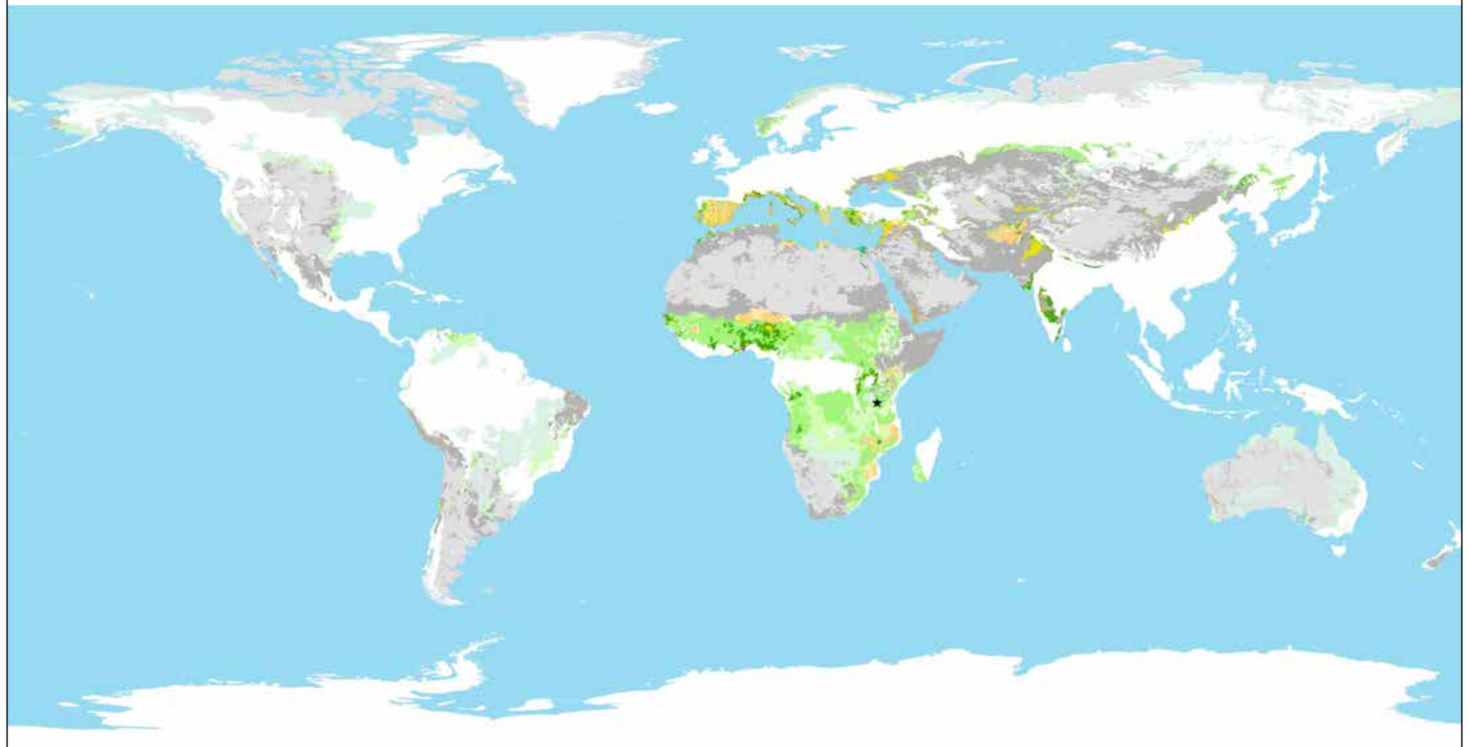
In addition, livestock keepers' associations have been established for those owning livestock from the villages with the shared grazing lands. Certificates of Customary Rights of Occupancy (CCROs) have been issued to these associations by the relevant Village Council, overseen by the district government. The livestock keepers are now developing participatory rangeland management (PRM) plans to guide local investments in rangelands restoration and improve rangeland productivity. Water access in these drylands still remains a major challenge.

For more information, please see:
Improving the Implementation of Land Policy Legislation in Pastoral Areas
https://cgspace.cgiar.org/handle/10568/79796

For more information on the map see:
https://ecotope.org/people/ellis/papers/ellis_2008.pdf

ILRI, 2021

Anthropogenic biomes found in rangelands globally (Year 1700)



No	Anthropogenic biomes	Area km²
1	Inhabited treeless and barren lands	18,391,576.68
2	Irrigated villages	10,054.37
3	Mixed settlements	12,326.47
4	Others	4,807,005.29
5	Pastoral villages	1,566.05
6	Populated croplands	287,308.44
7	Populated rangelands	1,101,217.15
8	Populated woodlands	7,217,694.16
9	Rainfed villages	47,264.27
10	Remote croplands	8,310.72
11	Remote rangelands	504,295.35
12	Remote woodlands	4,874,360.31
13	Residential irrigated croplands	12,633.85
14	Residential rainfed croplands	873,039.79
15	Residential rangelands	92,594.82
16	Residential woodlands	1,140,578.24
17	Rice villages	16,365.48
18	Urban	687.03
19	Wild treeless and barren lands	30,586,607.79
20	Wild woodlands	9,523,934.35
	Total	**79,509,420.61**

Anthropogenic biomes

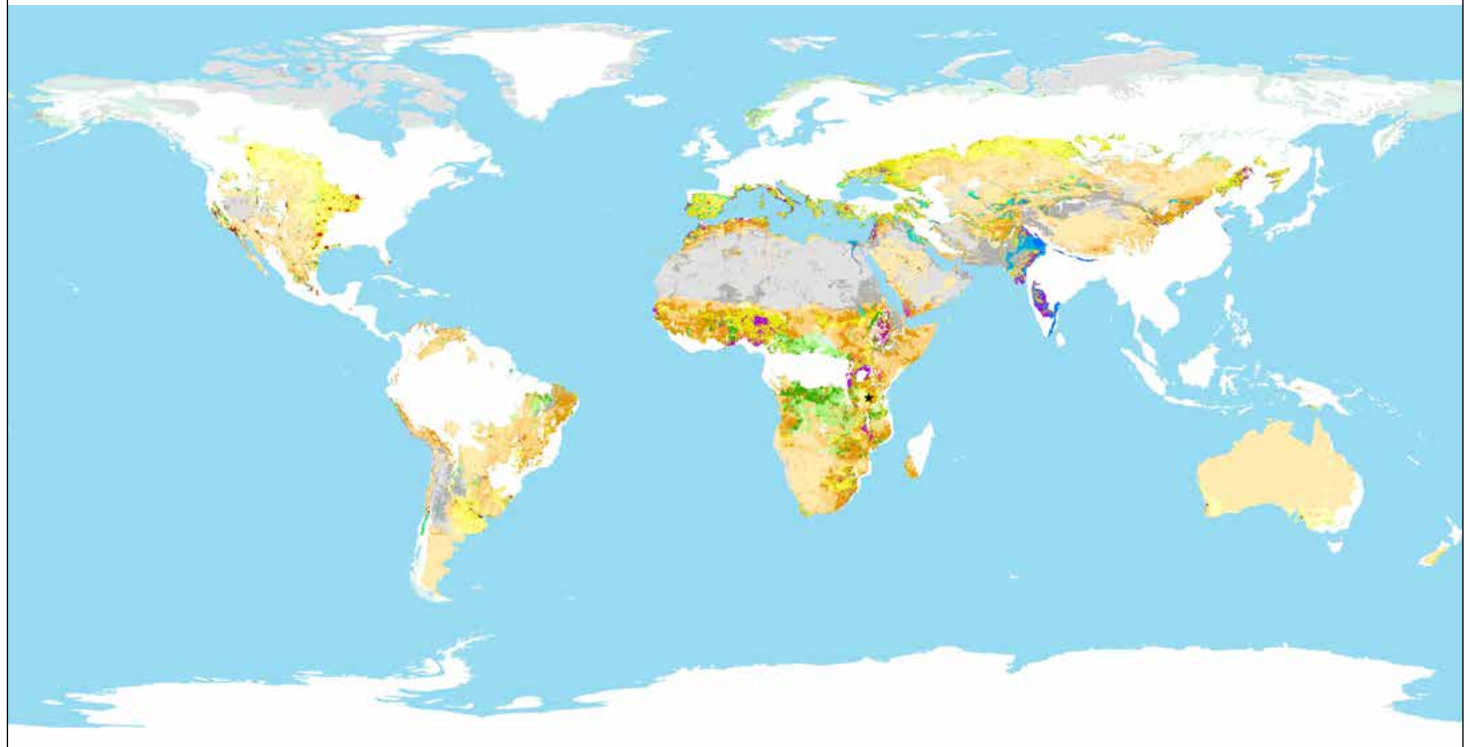
- Urban
- Mixed settlements
- Rice villages
- Irrigated villages
- Rainfed villages
- Pastoral villages
- Residential irrigated croplands
- Residential rainfed croplands
- Populated croplands
- Remote croplands
- Residential rangelands
- Populated rangelands
- Remote rangelands
- Residential woodlands
- Populated woodlands
- Remote woodlands
- Inhabited treeless and barren lands
- Wild woodlands
- Wild treeless and barren lands
- Others

Source 1: Terrestrial ecoregions of the world. Downloaded in 2021 from: https://globil-panda.opendata.arcgis.com/datasets/wwf-priority-35-ecoregions?geometry=-172.266%2C-86.819%2C172.266%2C89.233. Original source: Olson, D. M., Dinerstein, E., Wikramanayake, E. D., Burgess, N. D., Powell, G. V. N., Underwood, E. C., D'Amico, J. A., Itoua, I., Strand, H. E., Morrison, J. C., Loucks, C. J., Allnutt, T. F., Ricketts, T. H., Kura, Y., Lamoreux, J. F., Wettengel, W. W., Hedao, P., Kassem, K. R. 2001. Terrestrial ecoregions of the world: a new map of life on Earth. Bioscience 51(11):933-938.

Source 2: Anthropogenic Biomes of the World, Version 2: 2000. Downloaded in 2021 from: https://sedac.ciesin.columbia.edu/data/set/anthromes-anthropogenic-biomes-world-v2-2000/data-download Ellis, E.C., K.K. Goldewijk, S. Siebert, D. Lightman, and N. Ramankutty. 2014. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). https://doi.org/10.7927/H4D798B9.

ILRI, 2021

Anthropogenic biomes found in rangelands globally (Year 2000)



No	Anthropogenic biomes	Area km²
1	Inhabited treeless and barren lands	4,989,309.00
2	Irrigated villages	695,704.59
3	Mixed settlements	208,770.88
4	Others	4,844,954.46
5	Pastoral villages	365,064.49
6	Populated croplands	4,010,016.71
7	Populated rangelands	11,209,681.39
8	Populated woodlands	1,899,952.31
9	Rainfed villages	1,081,253.29
10	Remote croplands	1,991,376.41
11	Remote rangelands	18,372,805.74
12	Remote woodlands	566,791.09
13	Residential irrigated croplands	675,168.47
14	Residential rainfed croplands	4,274,270.78
15	Residential rangelands	5,303,138.37
16	Residential woodlands	1,183,882.30
17	Rice villages	146,735.84
18	Urban	195,394.07
19	Wild treeless and barren lands	14,458,293.43
20	Wild woodlands	3,036,857.03
	Total	**79,509,420.65**

Anthropogenic biomes

- Urban
- Mixed settlements
- Rice villages
- Irrigated villages
- Rainfed villages
- Pastoral villages
- Residential irrigated croplands
- Residential rainfed croplands
- Populated croplands
- Remote croplands
- Residential rangelands
- Populated rangelands
- Remote rangelands
- Residential woodlands
- Populated woodlands
- Remote woodlands
- Inhabited treeless and barren lands
- Wild woodlands
- Wild treeless and barren lands
- Others

Source 1: Terrestrial ecoregions of the world. Downloaded in 2021 from: https://globil-panda.opendata.arcgis.com/datasets/wwf-priority-35-ecoregions?geometry=-172.266%2C-86.819%2C172.266%2C89.233. Original source: Olson, D. M., Dinerstein, E., Wikramanayake, E. D., Burgess, N. D., Powell, G. V. N., Underwood, E. C., D'Amico, J. A., Itoua, I., Strand, H. E., Morrison, J. C., Loucks, C. J., Allnutt, T. F., Ricketts, T. H., Kura, Y., Lamoreux, J. F., Wettengel, W. W., Hedao, P., Kassem, K. R. 2001. Terrestrial ecoregions of the world: a new map of life on Earth. Bioscience 51(11):933-938.

Source 2: Anthropogenic Biomes of the World, Version 2: 2000. Downloaded in 2021 from: https://sedac.ciesin.columbia.edu/data/set/anthromes-anthropogenic-biomes-world-v2-2000/data-download Ellis, E.C., K.K. Goldewijk, S. Siebert, D. Lightman, and N. Ramankutty. 2014. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). https://doi.org/10.7927/H4D798B9.

Terrestrial protected areas found in rangelands globally

The map on protected areas draws from data of the WDPA (World Database on Protected Areas) which uses the IUCN's definition of a protected area as the main criteria for entries to be included in the database. The database contains comprehensive information on the different types of protected areas ranging from those strictly protected for conservation purposes to those where sustainable use of natural resources is allowed; and includes government, co-managed, private and community-managed areas. For more information visit the Protected Planet website: https://portals.iucn.org/library/node/46259

KEY DATA

1. **Protected areas in rangelands cover 9,438,874 km² plus an additional 344,790 km² proposed, that is 7% of global terrestrial surface.**
2. **12% of rangelands are classified as protected areas – that is 12% of rangelands (79,509,421 km²) to a total of 9,783,664 km².**

Indigenous peoples right vs. Nature Conservation? Pastoralism within the Reisa National Park

In Norway, reindeer husbandry is recognised as an indigenous livelihood and a vital basis for Sámi language, knowledge and worldviews. The reindeer herding area covers approximately 40% of the Norwegian mainland, and the herders have customary rights to the grazing areas. The linkages between the reindeer herders and the environment are strong. Through their daily work, the herders have gained deep knowledge about the surrounding environment, adapted their practices to varying grazing conditions and helped to conserve the biodiversity. Today, however, the herders' ability to adapt to new challenges of climate change, acceleratng industrial development, resource extraction and other competing land-use interests has been weakened by land fragmentation and degradation. Nature conservation can be one of these land-use conflicts if it limits the herders' access to traditional grazing areas.

National parks cover about 10% of the Norwegian mainland, and about half of the 40 parks are located within reindeer herding areas. The Reisa National Park, established in 1986, covers 803 km² and consists of canyons, stream valleys, wetlands and a mountain plateau. No other national park in Norway is larger in terms of reindeer husbandry; it provides pastures and migration routes for about 22,000 reindeer and 241 owners. Here, reindeer husbandry was established long before the borders of northern Scandinavia were officially drawn. The authorities assured the reindeer herders that they would not be negatively affected by the park. Yet, none of the herding groups were involved in the development or the management of the park; and, they were not represented on the park's management board until 2011.

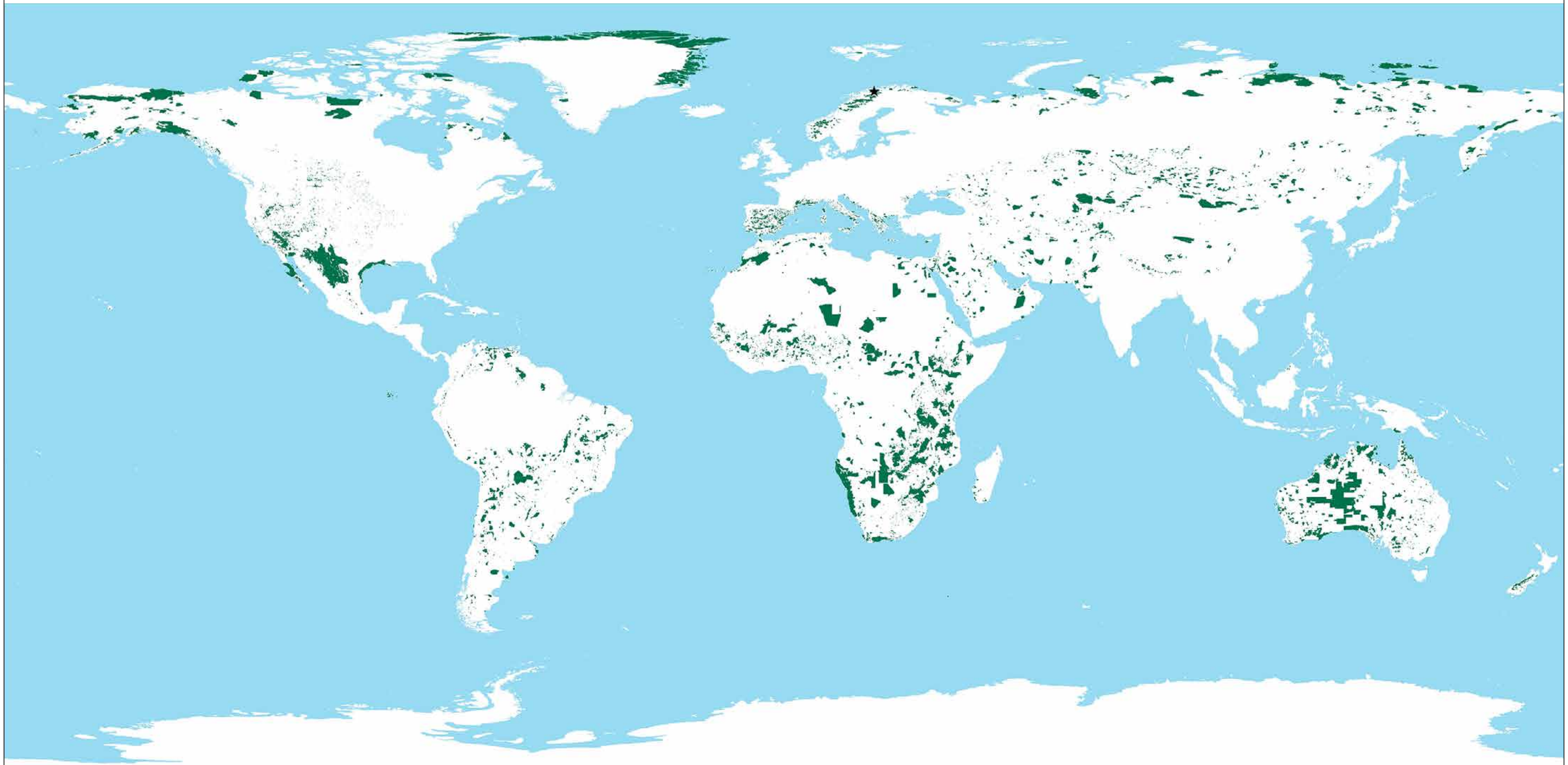
The lack of participation has created misunderstandings and conflicts. According to the reindeer owners, there has been – and still is – little understanding of historical land-use and the herders' practices and knowledge. The management of the park limits the flexibility of reindeer husbandry, and thereby its ability to adapt to the seasonal and spatial changes affecting the nature and climate. It has also become more challenging to respond to disturbances from predators and human activities, and to accommodate other herding groups moving through the same area. While the Reisa National Park protects the traditional pastures of the Sámi reindeer herders from industrial development, the limits it puts on movements is a critical challenge. Further, formal procedures of decision-making related to the Park exclude the Sámi, alienating them from their lands whilst also losing the opportunity of learning from their traditional knowledge.

For more information:
Elenius, L., Allard, C., & Sandström, C. (Eds.) (2016). *Indigenous rights in modern landscapes: Nordic conservation regimes in global context.* Taylor & Francis.

Johnsen, K. I., & Benjaminsen, T. A. (2017). The art of governing and everyday resistance: 'rationalisation' of Sámi reindeer husbandry in Norway since the 1970s. Acta Borealia, 34(1), 1-25. Internet: https://www.tandfonline.com/doi/abs/10.1080/08003831.2017.1317981

ILRI, 2021

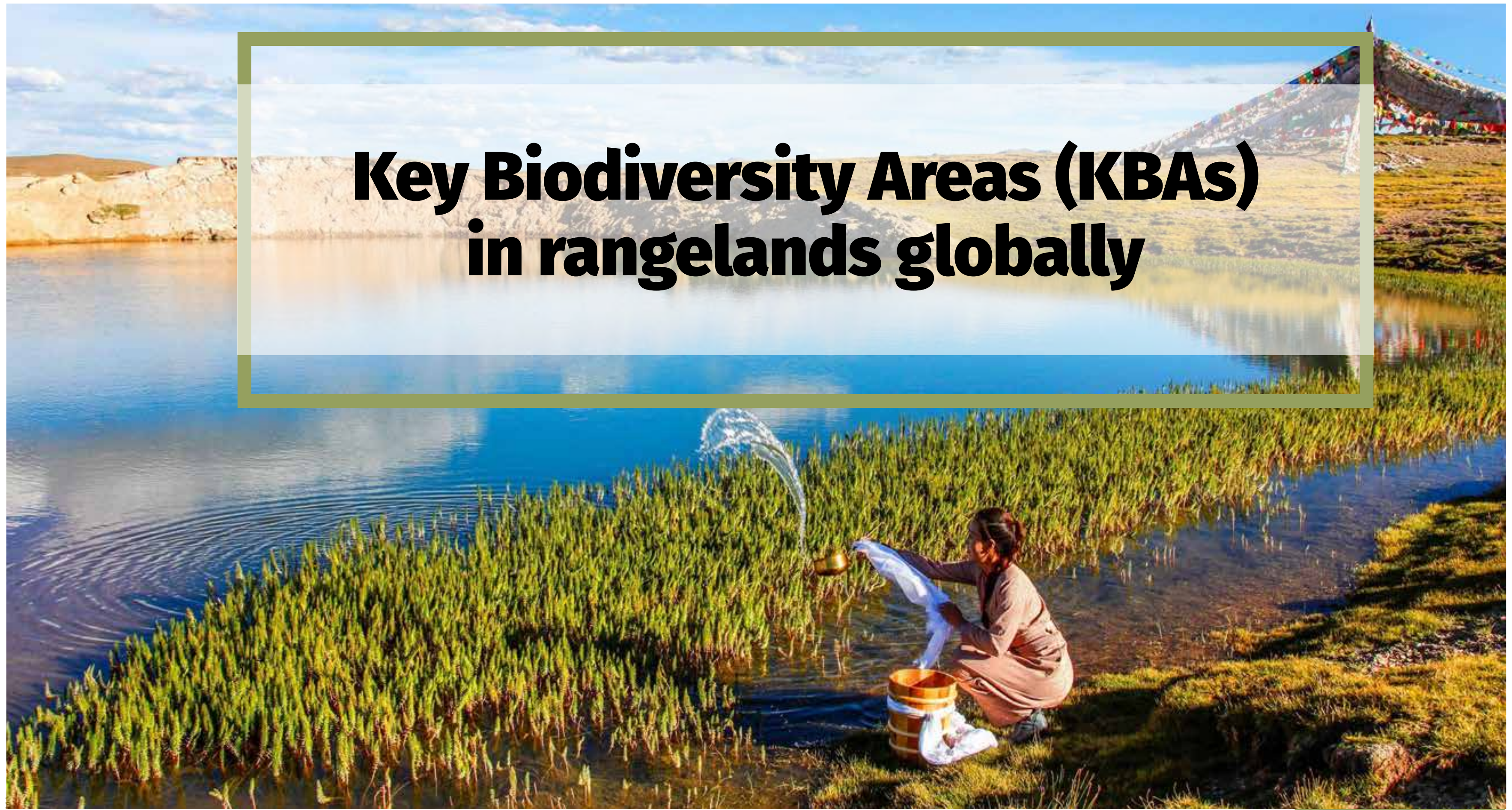
Terrestrial protected areas found in rangelands globally



No	WDPA status	Area km²
1	Designated	9,012,602.18
2	Established	14,625.82
3	Inscribed	386,305.79
4	Not reported	25,340.04
5	Proposed	344,789.69
	Total	**9,783,663.53**

Source 1: Terrestrial ecoregions of the world. Downloaded in 2021 from: https://globil-panda.opendata.arcgis.com/datasets/wwf-priority-35-ecoregions?geometry=-172.266%2C-86.819%2C172.266%2C89.233. Original source: Olson, D. M., Dinerstein, E., Wikramanayake, E. D., Burgess, N. D., Powell, G. V. N., Underwood, E. C., D'Amico, J. A., Itoua, I., Strand, H. E., Morrison, J. C., Loucks, C. J., Allnutt, T. F., Ricketts, T. H., Kura, Y., Lamoreux, J. F., Wettengel, W. W., Hedao, P., Kassem, K. R. 2001. Terrestrial ecoregions of the world: a new map of life on Earth. Bioscience 51(11):933-938.

Source 2: UNEP-WCMC and IUCN (2021), Protected Planet: The World Database on Protected Areas (WDPA). Downloaded in 2021 from: www.protectedplanet.net Cambridge, UK: UNEP-WCMC and IUCN.



Key Biodiversity Areas (KBAs) in rangelands globally

Key Biodiversity Areas (KBAs) are 'sites contributing significantly to the global persistence of biodiversity', in terrestrial, freshwater and marine ecosystems. The Global Standard for the Identification of Key Biodiversity Areas (IUCN 2016) sets out globally agreed criteria for the identification of KBAs worldwide. This map shows the distribution of KBAs in rangelands.

Identifying KBAs is an essential step towards enabling effective conservation and development decisions. With many countries still in the process of analysis, the data is likely to be an underestimation – many sites in rangelands may well meet the KBA criteria but have not yet been officially identified as KBAs. As KBA identification in rangelands becomes more complete, the below data can be updated.

KEY DATA

1. Confirmed key biodiversity areas (KBAs) in rangelands cover 1,341,354 km², that is nearly 1% of global terrestrial surface.
2. Of rangelands worldwide, 1.7% are classified as confirmed key biodiversity areas (KBAs) – that is 1,341,354 km² of total rangeland area of 79,509,421 km².

The contribution of Key Biodiversity Areas (KBAs) to the protection of rangelands in China

China is a vast country covering 9,562 million km² [1] and the world's most populous country with 1.4 billion inhabitants[2]. Because of its variety of ecosystems – grassland, desert, mountain ranges, lakes and rivers – China is home to a rich variety of wildlife, including the giant panda, wild yaks, snow leopards, the Tibetan antelope and the Tibetan gazelle[3]. China is also home to a diversity of people, cultures and livelihoods. In Western China, many ethnic minority groups contribute to the conservation of the vast grassland environment through their traditional pastoral management systems,[4] such as the multi-species grazing system by the Tibetan nomads. In addition to a diversity of herds, traditional nomadic pastoralism is characterised by complex herd structures, regulated movements of livestock in rangeland sites and a connection with farmers, which has helped maintain the rangeland ecosystems over time.[5]

KBAs are sites contributing significantly to the global persistence of biodiversity.[6] There are 16,315 KBAs worldwide, and 668 KBAs in mainland China, covering an area of 1,149,679 km². Threats to KBAs include: agriculture and aquaculture, biological resource use, energy production and mining, human disturbance, invasive species and diseases, residential and commercial development, and transportation[7]. These activities also contribute to increasing the number of species threatened by extinction.

In China, nature reserves protect these vulnerable habitats, like the Sanjiangyuan Nature Reserve. This reserve is located in the Sanjiangyuan area, which means 'the origin of three rivers', the Yangtze, Yellow and Lancang (Mekong) rivers, and is home to Tibetan nomadic herders. The reserve was classified as a KBA in 2009, because it is a biodiversity hotspot with natural habitats ranging from montane forest to cold alpine grassland and desert.[8] However, human activities have affected the integrity of the reserve. China is currently strengthening the management and biodiversity conservation of nature reserves through the creation of a new system of national parks and protected areas, and piloting 12 national parks, including Sanjiangyuan. The management of this new national park will allow herders and farmers to combine sustainable livestock grazing with wildlife protection and is expected to create jobs and improve the incomes of local communities[9].

For more information see:
https://www.iucn.org/regions/mediterranean/our-work/biodiversity-knowledge-and-action/biodiversity-standards-and-indicators/key-biodiversity-areas

[1] http://wdi.worldbank.org/table/WV.1

[2] https://data.worldbank.org/indicator/SP.POP.TOTL?locations=CN

[3] http://www.paulsoninstitute.org/wp-content/uploads/2020/05/Sanjiangyuan_National_Park_FullReport-English.pdf

[4] https://pastoralismjournal.springeropen.com/articles/10.1186/2041-7136-2-17

[5] https://journals.uair.arizona.edu/index.php/rangelands/article/viewFile/11540/10813

[6] IUCN (2016).A Global Standard for the Identification of Key Biodiversity Areas, Version 1.0. First edition. Gland, Switzerland: IUCN

[7] http://www.keybiodiversityareas.org

[8] Key Biodiversity Areas Partnership (2020) Key Biodiversity Areas factsheet: Sanjiangyuan Nature Reserve. Extracted from the World Database of Key Biodiversity Areas. Developed by the Key Biodiversity Areas Partnership: BirdLife International, IUCN, American Bird Conservancy, Amphibian Survival Alliance, Conservation International, Critical Ecosystem Partnership Fund, Global Environment Facility, Global Wildlife Conservation, NatureServe, Rainforest Trust, Royal Society for the Protection of Birds, World Wildlife Fund and Wildlife Conservation Society. Downloaded from http://www.keybiodiversityareas.org/ on 19/04/2021.

[9] China's first national park to be established in Sanjiangyuan area in 2020 – Global Times

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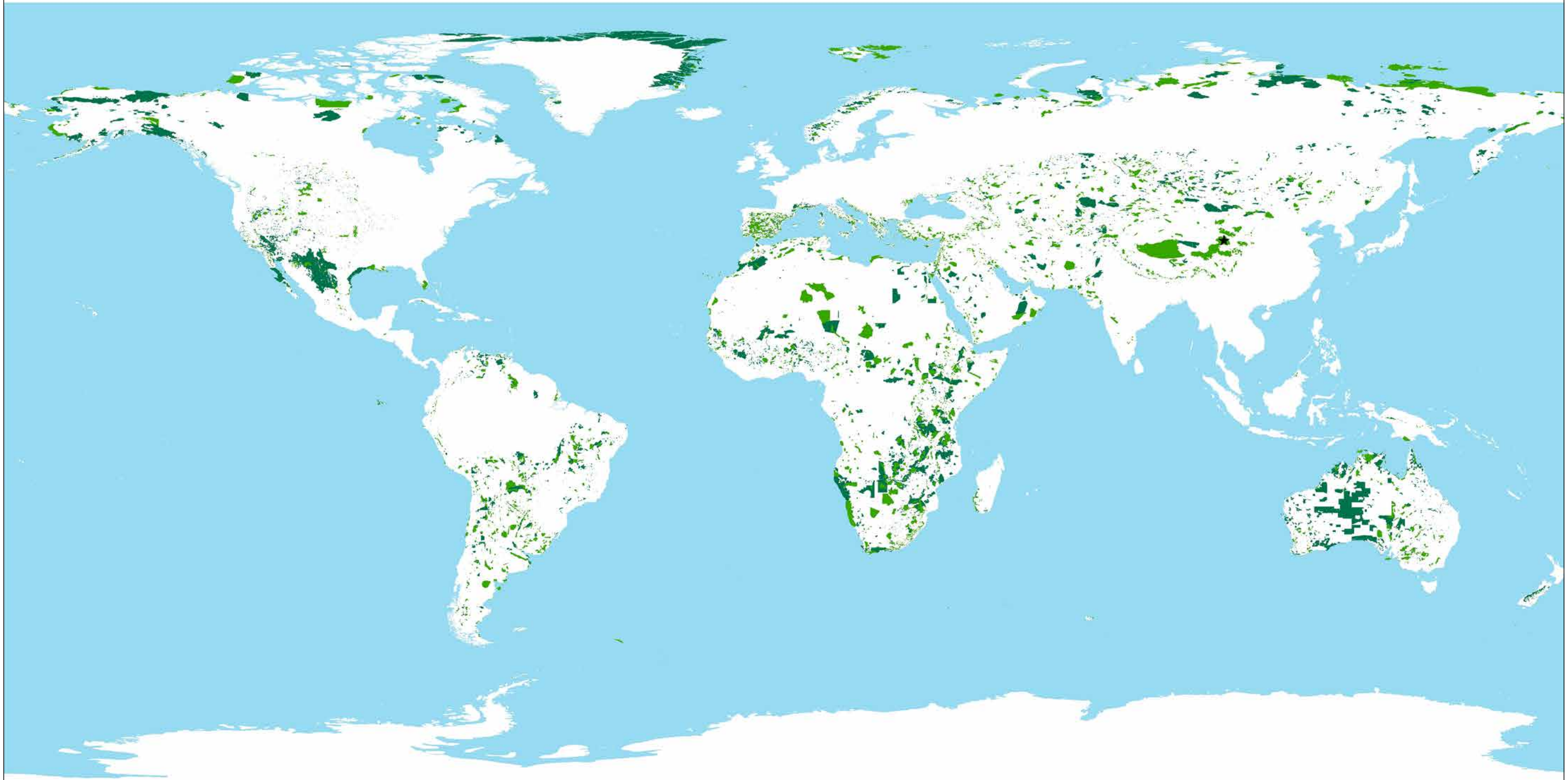
Key Biodiversity Areas (KBAs) found in rangelands globally



Source 1: Terrestrial ecoregions of the world. Downloaded in 2021 from: https://globil-panda.opendata.arcgis.com/datasets/wwf-priority-35-ecoregions?geometry=-172.266%2C-86.819%2C172.266%2C89.233. Original source: Olson, D. M., Dinerstein, E., Wikramanayake, E. D., Burgess, N. D., Powell, G. V. N., Underwood, E. C., D'Amico, J. A., Itoua, I., Strand, H. E., Morrison, J. C., Loucks, C. J., Allnutt, T. F., Ricketts, T. H., Kura, Y., Lamoreux, J. F., Wettengel, W. W., Hedao, P., Kassem, K. R. 2001. Terrestrial ecoregions of the world: a new map of life on Earth. Bioscience 51(11):933-938.

Source 2: BirdLife International (2017). Key Biodiversity Area digital boundaries. Version (2016-4). Derived from the World Database of Key Biodiversity Areas. Developed by the KBA Partnership (BirdLife International, International Union for the Conservation of Nature, Amphibian Survival Alliance, Conservation International, Critical Ecosystem Partnership Fund, Global Environment Facility, Global Wildlife Conservation, NatureServe, Royal Society for the Conservation of Birds, Wildlife Conservation Society and World Wildlife Fund). Available at www.keybiodiversityareas.org. Downloaded in 2019 from: https://wwf-sight-maps.org/arcgis/rest/services/Global/KBAs/MapServer

No	KBA status	Area km^2
1	Candidate	6,673.30
2	Confirmed	1,341,354.35
3	De-listed	13,683.77
4	Does not qualify	172.42
5	Proposed	1,218.43
6	Superseded	4,832.28
	Total	**1,367,934.55**

Key biodiversity areas

Numbers of threatened vertebrates found in rangelands

This map shows the number of threatened vertebrates in rangelands, highlighting an emerging picture of significant threats. The threatened vertebrates map and dataset was developed by compiling a vertebrate species list for each ecoregion from WWF's WildFinder database (WWF 2006). This list was then compared against the IUCN Red List of Threatened Species (2008) to determine the number of vertebrate species per ecoregion that are threatened. Threatened species are those listed by IUCN Red List as Vulnerable, Endangered, or Critically Endangered (www.redlist.org).

It should be noted that this data is likely to be an underestimation. Not all species have yet been assessed and included in the IUCN Red List and the data does not represent the hundreds of invertebrates that are essential elements of healthy rangelands.

KEY DATA

1. **There are a significant amount of threatened vertebrate species in rangelands: 3,302,241 km^2 (4%) of rangelands have between 60-100 threatened species, 5,701,959 km^2 (7%), have 41-60 threatened species, 14,386,045 km^2 (18%) have 31-40, 23,517,276 km^2 (30%) have 21-30, 21,983,038 km^2 (28%) have 11-20 and 10,618,862 km^2 (13%) have less than 10 threatened species.**

Partnerships to protect threatened animal species in the lowland Terai of Nepal

Grasslands cover roughly 17,000 km^2, about 11.5% of Nepal. They are found in four distinct regions with their own associated species: The Terai lowlands, the mid hills, the high mountains, and the Himalayas. The lowland Terai grasslands are one of the world's most productive ecosystems with over 50 recorded grass species. They are home to rare and endangered species including greater one-horned rhinoceros, Asian elephants, tigers, hog deer, swamp deer, wild water buffalo and the Bengal bustard. Formed by natural processes over the years like floods, fires and riverine erosion, only 4% of these unique grassland ecosystems are protected in Nepal.

Human activities now contribute to sustained pressure on these grasslands leading to conversion, fragmentation and degradation of habitats and the ecosystem services they provide. This is particularly acute in relation to large scale infrastructure development and overgrazing from livestock production. Climate change is exacerbating these challenges with more frequent droughts and wildfires. In addition to these shifts the habitats become more vulnerable to the spread of invasive woody perennial plant species that are not palatable to the native wildlife.

WWF Nepal is working with the government to develop a framework and standards for habitat management in the lowland Terai which will guide the future of grassland management in Nepal. The Government of Nepal is working on mapping ecosystem types including the grassland ecosystem. Partnership with local communities to deliver this habitat management is essential. The collaboration focuses on managing critical grasslands for wildlife conservation, it focuses on the removal of young trees and other invasive woody species with the aim to prevent them spreading into grasslands. Community forest groups practice controlled burning of grassland patches to increase the amount of young, succulent vegetation most favoured by ungulates. Additionally, regulation of annual grass cutting – *khar khadai* in local dialect – within national protected areas provides thatch for the local communities and benefits herbivores by retaining short grasslands.

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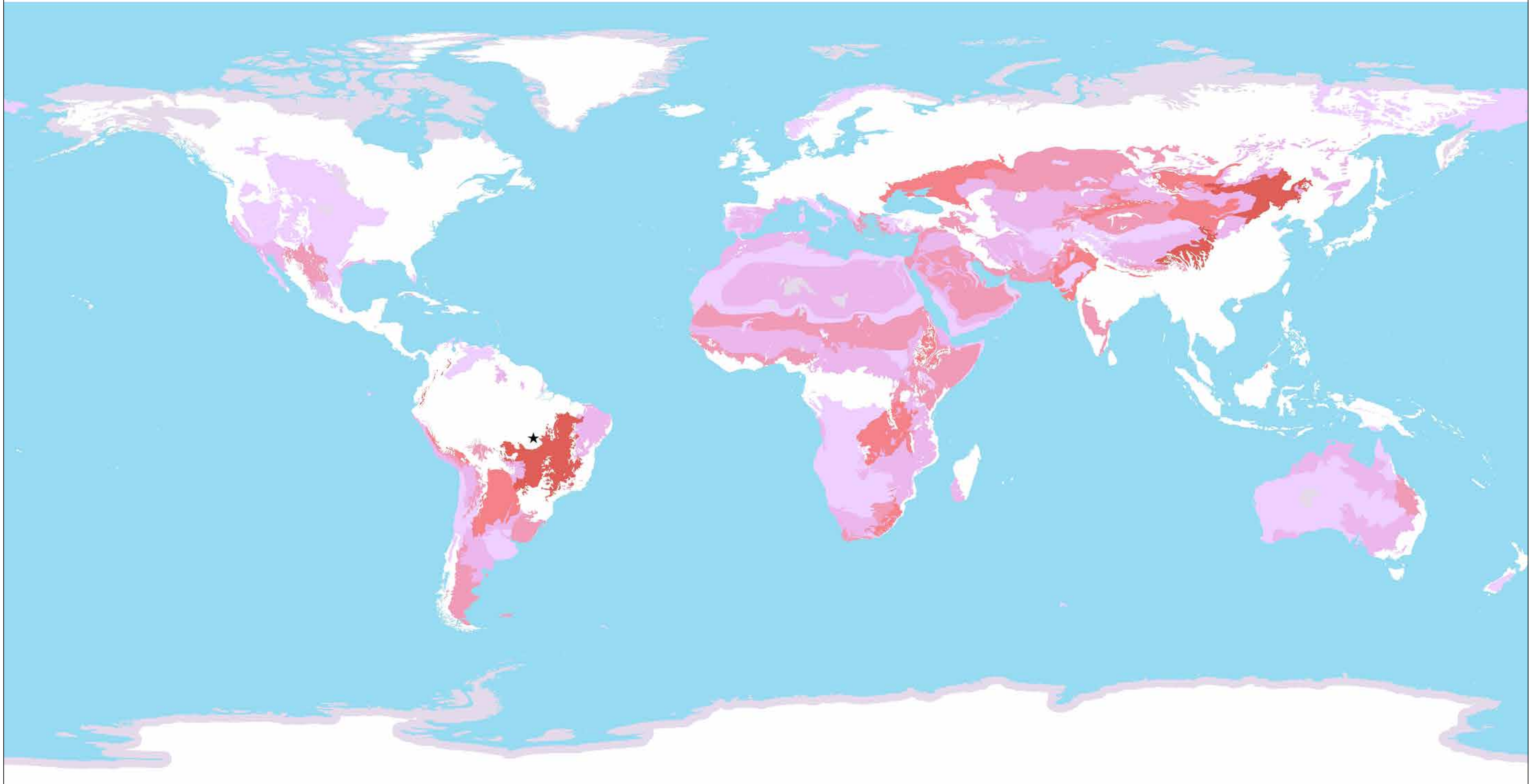
Numbers of threatened vertebrates in rangelands globally



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Source 2: Hoekstra, J. M., J. L. Molnar, M. Jennings, C. Revenga, M. D. Spalding, T. M. Boucher, J. C. Robertson, T. J. Heibel, with K. Ellison. 2010. The Atlas of Global Conservation: Changes, Challenges, and Opportunities to Make a Difference. Ed. J. L. Molnar. Berkeley: University of California Press. Data were derived by The Nature Conservancy. Downloaded in 2021 from: https://globil-panda.opendata.arcgis.com/datasets/bd48180f31bb4c73b37405b12d2c0b18

No	Threatened vertebrate class	Area km^2
1	Less than 10	10,618,862.09
2	10 - 20	21,983,038.11
3	21 - 30	23,517,275.55
4	31 - 40	14,386,044.58
5	41 - 60	5,701,959.19
6	61 -100	3,302,240.81
	Total	**79,509,420.33**

Less than 10
10 - 20
21 - 30
31 - 40
41 - 60
61 - 100

Land productivity changes in rangelands between 2001-2015

As part of Land Degradation Neutrality (LDN) calculations, land productivity can be described as 'the biological productive capacity of the land, the source of all the food, fibre and fuel that sustains humans.' Land productivity points to long-term changes in the health and productive capacity of the land and reflects the net effects of changes in ecosystem functioning on plant and biomass growth. Land productivity is assessed using three measures of change derived from NDVI (Normalized Difference Vegetation Index) time series data: trajectory, performance and state (see below).

In the map, productivity is measured against the baseline year of 2000. Changes in productivity have been attributed to a number of factors, including expansion in woody biomass, expansion of irrigated cultivation, increased CO_2 fertilisation and other.

KEY DATA

1. **According to LDN measurements between 2001-2015 the majority of rangelands have been stable or increased in productivity terms: 48% of rangelands were stable, 13% showed early signs of increase and 18% showed increasing productivity. An additional 6% of rangelands showed declining productivity and 9% early signs of decline.**
2. **Approximately 58,000,000 km^2 or 74% of rangelands showed mid land productivity performance, and 9% (approximately 7,000,000 km^2) showed high land productivity performance, with 12% of rangelands (approximately 4,000,000 km^2) having low productivity performance.**
3. **According to LDN measurements between 2001-2015, 56% (approximately 44,000,000 km^2) of rangelands were stable and 26% (21,500,000 km^2) showed improvement in land productivity state. According to LDN measurements between 2001-2015, 13% (approximately 10,000,000 km^2) showed degradation in land productivity state.**
4. **The land productivity trajectory for 73% of rangelands (approximately 57,000,000 km^2) is stable, and for 17% (approximately 13,000,000 km^2) the land productivity trajectory is improvement. The land productivity trajectory for 6% of rangelands (approximately 4,000,000 km^2) is degradation.**

Changes in productivity of rangelands and pasture conditions in Kyrgyzstan

Kyrgyzstan land cover falls primarily under agricultural use. This total is commonly subdivided among permanent pasture land (48%) followed by arable cropping land (7%) and forestry (4%); the rest is comprised of other land cover types, mostly non-productive lands in the higher altitudes, rocky outcrops, glacial and snowfields and urban areas. Winter pastures are located in lower altitudes, Spring-Autumn in mid-lower (transitional) altitudes, and Summer pastures in high altitude areas. Animal husbandry, through production of cattle, sheep, horse, goat, and yaks, is a key livelihood activity. However, production is facing challenges, including disregard for grazing mobility, leading to pasture degradation exacerbated by a changing climate and lack of suitable policies.

Rangeland health assessments rarely incorporate herder perspectives and data sharing remains fragmented. An assessment was carried out in Naryn oblast by FAO and Camp Alatoo, a local NGO. It integrated remote sensing, field assessment and traditional knowledge. Using Land Degradation Neutrality (LDN) indicators, it assessed degradation trends between 2000 to 2015. Local knowledge provided additional indicators to help with validation of remote sensing.

The results show that vegetation related indicators, such as Normalized Difference Vegetation Index (NDVI), were the most important. In low altitude pastures, the increasing NDVI was due to arable lands. In the high-altitude pastures, remote sensing showed increasing degradation, even though bare ground is a natural occurrence in high altitudes and grassland cover rarely exceeds 80%. In the spring-autumn pastures, increasing NDVI was partly due to non-palatable species. Here, high temperatures and precipitation favour vegetation growth leading to high diversity of vegetation, including non-palatable species.

The conclusions considered that rangeland health assessment should be contingent upon the use and management objectives of the landscape. Sub-national level assessments enable identification of the main rangeland users, incorporation of local indicators (to improve quality of LDN indicators) and buy-in by local communities.

For more information: https://pragaproject.org/

Terminologies used

The **land productivity performance** indicator measures local productivity relative to other similar vegetation types in similar land cover types or bioclimatic regions. **Productivity performance** compares local productivity levels to the range of productivity levels measured from similar land units across the study area in the assessment year. The **productivity state** indicator allows for the detection of recent changes in primary productivity as compared to a baseline period. Productivity state represents the level of relative productivity in a spatial unit (pixel or feature) compared to the historical observations of productivity for that spatial unit over time. **Productivity trend** describes the trajectory of change in productivity over time. It is calculated by fitting a robust, non-parametric linear regression model. Trajectory measures the rate of change in primary productivity over time.

[1]FAO (2012). 'Kyrgyzstan'. *Irrigation in Central Asia in figures – AQUASTAT Survey – 2012.* Food and Agriculture Organization of the United Nations.

Land productivity changes over the period 2001-2015 in rangelands

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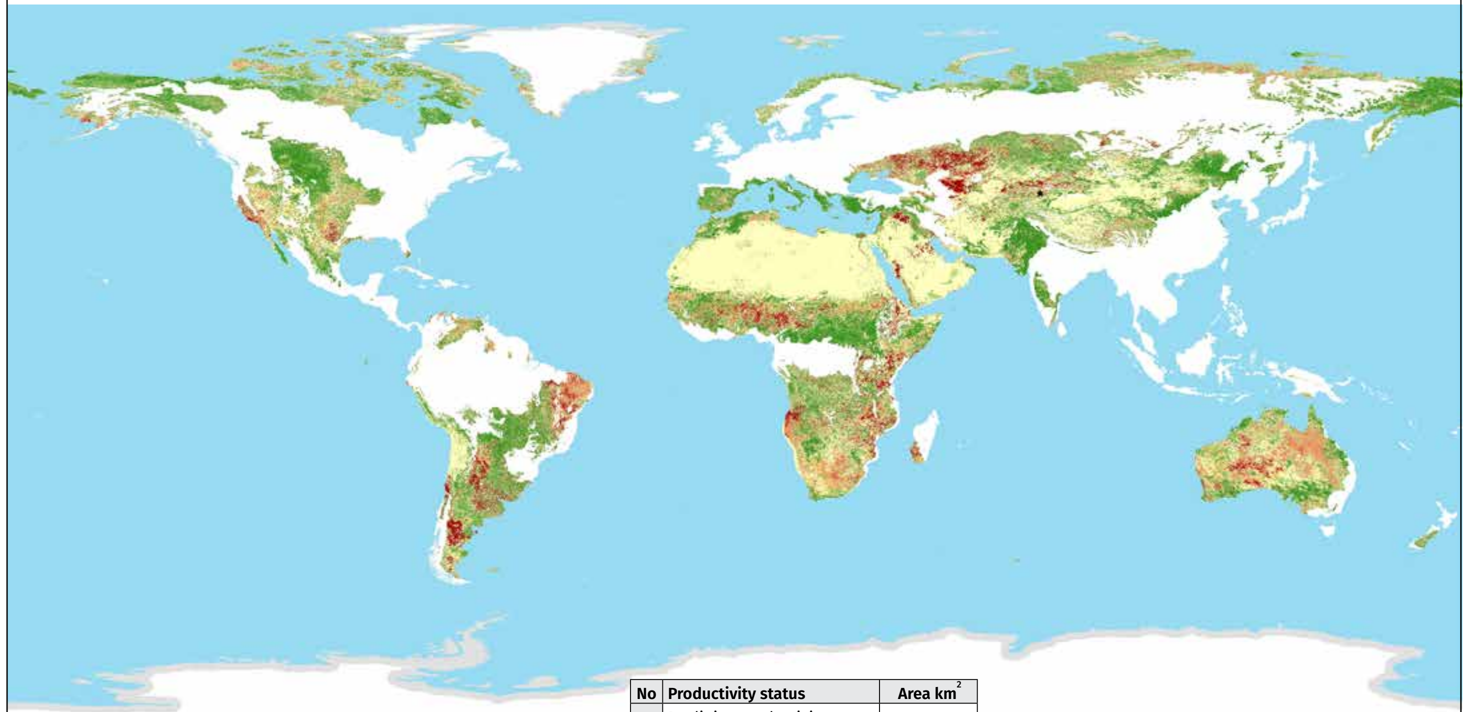


Source 1: Terrestial ecoregions of the World. World Wide Fund for Nature (WWF). Downloaded in 2021: https://globil-panda.opendata.arcgis.com/datasets/wwf-priority-35-ecoregions?geometry=-172.266%2C-86.819%2C172.266%2C89.233. Original source: Olson, D. M., Dinerstein, E., Wikramanayake, E. D., Burgess, N. D., Powell, G. V. N., Underwood, E. C., D'Amico, J. A., Itoua, I., Strand, H. E., Morrison, J. C., Loucks, C. J., Allnutt, T. F., Ricketts, T. H., Kura, Y., Lamoreux, J. F., Wettengel, W. W., Hedao, P., Kassem, K. R. 2001. Terrestrial ecoregions of the world: a new map of life on Earth. Bioscience 51(11):933-938.

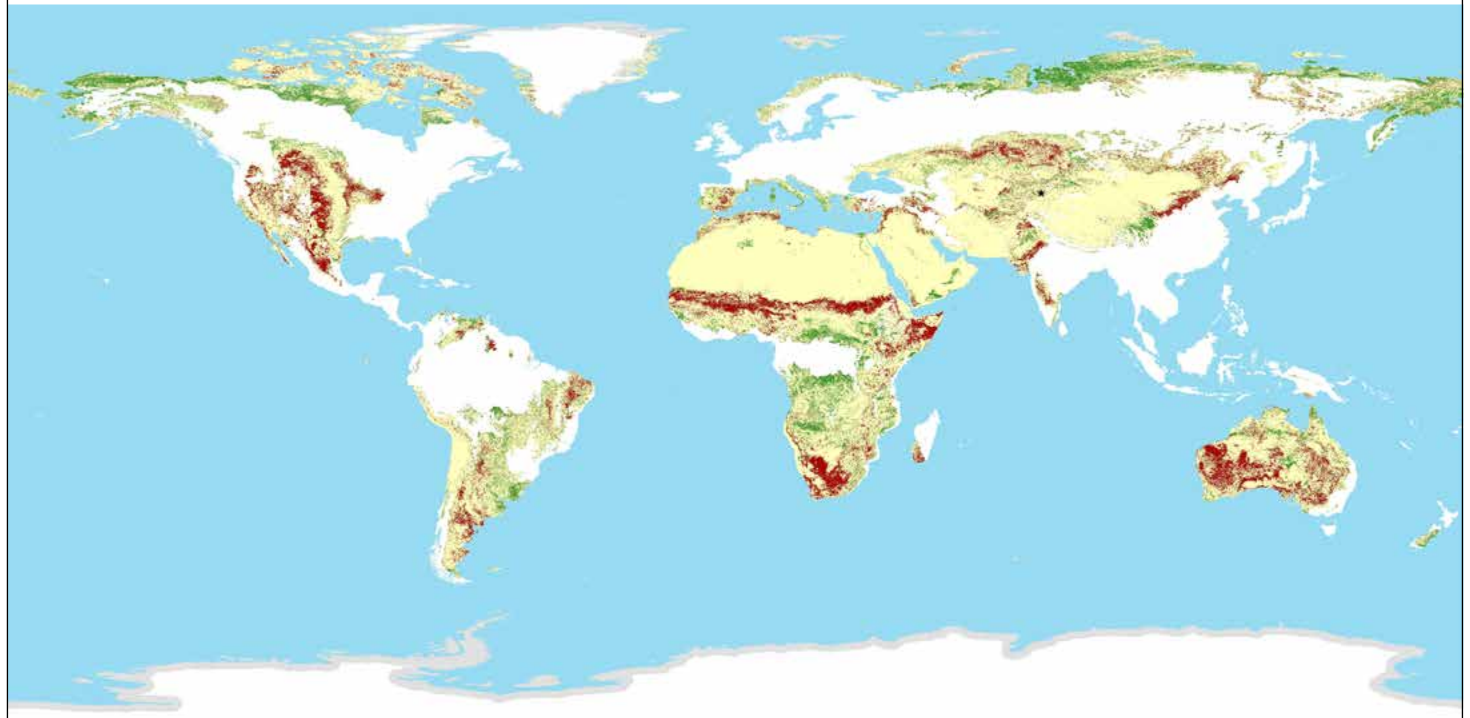
Source 2: Gonzalez-Roglich, M., Zvoleff, A., Noon, M., Liniger, H., Fleiner, R., Harari, N., Garcia, C., 2019. Synergising global tools to monitor progress towards land degradation neutrality: Trends. Earth and the World Overview of Conservation Approaches and Technologies sustainable land management database. Environ. Sci. Policy 93, 34-42. https://doi.org/10.1016/j.envsci.2018.12.019. Downloaded in 2021 http://trends.earth/

No	Productivity status	Area km^2
1	Declining productivity	4,730,193
2	Early signs of decline	6,989,279
3	Stable low performance	4,084,593
4	Stable moderate performance	31,737,569
5	Stable high performance	2,741,334
6	Early signs of increase	10,081,059
7	Increasing productivity	13,987,264
	Total	**78,559,787**

No data
Declining productivity
Early signs of decline
Stable low performance
Stable moderate performance
Stable high performance
Early signs of increase
Increasing productivity

Land productivity performance over the period 2001-2015 in rangelands

ILRI, 2021



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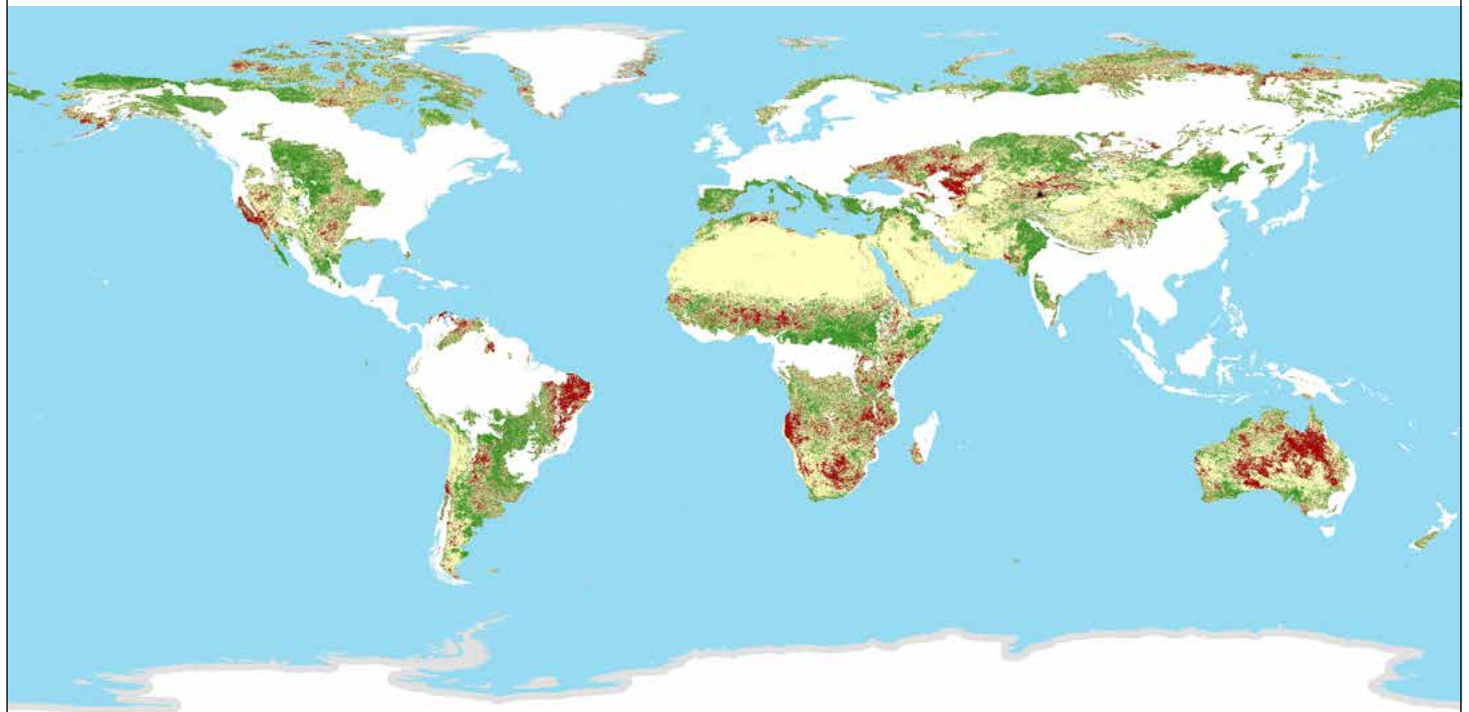
No	Performance status	Area km^2
1	Low	9,529,836
2	Mid	57,789,892
3	High	6,799,389
	Total	**74,119,117**

No data
Low
Mid
High

Land productivity state over the period 2001-2015 in rangelands

ILRI, 2021



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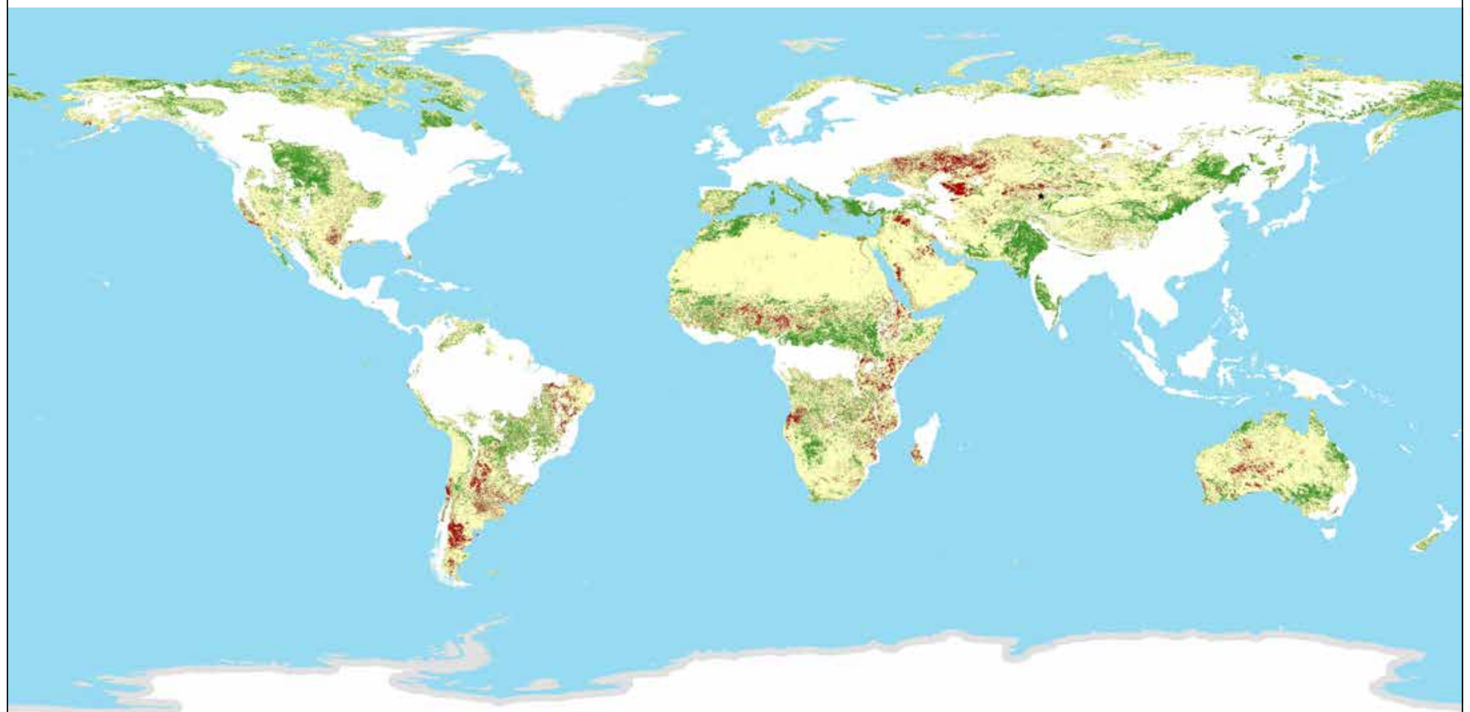
No	Productivity state status	Area km^2
1	Degradation	10,041,435
2	Stable	43,930,429
3	Improvement	20,594,863
	Total	**74,566,727**

No data
Degradation
Stable
Improvement

Land productivity trajectory over the period 2001-2015 in rangelands

ILRI, 2021



Source 1: Terrestial ecoregions of the World. World Wide Fund for Nature (WWF). Downloaded in 2021: https://globil-panda.opendata.arcgis.com/datasets/wwf-priority-35-ecoregions?geometry=-172.266%2C-86.819%2C172.266%2C89.233. Original source: Olson, D. M., Dinerstein, E., Wikramanayake, E. D., Burgess, N. D., Powell, G. V. N., Underwood, E. C., D'Amico, J. A., Itoua, I., Strand, H. E., Morrison, J. C., Loucks, C. J., Allnutt, T. F., Ricketts, T. H., Kura, Y., Lamoreux, J. F., Wettengel, W. W., Hedao, P., Kassem, K. R. 2001. Terrestrial ecoregions of the world: a new map of life on Earth. Bioscience 51(11):933-938.

Source 2: Gonzalez-Roglich, M., Zvoleff, A., Noon, M., Liniger, H., Fleiner, R., Harari, N., Garcia, C., 2019. Synergising global tools to monitor progress towards land degradation neutrality: Trends. Earth and the World Overview of Conservation Approaches and Technologies sustainable land management database. Environ. Sci. Policy 93, 34-42. https://doi.org/10.1016/j.envsci.2018.12.019. Downloaded in 2021 http://trends.earth/

No	Trajectory status	Area km^2
1	Degradation	4,318,281
2	Stable	56,998,288
3	Improvement	13,164,015
	Total	**74,480,584**

No data
Degradation
Stable
Improvement

Changes in land cover over the period 2001-2015 in rangelands

Land Degradation Neutrality (LDN) indicator for land cover change describes the transition from one land cover class to another. Land degradation or improvement processes are determined from the land cover transition analysis of yearly land cover maps from the ESA (European Space Agency) and CCI (Climate Change Initiative) land cover project. In interpretation of the map it should be remembered that analysis at this scale fails to take into account local level changes. Further, in rangelands an increase in land cover may not always be positive, and rather could reflect negative trends of an increase in bush encroachment or invasive species.

KEY DATA

1. **Across rangelands globally, according to LDN measurements between 2001-2015 land cover of 99% of rangelands (approximately 77,000,000 km^2) was stable. As measured through LDN indicators, 1% (664,791 km^2) showed 'improvement' in land cover, and 1% (399,121 km^2) showed 'degradation' in land cover.**

Reversing land degradation in Ait Ben Yacoub, Morocco

In Ait Ben Yacoub, which is part of the Moulay Valley in northeastern Morocco, tribes have coveted the area since the Middle Ages, crossing it as they move towards the wetter central and Atlantic plains from the deserts of the Middle East and the Maghreb. The movement of pastoral communities, from the south-east of the country to the northwest, has been amplified by desertification, which is advancing in the same direction. The area is currently inhabited by Arab-Berber tribes, who come from the drier zones in the southeastern part of the country and move towards the greener pastures in the mountains and the plains.

The forests of Ait Ben Yacoub are populated with around 10,000 hectares of holm oak, thuya (*Tetraclinis articulata*) and cedar (property of the State); 7,500 hectares of collective stoney pastures predominated by alfa grass (*Stipa tenacissima*) and Moroccan mugwort (*Artemesia herba alba*); and 6,000 hectares of private land. Around 19,500 heads of sheep and goats graze in Ait Ben Yacoub, with around 12,000 of these belonging to those tribes from other regions, who are increasingly coming to the area and settling down, causing conflict with the 5,000 or so original inhabitants.

In recent years, the forests have gradually been stripped for livestock fodder and firewood. Alfa grass is degraded, and the Moroccan mugwort has disappeared and been replaced by harmel (*Peganum harmala*), which can cause livestock to fall sick or die. The soils are impoverished and water has become a critical issue. This has made livestock production ineffective. With around 200 mm of rain per year and a low and randomly distributed water table, agriculture is difficult to sustain. As a result, many locals have migrated to other regions and/or cities to try and make a living in another way.

In order to reverse this degradation and rehabilitate land cover and its productivity, there is an urgent need for investment in soil and water conservation, reseeding, replanting and most importantly, improved land management. The responsibility of this management should sit with the local population of pastoralists, who will require support to strengthen their collective institutions and develop and implement sustainable management plans. A more enabling policy and legislative environment will also be required to facilitate this effort. Local organisations, such as the Association Pastorale Ait Ben Yacoub (APABY) are lobbying for such changes.

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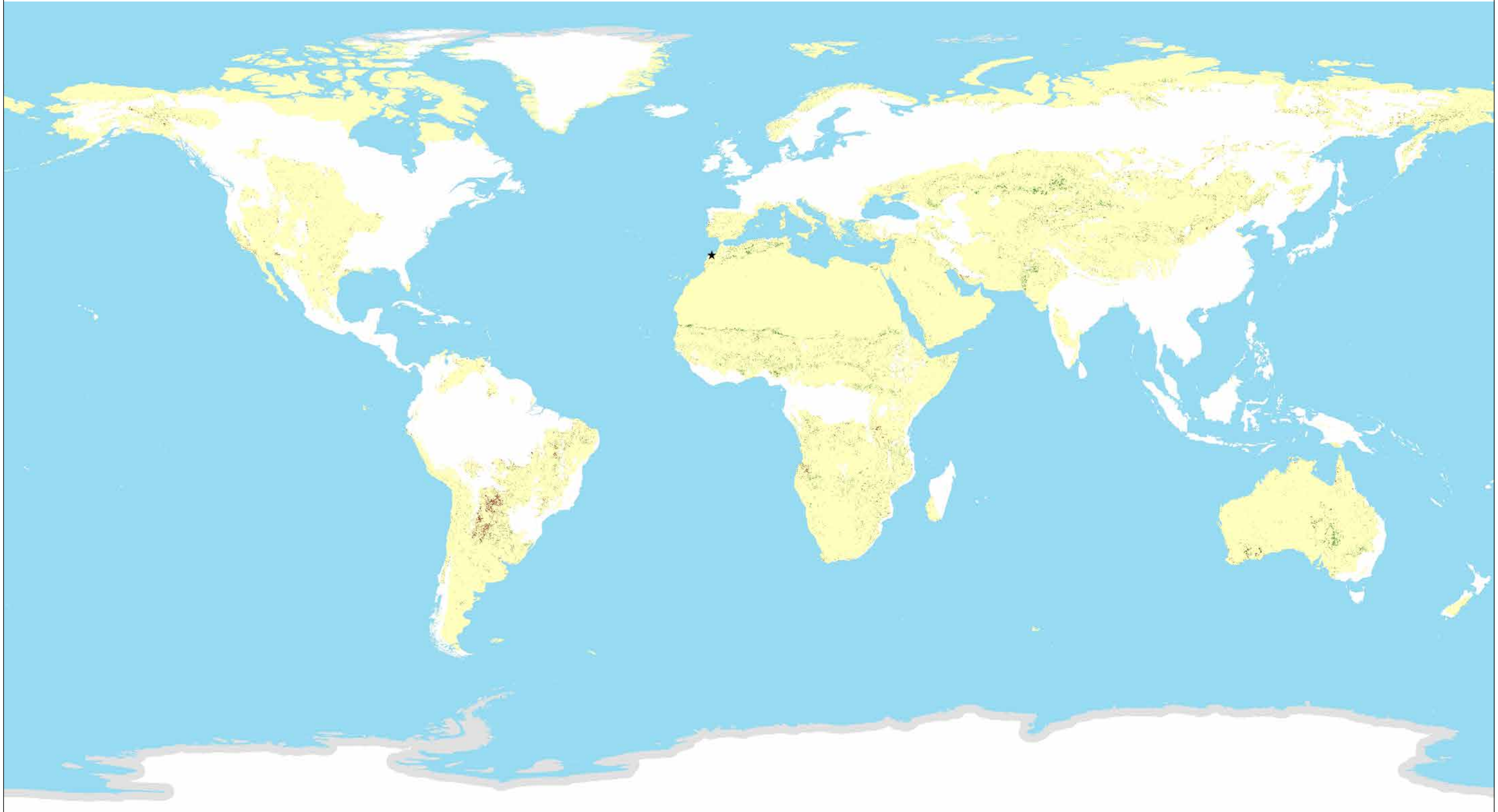
Changes in land cover over the period 2001-2015 in rangelands



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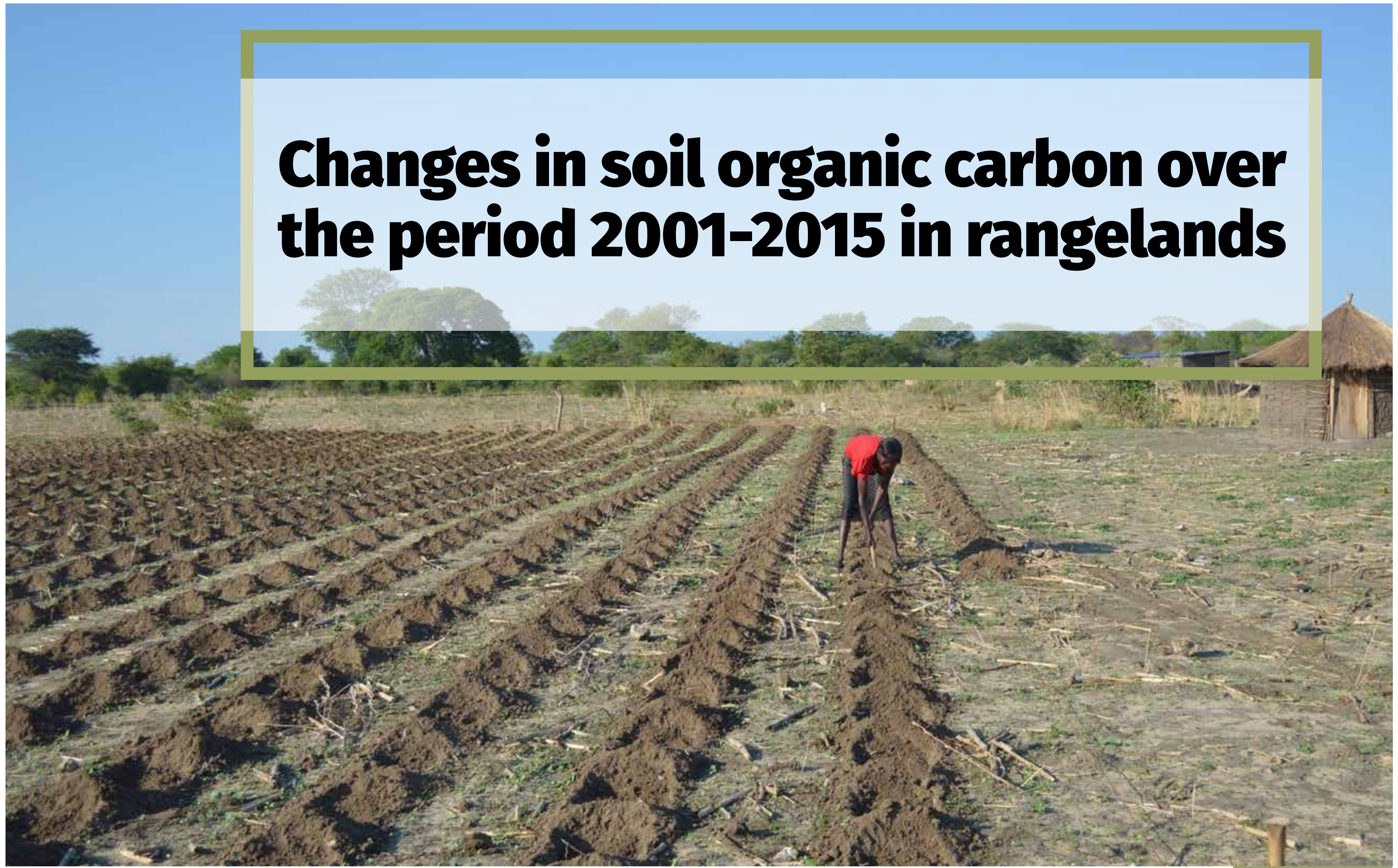
Source 2: Gonzalez-Roglich, M., Zvoleff, A., Noon, M., Liniger, H., Fleiner, R., Harari, N., Garcia, C., 2019. Synergising global tools to monitor progress towards land degradation neutrality: Trends. Earth and the World Overview of Conservation Approaches and Technologies sustainable land management database. Environ. Sci. Policy 93, 34-42. https://doi.org/10.1016/j.envsci.2018.12.019.
Downloaded in 2021: http://trends.earth/

No	Land cover status	Area km²
1	Degradation	399,121
2	Stable	77,083,390
3	Improvement	664,791
	Total	**78,147,302**

No data
Degradation
Stable
Improvement



This map shows another indicator used in calculating LDN being SOC (soil organic carbon). SOC is the amount of carbon stored in soil and is the main component of soil organic matter. Changes in SOC at global level are particularly difficult to assess. In this map a combined land cover/SOC method is used to estimate changes in SOC and identify potentially degraded areas. In the interpretation of the map it should be remembered that analysis at this scale fails to take into account local level changes.

KEY DATA

1. **Across rangelands globally, according to LDN measurements between 2001-2015 soil organic carbon in 93% of rangelands (approximately 74,000,000 km^2) was stable. Soil organic carbon levels were improving in 0.55% (435,350 km^2) and degrading in 0.43% (343,570 km^2) of rangelands.**

Supporting conservation agriculture to improve soil organic carbon in the Silowana Complex, Zambia

The Silowana Complex, the buffer zone of the Sioma Ngwezi National Park, is situated in the southwest corner of Zambia, bordering Angola and Namibia. These three countries together with Botswana and Zimbabwe form Kavango-Zambezi (KAZA), one of the world's biggest trans-boundary conservation areas. The Silowana Complex encompasses 4,322 km^2 and has a tropical savanna climate, the northern part of the park is a complex of open grassy plains. It plays an essential ecological role in wildlife movement along the Kwando and Zambezi rivers. The entire area is inhabited by local subsistence farming communities, some of whom are within the national park itself.

Rural communities practice shifting cultivation as a means to sustain their families. Due to the poor soil fertility, harvests and crop productivity are low, so farmers need to open new fields at least every three – four years to ensure production levels are maintained. This leads to a situation where farmers gradually encroach on the Miombo woodlands sometimes referred to as trees savannas. Fields are often cleared by fire, which can get out of control further reducing habitats. The impacts of the changing climate lead to more frequent droughts combined with changes in rainfall patterns which exacerbates the challenges for both the ecosystems and the livelihoods of the communities.

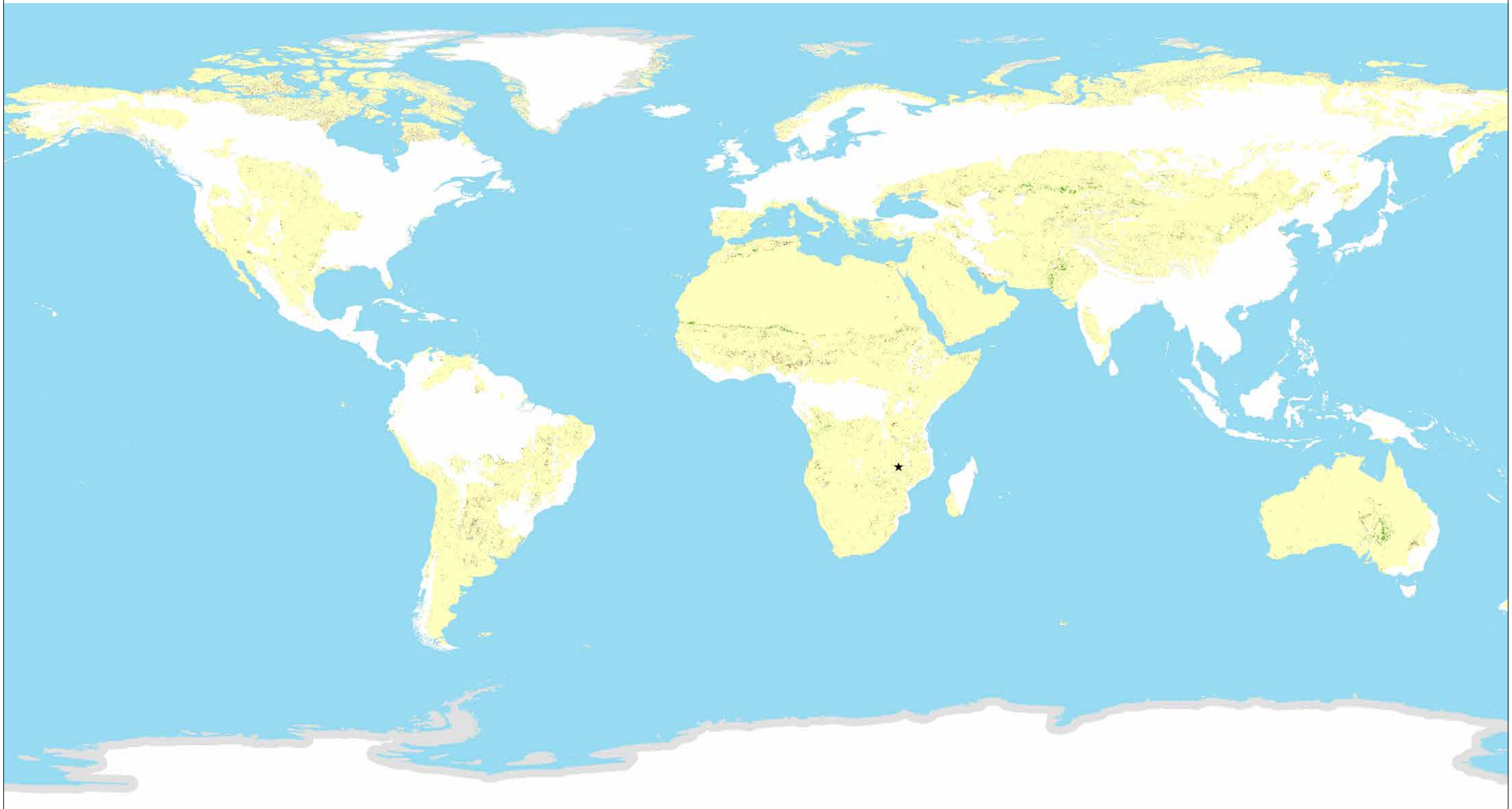
Zambia has been undertaking efforts to address climate change guided by the 2017 National Policy on Climate Change (NPCC). The National Climate Change Response Strategy and policy aims to establish climate resilience and help fulfil development priorities as listed under Zambia's 2030 National Long-Term Vision. Together with partners, organisations are working to tackle some of the issues including improved soil productivity through climate adaptive conservation agriculture, that will not only improve the living conditions and livelihoods of the communities in the region, but simultaneously help to protect these surrounding vital ecosystems.

More information can be found here:

- The Kaza story https://space-science.wwf.de/KAZAStory/
- Kaza TFA
  https://www.worldwildlife.org/magazine/issues/spring-2016/articles/five-countries-work-toward-a-common-goal-in-southern-africa

ILRI, 2021

Changes in soil organic carbon (SOC) over the period 2001-2015 in rangelands



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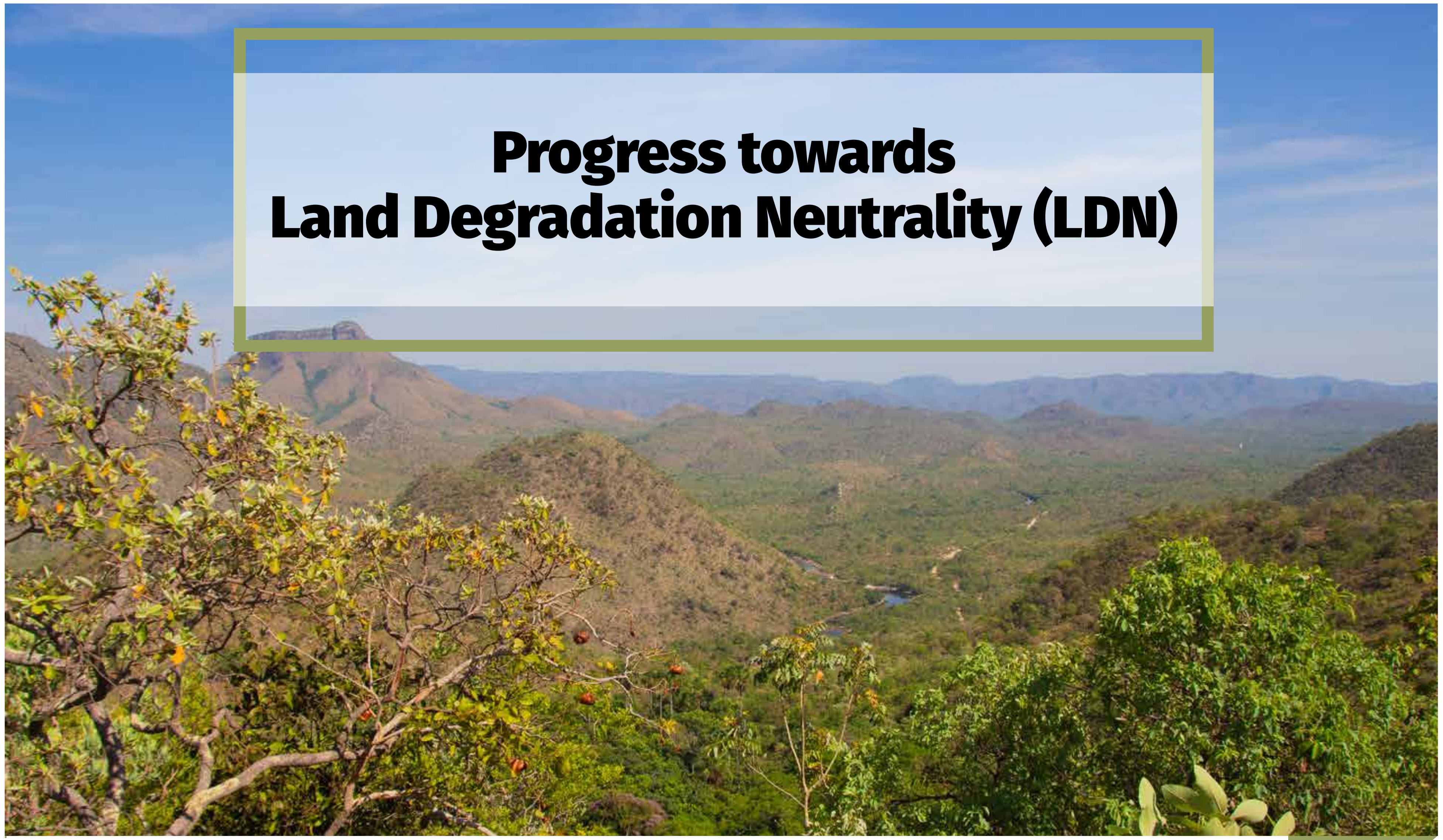
No	SOC status	Area km^2
1	Degradation	435,350
2	Stable	73,658,824
3	Improvement	343,570
	Total	**74,437,744**

No data
Degradation
Stable
Improvement



Progress towards Land Degradation Neutrality (LDN)

LDN (Land Degradation Neutrality) is a binary (degraded/not-degraded) quantification based on the analysis of available data for three sub-indicators: i) trends in land cover, ii) land productivity and iii) carbon stocks. The UNCCD's governing body adopted these in 2015 as part of its monitoring and evaluation approach.

KEY DATA

1. **Across rangelands globally, according to LDN measurements between 2001-2015, 11% of rangelands (approximately 8,000,000 km^2) degraded, 51% (approximately 37,000,000 km^2) remained stable, and 32% (approximately 24,000,000 km^2) showed improvement. There was no data for the remaining 6%.**

Contributing to Land Degradation Neutrality (LDN) in the Brazillian Cerrado

Extending over two million km^2, Brazil's Cerrado is the oldest and most biodiverse savanna in the world. An upside-down forest, its deep root system is five times bigger than the vegetation above ground. It stores 70% of the 13.7 billion tonnes of CO_2 underground in these roots. Conversion and degradation of the Cerrado's natural habitat has the potential to release emissions similar to deforestation in the Amazon. Some 25 million people, or 12% of Brazil's population, live in the Cerrado, which includes 80 different ethnic groups, many of whom depend on its rich native produce. Considered the cradle of water, the Cerrado provides 40% of Brazil's freshwater. It is home to 5% of the world's biodiversity with a staggering, 206 mammals, 866 birds, 244 amphibians, 1,200 fishes, 309 reptiles and over 90,000 insects. About 30% of Brazil's species are only found in the Cerrado.

The Cerrado is one of the biggest and most active agricultural hubs in the world, producing crops and livestock for both national and global markets. While there are environmental protection laws in Brazil, landowners are only required to conserve between 20-35% of the native vegetation on their land. Only 8% of the Cerrado is under formal protection. Over half of the original biome has already been lost to agriculture expansion and the rest is under immediate threat with an estimated one million hectares of native vegetation lost annually in recent years. Unsustainable land use results in underperforming and badly degraded pastures. Furthermore, due to a lack of law enforcement, the landscape is left open to land grabbing and illegal conversion for agriculture expansion.

In an effort to safeguard the Cerrado's biodiverse savanna, global, state and local partners from conservation, business, government and development agencies are working together with traditional communities. For example, WWF employs levers though governance, international markets, financial interventions and advocacy to halt further conversion and degradation in the Cerrado. The shared goal of all these stakeholders is to increase connectivity and ecosystem services through the restoration of natural vegetation, rehabilitate degraded pastures through improved land use, and increase and effectively manage protected areas, while focusing on the sustainable production of native produce, inclusive conservation planning and improved livelihoods.

Links to further reading:

Stories of struggle and perseverance to keep the Cerrado alive: https://www.wwf.org.br/informacoes/english/?78030/Stories-of-struggle-and-perseverance-to-keep-the-Cerrado-alive

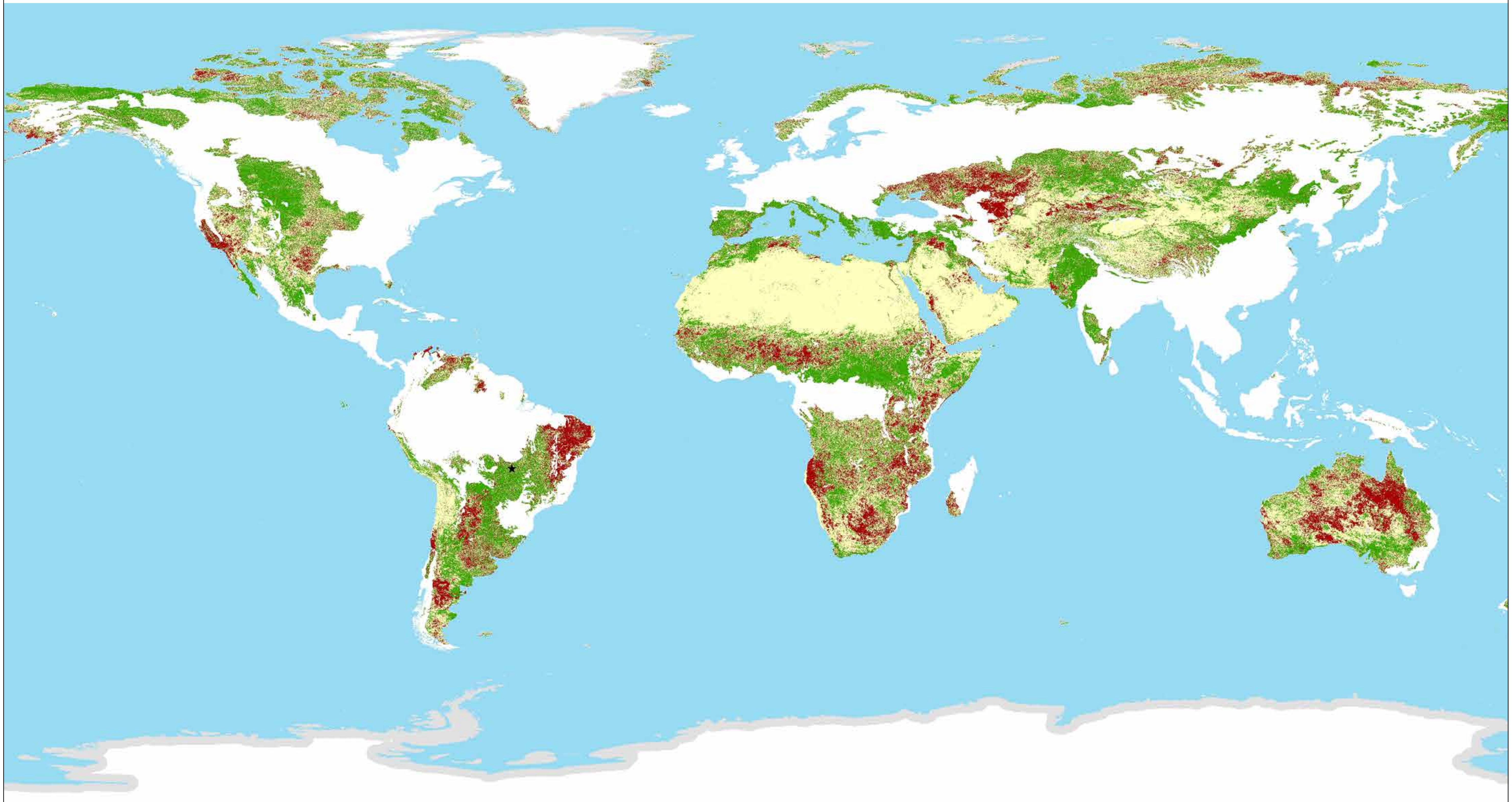
Cerrado destruction increases by 13%, and biome loses 7.3 thousand km² of native vegetation: https://www.wwf.org.br/informacoes/english/?77611/cerrado-prodes-destruction-deforestation-increase-123

Conservation of the Cerrado in the Economic Logic: https://www.wwf.org.br/informacoes/english/?77034/Conservation-of-the-Cerrado-in-the-economic-logic

Soy moratorium
https://www.wwf.org.br/?54622/Soy-Moratorium-the-main-global-Zero-Deforestation-benchmark

ILRI, 2021

Progress towards Land Degradation Neutrality (LDN) over the period 2001-2015 found in rangelands



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Original source: Olson, D. M., Dinerstein, E., Wikramanayake, E. D., Burgess, N. D., Powell, G. V. N., Underwood, E. C., D'Amico, J. A., Itoua, I., Strand, H. E., Morrison, J. C., Loucks, C. J., Allnutt, T. F., Ricketts, T. H., Kura, Y., Lamoreux, J. F., Wettengel, W. W., Hedao, P., Kassem, K. R. 2001. Terrestrial ecoregions of the world: a new map of life on Earth. Bioscience 51(11):933-938.

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Downloaded in 2021: http://trends.earth/

No	LDN status	Area km²
1	Degradation	37,429,206
2	Stable	23,903,629
3	Improvement	69,258,736
	Total	**130,591,571**

No data
Degradation
Stable
Improvement

Predicted changes in variation of annual rainfall, length of growing period, and temperature by 2050

This series of maps shows predicted changes in different climate phenomena by 2050 using scenarios developed by the IPCC (Intergovernmental Panel for Climate Change). The impacts of climate change on the rangelands of the globe and on the vulnerability of the people who inhabit them will be severe and diverse, and will require multiple, simultaneous responses. Map C shows the rangeland areas in which the average annual temperature flips from below 8°C in the 2000s to above 8°C by the 2050s. It is possible that between now and the middle of the century the growing period in the rangelands where average temperature flip to above 8°C could expand and become increasingly suitable for some kinds of rangeland vegetation. Map D shows the rangeland areas with an average maximum temperature (both annual and during the primary growing season) that flips from below 35°C to greater than 35°C by 2050. This will be a critical threshold for rangeland vegetation and heat tolerance in some species.

KEY DATA

1 According to climate change simulations rangelands can expect changes in the coefficient of variation of annual rainfall i.e. its variability between 2000 and 2050. 12% or approximately 9,000,000 km^2 of rangelands can expect to see greater than 35% change, 10% or approximately 8,000,000 km^2 can expect 30-35% change, 20% or approximately 16,000,000 km^2 can expect 25-30%, 18% or 14,000,000 km^2 can expect 20-25% change, 9% or approximately 7,000,000 km^2 can expect 0-20% and 32% or approximately 25,000,000 km^2 can expect no change at all.

2. 12% of rangelands (approximately 10,000,000 km^2) are predicted to have more than a 20% loss of length of growing period between 2000 and 2050. 88% of rangelands (66,000,000 km^2) are predicted to have less than a 20% loss of length of growing period between 2000 and 2050.

3. In around 4% of rangelands (approximately 3,000,000 km^2) the average annual temperature will flip from below 8°C in the 2000s to above 8°C by the 2050s. The remaining 96% will not flip and/or will do so to a lower temperature.

4. In around 16% of rangelands (approximately 12,000,000 km^2) the average maximum temperature is predicted to flip from below 35°C to greater than 35°C by 2050. This flip will be a critical threshold for rangeland vegetation and heat tolerance in some species. In the remaining 84% of rangelands the temperature will not flip and/or will do so to a lower temperature.

Adapting to climate change in Australia's rangelands

In line with current forecasts, Australia is set to experience substantial warming and more frequent extreme climate events as a result of climate change. Temperatures are forecast to increase with more frequent and intense heatwaves, continuing high variability in annual rainfall, increased intensity of heavy rainfall[1], a probable increase in the frequency and severity of drought and increased periods of high fire-danger weather are all likely to be experienced.

Changes will be required in extensive rangeland grazing herd management, including stocking rate decisions informed by longer-term (e.g. sub-seasonal to seasonal to multi-year) climate forecasts, changing heat-sensitive operations to relatively cooler months, and relocating fences and tracks away from more erodible lands. A longer-term transformational change is already taking place, with moves to a different form of livestock production, combined with drought-proofing activities and diversifying sources of income within and beyond the pastoral enterprise: Adaptation has always been an ongoing challenge for Australian livestock producers and a feature of production systems.[2]

The Northern Australia Climate Program (NACP) operates across the rangelands in the northern half of Australia. It improves existing climate models and forecasting tools, develops new products to meet the needs of pastoralists and builds the capacity of pastoralists to manage the challenges posed by future droughts or failed wet seasons as well as climate variability. Extension staff are local people, who are based across northern Australia, and run workshops and liaise with pastoralists in their region. Many are local pastoralists themselves, which give them credibility as well an understanding of the local context. In addition, at the national level, the federal government is investing millions in a Future Drought Fund, with hubs around various states. Further such responses will continue to be needed together with policy change, structural adjustment and development of new breeds and technologies.[3]

For more information see:

Bastin G, Stokes C, Green D and Forrest K (2014) *Australian rangelands and climate change – pastoral production and adaptation*. Ninti One Limited and CSIRO, Alice Springs. http://www.nintione.com.au/resource/AustralianRangelandsAndClimateChange_PastoralProduction.pdf

For more on the methods for the thresholds mapped: https://cgspace.cgiar.org/handle/10568/3826 and https://www.ifpri.org/publication/atlas-african-agriculture-research-development

For more information on climate change impacts on pastoralism see *Climate change and pastoralism: impacts, consequences and adaptation*. M. Herrero, J. Addison, C. Bedelian, E. Carabine, P. Havlik, B. Henderson, J. van de Steeg and P. Thornton. Rev. Sci. Tech. Off. Int. Epiz (2016) Vol. 35 (2).

Terminologies used

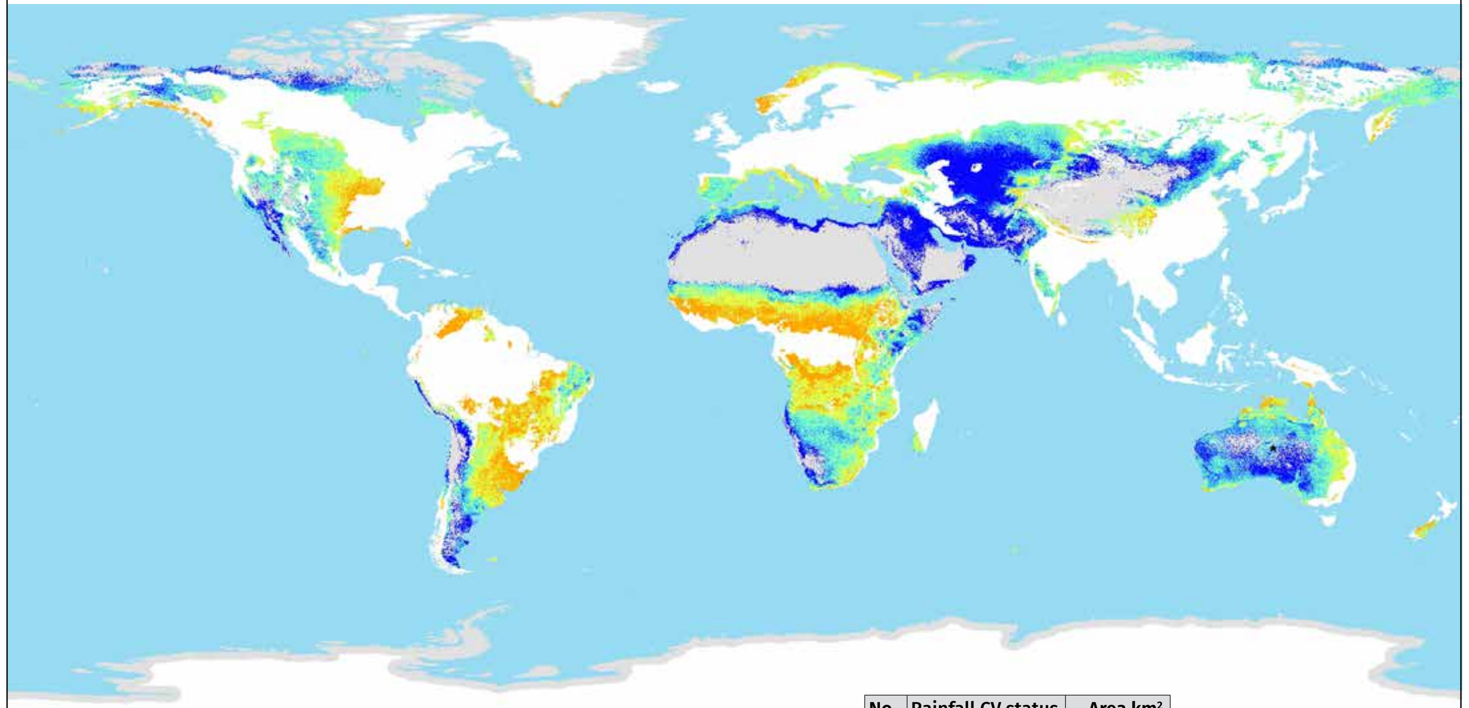
CV of annual rainfall is an index, expressed as a percentage, of climatic risk. It estimates the rainfall variability in an area where the higher the CV, the more variable the year-to-year rainfall of an area is.
LGP (length of growing period) is the average number of growing days per year (where rainfall and moisture stored in the soil exceeds half of potential evapotranspiration) and can be interpreted as a proxy for the number of grazing days too.

The source of all these projections to 2015 are made using a high-emissions scenario (RCP 8.5) developed by the Intergovernmental Panel on Climate Change and data form; an ensemble of 17 climate models taken from the fifth phase of the Coupled Model Intercomparison Project (CMIP5) of the World Climate Research Program.

[1] Cobon, D., Kouadio, L., Mushtaq, S., Jarvis, C., Carter, J., Stone, G. and Davis, P. (2019). "Evaluating the shifts in rainfall and pasture-growth variabilities across the pastoral zone of Australia during 1920-2010". *Crop and Pasture Science, Vol. 70: 634-647.*
[2] Bastin, G., Stokes, C., Green, D. and Forrest, K. (2014). *Australian rangelands and climate change – pastoral production and adaptation*. Ninti One Limited and CSIRO, Alice Springs.
[3] Stokes, C., Ash, A., Scanlan, J. and Webb, N. (2011). *Strategies for adapting to climate change*. Conference: Proceedings of the Northern Beef Research Update Conference, pp. 81-86.

Coefficient of variation of annual rainfall by 2050 in rangelands

ILRI, 2021



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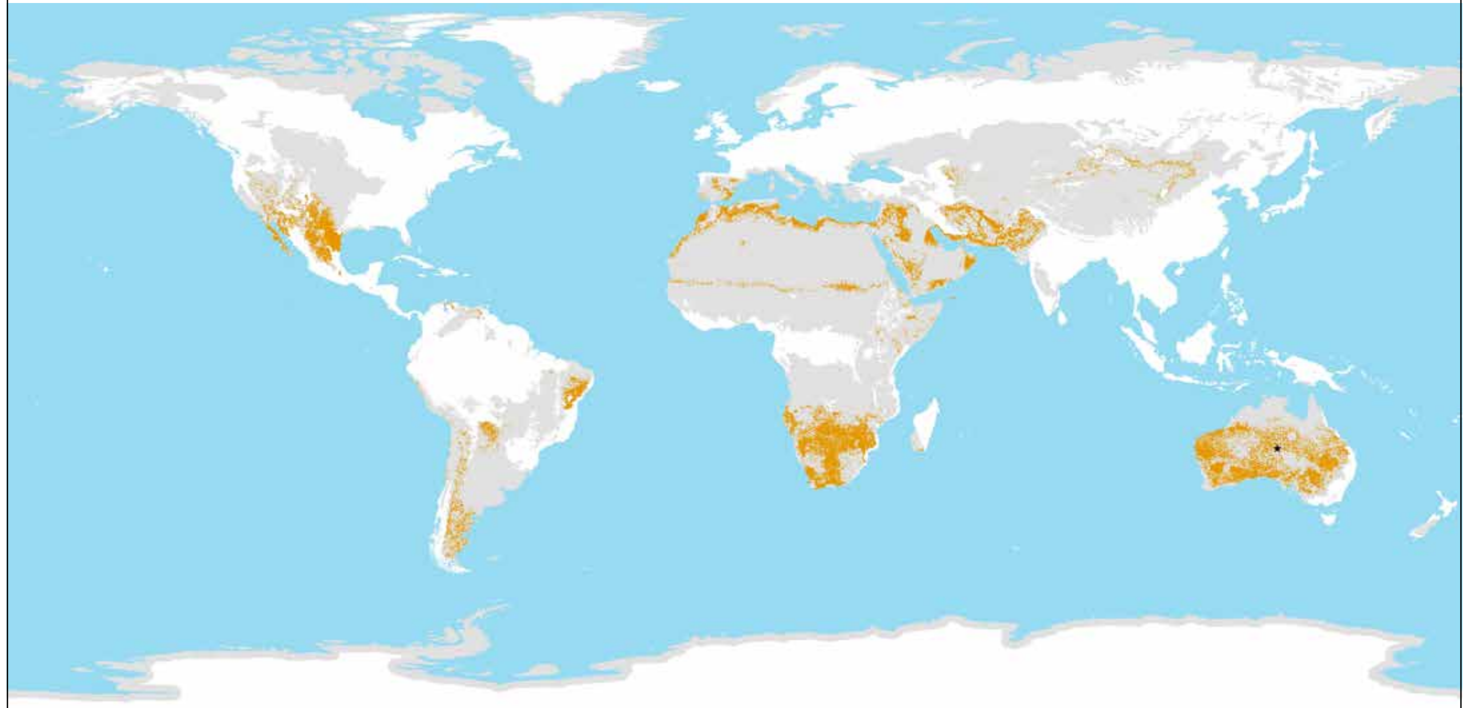
Source 2: Projections to 2050 using a high-emissions scenario (RCP 8.5) developed by the Intergovernmental Panel on Climate Change and data from an ensemble of 17 climate models taken from the fifth phase of the Coupled Model Intercomparison Project (CMIP5) of the World Climate Research Programme. Reference paper: Herrero M., Addison J., Bedelian C., Carabine E., Havlík P., Henderson B., van de Steeg J. & Thornton P.K. – Climate change and pastoralism: impacts, consequences and adaptation. Rev. Sci. Tech. Off. Int. Epiz., 2016, 35 (2), 417-433.

No	Rainfall CV status	Area km²
1	0%	24,774,702
2	0-20%	6,981,734
3	20-25%	13,761,107
4	25-30%	15,505,479
5	30-35%	7,984,837
6	> 35 %	9,408,701
	Total	**78,416,559**

0
< 20
20-25
25-30
30-35
> 35

20% Loss of length of growing period between 2000 and 2050 found in rangelands

ILRI, 2021



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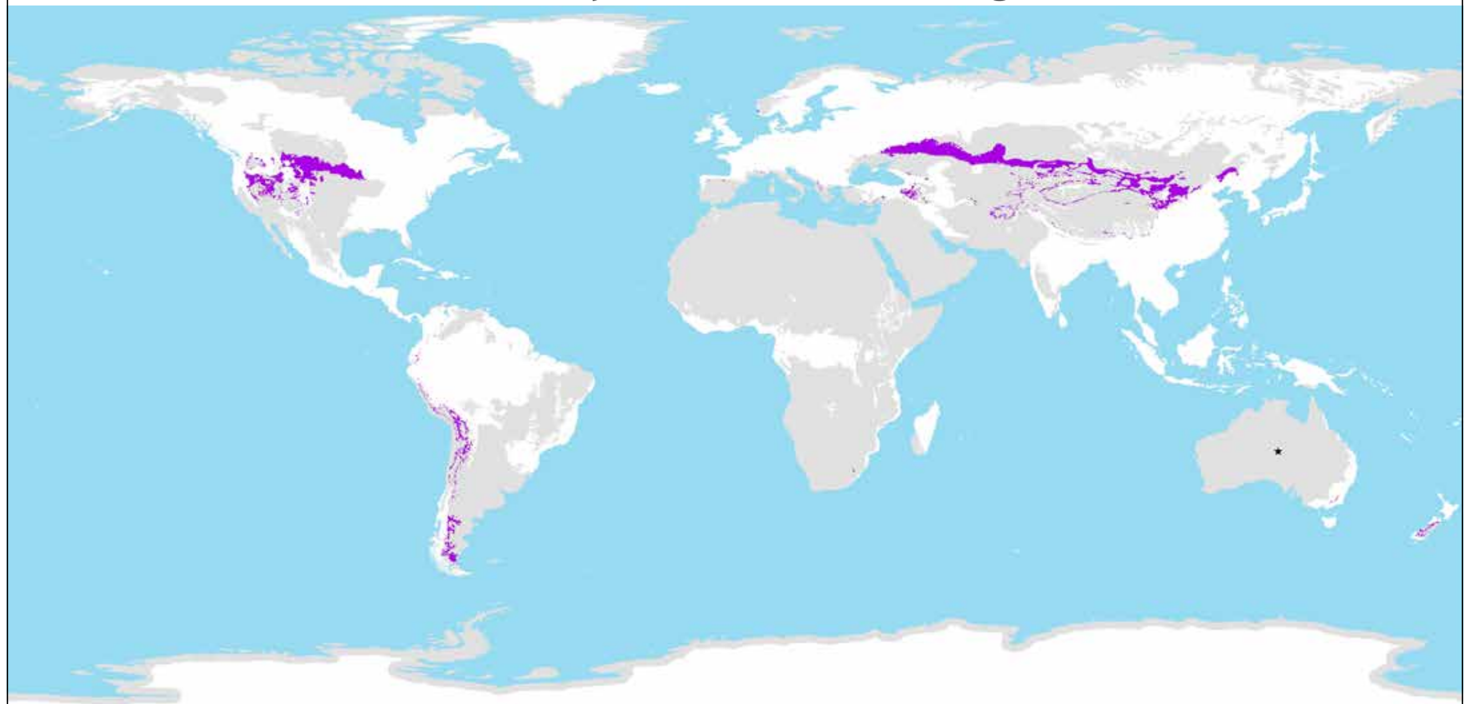
No	LGP status	Area km²
1	Not impacted	68,228,113
2	LGP decreased	9,644,714
	Total	**77,872,827**

Not impacted
LGP decreased

Average annual temperature from below 8°c in the 2000s to above 8°c by the 2050s found in rangelands

ILRI, 2021



Source 1: Terrestial ecoregions of the World. World Wide Fund for Nature (WWF). Downloaded in 2021: https://globil-panda.opendata.arcgis.com/datasets/wwf-priority-35-ecoregions?geometry=-172.266%2C-86.819%2C172.266%2C89.233. Original source: Olson, D. M., Dinerstein, E., Wikramanayake, E. D., Burgess, N. D., Powell, G. V. N., Underwood, E. C., D'Amico, J. A., Itoua, I., Strand, H. E., Morrison, J. C., Loucks, C. J., Allnutt, T. F., Ricketts, T. H., Kura, Y., Lamoreux, J. F., Wettengel, W. W., Hedao, P., Kassem, K. R. 2001. Terrestrial ecoregions of the world: a new map of life on Earth. Bioscience 51(11):933-938.

Source 2: Projections to 2050 using a high-emissions scenario (RCP8.5) developed by the Intergovernmental Panel on Climate Change and data from an ensemble of 17 climate models taken from the fifth phase of the Coupled Model Intercomparison Project (CMIP5) of the World Climate Research Programme. Reference paper: Herrero M., Addison J., Bedelian C., Carabine E., Havlík P., Henderson B., van de Steeg J. & Thornton P.K. – Climate change and pastoralism: impacts, consequences and adaptation. Rev. Sci. Tech. Off. Int. Epiz., 2016, 35 (2), 417-433.

No	AAT status	Area km²
1	Not impacted	74,791,530
2	Temp flip	3,081,541
	Total	**77,873,071**

Not impacted
Temp flip

Average maximum temperature that flipping from below 35°C to greater than 35°C by 2050 found in rangelands

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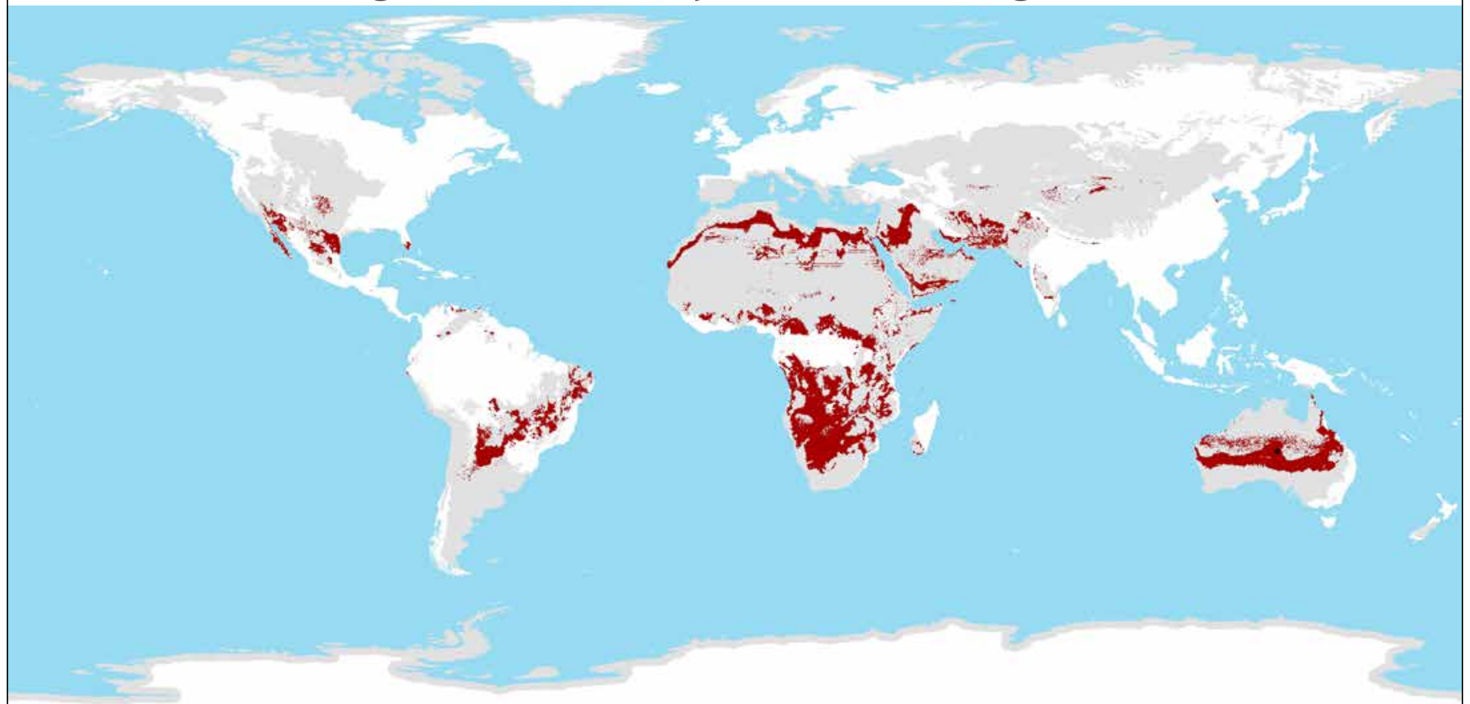

Source 1: Terrestial ecoregions of the World. World Wide Fund for Nature (WWF). Downloaded in 2021: https://globil-panda.opendata.arcgis.com/datasets/wwf-priority-35-ecoregions?geometry=-172.266%2C-86.819%2C172.266%2C89.233. Original source: Olson, D. M., Dinerstein, E., Wikramanayake, E. D., Burgess, N. D., Powell, G. V. N., Underwood, E. C., D'Amico, J. A., Itoua, I., Strand, H. E., Morrison, J. C., Loucks, C. J., Allnutt, T. F., Ricketts, T. H., Kura, Y., Lamoreux, J. F., Wettengel, W. W., Hedao, P., Kassem, K. R. 2001. Terrestrial ecoregions of the world: a new map of life on Earth. Bioscience 51(11):933-938.

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No	AMT status	Area km²
1	Not impacted	66,201,053
2	Temp flip	12,298,038
	Total	**78,499,090**

Not impacted
Temp flip

Rangelands affected by three climate thresholds

Climate threshold is a critical limit where a climate system responds drastically when exposed to an external forcing, resulting in the system changing into a different stable state (e.g., melt of Greenland ice-sheet, Sahara greening, instability of West Antarctic ice-sheet, tundra lost, etc). This map shows how rangelands will be affected by several climate change thresholds that are expected to change by 2050. Three threshold flips are mapped; the 20% loss of LGP (length of growing period) and maximum temperature over 30 degrees will have negative effects on production and productivity in those areas of the rangelands that are so affected, while the third (annual temperature over 8 degrees) may have positive effects via the extension of growing season and/or an increase in the land areas suitable for rangeland vegetation.

KEY DATA

1. **It is predicted that 27.74% (22,053,984 km²) of all rangelands (79,509,421 km²) will be affected by climate change as per the three thresholds listed above.**
2. **It is predicted that more than half – 56.45% or 6,547,681 km² – of Tundra (total of 11,598,465 km² globally) will be affected by climate change (see three thresholds above).**
3. **According to climate simulations, 39.21% (10,973,597 km²) of deserts and xeric shrublands will be affected by climate change; 22.54% (247,034 km²) of flooded grasslands and savannas; 25.98% (838,377 km²); 13.17% (685,299 km²); of mediterranean forests, woodlands and scrub; 6.78% (685,299 km²) of temperate grasslands, savannas and shrublands; 10.23% (2,076,697 km²) of tropical and subtropical grasslands, savannas and shrublands; and 56.45% (6,547,681 km²) of tundra will be affected by climate change as per the thresholds above.**

Reinstating the *Hima* in Bani Hashem, Jordan to build resilience to climate change

Jordan is primarily arid to semi-arid in climate, characterised by very low annual precipitation averaging less than 220 mm. The annual total precipitation varies from a minimum of 28 mm at the southern Badia region to a maximum of 570 mm at the upper northern highlands region of Ras Muneef. Aridity and water scarcity make Jordan environmentally sensitive to climate change.

Climate change studies in Jordan show that the minimum temperature has increased between 0.4-2.8°C across all regions[1] with a decline in precipitation by 5-20 percent across the country[2]. The expected impact and risks from climate change on ecosystems in Jordan include droughts, forest dieback, expansion of drier biomes into marginal lands, habitat degradation and species loss.

Badia is an Arabic word describing the open rangeland inhabited by Bedouins (nomads). The Jordan Badia which covers about 80% of the country has over the years been degraded due to land use change, urbanisation, overgrazing, mining and increased demand for wood fuel, amplified by climate change. Hima comes from the arabic word for 'protection' – *alhimaya*. The *Hima* is a traditional rangeland management system in which land and key resources are set aside so that communities can conserve them and regulate their use.

In Bani Hashem local communities have been reinstating the *Hima* to protect and manage their land resources and reduce the effects and risks of climate change. The community identified 1,500 hectares of public forest land that they refer to as 'the last green area' in the rapidly industrialising Zarqa river basin area. The community started by putting 100 hectares of land under *Hima*. After one year, biodiversity benefits were observed through the increase of biomass and restoration of indigenous floral species such as *Artemisia herba-alba*. Protecting the pilot area allowed shrubs and grasses to regenerate, restoring the land's vegetation. A total of 36 native plant species were recorded in the site, though mainly in the area that receives the highest rainfall.

For more information:

Al Hima: Possibilities are Endless –
https://www.iucn.org/sites/dev/files/import/downloads/hima_case__1_.pdf

The Zarqa River Basin, Reviving Hima Sites –
https://www.iucn.org/sites/dev/files/import/downloads/iucn_aug_30.pdf

For more information on climate change impacts on pastoralism see *Climate change and pastoralism: impacts, consequences and adaptation*. M. Herrero, J. Addison, C. Bedelian, E. Carabine, P. Havlik, B. Henderson, J. van de Steeg and P. Thornton. Rev. Sci. Tech. Off. Int. Epiz (2016) Vol. 35 (2).

Projections to 2015 were made using a high-emissions scenario (RCP 8.5) developed by the Intergovernmental Panel on Climate Change and data form an ensemble of 17 climate models taken from the fifth phase of the Coupled Model Intercomparison Project (CMIP5) of the World Climate Research Program.

[1] F. Abdulla, T. Eshtawi, H. Assaf (2009), "Assessment of the impact of potential climate change on the water balance of a semi-arid watershed." Water Resource Management. Vol. 23: 2051-2068.
[2] M. Freiwan and M. Kadioglu (2008) "Climate variability in Jordan." International Journal of Climatology. Vol. 28: 69 – 89.

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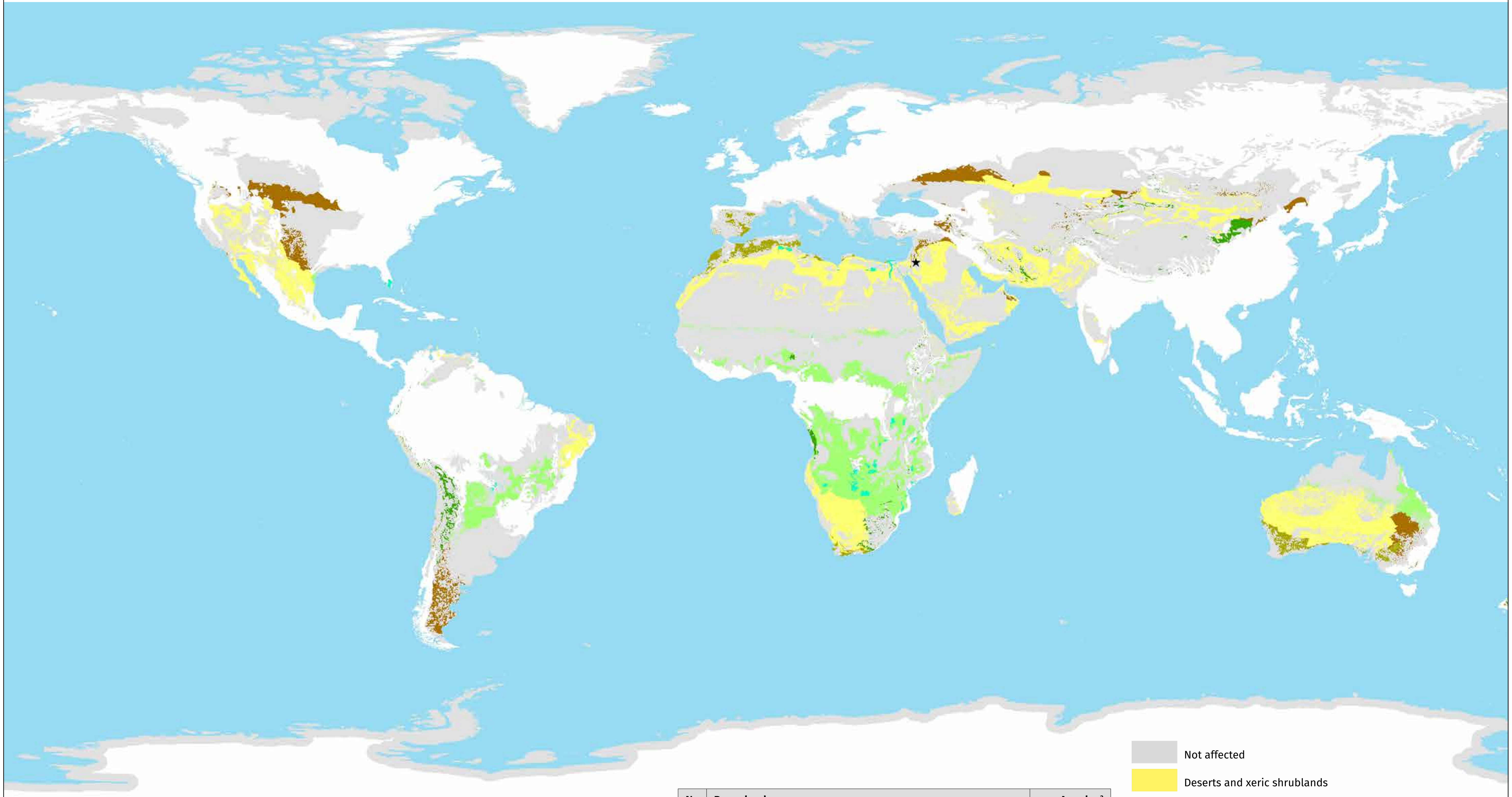
Rangelands affected by three climate thresholds



No	Rangelands	Area km²
1	Deserts and xeric shrublands	27,984,644
2	Flooded grasslands and savannas	1,096,130
3	Mediterranean forests, woodlands, and scrub	3,227,266
4	Montane grasslands and shrublands	5,203,411
5	Temperate grasslands, savannas, and shrublands	10,104,080
6	Tropical and subtropical grasslands, savannas, and shrublands	20,295,424
7	Tundra	11,598,465
	Total	**79,509,420**

Source 1: Terrestial ecoregions of the World. World Wide Fund for Nature (WWF). Downloaded in 2021: https://globil-panda.opendata.arcgis.com/datasets/wwf-priority-35-ecoregions?geometry=-172.266%2C-86.819%2C172.266%2C89.233. Original source: Olson, D. M., Dinerstein, E., Wikramanayake, E. D., Burgess, N. D., Powell, G. V. N., Underwood, E. C., D'Amico, J. A., Itoua, I., Strand, H. E., Morrison, J. C., Loucks, C. J., Allnutt, T. F., Ricketts, T. H., Kura, Y., Lamoreux, J. F., Wettengel, W. W., Hedao, P., Kassem, K. R. 2001. Terrestrial ecoregions of the world: a new map of life on Earth. Bioscience 51(11):933-938.

Source 2: Projections to 2050 using a high-emissions scenario (RCP 8.5) developed by the Intergovernmental Panel on Climate Change and data from an ensemble of 17 climate models taken from the fifth phase of the Coupled Model Intercomparison Project (CMIP5) of the World Climate Research Programme. Reference paper: Herrero M., Addison J., Bedelian C., Carabine E., Havlík P., Henderson B., van de Steeg J. & Thornton P.K. – Climate change and pastoralism: impacts, consequences and adaptation. Rev. Sci. Tech. Off. Int. Epiz., 2016, 35 (2), 417-433.

Three climate thresholds in rangelands

This map shows how several climate change thresholds are expected to change by 2050. Three threshold flips are mapped; the 20% loss of LGP and maximum temperature over 30°C will have negative effects on production and productivity in those areas of the rangelands that are so affected, while the third (annual temperature over 8°C) may have positive effects via the extension of growing season and/or an increase in the land areas suitable for rangeland vegetation. Whereas the previous map focused on the rangelands and types of rangelands affected, this map focuses on the climate thresholds themselves.

KEY DATA

1. **It is predicted that approximately 31% of rangelands will be affected by one or more climate change thresholds by the year 2050. It is predicted that approximately 12 million km^2 will be affected by a maximum temperature of average 30°C, and 9.6 million km^2 will be affected by a shorter growing season. A further three million km^2 will be impacted by annual temperature over 8 degrees.**
2. **It is predicted that approximately 13 million km^2 of deserts and xeric shrublands, 7.5 million km^2 of tropical and subtropical grasslands, savannas and shrublands, and two million km^2 of temperate grasslands, savannas and shrublands will be affected by 1-2 of the three climate change thresholds.**
3. **Most (approximately 17.6 million km^2) rangelands will be impacted by one climate change threshold, and 3.3 million km^2 will be impacted by two climate change thresholds. It is predicted that no rangeland will be impacted by all three thresholds.**

Adapting to climate change in the Italian Alps

The Alps have been identified as one of the most vulnerable areas to climate change in Europe. Over the last century, global warming has caused all Alpine glaciers in Europe to recede as well as triggered changes in rain and snowfall patterns shortening snow seasons and causing glaciers to recede.[1] [2]Snowmelt is predicted at 10,000 feet by the end of the century.

The province of Trento is found in the southern Alps of northern Italy. Here it is common to find dairy cattle breeding, including the *Bruna Italiana* or *Bruna alpina* – a hardy breed that has adapted well to mountain pastures, as well as sheep and goat farming.

Cattle breeders practice transhumance, herding the animals up into the mountains during the summer from June until their return in September. Above 1,600 m, the pastures are held in common and governed by user rights, or *usicivici*. A pasture management committee in each village defines the usage rules of the mountain pastures avoiding conflict and making optimal use of the common pastures.

Sheep and goats are taken on longer transhumance, following ancient well-trodden routes over the mountains. One of the first Alpine transhumance routes is found in Südtirol and is now protected under UNESCO as Intangible Cultural Heritage. The route has been used for over 10,000 years, with some sections known to have been used for 40,000 years. Shepherd's associations manage the transhumance according to suitable weather conditions, which are increasingly unpredictable.

In the Schnalstal Valley the local association has been chaired by Bauer Joseph Götsch of Gurschlerhof since 2005. Every year he and his family organise the outward and return transhumance of thousands of sheep to summer pastures in neighbouring Austria, to which the community hold an ancient right. Since the Middle Ages, these rights and associated events have been documented including climatic events such as the little ice age noted in 1599 as causing a new glacier to form preventing further transhumance of cattle. Today, warmer temperatures and drier summers have meant that farmers and breeders need to irrigate their pastures, and sudden and sometimes violent atmospheric variations cause problems for the transhumance. For the communities reliant on livestock in these areas, future climate change is a significant concern.

For further information, see
https://www.merano-suedtirol.it/it/val-senales/natura-cultura/il-territorio-le-persone/transumanza.html

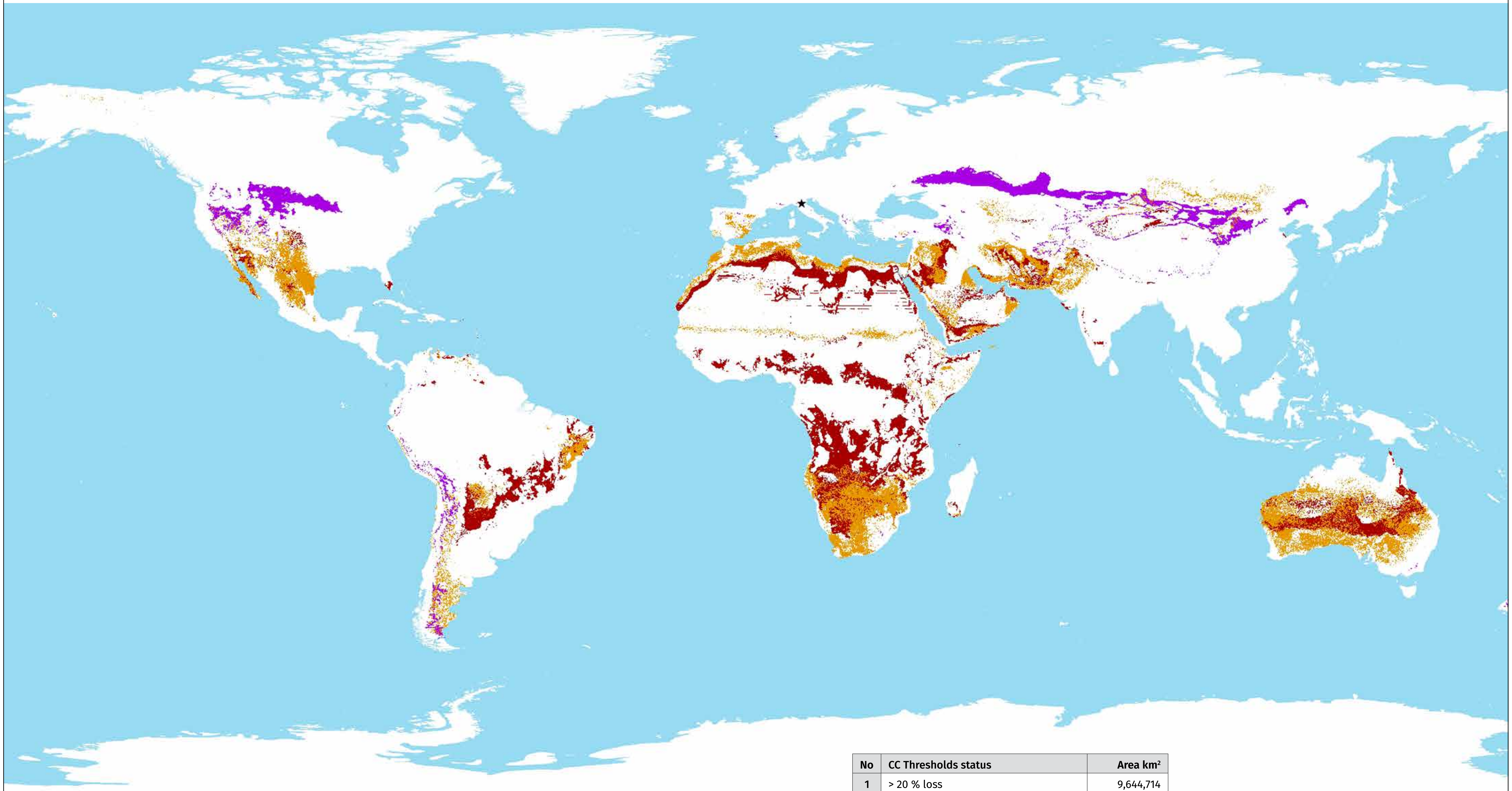
At the European level, an Alpine Convention has been established to address the problem as a coordinated response. In 2014, guidelines for climate change adaptation were developed; see here:
https://www.researchgate.net/publication/235939157_Alpine_strategy_for_adaptation_to_climate_change_in_the_field_of_natural_hazards_Developed_by_the_Platform_on_Natural_Hazards_of_the_Alpine_Convention_PLANALP

Projections to 2015 were made using a high-emissions scenario (RCP 8.5) developed by the Intergovernmental Panel on climate change and data form; an ensemble of 17 climate models taken from the fifth phase of the Coupled Model Intercomparison Project (CMIP5) of the World Climate Research Program.

[1] Global warming will impact mountain areas in a particularly severe way, posing a very serious threat to Alpine nature. WWF European Alpine Programme (n.d.).
[2] The Big Melt. Jeffry Kluger (undated) https://time.com/italy-alps-climate-change/

ILRI, 2021

Three climate change thresholds found in rangelands



No	CC Thresholds status	Area km²
1	> 20 % loss	9,644,714
2	> 8 ° C	3,080,657
3	> 35° C	12,298,038
	Total	**25,023,409**

No	No CC Threshold	Area km²
1	Threshold	17,600,606
2	Thresholds	3,302,202
3	Thresholds	0
	Total	**20,902,808**

> 20% loss
> 8° C
> 35° C

Source 1: Terrestial ecoregions of the World. World Wide Fund for Nature (WWF). Downloaded in 2021:
https://globil-panda.opendata.arcgis.com/datasets/wwf-priority-35-ecoregions?geometry=-172.266%2C-86.819%2C172.266%2C89.233.
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ILRI/Barbara Wieland, Livestock is vital to the local and national economy in Mongolia – **8**

FAO/Carl De Souza, Landscape near Fada, Northeastern Chad – **10**

WWF/Clay Bold, Daybreak ranch, South Dakota USA – **12**
WWF/Conservation Media, Snake Butte Pasture, Montana – **12**

ILRI/Marco Buemi, The Dehesa – a sustainable silvolpastoral system in Spain – **14**

ILRI/Marco Buemi, Berber pastoralists in Medinine, Tunisia – **16**

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SEE-Intl/Augenstein, Livestock tillage and land conversion, Atlas Mountains – **28**

WWF/Farmer planting crops applying agroecological planting methods, Zambia – **30**

WWF/Diverse landscape of the Cerrado Goias, Brazil – **32**

C. Watson_Wikimedia commons/Dunes at the edge of the Simpson Desert, South Australia – **34**

ILRI/Marco Buemi, The Alps are one of the most vulnerable places for climate change in Europe – **38**

RangelandsATLAS

This Rangelands Atlas is a collaborative initiative of the International Livestock Research Institute (ILRI), International Union for Conservation of Nature (IUCN), Food and Agricultural Organization (FAO) of the United Nations, World Wide Fund for Nature (WWF), the United Nations Environment Programme (UNEP), and the global Rangelands Initiative of the International Land Coalition (ILC).

This Rangelands Atlas has been developed to document and raise awareness on the enormous environmental, economic and social value of rangelands as well as their different ecosystems. It highlights many of the changes taking place in rangelands due to climate change, land use and conversion trends, investments and other changes: of most concern is the predicted trends of climate change and biodiversity loss, which will have significant impacts on some rangeland ecosystems.

Drawing on publicly available data, this Atlas provides a preliminary set of maps, which will be added to over time. These maps illustrate the complex nature of rangelands found around the world. Furthermore, the Rangelands Atlas reflects a strengthening, global movement to protect, restore and appropriately invest in rangelands. Join us in this journey and learn about some of the different initiatives taking place in rangelands around the world.

The Rangelands Atlas is available online at:
www.rangelandsdata.org/atlas

CGIAR RESEARCH PROGRAM ON Livestock
CGIAR RESEARCH PROGRAM ON Policies, Institutions, and Markets Led by IFPRI
CGIAR Platform for Big Data in Agriculture
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