THE IPCC'S SPECIAL REPORT ON CLIMATE CHANGE AND LAND: WHAT'S IN IT FOR LATIN AMERICA?

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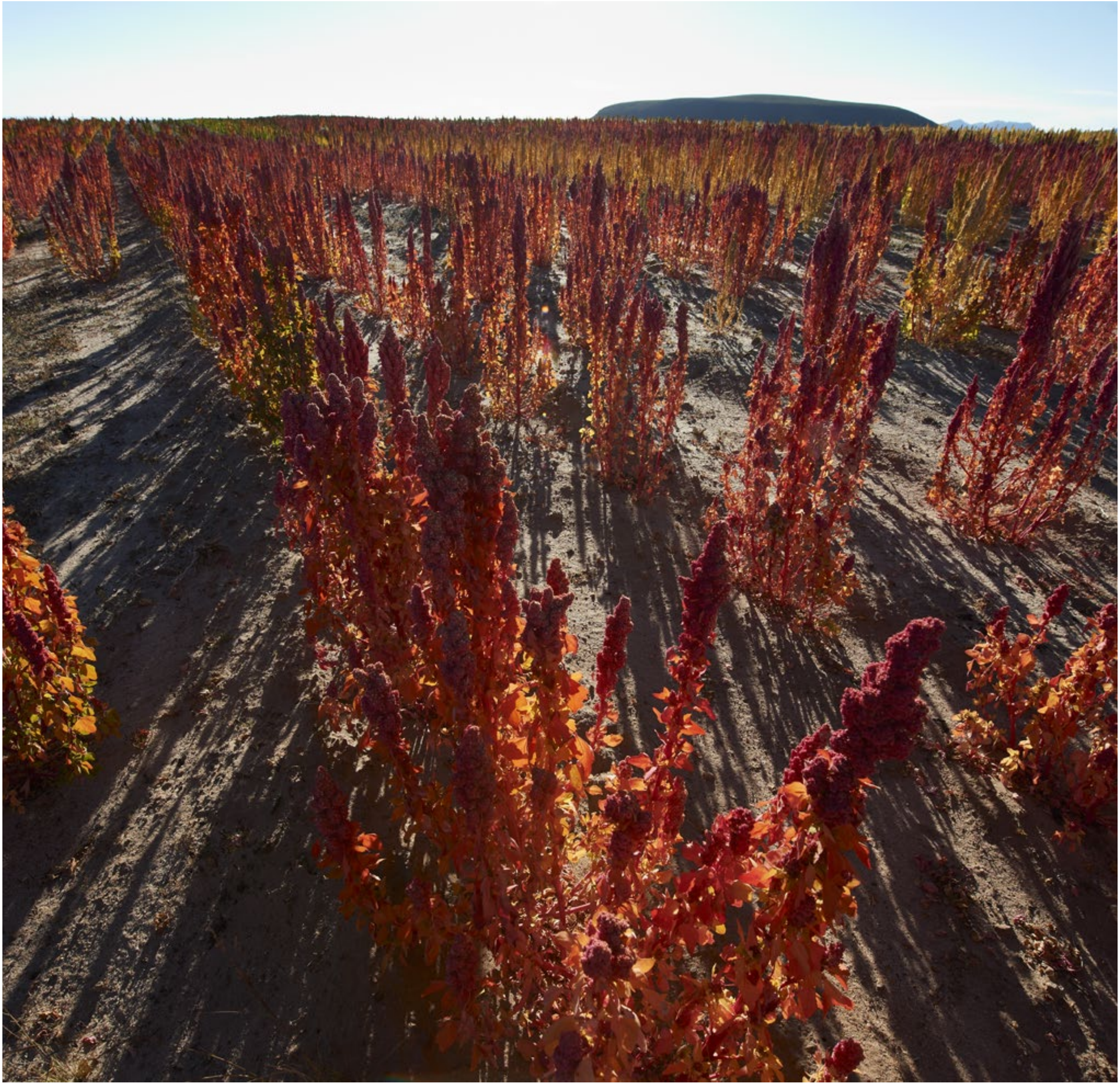
The IPCC's Special Report on Climate Change and Land

What's in it for Latin America?

Climate & Development Knowledge Network



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The IPCC's Special Report on Climate Change and Land: What's in it for Latin America?

Key messages

1. The climate and land interact with and influence each other
2. Dryland areas are expected to become more vulnerable to desertification in Latin America
3. Land degradation has implications for livelihoods and food security in Latin America
4. Community and policy responses can combat land degradation
5. Improved management of land, value chains and climate risks can deliver climate adaptation, mitigation and development
6. Insecure property rights and lack of access to credit and agricultural advisory services hamper progress – especially by women
7. The skills and knowledge of women and marginalised groups are not yet sufficiently recognised
8. Integrated governance is needed to maximise the benefits of land and water
9. Emissions reductions in other sectors are vital to relieve pressure on land

About this report

The Intergovernmental Panel on Climate Change (IPCC) published its *Climate Change and Land: An IPCC Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems* in 2019 (www.ipcc.ch/srccl). We refer to the IPCC's report in short here as the *Special Report on Climate Change and Land*. The Special Report was a response to proposals from governments and observer organisations to the IPCC. It assesses the existing science to date on how greenhouse gases are released and absorbed by land-based ecosystems, and the science on land use and sustainable land management in relation to climate change adaptation and mitigation, desertification, land degradation and food security. The findings are of great importance to decision-makers across Latin America and the world.

This publication offers a guide to the IPCC's *Special Report on Climate Change and Land* prepared for decision makers in Latin America by the Climate and Development Knowledge Network (CDKN), Overseas Development Institute (ODI), Fundación Futuro Latinoamericano and SouthSouthNorth. This is not an official IPCC publication.

The IPCC's own *Summary for Policy-Makers*, www.ipcc.ch/srccl, focuses principally on global issues and trends. This report distils the richest material available in the reports from Latin America from the 1,300 pages of the *Special Report*. The publication has not been through the comprehensive governmental approval process that IPCC endorsement requires. However, CDKN has benefited from review by IPCC lead authors and other expert reviewers to ensure fidelity to the original report (see *Acknowledgements*).

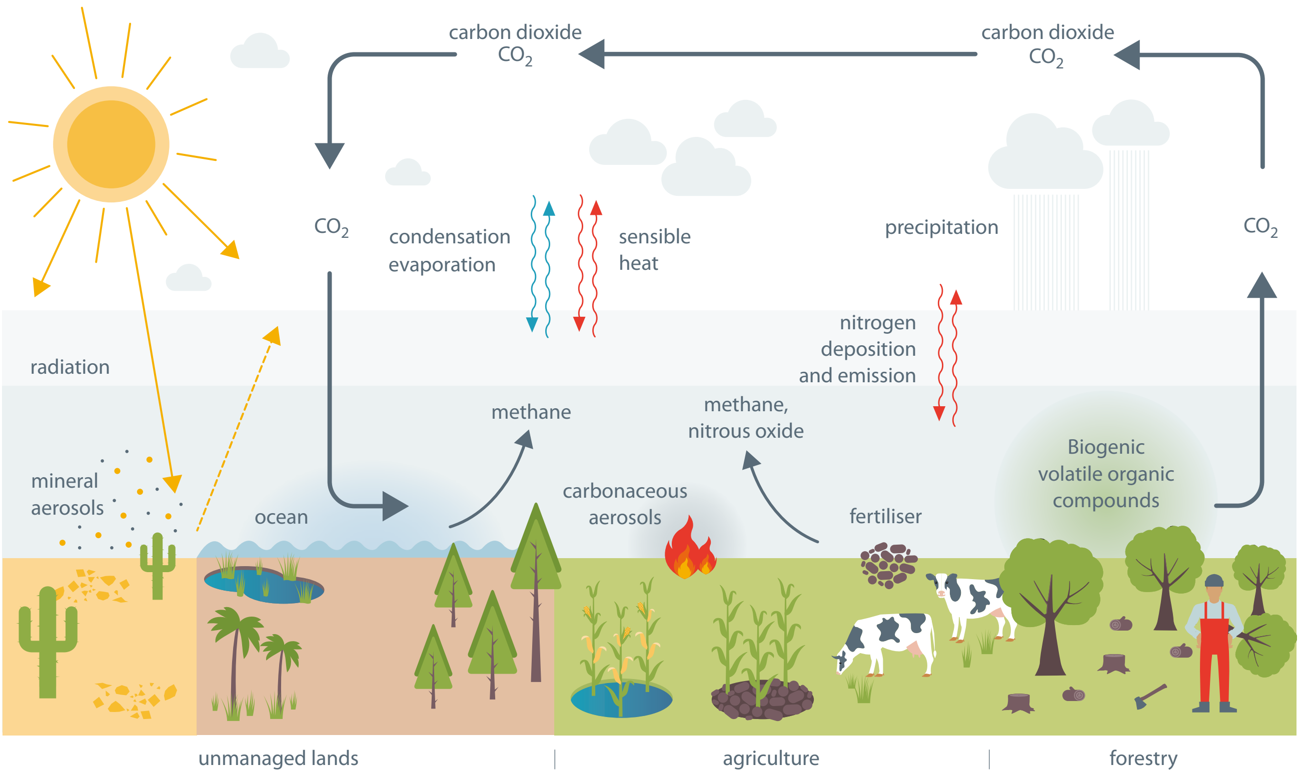
We have extracted the Latin America-specific data, trends and analysis directly from the *Special Report on Climate Change and Land* for this guide. In a few places, we have included supplementary material from recently published research that extends and explains the points made in the IPCC's *Special Report*. We have clearly labelled this supplementary material 'Beyond the IPCC'. This guide responds to widespread demand among CDKN's Latin American partner networks for region-specific information.

Please visit **www.cdkn.org/landreport** for slides, images and infographics you can use in association with this guide.

Contents

"About a quarter of the Earth's ice-free land area is subject to human-induced degradation (medium confidence) … Climate change exacerbates land degradation, particularly in low-lying coastal areas, river deltas and drylands (high confidence)."[1]

FIGURE 1: How land and climate interact[2]



Box 1: Glossary of terms for Figure 1

Aerosols: A suspension of airborne solid or liquid particles, with a typical size between a few nanometres and 10 micrometres or microns (μm) that reside in the atmosphere for at least several hours – and often longer, especially for volcanic and desert dust, which are more influential on the climate. The bulk of aerosols are of natural origin and can include mineral aerosols (such as desert dust).[3] Carbonaceous aerosols are small particles that are rich in carbon. They come from vehicle exhausts as well as the soot and remnants of burned wood, etc.[4]

BVOC: The term biogenic volatile organic compounds includes organic atmospheric trace gases other than carbon dioxide and monoxide.[5]

Nitrogen deposition: Nitrogen deposition describes what happens when reactive nitrogen passes from the atmosphere to the biosphere either as a gas (dry deposition) or through precipitation (wet deposition).[6]

Sensible heat: Sensible heat is thermal energy whose transfer to or from a substance or body results in a change of temperature (such as between one layer of atmosphere and another).

1 The climate and land interact with and influence each other

Climate change affects the land

Climate change affects land-based ecosystems.[7] Climate change is expected to alter:

- the distribution of land cover
- biodiversity and the mix of plant and animal species in ecosystems
- vegetation structure and productivity and
- nutrient and water cycles.[8]

In recent decades, climate change has led to shifts in the range and location of many plant and animal species – their 'climate zones', or territories where these species can exist. Climate change has also led to changes in the timing of species' seasonal activities, such as when plants flower, when animals breed and young animals are born and hatch, etc.[9] Already, climate zones for different ecosystems and species are shifting around the world, as icy regions retreat and dry, arid regions expand. Shifting climate zones have been observed in Northeast Brazil and southern Argentina.[10]

Increasing concentrations of carbon dioxide (CO_2) in the air can stimulate more photosynthesis in vegetation, known as CO_2 fertilisation. However, this may contribute to the growth of scrub vegetation or may favour invasive species, so it does not necessarily enrich land-based ecosystems. Overall, CO_2 fertilisation tends to decrease the nutritional content of crops.[11]

'Greening' of the land has increased globally by 22–33% over the past 20–30 years (where greening means the steady growth of vegetation over a land area over time). This is due both to *direct* activities such as land use and management and forest conservation and to *indirect* factors linked to human activity such as CO_2 fertilisation, extended growing seasons and global warming.[12] Greening has been observed in southern Amazonia.

In many places, increased climate change will contribute to more drought and heat waves, which will cause 'browning', which means less photosynthesis by plants and an overall decrease in the volume of vegetation in the affected areas. There are low levels of scientific confidence about future trends in greening and browning.

The frequency and intensity of some extreme weather and climate events have increased as a consequence of global warming and will continue to increase under medium and high emission scenarios. Recent heat-related events, e.g., heat waves, have been made more frequent or intense due to human-made greenhouse gas emissions in most land regions. The frequency and intensity of drought has increased in Amazonia and Northeast Brazil.[13]

Drought frequency and intensity is projected to increase in some regions that are already drought prone, including the southern Amazon. These changes will impact ecosystems, food security and land processes including fluxes in greenhouse gases.[14]

Box 2: The IPCC's confidence levels

This matrix helps explain what the IPCC means by high, medium or low confidence.[15] High confidence means that there is a high level of agreement and evidence in the literature to support the categorisation as high, medium or low.

Low confidence denotes that the categorisation of magnitude is based on only a few studies. Medium confidence reflects medium evidence and agreement on the magnitude of response.[16] Confidence increases towards the top right corner, as suggested by the increasing strength of shading.

Agreement			
	High agreement Limited evidence	***High agreement Medium evidence***	***High agreement Robust evidence***
	Medium agreement Limited evidence	***Medium agreement Medium evidence***	***Medium agreement Robust evidence***
	Low agreement Limited evidence	***Low agreement Medium evidence***	***Low agreement Robust evidence***

Evidence (type, amount, quality, consistency)

Confidence Scale: higher / lower

Conditions on land affect the climate

Just as climate change affects the land and the species that live on it, so land plays an important role in the climate system.

The physical, ecological and hydrological conditions of land all influence its interaction with the atmosphere. This includes the composition of rocks, soils and man-made surfaces, the vegetation cover, and the amount of water or ice on the land. Land conditions which influence climate can be a result of direct human management and use, e.g. deforestation, afforestation, urbanisation, irrigated agriculture, as well as land state (i.e. degree of wetness, degree of greening, amount of snow, amount of permafrost).[17] Land can be both a source of greenhouse gas emissions, and a sink for emissions, meaning that land both releases and absorbs greenhouse gases. See Figure [1].

"Land changes influence regional climates."[18]

When the condition of the land changes, either because people change land use directly, or because climate change affects land conditions, this, in turn, affects global and regional climates.[19] The links between land and the *global* climate have long been known, but scientists now recognise that land changes have a greater role in influencing *regional* climates than was previously thought.

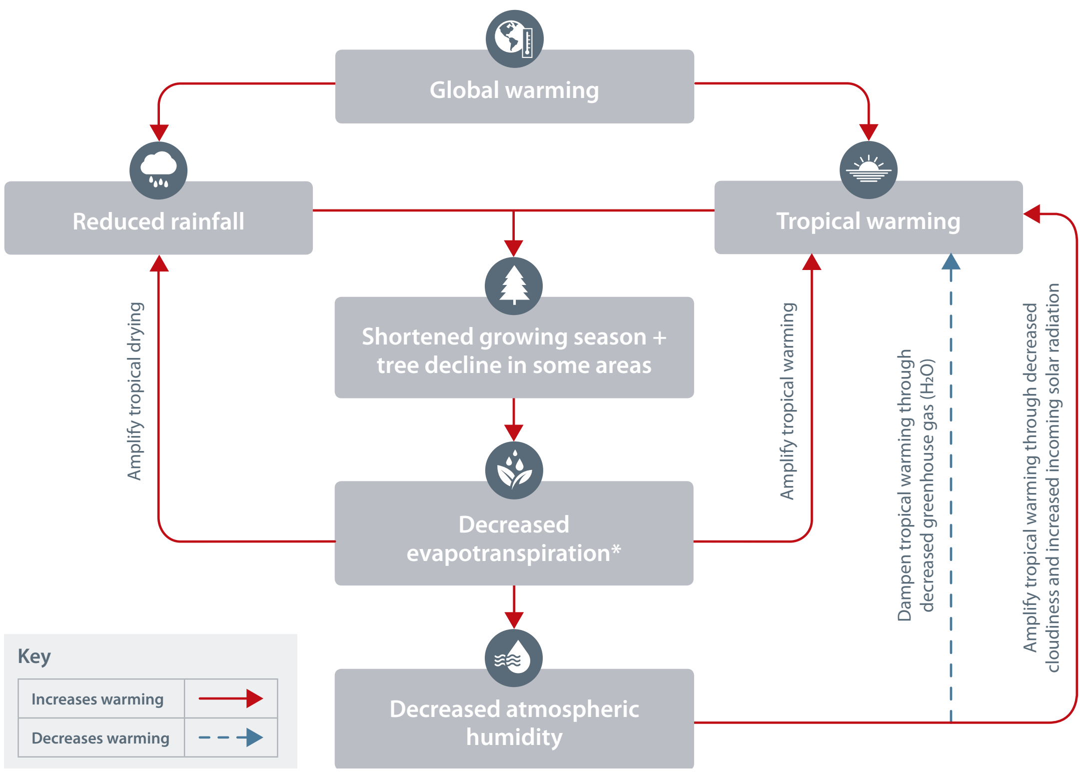
Regionally, changes in land conditions can reduce or accentuate warming. They can affect the intensity, frequency and duration of extreme weather events, including heat waves, droughts and rainfall. The magnitude and direction of these changes vary with location and season.[20]

Actions on land that change the land cover, such as large-scale loss of trees or tree planting, will affect the local climate. The way this works is shown in Figure 2 below.

Not only do land cover changes affect local climates, but they also generate atmospheric changes in neighbouring regions, downwind.[21] For example, forests release water vapour into to the atmosphere which supports rainfall downwind. Within a few days, water vapour can travel several hundreds of kilometres before being condensed into rain. This 'moisture recycling' has been observed in South America. Deforestation can potentially decrease rainfall downwind from where it occurs.[22]

"Planting trees will always result in capturing more atmospheric CO_2 and thus in annual mean cooling of the globe."[23]

FIGURE 2: How land and climate interact: An illustration of processes in the Amazon region [24]



*Decreased evaporation of water from soil and transpiration from plants

"About a quarter of the climate change mitigation pledged by countries in their initial Nationally Determined Contributions (NDCs) is expected to come from land-based options (medium confidence)."[25]

Unsustainable land management contributes to global warming

Human over-exploitation is depleting land resources.[26] Globally, the demand for meat and vegetable oil, as well as fibre, fuel and other natural resources, has leaped in recent decades. These changes in production are linked to consumption: 2 billion people globally are overweight, even as 821 million people are undernourished.[27]

Climate change adds to these stresses on land and speeds up the rate of land depletion.

At present, land is a source of greenhouse gases into the atmosphere, contributing to human-made climate change. It does not have to be this way.

Agriculture, forestry and other types of land use account for 23% of human greenhouse gas emissions.[28] At the same time, natural land processes absorb carbon dioxide equivalent to almost a third of carbon dioxide emissions from fossil fuels and industry.[29]

Recent satellite observation and model simulation suggest that Amazonian deforestation in the last three decades led to a shift from forested land being a carbon sink (a net absorber of carbon dioxide) towards being a net carbon source.

If countries fully carry out their Nationally Determined Contributions (NDCs) under the Paris Agreement as submitted in 2016, then land use change could turn global land from a net source of human greenhouse gas emissions during 1990-2010 to a net sink by the year 2030.[30]

Climate change reduces the productivity of land

Since pre-industrial times, the air temperature over the land's surface has risen by 1.5ºC, compared to a 1ºC average rise over land and oceans together.[31]

The impacts of global warming on the productivity of land fall most heavily on the world's poorest people. The majority of those affected will continue to be in the global South. By increasing stresses on land, climate change worsens existing risks to livelihoods, biodiversity, human and ecosystem health, infrastructure and food systems.[32]

© SPDA | Unsustainable logging, Peru.

In the Andes, people are beginning to experience changes in the timing, severity and patterns of the annual weather cycle. Data collected through participatory workshops, semi-structured interviews with agronomists and qualitative fieldwork suggest that in Colomi, Bolivia, climate change is affecting crop yields. It is causing farmers to alter the timing of planting, their soil management strategies, and the use and spatial distribution of crop varieties.[33] In Argentina, there is now more variability in the yield sizes of maize and soybeans.[34]

The increasing impacts of climate change on land are predicted under all future greenhouse gas scenarios.[35] Figure 3 shows how climate-related risks to land will increase with every further degree of average global warming. These risks include dryland water scarcity, soil erosion, vegetation loss, wildfire damage, permafrost degradation, declines in the yields of tropical crops and instabilities in food supply.

Image: © SPDA | Land degradation from mining, Peru.

At around 1.5°C of average global warming, the global risk from dryland water scarcity, wildfire damage, permafrost degradation and food supply instabilities is projected to be high. At around 2°C of global warming, the risks from food supply instabilities is projected to be very high. Additionally, at around 3°C of global warming, the risk from vegetation loss, wildfire damage and dryland water scarcity is also projected to be very high.[36] For every 1°C of average warming, *globally* there will be:

- a 6% decrease in wheat yields
- a 3.2% decrease in rice yields
- a 7.4% decrease in maize yields.

FIGURE 3: Risks to humans and ecosystems from every 1°C of average global warming[37]

Increases in global mean surface temperature (GMST), relative to pre-industrial levels, affect processes involved in **desertification** (water scarcity), **land degradation** (soil erosion, vegetation loss, wildfire, permafrost thaw) and **food security** (crop yield and food supply instabilities). Changes in these processes drive risks to food systems, livelihoods, infrastructure, the value of land, and human and ecosystem health. Changes in one process (e.g. wildfires or water scarcity) may result in compound risks. Risks are location-specific and differ by region.

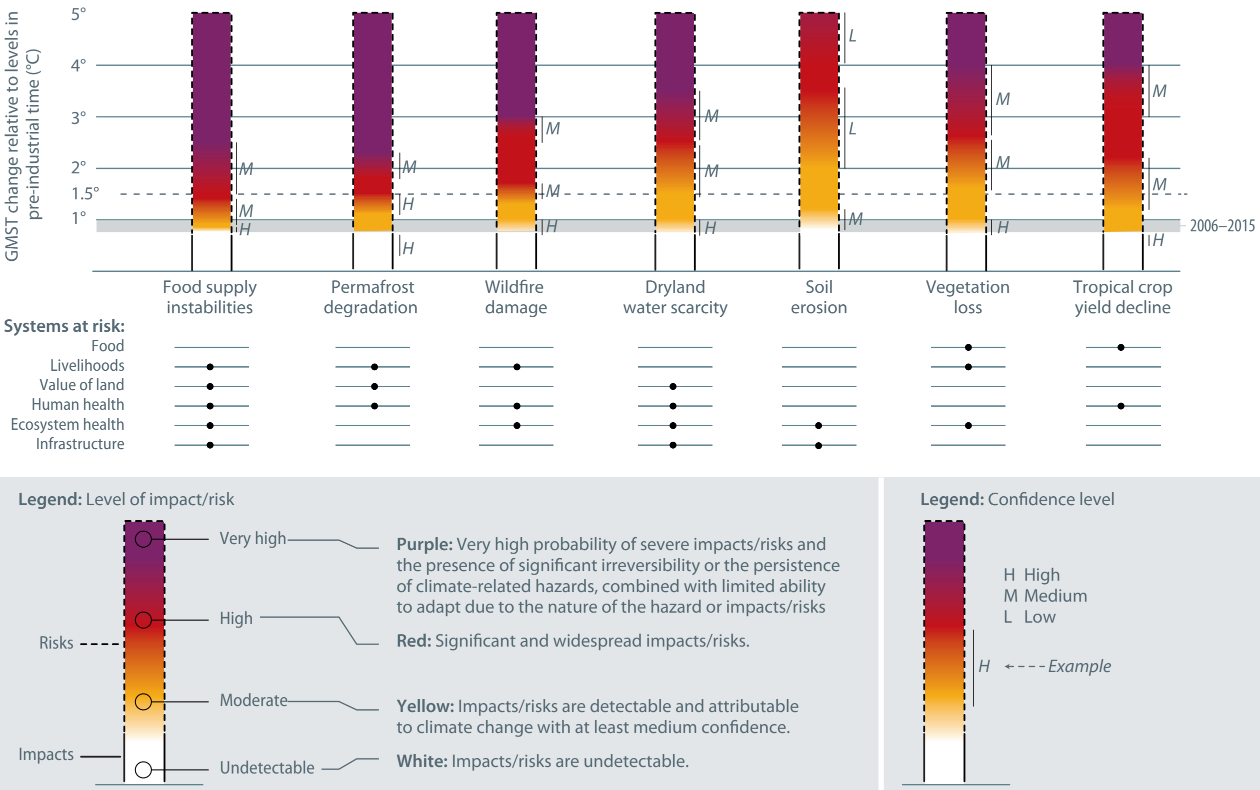


Image: © SPDA | Coffer grower, Bolivia.

2 Dryland areas are expected to become more vulnerable to desertification in Latin America

FIGURE 4: Increasing population of Latin America's drylands[38]

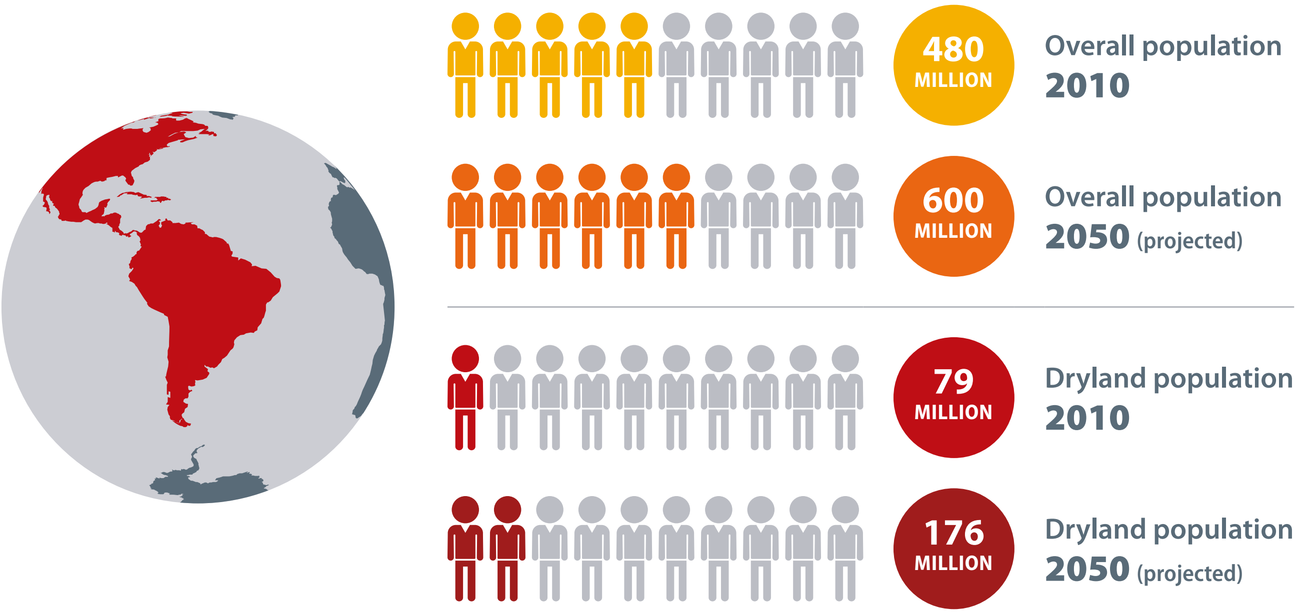
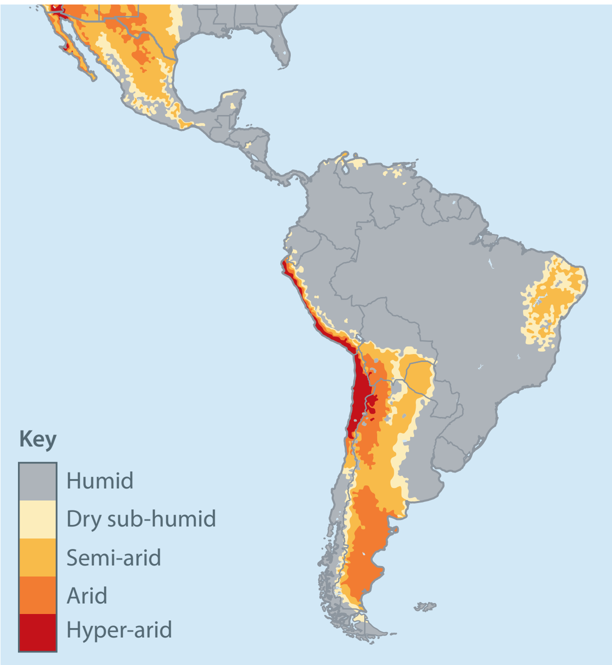


FIGURE 5: Map of drylands in Latin America[39]



Box 3: What is desertification?

Desertification is land degradation in drylands. Desertification comes about as a result of both processes that involve living things and processes which do not involve living things. Biological processes include changes in vegetation cover and composition, including over- and under-grazing, deforestation, biodiversity loss and degradation of soil structures.

Desertification can also happen through physical processes, including soil erosion by water and wind, and soil structure degradation; and chemical processes, including salinisation and nutrient depletion.

Desertification can be caused directly by human mismanagement and also by the climate.[40]

"The interaction of climate change and desertification reduces the provision of dryland ecosystem services and lowers ecosystem health, including loss of biodiversity, affecting food security and human wellbeing (high confidence)."[41]

Image: © SPDA | Horse rearing on arid land.

Desertification is the term for land degradation in drylands (see box). Drylands are often classified based on aridity. Aridity is a long-term feature of the climate, when there is low average rainfall or available water in a region. It is different from drought; drought is a temporary event.[42]

Latin America is already affected by desertification:

- Desertification costs between 8% and 14% of gross agricultural product in many Central and South American countries.[43]
- Parts of the dry Chaco and Caldenal regions of Argentina have undergone widespread degradation over the last century.[44]
- Vieira et al found that 94% of Northeast Brazilian drylands were susceptible to desertification. It is estimated that up to 50% of the area has been degraded due to frequent prolonged droughts and the clearing of forests for agriculture.[45] This land use change threatens the extinction of around 28 native species.[46]

Future climate change will increase the frequency, intensity and scale of extreme weather events such as droughts and heat waves. This will worsen the vulnerability of people and ecosystems to desertification. Drought and aridity are both predicted to increase in a world where average global warming is 1.5°C to 2°C.[47] There is a risk of increased drought hazards in the Amazon region in all future climate scenarios.[48]

3 Land degradation, including desertification, has implications for livelihoods and food security in Latin America

"There is high evidence and high agreement that both climate change and land degradation can affect livelihoods and poverty through their threat multiplier effect."[49]

Lives and livelihoods depend on healthy land

Land degradation and climate change, both individually and in combination, have deep implications for people who depend on natural resources for their livelihoods.

People who directly depend on natural resources for subsistence, food security and income, including women and youth with limited adaptation options, are especially vulnerable to land degradation and climate change.[50] Because land degradation reduces the productivity of land, when land is degraded, the workload for managing the land increases. This affects women disproportionally in many places.

Land degradation as a result of sea level rise and more intense cyclones – to which climate change is contributing – is imperilling lives and livelihoods in cyclone-prone areas. Extreme weather and climate, including slow-onset climatic changes such as sea level rise, could threaten livelihoods and lead to more displacement of people.[51]

Where livelihoods are already precarious, land degradation and climate change act as 'threat multipliers'. Already-vulnerable people are highly sensitive to extreme weather and climate events, which are likely to tip them into increased poverty and food insecurity.[52]

The World Bank projects that climate change will reduce the mean yields of 11 major global crops – millet, field pea, sugar beet, sweet potato, wheat, rice, maize, soybean, groundnut, sunflower and rapeseed – by 6% in Latin America and the Caribbean by 2046–2055 compared with 1996–2005.[53]

The specific impacts of climate change on poverty and food security vary significantly, depending on whether the household is a net agricultural buyer or seller. As reduced crop yields drive up agricultural prices, urban dwellers and rural households who are 'net food buyers' suffer the greatest losses in food security. Those who are 'net food producers' are less worse off.

For example, one study found that poverty rates fell among agricultural households in Chile because although their crops were less productive, they earned higher prices for their produce.[54]

Image: © SPDA | Bolivia.

“Desertification processes, coupled with climate change, are expected to cause a reduction in crop and livestock productivity (high confidence).”[55]

Desertification has implications for Latin American development

Desertification processes – referring to land degradation in drylands specifically – bring their own specific challenges. Desertification may be caused by a combination of direct human activities (unsustainable land management) as well as indirect human causes, via climate change.

Desertification is driving losses in agricultural productivity and incomes in dryland areas.[56] Although the majority of the world’s people living in desertified areas are in Africa and Asia and a minority are in Latin America, the population living in Latin America’s drylands, exposed to these threats, is still growing. (See Figure 4, page 10.)

Another risk of desertification to Latin American development is the risk of dust storms to energy infrastructure. Dust storms affect the operational effectiveness of solar power systems and wind farms when dust settles on the surface of solar panels and in the parts of wind turbines. Dust storms also reduce the effectiveness of electricity distribution in high voltage transmission lines.[57] In the Atacama Desert, Chile, one month of exposure reduced the performance of thin-film solar power modules by almost 19% due to the deposition of dust.[58]

The abundance of solar radiation in dryland areas such as the Atacama Desert makes them prime locations for solar energy systems. However, the more intense and frequent dust storms caused by desertification will make it more difficult and costly to maintain the equipment. The most popular solution to dust deposition is to wipe or wash surfaces with water, but this puts pressure on scarce water resources. Special coatings have been developed to coat the surface of solar panels, to help prevent the deposition of dust.[59]

Image: © Pierre Lesage, Flickr | Atacama Desert solar installation, Chile.

4 Community and policy responses can combat land degradation

Sustainable land management is possible. There are many examples of long-term sustainably managed land around the world, such as terraced agricultural systems and sustainably managed forests.[60] The IPCC's Special Report discusses promising approaches for halting land degradation and restoring land (this section). The IPCC has also assessed a range of measures for their ability to restore land, combat desertification and achieve other development goals such as food security (See Section 5.)

Approaches to reversing land degradation

Implementing sustainable land management increases the productivity of land and provides good economic returns on investment around the world. One study of 363 sustainable land management projects found:

- three quarters of sustainable land management projects had positive short-term cost-benefit returns
- 97% of the projects had positive or very positive cost-benefit ratios in the long term.[61]

Stopping and reversing land degradation involves:

- improving the carbon content of soils; and
- retaining and restoring soil nutrients (including through soil and water management techniques and land-livestock interactions).[62]

On farmland, options include growing green manure crops and cover crops, retaining crop residues, practising reduced or zero tillage and improving grazing management.

Agroforestry is scientifically proven to have important land restoration benefits, but uptake by farmers is often slow.[63] Policy measures such as Payments for Environmental Services and support for households to diversify their livelihoods can also play a role. (See Costa Rica, opposite.)

"Using indigenous and local knowledge for combating desertification could contribute to climate change adaptation strategies."[64]

Measures to combat soil erosion

Soil erosion is a major form of land degradation. There are several ways in which climate change could make erosion worse:

- More frequent heavy rainfall events and rainfall variability under climate change, and more intense flood events, can intensify erosion processes.
- Sea level rise and increased storm surge intensities can increase erosion.
- Glacier retreat can increase soil erosion in some regions.[65]

Numerous conservation measures can help reduce soil erosion. Such soil management measures include afforestation and reforestation, rehabilitation of degraded forests, erosion control measures, prevention of overgrazing, diversification of crop rotations, and improvements to irrigation techniques, especially in sloping areas. Effective measures for soil conservation can also use spatial patterns of plant cover to reduce sediment connectivity, and reduce the relationship between hillslopes and sediment transfer in eroded channels.[66]

Sustainable forest management

Reducing deforestation and forest degradation and sustainable forest management are also extremely important practices for reversing land degradation, and for both mitigating against and adapting to climate change.

Sustainable forest management practices are evolving. Primary (natural, undisturbed) forests can be converted to sustainably managed forest ecosystems that deliver more economic and social benefits to people.

However, some carbon emissions are released in the transition from primary to managed forest systems and the transition often comes at the expense of biodiversity.[67] In the Amazon region, for instance, there is an incredible diversity of tree species, estimated at 16,000 tree species.[68]

Certification schemes have been shown to improve the sustainability of forest management in tropical areas. For example, selective logging accounts for 6% of tropical greenhouse gases annually, but improved logging practices can reduce such emissions by 44%.[69]

“Sustainable forestry, with other forms of sustainable land management, has the potential to provide cost effective, immediate and long-term benefits to communities and support several Sustainable Development Goals.”[70]

Traditional woodfuels account for 1.9–2.3% of global greenhouse gas emissions, and are particularly concentrated in 'hotspots' of land degradation and fuelwood depletion, including Latin America. One third of traditional woodfuels globally are harvested unsustainably. Reducing people's reliance on traditional biomass in developing countries and switching them to cleaner forms of energy presents a major opportunity for taking climate action and improving people's wellbeing.

Reducing fuelwood use can, for instance, reduce emissions of black carbon, a climate pollutant that causes respiratory disease. It also reduces the workload (in gathering wood) for women and young people.[71]

Beyond the IPCC: Costa Rica's Payment for Ecosystem Services programme[72]

Costa-Rica's government-led Payments for Ecosystem Services (PES) programme bundles together the provision of four main ecosystem services: carbon sequestration, biodiversity protection, water regulation and landscape beauty. It makes direct cash transfers to private landowners for five-year contracts for different modalities of forest protection, reforestation, sustainable forest management and agroforestry.

The programme focuses on forests that are not legally protected and are at risk of conversion to other uses, by protecting these areas and improving connectivity between forests through establishing biological corridors. Apart from giving priority to indigenous communities, the programme has a social focus, prioritising applications from farmers in areas of low development. Created by legislation in 1996, the programme is a mix of rules and regulations (for example, a ban on cutting down primary forest) and positive rewards.

Image: © William Warby, Flickr | Rainforest garden at accommodation in La Fortuna, Costa Rica.

The scheme has been underway for over 20 years and is mostly publicly funded, which is an indicator of the political commitment behind it. Sources of funds for the programme are: fuel tax; water tax; loans from the World Bank to initiate the programme, combined with some smaller grants, notably from the German Development Bank (KFW) and the Global Environmental Facility (GEF); and agreements with private and semi-private companies. These companies have an interest in promoting forest protection for water protection, biodiversity conservation or landscape beauty in their areas (for example, the tourism sector, conservation groups).

This is the first national-level programme to give direct cash rewards for ecosystem services. It has protected over one million hectares of standing forest and resulted in more than 6.8 million trees being planted. Evaluations and course corrections over time have improved the targeting of areas at risk of deforestation. The programme's legal foundations allow it to access a variety of funds. Despite this, the programme remains oversubscribed and underfunded; it needs to work better with other financing mechanisms to continue to improve results.

Image: © SPDA | Peru.

Image: © SPDA | Cloud forest, Ecuador.

5 Improved management of land, value chains and climate risks can deliver climate adaptation, mitigation and development

A range of policies and practices has been identified which can, at the same time, help people adapt to climate change, mitigate against further climate change, combat land degradation and desertification, and improve food security.

The policies and practices fall into three broad categories:

- sustainable land management
- value chain management
- risk management.

The IPCC has divided the set of policies and practices into those which either (1) relieve pressure or minimise pressure on land; or (2) have the potential to increase pressure on land – although mitigating measures can be taken to reduce the pressure.

Some actions minimise pressure on land

Table 1 (overleaf) lists a range of actions for decision makers to consider that promote food security and climate mitigation and adaptation, and combat desertification and land degradation. Importantly, these activities do not create further pressures on land. They may even relieve pressures with regard to the multiple uses of land.

Many of the options identified are 'no regrets' or 'low regrets' options, meaning that to take these measures makes economic and financial sense, irrespective of the climate benefits.

'No regrets' options that save money and are economically beneficial include value chain management measures such as reducing post-harvest losses and food waste at retail and consumer level. Another 'no regrets' option involves changing diets, such as eating less highly processed food that is produced at an industrial scale (such as highly processed red meat).[73]

On the land management side, 'low regrets' options include, for example, restoring peatlands and avoiding their conversion to cropland. This increases carbon sinks, avoids ongoing carbon dioxide emissions from degraded peatlands and yields benefits for climate adaptation because peatlands hold and regulate water.[74]

Image: © SPDA | Bolivia.

TABLE 1: Actions that minimise pressure on land

The IPCC Special Report's Chapter 6 on 'Interlinkages between desertification, land degradation, food security and greenhouse gas fluxes, synergies, trade-offs and integrated response options' assesses each of the options shown in the table in detail. The report explains the positive and potential negative impacts of each measure, with best practices on how to manage downside risks.

Both the benefits and the adverse side effects of the different actions are shown quantitatively based on the *high end* of their potential – as assessed by IPCC scientists. Letters H, M and L inside the cells show the level of scientific confidence about the degree of positive or negative impact caused by each action. (See Box 2, page 5 for an explanation of scientific confidence.)

Category	Response option	Mitigation	Adaptation	Desertification	Land Degradation	Food Security	Cost
Response options based on land management							
Agriculture	Increased food productivity	Large, L	Large, M	Large, L	Large, M	Large, H	No data
Agriculture	Agro-forestry	Large, M	Large, M	Large, M	Large, M	Large, L	Low cost
Agriculture	Improved cropland management	Moderate, M	Large, L	Large, L	Large, L	Large, L	Medium cost
Agriculture	Improved livestock management	Moderate, M	Moderate, L	Moderate, L	Large, L	Large, L	High cost
Agriculture	Agricultural diversification	Small, L	Large, L	Moderate, L	Large, M	Large, L	Low cost
Agriculture	Improved grazing land management	Moderate, M	Moderate, L	Moderate, L	Large, L	Large, L	No data
Agriculture	Integrated water management	Moderate, L	Large, L	Small, L	Small, L	Large, L	Medium cost
Agriculture	Reduced grassland conversion to cropland	Moderate, L	No data	Small, L	Small, L	Negative moderate (–), L	Low cost
Forests	Forest management	Moderate, M	Large, L	Large, L	Large, L	Moderate, L	Medium cost
Forests	Reduced deforestation and forest degradation	Large, H	Moderate, L	Large, L	Large, L	Small, L	Medium cost
Soils	Increased soil organic carbon content	Large, H	Large, L	Large, M	Large, M	Large, L	Medium cost
Soils	Reduced soil erosion	Variable (⟷), L	Large, L	Large, M	Large, M	Large, L	Medium cost
Soils	Reduced soil salinisation	No data	Moderate, L	Moderate, L	Moderate, L	Moderate, L	Medium cost
Soils	Reduced soil compaction	No data	Small, L	No data	Large, L	Moderate, L	Low cost
Other ecosystems	Fire management	Large, M	Moderate, M	Large, M	Large, M	Moderate, L	Low cost
Other ecosystems	Reduced landslides and natural hazards	Small, L	Large, L	Small, L	Large, L	Moderate, L	No data
Other ecosystems	Reduced pollution including acidification	Variable (⟷), M	Moderate, M	Moderate, L	Moderate, L	Large, L	No data
Other ecosystems	Restoration & reduced conversion of coastal wetlands	Large, M	Large, L	Negligible, M	Small, M	Variable (⟷), L	No data
Other ecosystems	Restoration & reduced conversion of peatlands	Moderate, M	No data	na	Moderate, M	Negative moderate (–), L	Low cost
Response options based on value chain management							
Demand	Reduced post-harvest losses	Large, H	Large, M	Moderate, L	Moderate, L	Large, H	No data
Demand	Dietary change	Large, H	No data	Moderate, L	Moderate, H	Large, H	No data
Demand	Reduced food waste (consumer or retailer)	Large, H	No data	Moderate, L	Moderate, M	Large, M	No data
Supply	Sustainable sourcing	No data	Moderate, L	No data	Large, L	Moderate, L	No data
Supply	Improved food processing and retailing	Moderate, L	Large, L	No data	No data	Large, L	No data
Supply	Improved energy use in food systems	Moderate, L	Large, L	No data	No data	Large, L	No data
Response options based on risk management							
Risk	Livelihood diversification	No data	Large, L	No data	Small, L	Large, L	No data
Risk	Management of urban sprawl	No data	Moderate, L	Small, L	Small, M	Moderate, L	No data
Risk	Risk sharing instruments	Variable (⟷), L	Moderate, L	No data	Variable (⟷), L	Moderate, L	Medium cost

Options shown are those for which data are available to assess global potential for three or more land challenges.
The magnitudes are assessed independently for each option and are not additive.

Key for criteria used to define magnitude of impact of each integrated response option

		Mitigation *Gt CO_2-eq yr^{-1}*	Adaptation *Million people*	Desertification *Million km²*	Land Degradation *Million km²*	Food Security *Million people*
Positive	Large	More than 3	Positive for more than 25	Positive for more than 3	Positive for more than 3	Positive for more than 100
Positive	Moderate	0.3 to 3	1 to 25	0.5 to 3	0.5 to 3	1 to 100
Positive	Small	Less than 0.3	Less than 1	Less than 0.5	Less than 0.5	Less than 1
	Negligible	No effect	No effect	No effect	No effect	No effect
Negative	Small	Less than –0.3	Less than 1	Less than 0.5	Less than 0.5	Less than 1
Negative	Moderate	–0.3 to –3	1 to 25	0.5 to 3	0.5 to 3	1 to 100
Negative	Large	More than –3	Negative for more than 25	Negative for more than 3	Negative for more than 3	Negative for more than 100

⟷ **Variable:** Can be positive or negative —— no data na not applicable

Confidence level

Indicates confidence in the estimate of magnitude category.

H High confidence
M Medium confidence
L Low confidence

Cost range

Relative costs for each option. See the IPCC's Summary for Policy Makers for cost ranges in US$.

- ●●● High cost
- ●● Medium cost
- ● Low cost
- —— No data

"Near-term action to address climate change adaptation and mitigation, desertification, land degradation and food security can bring social, ecological, economic and development co-benefits (high confidence). Co-benefits can contribute to poverty eradication and more resilient livelihoods for those who are vulnerable (high confidence)."[75]

Some actions increase competition for land – 'best practices' can reduce the pressure

Some measures that are intended to achieve climate mitigation and adaptation, combat desertification and land degradation and enhance food security risk are creating more pressures on land. There are 'best practice' ways to approach these options to ensure that they are environmentally and socially sustainable. For example, afforestation and reforestation are considered important ways to remove carbon dioxide from the atmosphere and help stabilise the climate. A 'best practice' way of afforestation is to use native tree species and involve local people fully in implementation so that their food supplies are secure. A potentially harmful way of afforesting would be to use non-native species and exclude local people.

TABLE 2: Climate actions that increase competition for land – and 'best practices' that can reduce the pressure[76]

Bioenergy and Bioenergy with Carbon Capture and Storage (BECCS)

	Mitigation	Adaptation	Desertification	Land degradation	Food security	Cost
	H	L			L	● / ●●●
Best practice						

Best practice: The sign and magnitude of the effects of bioenergy and BECCS depends on the scale of deployment, the type of bioenergy feedstock, which other response options are included, and where bioenergy is grown (including prior land use and indirect land use change emissions). For example, limiting bioenergy production to marginal lands or abandoned cropland would have negligible effects on biodiversity, food security, and potentially co-benefits for land degradation; however, the benefits for mitigation could also be smaller.

Reforestation and forest restoration

	Mitigation	Adaptation	Desertification	Land degradation	Food security	Cost
	M	M	M	M	M	●●
Best practice						

Best practice: There are co-benefits of reforestation and forest restoration in previously forested areas, assuming small-scale deployment using native species and involving local stakeholders to provide a safety net for food security. Examples of sustainable implementation include, but are not limited to, reducing illegal logging and halting illegal forest loss in protected areas, reforesting and restoring forests in degraded and desertified lands.

Afforestation

	Mitigation	Adaptation	Desertification	Land degradation	Food security	Cost
	M	M	M	L	M	●●
Best practice						

Best practice: Afforestation is used to prevent desertification and to tackle land degradation. Forested land also offers benefits in terms of food supply, especially when forest is established on degraded land, mangroves and other land that cannot be used for agriculture. For example, food from forests represents a safety-net during times of food and income insecurity.

Biochar addition to soil

	Mitigation	Adaptation	Desertification	Land degradation	Food security	Cost
	M	—	—	L	L	●●●
Best practice						

Best practice: When applied to land, biochar could provide moderate benefits for food security by improving yields by 25% in the tropics, but with more limited impacts in temperate regions, or through improved water holding capacity and nutrient use efficiency. Abandoned cropland could be used to supply biomass for biochar, thus avoiding competition with food production; $5-9\ Mkm^2$ of land is estimated to be available for biomass production without compromising food security and biodiversity, considering marginal and degraded land and land released by pasture intensification.

"Large-scale implementation of dedicated biomass production for bioenergy increases competition for land with potentially serious consequences for food security and land degradation (high confidence)."[77]

Image: © SPDA | Potatoe growers, Ecuador.

Coordinated action on climate change and food can address dangerous climate change and end hunger

At present, around 25–30% of total global greenhouse gas emissions come from the food system. This includes agriculture and land use, storage, transport, packaging, processing, retail and consumption.

Policies that operate across the food system can support more sustainable land use management, enhanced food security and low-emissions development. This includes policies that reduce food loss and waste and influence dietary choices. More sustainable diets are high in coarse grains, pulses, fruits and vegetables, and nuts and seeds; they are low in discretionary foods (such as sugary beverages) which are becoming more prevalent in modern diets and can contribute to obesity.

Combining large-scale climate change adaptation and mitigation strategies across the supply and demand sides is possible, in ways that manage the competition for land for food production and combat higher food prices effectively.

This can be achieved by intensifying agriculture, but it must be *sustainable intensification* – ways of managing inputs (such as water and fertilisers) to increase agricultural production, but without depleting and polluting soils and larger ecosystems and undermining their ability to support agriculture for future generations.[78]

On the supply side, resilience to the increasing frequency of extreme weather events can be achieved through economic instruments that share and transfer risk, such as insurance markets and index-based weather insurance.

“Agriculture and the food system are key to global climate change responses. Combining supply-side actions such as efficient production, transport and processing with demand-side interventions such as modification of food choices, and reduction of food loss and waste, reduces greenhouse gas emissions and enhances food system resilience (high confidence).”[79]

Policy measures to tackle climate change adaptation and mitigation, reduce land degradation, desertification and poverty, and improve public health simultaneously include:

- improving access to markets
- securing land tenure
- factoring environmental costs into food prices
- making payments for ecosystem services, and
- enhancing local and community collective action.[80]

Policy measures should be equitable, providing benefits for women and girls as well as men and boys, and explicitly addressing women's barriers to participation.[81] Empowering and valuing women increases their capacity to improve food security in a changing climate and substantially improves the wellbeing of themselves, their families and their communities.

Women's empowerment includes economic, social and institutional arrangements and may include targeting men in integrated agriculture programmes to change gender norms and improve nutrition. Empowerment through collective action in the near term has the potential to equalise relationships on the local, national and global scale. Empowered women are crucial to creating effective synergies among adaptation, mitigation and food security.[82]

On the demand side, public health policies to improve nutrition – such as school procurement, health insurance incentives, and awareness-raising campaigns – can potentially change demand, reduce healthcare costs, and contribute to lower greenhouse gas emissions.[83]

“Without combined food system measures in farm management, supply chains and demand, adverse effects would include an increased number of malnourished people and impacts on smallholder farmers. Just transitions are needed to address these effects.”[84]

Image: © SPDA | Plowing the land, Ecuador.

6 Insecure property rights and lack of access to credit and agricultural advisory services hamper progress – especially by women

"Improving capacities, providing higher access to climate services, including local-level early warning systems, and expanding the use of remote sensing technologies are high-return investments for enabling effective adaptation and mitigation responses that help address desertification (high confidence)."[85]

Land tenure insecurity, lack of property rights, lack of access to markets and to agricultural advisory services, lack of technical knowledge and skills, agricultural price distortions, and lack of agricultural support and subsidies contribute to desertification and drive unsustainable land management.[86] Women's lack of access to these services (for social and cultural reasons), in particular, hampers their ability to be more effective agents of sustainable change.

Tackling this range of knowledge gaps and distorting policies will be key to the sustainable stewardship of land, which will, in turn, be key to successful climate adaptation and mitigation.[87]

Policy responses to land degradation, which are widely discussed in the literature, particularly in the context of climate change, are:[88]

- improving market access
- increasing gender empowerment
- expanding access to rural advisory services
- strengthening land tenure security
- payments for ecosystem services[89]
- decentralising natural resource management – but only when done in a democratic way that does not further concentrate power in the hands of local elites
- investing in research and development
- investing in monitoring of desertification and desert storms
- developing modern renewable energy sources (especially those which replace fuelwood/biomass); and
- diversifying dryland economies – including by investing in irrigation and agricultural commercialisation and structural transformations.

***Beyond the IPCC:* Gender-related differences in vulnerability to climate change: Evidence from Latin American localities**

The Climate Resilient Cities in Latin America programme, a three-year action research programme managed by Fundación Futuro Latinoamericano with the support of CDKN and IDRC, investigated drivers of climate vulnerability and risk, and options for improved resilience in Latin American secondary cities.

Gender analysis found that women are particularly at risk of negative impacts from larger land degradation processes, whether due to direct human mismanagement or indirect degradation from climate change. Women's vulnerability arises from historic gender-based roles and discrimination.

In the Cumbaza River microbasin of Peru, rural women face difficulties in accessing scarce biomass for food preparation, which forces them to spend more time searching for firewood. On the other hand, the holders of rights of irrigated rice plots are mostly men, which reflects an issue of gender inequality in land ownership. The role of women in this activity is confined to salaried work as part of family groups that specialise in rice planting and harvesting under irrigation.[90]

Women heads of household in Chicolândia (Abaetetuba, Brazil) reported their difficulties in accessing food, and mentioned that their children frequently had only one meal a day or went a day without eating. This is directly related to the limited opportunities for formal or informal paid economic activities. Often, these women exchange care jobs for food with members of other families.[91]

Image: © SPDA | Peru.

7 The skills and knowledge of women and marginalised groups are not yet sufficiently recognised

"[The] collective action and agency of women, including widows, has led to the prevention of crop failure, reduced workload, increased nutritional intake, increased sustainable water management, diversified and increased income, and improved strategic planning."[92]

It is well recognised that people are differently affected by the impacts of climate change and by society's responses to climate change, and that women may be particularly affected. Women, indigenous people and other typically marginalised groups have vital knowledge and are demonstrating ingenuity in land management practices to adapt to climate change.

Most of the literature focuses on the greater vulnerability of women and other socially marginalised groups to the negative impacts of climate change. However, it is important not to fall into framing people as 'victims'. Narratives should recognise the real strengths and ingenuity of women, indigenous people and other marginalised groups, particularly in adapting to climate change. Also, it should be recognised that women often assume new leadership roles when adapting to already-felt impacts of climate change.

Image: © SPDA | Indigenous people working the land, Peru.

A broad approach to gender issues

There is insufficient research to date on how climate *mitigation* activities are empowering or disempowering women and affecting women's and girls' wellbeing. This is a priority area for further enquiry. For land-based climate mitigation, there is some evidence that these activities 'may interfere with traditional livelihoods in rural areas, cause conflicts, lead to a decline in women's livelihoods and reinforce existing inequities and social exclusions if elite capture is not prevented.'[93] These include cultivating biofuel crops, Reduced Emissions from Deforestation and forest Degradation and related forest conservation activities for financing on global markets (REDD+) and other policies such as developing large solar farms requiring large areas of land.

Although women's needs in a changing climate often call for special attention to ensure that climate policies and programmes are not designed for a 'man's world', it is useful to understand issues through the lens of gender more broadly. Gender approaches recognise that some climate change impacts and responses to climate change affect men and masculinity in ways that need to be better understood.

Despite known differences between women and men, land restoration and rehabilitation efforts have tended to be 'gender-blind'.[94]

Tackling inequality

Inequality is one of the greatest overall challenges in the context of land management and sustainable development in a changing climate. Effective and reliable social safety nets are required to address the impacts of climate change on the poorest. Social protection coverage is currently low, especially for poor rural people. Here, social protection refers to policies and programmes to decrease the poverty and vulnerability of targeted populations, such as state assistance for people who are pregnant, elderly, unemployed or suffering from long-term sickness or disability. There is a need to explore how local support institutions could be strengthened to extend social protection.[95]

"There is high agreement and medium evidence that one of the greatest challenges is posed by inequalities that influence local coping and adaptive capacity."[96]

People's diverse needs and talents

Intersectional approaches are growing in importance as a more nuanced way of looking at how climate policies and programmes affect the agency and wellbeing of different groups of people. This means looking at the many ways in which people could be vulnerable to climate change and are able to respond effectively – based not only on gender but also on income, age, ethnicity, (dis)ability and other social and physical attributes.

Women's and men's responses to climate change tend to be very context specific. For example, in some areas, climate change is expected to contribute to widespread shortages of freshwater. Where women are the primary natural resource managers and providers of food, they may be expected to collect water and fuelwood from increasingly remote areas. By contrast, men may migrate to nearby towns or other countries for better opportunities, leaving women behind with more responsibilities.[97]

These socially-defined, gender-specific roles are not static but shaped by factors such as wealth, age, ethnicity and formal education.[98] Effective climate change adaptation and mitigation strategies recognise and respond to people's differences, and consider how to build on people's strengths.

Image: © SPDA | Tilling land, Ecuador.

8 Integrated governance is needed to maximise the benefits of land and water

Integrated governance across sectors and scales is needed to manage the pressure on land and water, both to meet the requirements of people and biodiversity and relieve the increased pressures caused by climate change.

Integrated governance makes it more likely that the co-benefits of development and climate change adaptation/mitigation will be maximised.[99] Integrated governance is especially important at national, river basin and ecosystem levels.

There are gaps in the Sustainable Development Goals; for example, there is no goal to protect and restore freshwater ecosystems. Thus other frameworks need to be considered beyond the SDGs, such as the 'Nature's Contribution to People' approach used by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). Nature's Contribution to People is about the contributions, both positive and negative, of living nature – the diversity of organisms, ecosystems, and their ecological processes – to people's quality of life.[100]

A mix of coherent policies helps deliver sustainable development in the context of natural resource pressures and a changing climate. The importance of a mix of coherent policies is shown when farmers are helped to respond to drought. A mix of crop insurance, sustainable land management practices, bankruptcy and insolvency measures, co-management by communities for water and disaster planning, and water infrastructure programmes have proven effective when combined.

Similarly, a mix of coherent policies was found to be effective for responding to floods: flood zone mapping, land use planning, flood zone building restrictions, business and crop insurance, disaster assistance payments, preventative instruments such as soil and water management measures for farms and farm infrastructure projects, and bankruptcy measures to help farmers recover from debilitating economic losses.[101]

Adaptive, iterative decision-making is increasingly in use to explore synergies and trade-offs between goals and targets.[102] Adaptive approaches can help tackle the negative impacts of land use change and climate change. Adaptive management can halt species decline and habitat loss, help to manage competing land interests, manage land more sustainably, conserve biodiversity, increase carbon storage and improve livelihoods.

However, adaptive management is hard to achieve in practice, due to social uncertainties, donor preferences and shifting objectives. Boosting people's participation, using indicators effectively, and taking intentional steps to avoid 'maladaptation' are all important components of adaptive management. Maladaptation is a kind of unsustainable adaptation and policy incoherence.[103]

"Many sustainable development efforts fail because of lack of attention to societal issues including inequality, discrimination, social exclusion and marginalisation … citizen engagement is important in enhancing natural resource service delivery."[104]

Image: © SPDA | Peru.

***Beyond the IPCC:* An integrated watershed approach in the Cumbaza micro basin, Peru**[105]

The city of Tarapoto is one of the municipalities most affected by droughts and heavy rains in the Peruvian Amazon region. This is due to a lack of adequate planning, which has led the city to develop in high-risk areas such as the hillsides of the Cumbaza River. The river is constantly flooded when flow increases. In addition, high levels of environmental degradation affect the water services upon which urban and rural stakeholders in the micro-watershed depend. Between 1977 and 2005, forest cover in this area was reduced by 58% as a result of unsustainable agricultural practices, infrastructure development and urban growth, generating a reduction in the availability and quality of water resources. Climate change is exacerbating the situation.

A project called 'Climate Resilient Cumbaza' analysed the link between water, energy and food, making it possible for the first time to visualise and account for the interdependencies among these systems. The project recognised the complex relationships and competition among economic sectors, the biophysical environment, natural ecosystems and social arrangements (governance at the local and regional levels). These complex relationships affect decision-making processes in the face of a changing climate in the microbasin of the Cumbaza River.

Image: © SPDA | Peru.

In close collaboration with the regional and local government, private entities and civil society, the project:

- evaluated the complex interdependencies and risks in the demand, availability and management of resources among sectors and stakeholders of Tarapoto in the Cumbaza River microbasin, under different climate and development scenarios;
- promoted the development and adoption of consistent strategies, actions and measures at multiple scales (city, districts, provinces, basin) that can reinforce the integral management of resources and reduce vulnerability to climate change;
- expanded the participation and contribution to a mechanism based on the payment for water ecosystem services, to promote the funding of activities that favour resilient development to climate change. This values the role played by forest ecosystem services, on which different sectors and urban-rural stakeholders of the microbasin depend;
- trained and promoted knowledge regarding the concept of the water-energy-food link for integrated resource management and climate-resilient development, as a key factor to strengthen governance in the Cumbaza microbasin; and
- generated technical instruments such as a Methodological Manual for an analysis of the water-energy-food link in the Amazon basin, which will help to promote this approach and its replication in other basins of the region.

Image: © SPDA | Peru.

Image: © SPDA.

Beyond the IPCC: How could regional cooperation enhance Amazonian land and water management?

In Amazonia, sustainable land management and its relationship to climate change is now identified as an issue of profound human security. Regional leaders must work together across political boundaries to respect ecosystem dynamics in a changing climate, according to a study and dialogue process undertaken by Fundación Futuro Latinoamericano, CDKN and the Global Canopy Programme.

'Large-scale development in Amazonia has always resulted in large-scale deforestation,' narrates Yolanda Kakabadse, WWF President, in the documentary animation 'Amazonia Security Agenda'. 'Now, the whole system is under threat. In recent years, extreme droughts have demonstrated that Amazonia's water resources cannot be taken for granted. Scientists predict more frequent and intense droughts and floods, dramatic temperature rises and changing rainfall patterns.

'People across the region depend on the forest's irreplaceable ability to generate rain and moderate the climate. This is more than an environmental issue. It is a fundamental question of national prosperity and regional security. That is why leaders need to work together, keeping our dependence on Amazonia firmly in the foreground.'

In the Amazon region, analysts have called for a more coherent policy approach, which explicitly recognises the synergies and trade-offs among human needs for water, energy and food security, and which helps people manage land and water sustainably in a changing climate. Such approaches must be underpinned by robust, transparent data, including data on supply chains for the many agricultural commodities produced across the region.[106]

A study of pressures on Amazonia's land-based ecosystem and policy opportunities in Brazil, Colombia and Peru highlighted that:

- National development policies will need to recognise and account for the strategic importance of the Amazon biome and its environmental services, particularly water, in future energy and food security agendas.
- The reliance on water resources for biofuel production and hydropower generation, coupled with increasing demands by industry and urban centres, is a unifying factor across sectoral policies. This highlights the need to strengthen integrated water management agendas in Amazonia.
- Amazonia contains particular sub-regional dynamics and realities, in terms of infrastructure, access to technical assistance, credit and human capital. It therefore requires differentiated development models and tailored policy instruments.
- Granular zoning and land use plans can support policy implementation and direct opportunities for sustainable agricultural production, forest restoration and resource management in accordance with socio-ecological capacity.
- Improving supply chain transparency and monitoring systems is a critical step for identifying interdependencies among actors who have a shared interest and impact on productive landscapes in the region.
- Recent public-private commitments and financial pledges to tackle deforestation offer an opportunity for aligning current national development and climate plans, and for funding the implementation of these key policy instruments.
- In this context, efforts are needed to strengthen the inclusion of socio-environmental safeguards in public-private financing mechanisms to incentivise the transition to more sustainable practices and supply chains.
- Regional cooperation is necessary to reduce and reverse environmental degradation and address leakage across the Andean-Amazon-Cerrado ecosystems, and to support transnational watershed management.

9 Emissions reductions in other sectors are vital to relieve pressure on land

Land must be managed to provide food security as the world's population increases and to support other sustainable development goals. This means there are limits to the contribution of land to climate change mitigation by, for example, cultivating bioenergy crops and afforesting land to sequester carbon dioxide from the atmosphere. It also takes time for trees and soils to store carbon effectively.[107]

If bioenergy crops and trees were planted on a scale that delivered millions of gigatons per year of carbon sequestration, then land conversion would increase greatly. This could lead to adverse side effects for climate change adaptation, desertification, land degradation and food security.[108]

Without the widespread uptake of sustainable land management, the deployment of bioenergy crops and tree plantations at this scale could jeopardise the achievement of Sustainable Development Goals (SDGs) that depend on land-based ecosystem services.[109]

Bioenergy and afforestation need to be carefully managed to avoid these risks. Desirable outcomes will depend on locally appropriate policies and governance systems.[110]

Lowering greenhouse gas emissions in other sectors and areas of human behaviour can ease the pressure on land.[111]

"Land cannot do it all."[112]

Image: © SPDA | Peru.

Conclusion

In summary, if we care for the land, it will care for us. If we nurture healthy soils and productive and diverse ecosystems, the land can more effectively regulate the local, regional and global climate. It is possible to manage land responsibly to provide food, fibre, fuel and the other benefits that sustain human resilience and wellbeing directly.

However, sustainable land management needs to happen in the context of cross-cutting policies and governance that relieve pressure on the land and enable human society to pursue its range of vital development goals in less 'land hungry' ways.

Image: © SPDA | Peru.

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Image: © SPDA | Peru.

Glossary

Adaptive capacity: The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences.[113]

Afforestation: Conversion to forest of land that historically has not contained forests.[114]

Agroforestry: Land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately used on the same land management units as agricultural crops and/or animals, in some form of spatial arrangement or timed sequence. In agroforestry systems there are both ecological and economical interactions among the different components.[115]

Albedo: The proportion of sunlight (solar radiation) reflected by a surface or object, often expressed as a percentage. Clouds, snow and ice usually have high albedo; soil surfaces cover the albedo range from high to low; vegetation in the dry season and/or in arid zones can have high albedo, whereas photosynthetically active vegetation and the ocean have low albedo. The Earth's planetary albedo changes mainly through varying cloudiness, snow, ice, leaf area and land cover changes.[116]

Aridity: A long-term climatic feature whereby there is low average rainfall or available water in a region.[117]

Biochar: Relatively stable, carbon-rich material produced by heating biomass in an oxygen-limited environment. Biochar is distinguished from charcoal by its application: biochar is added to soil with the aim of improving soil functions and to reduce greenhouse gas emissions from biomass that would otherwise decompose rapidly.[118]

Bioenergy: Energy derived from any form of biomass (organic matter) or its metabolic by-products.[119]

Bioenergy with carbon dioxide capture and storage (BECCS): Carbon dioxide capture and storage (CCS) technology applied to a bioenergy facility. CCS is when carbon dioxide (CO_2) from industrial and energy-related sources is separated, conditioned, compressed and transported to a storage location to be isolated from the atmosphere.[120]

Biofuel: A fuel, generally in liquid form, produced from biomass. Biofuels include bioethanol from sugarcane, sugar beet or maize, and biodiesel from the oil of canola, jatropha or soybeans.

Carbon dioxide (CO_2) fertilisation: This is an effect whereby increased CO_2 levels encourage photosynthesis and plant growth. However, this phenomenon does not necessarily enrich land-based ecosystems (it may contribute to the growth of scrub vegetation) and overall, CO_2 fertilisation tends to decrease the nutritional content of crops.[121]

Confidence: The robustness of a finding based on the type, amount, quality and consistency of evidence and on the degree of agreement across multiple lines of evidence. In this report, confidence is expressed qualitatively.[122]

Deforestation: Conversion of forest to non-forest.[123]

Desertification: Land degradation in arid, semi-arid, and dry sub-humid areas resulting from many factors, including climatic variations and human activities.[124]

Drought: A period of abnormally dry weather long enough to cause a serious hydrological imbalance.[125]

Ecosystem: A functional unit consisting of living organisms, their non-living environment and the interactions within and between them. Ecosystem boundaries can change over time.

Ecosystem services: Ecological processes or functions having monetary or non-monetary value to individuals or society at large. These are frequently classified as (1) supporting services such as productivity or biodiversity maintenance, (2) provisioning services such as food or fibre, (3) regulating services such as climate regulation or carbon sequestration, and (4) cultural services such as tourism or spiritual and aesthetic appreciation.[126]

Evapotranspiration: The combined processes through which water is transferred to the atmosphere from open water and ice surfaces, bare soil and vegetation that make up the Earth's surface.[127]

Food security: The situation when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.[128]

Global warming: An increase in global mean surface temperature (GMST) averaged over a 30-year period, or the 30-year period centred on a particular year or decade, expressed relative to pre-industrial levels unless otherwise specified.[129]

Greenhouse gases (GHG): Gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation and cause the greenhouse effect. Water vapour (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and ozone (O_3) are the primary greenhouse gases in the Earth's atmosphere. Moreover, there are a number of entirely human-made greenhouse gases in the atmosphere, such as the halocarbons and other chlorine- and bromine-containing substances, dealt with under the Montreal Protocol. Beside CO_2, N_2O and CH_4, the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC) deals with the greenhouse gases sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs).

Land cover: The biophysical coverage of land (e.g. bare soil, rocks, forests, buildings and roads or lakes). Land cover is often categorised in broad land-cover classes (e.g. deciduous forest, coniferous forest, mixed forest, grassland, bare ground).[130]

Land degradation: This is defined in the IPCC's Special Report on Climate Change and Land as a 'negative trend in land condition, caused by direct or indirect human-induced processes including anthropogenic climate change, expressed as long-term reduction or loss of at least one of the following: biological productivity, ecological integrity or value to humans.' In this definition, land degradation applies to all lands, including forested lands, and not only drylands.[131]

Land restoration: Aiding the recovery of land from a degraded state.[132]

Nationally Determined Contributions (NDCs): A term used under the United Nations Framework Convention on Climate Change (UNFCCC) whereby a country that has joined the Paris Agreement outlines its plans for reducing its emissions. Some countries' NDCs also address how they will adapt to climate change impacts, and what support they need from, or will provide to, other countries to adopt low-carbon pathways and to build climate resilience.[133]

Paris Agreement: The Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC) was adopted on December 2015 in Paris, France by 196 parties to the UNFCCC. As of September 2019, 185 parties have ratified the agremeent.[134] One of the goals of the Paris Agreement is 'holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels'. The Paris Agreement is due to go into force in 2020.

Peatlands: Peatland is a land where soils are dominated by peat.[135]

Primary production: The synthesis of organic compounds by plants and microbes, on land or in the ocean, primarily by photosynthesis using light and carbon dioxide as sources of energy and carbon.[136]

Productivity: In ecology, productivity refers to the rate at which biomass is generated in an ecosystem, e.g. the mass of carbon generated, in number of grams per metre per day.[137]

Resilience: The ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including by ensuring the preservation, restoration, or improvement of its essential basic structures and functions.[138] Resilience is also defined as the capacity of interconnected social, economic and ecological systems to cope with a hazardous event, trend or disturbance.[139] A 'resilience threshold' is passed when the basic structures and functions can no longer be preserved, restored or improved.

Sink: Any process, activity or mechanism which removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas from the atmosphere.[140]

Source: Any process or activity which releases a greenhouse gas, an aerosol or a precursor of a greenhouse gas into the atmosphere.[141]

Sustainable intensification (of agriculture): Increasing yields from the same area of land while decreasing negative environmental impacts of agricultural production and increasing the provision of environmental services. [Note: this definition is based on the concept of meeting demand from a finite land area, but it is scale-dependent. Sustainable intensification at a given scale (e.g. global or national) may require a decrease in production intensity at smaller scales and in particular places (often associated with previous, unsustainable intensification) to achieve sustainability.][142]

Sustainable land management: The stewardship and use of land resources, including soils, water, animals and plants, to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions.[143]

Vegetation structure: Communities of species (in this case, plant species) and how they interact with each other in a particular area or habitat.[144]

Image: © SPDA | Burnted-out forest, Colombia.

Endnotes

1 Summary for Policy Makers, A1.5.
2 Chapter 2, Figure 2.1; p2-12. This figure is slightly modified from the version in the IPCC's Box 2.1 in the *Special Report on Climate Change and Land* (the terms are spelled out in full for ease of reading).
3 Glossary, IPCC *Special Report on Climate Change and Land*; and Joyce Kimutai, personal communication (September 2019).
4 Definition of carbonaceous aerosols from NASA: https://www.nasa.gov/topics/earth/features/cares-cali.html (accessed 20 September 2019).
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32 Summary for Policy Makers, Section A.5.
33 Chapter 5, p5-25.
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38 Source: Van der Esch et al. (2017). *Exploring future changes in land use and land condition and the impacts on food, water, climate change and biodiversity. Scenarios for the UNCCD Global Land Outlook*. The Hague: PBL Netherlands Environmental Assessment Agency.
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50 Chapter 4, Executive Summary, and Summary for Policy Makers, p17.
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53 Chapter 3, p3-44.
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61 Chapter 4, p4-60.
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