The IPCC's Special Report on Climate Change and Land

What's in it for South Asia?

Climate & Development Knowledge Network

Image: © Neil Palmer, CIAT, Flickr | Growing beans, Western Nepal.

Cover image: © Shutterstock | Woman with soya crop, India.

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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 South Asia
3. Land degradation, including desertification, has implications for livelihoods and food security in South Asia
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

This publication offers a guide to the IPCC's *Special Report on Climate Change and Land* prepared for decision makers in South Asia by the Climate and Development Knowledge Network (CDKN), Overseas Development Institute (ODI), ICLEI-South Asia 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 South Asia 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, the expert research team has benefited from review by IPCC lead authors and other expert reviewers to ensure fidelity to the original report (see *Acknowledgements*).

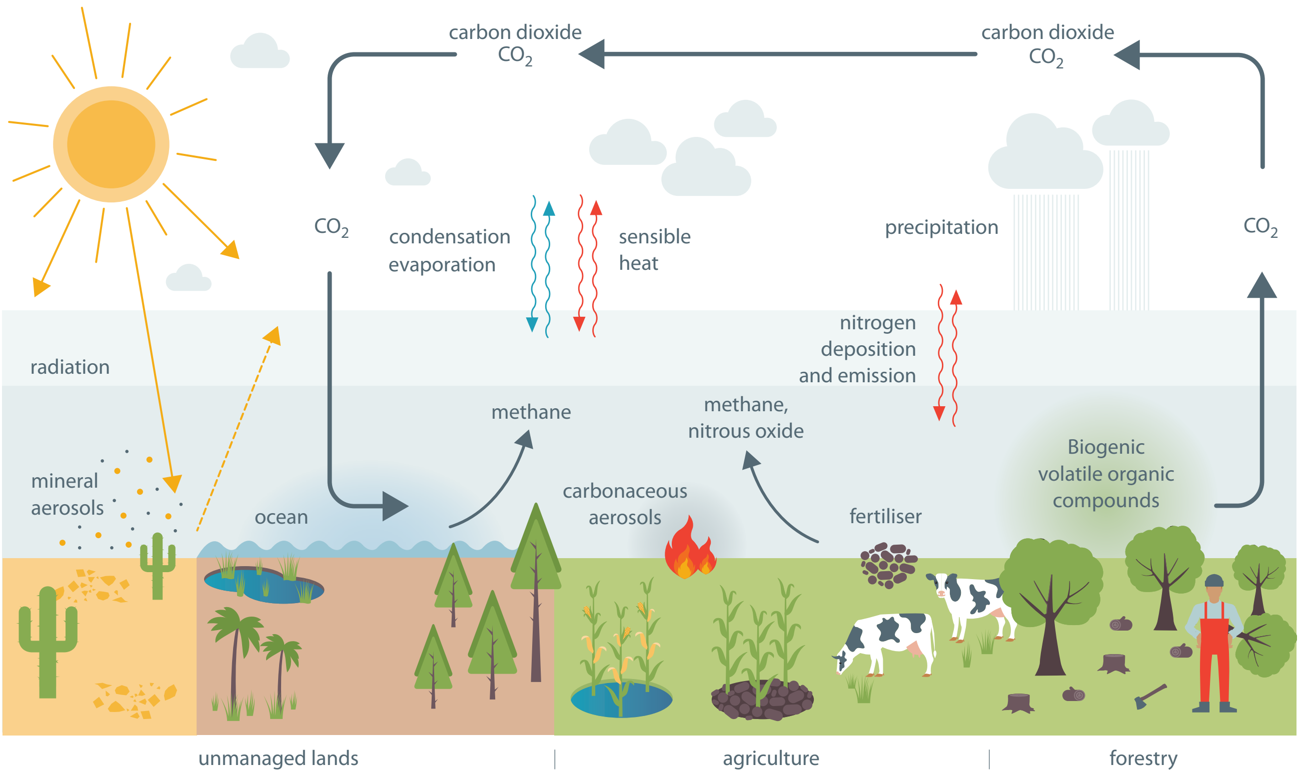
We have extracted the South Asia-specific data, trends and analysis directly from the *Special Report on Climate Change and Land* for this guide. In a few places, we have included supplementary material from recently published research that extends and explains the points made in the IPCC's *Special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

For example, climate change in recent decades has led to shifts in the range and location of many plant and animal species and shifts in the timing of their 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 the Asian monsoon region, China and Pakistan.[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 and particularly over China and India. This is due both to direct activities such as land use and management and forest conservation and also to indirect factors linked to human activity such as CO_2 fertilisation, extended growing seasons and global warming.[12]

In many places, increased climate change will contribute to more drought and heat waves, which will cause 'browning', which means less photosynthesis by plants in the affected areas. Because of this, there is low scientific confidence about future trends in greening and browning.

"Land changes influence regional climates."[13]

Box 2: The IPCC's confidence levels

This matrix helps explain what the IPCC means by high, medium or low confidence.[14]

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 magnitude. 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.[15]

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)

higher
lower
Confidence Scale

Image: © Neil Palmer, CIAT, Flickr | Climate-smart village in Nepal.

"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)."[16]

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. The land conditions which influence the 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.

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 climate.[18]

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.[19]

Unsustainable land management contributes to global warming

Human over-exploitation is depleting land resources.[20] Globally, 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.[21] Climate change adds to these stresses 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. Agriculture, forestry and other types of land use account for 23% of human greenhouse gas emissions. It does not have to be this way.

At the same time, natural land processes absorb carbon dioxide equivalent to almost a third of carbon dioxide emissions from fossil fuels and industry.[22]

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.[23]

Climate change reduces the productivity of land

Since pre-industrial times, the air temperature over the land's surface has risen by 1.5°C, compared to a 1°C average rise over land and oceans together.[24]

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.[25]

Global warming is already decreasing crop productivity and disrupting food systems in South Asia. For example, climate change reduced wheat yields in India by 5.2% between 1981–2009, despite adaptation efforts.[26]

Agriculture in Pakistan has also been affected by climate change. From 1980 to 2014, spring maize growing periods shifted earlier by an average of 4.6 days per decade and sowing of autumn maize was delayed by three days per decade due to climatic conditions.[27]

"Planting trees will always result in capturing more atmospheric CO_2 and thus in annual mean cooling of the globe."[28]

Furthermore, many coastal deltas are shrinking. Dams and overuse of water in upstream areas, and the subsidence of land due to groundwater or natural gas extraction and aquaculture, are causing this shrinkage.[29] Coastal areas are densely populated, particularly in Asia (Bangladesh, China, India, Indonesia, Vietnam). As a consequence, hundreds of millions of people are becoming exposed to these forms of land loss and degradation. Sea level rise is expected to increase coastal erosion dramatically. In some areas, the increasing intensity of cyclones will exacerbate coastal erosion.[30]

The increasing impacts of climate change on land are predicted under all future greenhouse gas scenarios.[31] Figure 2 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.

At around 1.5°C of average global warming, the global level of 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 risk 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.[32]

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 2: Risks to humans and ecosystems from every 1°C of average global warming[33]

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.

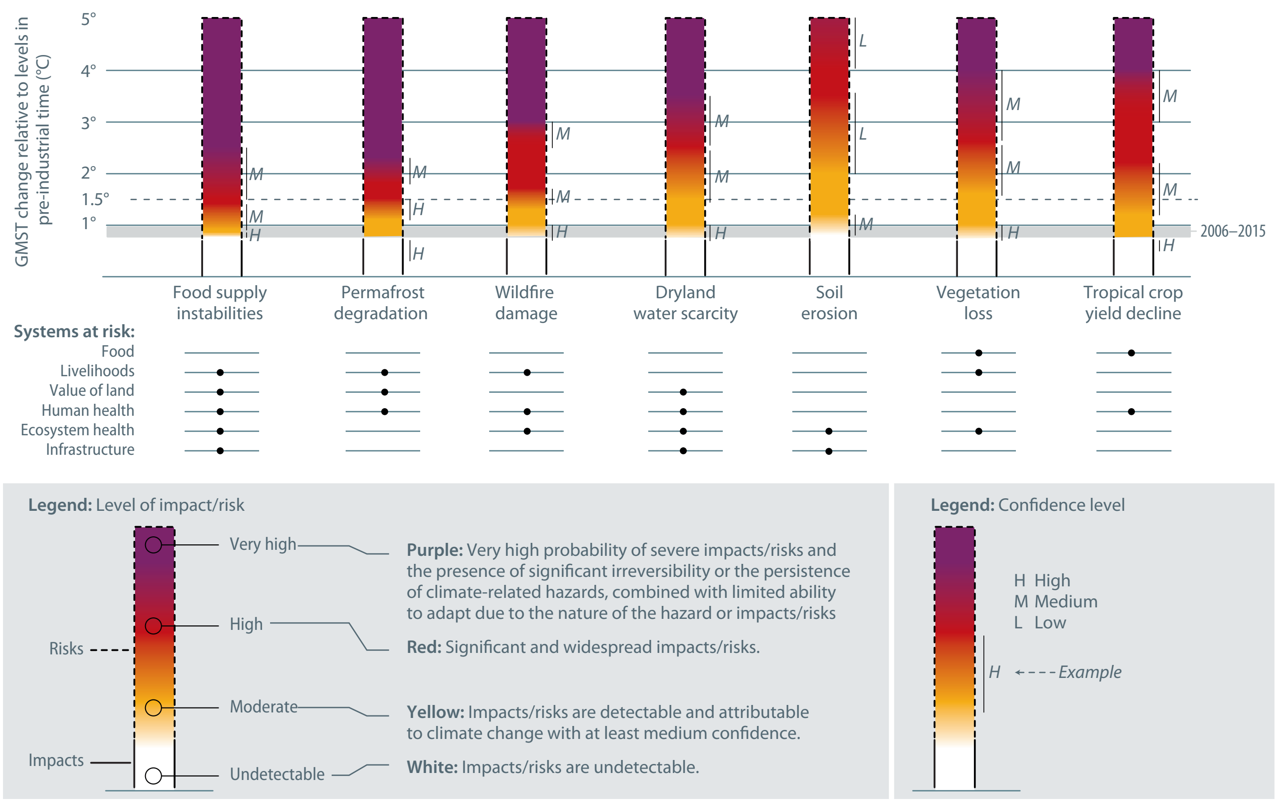
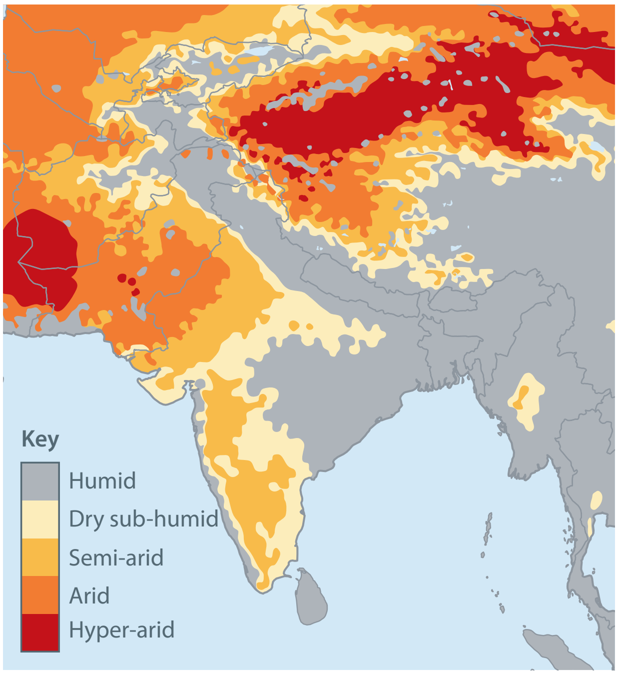
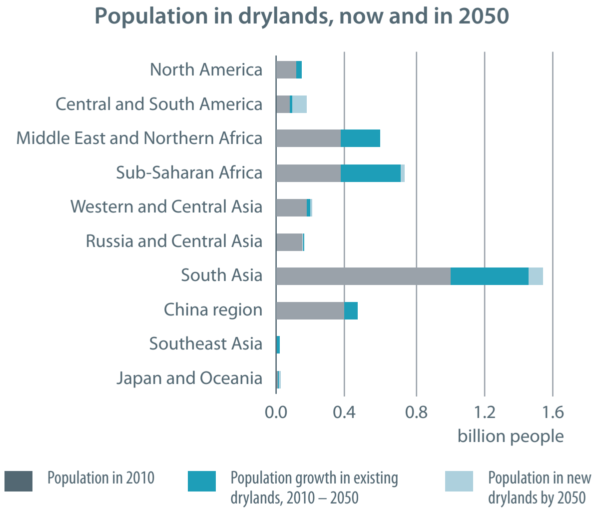


Image: © Neil Palmer, CIAT | Making green manure, India.

2 Dryland areas are expected to become more vulnerable to desertification in South Asia

FIGURE 3: Map of drylands in South Asia





The above represents a middle-of-the-road climate change and socioeconomic development scenario, called the SSP2 scenario, which assumes a continuation of current trends in population, economic development and technology

TABLE 1: Increasing population and water stress in South Asia[34]

Indicator	2010	Change, 2010 – 2050
Population	1.64 billion	+46%
Dryland population	1.01 billion	+53%
Water stress (including from low to high levels)	1.53 billion people exposed	+46%

The above represents a middle-of-the-road climate change and socioeconomic development scenario, called the SSP2 scenario, which assumes a continuation of current trends in population, economic development and technology.

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.[35]

"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)".[36]

Image: © Prashant Panjiar, Flickr | VDC President, Dudha Ram Choudhary (white turban and scarf), conducts a meeting at his home, Rajasthan, India.

Desertification is the term for land degradation in drylands (see Box 3). 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.[37]

South Asia is already substantially affected by desertification:

- Desertification currently affects 38 of 48 countries in Asia.[38]
- The changes in drylands in Asia from 1982–2011 were mixed – some areas experienced vegetation improvement while others showed reduced vegetation.[39]
- Desertification is a major problem in Pakistan, from both climatic and direct human-made causes.[40]
- Desertification also affects India. Satellite mapping shows that 81.4 million hectares are suffering from various processes of desertification in India.[41]
- Salinisation is a major concern across the drylands in Asia as it impacts both food and water security and is highly likely to be exacerbated by climate change.
- Examples of major river basins undergoing salinisation include the Indo-Gangetic basin in India, the Indus basin in Pakistan and the Aral Sea basin of Central Asia. Some 7 million hectares of land in India are subject to salinisation.[42]

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.[43] The number of dryland inhabitants exposed to water stress, more intense drought and habitat degradation would reach over one billion globally under a 'middle of the road' socioeconomic pathway consistent with 2°C or more of global warming.[44] (Here, a 'middle of the road' pathway means some reduction in greenhouse gas emissions and limiting of global warming and some adoption of sustainability policies.) Around half of the vulnerable population is in South Asia, followed by Central Asia, West Africa and East Asia.[45]

3 Land degradation, including desertification, has implications for livelihoods and food security in South Asia

"Desertification processes, coupled with climate change, are expected to cause reduction in crop and livestock productivity (high confidence)."[46]

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.[47]

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 contributes – 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.[48]

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.[49]

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 18% in South Asia by 2046–2055 compared with 1996–2005. A separate meta-analysis suggests a similar order of reduction in yields in Asia due to climate change by 2050.[50]

Image: © WorldFish, Flickr | Fish rearing and poultry farming, Bangladesh.

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.

Models show that poverty rates will increase by about one third among urban households and non-agricultural self-employed workers in Bangladesh under climate change, because these households will have to pay higher prices for agricultural goods.[51]

“There is high evidence and high agreement that both climate change and land degradation can affect livelihoods and poverty through their threat multiplier effect.”[52]

Desertification has implications for development in South Asia

Desertification processes overall (caused by a combination of unsustainable land management and climate change) are driving losses in agricultural productivity and incomes in drylands.[53] Local and national studies show how desertification is already causing farmers to suffer losses in income and wellbeing.

Image: © Australian Department of Foreign Affairs | Labourers, Rajasthan

In South Asia, 12% of the total population lives in extreme poverty, with an increasing concentration of poverty in the dryland areas.[54] Contributing to poverty in the dryland areas are rapid population growth, weak institutions, lack of infrastructure, geographic isolation, low market access, insecure land tenure and low agricultural productivity.[55]

Desertification can also cause direct harm to human health. Dust storms are becoming more frequent and intense due to land use changes and climate change. This is causing a heavy toll on people’s wellbeing, not only in the directly affected areas but also further afield.

Dust storms transport particulates, pollutants, pathogens and potential allergens over long distances. In the countries of the Sahara region, Middle East, South Asia and East Asia, dust storms are suggested as being behind 15–50% of all cardiopulmonary deaths. Much more research is needed on the human impacts of dust storms and what can be done to reduce harm and suffering.[56]

Beyond the IPCC: Climate change in semi-arid regions is changing people’s livelihood strategies

Home to millions of people, the semi-arid regions of India are particularly vulnerable to climatic and non-climatic impacts and risks. To adapt to these dynamic and challenging environments, people may shift or diversify their livelihoods. The Adaptation at Scale in Semi-Arid Regions (ASSAR) project found that doing so can affect people in both positive and negative ways.[57]

Women are not necessarily victims or powerless; they often diversify their livelihoods. Sometimes this can enhance their position in terms of economic contributions and social status. Women’s increased exposure to information and new networks as a result of working outside the home and having new sources of income may at times increase their control over their own lives, and their voices. However, in many cases, men remain in charge of how income is used.

Livelihood diversification sometimes leads to people feeling overwhelmed and stretched for time, so their wellbeing and resilience suffer. Workloads have increased for both men and women in the areas studied by ASSAR in India.

Furthermore, women and men sometimes choose risky livelihoods out of desperation. This impacts negatively on their long-term health and safety, including such onerous and unsafe work as brick kiln labour and sex work.

In conclusion, livelihood diversification is often promoted as an adaptation and risk management strategy, yet *what people diversify into* is critical.

To counter any negative outcomes, regulated labour laws, improved infrastructure, improved social protection and the provision of safety nets should accompany livelihood diversification.[58]

Image: © Prashant Panjiar, Flickr | Women water plants, Rajasthan, India.

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.[59] The IPCC's Special Report discusses promising approaches for halting land degradation and restoring land (this section). The IPCC has also assesses a range of measures for their ability to restore land, combat desertification and achieve other development goals such as food security. (See Section 5.)

"Delayed action on land degradation increases costs and can lead to irreversible biophysical and human impacts."[60]

Approaches to reversing land degradation

Implementing sustainable land management practices 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 and zero tillage, and improving grazing management.

Agroforestry is scientifically proven to have important land restoration benefits, but uptake by farmers is often slow. Experience in India shows a difference between rich and poor households in the adoption of agroforestry. One study over many years in South India found that overall only 18% of the households who had been actively encouraged to adopt agroforestry actually did so. However, among the relatively rich households who adopted agroforestry, 97% of them were still practising it six to eight years later, and some had expanded their operations. [63]

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

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 in South Asia. One third of traditional woodfuels globally are harvested unsustainably. Reducing people's reliance on traditional biomass in developing countries 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.[64]

Approaches for combatting desertification and erosion in drylands

Many dryland households and communities are already responding to land degradation in drylands, i.e. desertification (see, for example, the box on page 13). However, the big picture is that population pressure and climate change are already pushing people beyond their 'resilience thresholds' (see Glossary, page 32), requiring new technologies and policies to help people adapt successfully.[65]

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."[66]

Increasing population pressures combined with climate change are likely to push dryland populations beyond their abilities to adapt, requiring policy interventions to strengthen their resilience and adaptive capacities.[67]

The IPCC has identified that the following technologies play a role in combatting desertification today, and have the potential to tackle future desertification in a changing climate:

- integrated crop-soil-water management
- grazing and fire management in drylands
- clearance of bush encroachment
- rainwater harvesting
- incentivising sustainable land management and restoration
- planting salt-tolerant crops to revegetate salinised lands.

These include specific measures to combat soil erosion, (see page 16) and integrated water resource management approaches, which are considered important in restoring land-based ecosystems.

"Using indigenous and local knowledge for combating desertification could contribute to climate change adaptation strategies."[68]

Indigenous and local knowledge has enabled dryland residents to cope with climate variability historically. This indigenous knowledge, coupled with scientific innovation, can prevent and reduce desertification and contribute to climate adaptation and mitigation.[69] The case study in Box 4, below, provides an example of this.

Image: © Mokhamad Edliadi/CIFOR, Flickr | Land manager, Nalma, Lamjung, Nepal.

Box 4: Salt-tolerant plants in Pakistan

In Pakistan, over 6 million hectares of land have been affected by salinisation. Pioneering work has been done to use salt-tolerant plants to revegetate saline lands, dating back to the 1970s.

A range of local and exotic plant varieties were initially screened for salt tolerance in lab- and greenhouse-based studies, and then planted in saline areas. These included trees, forage plants and species of cotton, wheat, barley and fruit crops, including a form of date palm, all of which have a high salt tolerance. These have been cultivated successfully.

In India, tree species have also been used effectively to revegetate saline lands, and in some cases, used as biofuel crops. In all of the above cases, the most productive species often have yields equivalent to conventional crops, at salinity levels matching even that of sea water.[70]

Beyond the IPCC: Lessons in climate smart agriculture from Nepal[71]

There is an urgent need for climate-smart agriculture in Nepal. The negative effects of climate change – mainly drought, intense rainfall and rising temperatures – have affected the livelihoods of 60% of the population, since so many are engaged in agriculture.

Socially, women face inequalities in decision-making power, as well as poor access to resources and information that could help to bolster their resilience against climate-induced shocks and stresses. a male exodus of migrants seeking foreign employment has aggravated the situation. This is why a gender-responsive approach to climate-compatible development is vital.

Funded by CDKN, the 'Scaling up of climate-smart agriculture in Nepal' project sought to increase the resilience of farming communities in three distinct agro-ecological zones: Terai (low plains of Nepal), mid-hills and high hills.

Specifically, the project set out to identify relevant climate-smart agricultural technologies and practices that could simultaneously:

- sustain crop productivity;
- promote adaptaton to climate change; and
- foster energy efficiency and carbon sequestration

… and so enhance food security, climate resilience and climate change mitigation.

The project succeeded in identifying measures that delivered results across all of these criteria, but the solutions were highly specific to each local context. The project found that a technology that is acceptable

Image: © LI-BIRD | Farmers harvested crops after solar irrigation, Nepal.

to one community may not be accepted by another. For example, in Nawalparasi, a group of Tharu (indigenous) farmers showed an interest in combined rice and duck farming. Benefits include increased rice production, a reduced need for manure, reduced weeding for women and widely appreciated duck meat. However, Tharu farmers from another village did not embrace this combination, partly due to the risk of predation by foxes and jackals. The approach could work if farmers improved their knowledge and skill in dealing with human-wildlife conflict.

The project's 'success factors' for achieving climate-resilient rural development included:

- **Work with women farmers** to understand how new climate-smart agriculture technologies can deliver multiple development and wellbeing benefits. For example, this project has identified site-specific solutions that reduce women's workloads while delivering climate and sustainability benefits.
- **Design climate-smart agriculture interventions using socially disaggregated** vulnerability assessments which articulate the local context and climate risks. For example, work with targeted groups of female and male farmers from lower-caste and ethnic minority groups.
- **Integrate climate-smart agriculture** into the government's regular programme of agricultural development (province and municipal level) and increase coordination. Climate-smart agriculture has a better chance of success when different stakeholders match and apply leverage to share and obtain each other's resources. These can include the private sector, government exension offices and non-governmental organisations.
- **Pilot and promote packages of climate-smart agriculture measures in a portfolio approach**. This yields better results than in isolation and also helps to sustain outcomes.
- **Engage women political leaders** in the process. [72]

Specific measures to combat soil erosion

Soil erosion is a major form of desertification occurring in varying degrees in all dryland areas across the world, with negative effects on dryland ecosystems. 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.[73]

In South Asia, the economic and social impacts of erosion on major infrastructure is well documented. The Warsak dam in Pakistan, built in Khyber Pakhtunkhwa province on the Kabul River in 1960, was completely filled with sediment in three years. The lifespan of two other major dams, Tarbela and Mangla, was reduced by more than ten years as a result of erosion and sedimentation.[74]

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 improvement in 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.[75]

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 2 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 for 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).[76]

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.[77]

Image: © Prashant Panjiar, Flickr | Manibai with other village women, Rajasthan, India.

TABLE 2: Actions that minimise pressure on land

The 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, and explains the positive and potential negative impacts of each measure, with best practices for how to manage downside risks.

Co-benefits and adverse side effects of the different actions are shown quantitatively, based on the *high end* of their potential – as assessed by IPCC scientists. The 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 page 5 for an explanation of scientific confidence.)

Response options based on land management

		Mitigation	Adaptation	Desertification	Land Degradation	Food Security	Cost
Agriculture	Increased food productivity	*L*	*M*	*L*	*M*	*H*	—
	Agro-forestry	*M*	*M*	*M*	*M*	*L*	●
	Improved cropland management	*M*	*L*	*L*	*L*	*L*	●●
	Improved livestock management	*M*	*L*	*L*	*L*	*L*	●●●
	Agricultural diversification	*L*	*L*	*L*	*M*	*L*	●
	Improved grazing land management	*M*	*L*	*L*	*L*	*L*	—
	Integrated water management	*L*	*L*	*L*	*L*	*L*	●●
	Reduced grassland conversion to cropland	*L*	—	*L*	*L*	– *L*	●
Forests	Forest management	*M*	*L*	*L*	*L*	*L*	●●
	Reduced deforestation and forest degradation	*H*	*L*	*L*	*L*	*L*	●●
Soils	Increased soil organic carbon content	*H*	*L*	*M*	*M*	*L*	●●
	Reduced soil erosion	⟷ *L*	*L*	*M*	*M*	*L*	●●
	Reduced soil salinisation	—	*L*	*L*	*L*	*L*	●●
	Reduced soil compaction	—	*L*	—	*L*	*L*	●
Other ecosystems	Fire management	*M*	*M*	*M*	*M*	*L*	●
	Reduced landslides and natural hazards	*L*	*L*	*L*	*L*	*L*	—
	Reduced pollution including acidification	⟷ *M*	*M*	*L*	*L*	*L*	—
	Restoration & reduced conversion of coastal wetlands	*M*	*L*	*M*	*M*	⟷ *L*	—
	Restoration & reduced conversion of peatlands	*M*	—	na	*M*	– *L*	●

Response options based on value chain management

		Mitigation	Adaptation	Desertification	Land Degradation	Food Security	Cost
Demand	Reduced post-harvest losses	*H*	*M*	*L*	*L*	*H*	—
	Dietary change	*H*	—	*L*	*H*	*H*	—
	Reduced food waste (consumer or retailer)	*H*	—	*L*	*M*	*M*	—
Supply	Sustainable sourcing	—	*L*	—	*L*	*L*	—
	Improved food processing and retailing	*L*	*L*	—	—	*L*	—
	Improved energy use in food systems	*L*	*L*	—	—	*L*	—

Response options based on risk management

		Mitigation	Adaptation	Desertification	Land Degradation	Food Security	Cost
Risk	Livelihood diversification	—	*L*	—	*L*	*L*	—
	Management of urban sprawl	—	*L*	*L*	*M*	*L*	—
	Risk sharing instruments	⟷ *L*	*L*	—	⟷ *L*	*L*	●●

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
	Moderate	0.3 to 3	1 to 25	0.5 to 3	0.5 to 3	1 to 100
	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
	– Moderate	–0.3 to –3	1 to 25	0.5 to 3	0.5 to 3	1 to 100
	– 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

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

Some of the measures 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 (see Table 3) 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 3: Climate actions that increase competition for land – and 'best practices' that can reduce the pressure

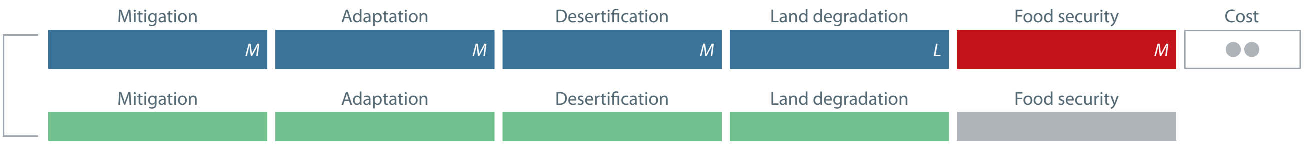
Bioenergy and Bioenergy with Carbon Capture and Storage (BECCS)

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

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



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

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.

Box 5: Integrated soil-water-crop management helps South Asian farms adapt to climate change

Farmers' ability to adapt to climate change is strongly influenced by the underlying health and stability of soils as well as improvements in crop varieties, irrigation efficiency and supplemental irrigation, e.g. through rainwater harvesting. Desertification often leads to a reduction in ground cover that in turn results in accelerated erosion by water and wind and an associated loss of fertile topsoil that can greatly reduce the resilience of agriculture to climate change.

Even a minimal cover of crop residue can substantially decrease wind erosion. Drip irrigation methods are also found to be very effective. Compared to conventional (flood or furrow) irrigation, drip irrigation methods are more efficient in supplying water to the plant root zone, resulting in lower water requirements and enhanced water use efficiency. For example, in the rainfed area of Fetehjang, Pakistan, the adoption of drip methods reduced water usage by 67–68% in the production of tomato, cucumber and bell peppers. In India, drip irrigation reduced the amount of water consumed in the production of sugarcane by 44%, grapes by 37%, bananas by 29% and cotton by 45%, while enhancing the yields by up to 29%.[78]

Box 6: Watershed scale management efforts show potential for improvement

The Green Revolution that transformed irrigated agriculture in India had little effect on agricultural productivity in the rain-fed and semi-arid regions, where land degradation and drought were serious concerns. In response to this challenge, integrated watershed management (IWM) projects have been implemented over large areas in semi-arid biomes over the past few decades. IWM was meant to become a key factor in meeting a range of social development goals in many semi-arid rain-fed agrarian landscapes in India.[79]

Some reports indicate significant improvements in the mitigation of drought impacts, raising crop, fodder and livestock productivity, expanding the availability of drinking water and increasing incomes as a result of IWM. However, the positive impact of the programme has been questioned and, except in a few cases, overall performance has not lived up to expectations. Rigorous comparisons of catchments with and without IWM projects have shown no significant enhancement of biomass.

The factors contributing to the successful cases were found to include effective participation of stakeholders in management. The difficulties in measuring and attributing success are partly due to a lack of rainfall monitoring and catchment hydrological indicators.

Social and economic trade-offs included a bias of benefits to downstream crop producers at the expense of pastoralists, women and upstream communities. This biased distribution of IWM benefits could potentially be addressed by compensation for environmental services between communities.

The successes in some areas has also led to increased demand for water, especially groundwater, since there was no corresponding social regulation of water use. Policies and management did not ensure water allocation to sectors with the highest social and economic benefits.

Furthermore, watershed projects are known to have increased expectations for irrigation water and overall water demand – thereby worsening water scarcity.

In summary, the poor overall performance of IWM projects has been linked to several factors, including: inequity in the distribution of benefits, a focus on institutional aspects rather than appropriate functional techniques to restore watersheds, a mismatch between scales of focus and those that are optimal for catchment processes, and sometimes inefficiencies of local non-governmental organisations.

Policies to improve IWM schemes would include:

- a greater emphasis on ecological restoration than on civil engineering;
- sharper focus on sustainability of livelihoods rather than on just conservation;
- the adoption of a water justice as an explicit goal;
- rigorous independent biophysical monitoring with feedback mechanisms; and
- integration with larger schemes for food and ecological security and maintenance of environmental flows for downstream areas.

The success of IWM schemes in the future would depend on several factors: how such schemes adapt and respond to the dynamics of large-scale land use and hydrology in a changing climate; how strongly livelihoods and rural incomes are linked with ecological restoration; the ability to regulate groundwater use; and an appropriate response to the fact that the aspirations of rural populations are changing.

"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)."[80]

Beyond the IPCC: Value Chain Analysis for Resilience in Drylands in Pakistan, VC-ARID

A three-step, innovative methodology called Value Chain Analysis for Resilience in Drylands (VC-ARID) was developed by the Pathways to Resilience in Semi-arid Economies (PRISE) Project. It enabled researchers, farmers, agricultural processors and businesses to work together to identify climate risks and adaptation options that are also opportunities for private sector development.

VC-ARID focussed on key value chains in semi-arid lands, selected for their importance for economic development that is resilient in a changing climate. The VC-ARID methodology has three principal steps:

- **Step one:** Mapping the value chain, explicitly considering seasonality, gender and informality.
- **Step two:** Assessing climate risks at each level of the value chain.
- **Step three:** Identifying adaptation and private sector investment options for climate-resilient value chain transformation.

Image: © Shutterstock | Cotton crop, Pakistan.

VC-ARID was applied to Pakistan's cotton value chain because cotton production and textiles were identified as two of the most resilient sectors in the semi-arid area of Pakistan and for the national economy. However, cotton production in Pakistan has suffered huge losses due to climate extremes in the past 35 years – from the cotton farmers, to the spinners, weavers and textile producers.[81]

The research found that climate change vulnerability is experienced differently by large and small producers along the value chain. For example, 'large textile manufacturing units are more resilient to climate change … due to a high reliance on imports, whereas small cottage industries suffer more because they solely rely on domestic cotton' which has been more affected by climate and weather extremes.

What is more, there is a disconnect between cotton farmers and actors higher up the value chain. Policy analysis reveals that the textile sector is better protected, whereas the cotton production sector faces a 'comparatively less supportive policy regime.'[82]

Cotton farmers are generally well aware of the direct climate risks facing their production. When researchers asked cotton farmers whether they had changed their practices after the catastrophic 2010 floods, almost 40% of the farmers reported that they had changed their practices, including: changing pesticides, shifting to new seed types including genetically-modified cotton seed, moving sowing dates to later in the season, and shifting away from cotton to alternative crops such as sugarcane and rice.

Farmers see the option to shift to other crops as a highly important long-term strategy for adapting to climate change but it will be important that these crops are assessed for their suitability under future conditions. Access to weather information significantly incentivises farmers to change their production to include new crop systems and new seeds. Farmers also felt that improved irrigation systems and capacity development through enhanced agriculture extension services could play a positive role in promoting resilience.

Access to credit deeply affects the economic resilience of farming households and their ability to adapt. Currently, credit is accessible only by those farmers who own land and not to seasonal labourers.[83]

The multiple stakeholders involved in the VC-ARID process recommended options for: creating specialised farmers' associations at the village level to support knowledge-sharing; separate bodies for female cotton labourers (to cover specific health, safety and other issues arising for women) and public-private sector collaboration to develop an effective crop insurance market.[84]

"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)."[85]

Beyond the IPCC: Climate resilient agriculture – insights from five South Asian countries[86]

The Action on Climate Today (ACT) programme worked in Afghanistan, Bangladesh, India, Nepal and Pakistan to help increase the resilience of agricultural systems by deploying the 'Climate Resilient Agriculture' (CRA) approach. Key conclusions of the five-year programme were:

Climate resilient agriculture is not business as usual. CRA is specially aimed at enhancing the resilience of agriculture systems and the people that depend on them. CRA activities must demonstrate the manner in which they are reducing vulnerability to climate change by addressing exposure or sensitivity to climate shocks and stressors or by increasing the adaptive capacity of target beneficiaries.

Stakeholder engagement is central to the CRA process. Delivering CRA systemically is complex, and therefore the participation of groups with diverse skills, perspectives and interests is vital. Groups should include multiple government departments, and representatives of the private sector, civil society, universities and farmers.

CRA is not simply a technical issue. Navigating complex issues of politics and power dynamics is important when seeking to enhance the resilience of farmers. Most agricultural interventions aim to improve the management of natural resources (water, soil, vegetation), which can be contentious in an over-populated and resource-scarce environment such as South Asia. Therefore, all of ACT's initiatives started with detailed context assessments and in-depth political economy analysis to map the potential for political pitfalls.

Image: © WorldFish, Flickr | Women harvesting, Bangladesh.

Integrating initiatives with government priorities is important for sustainable and institutionalised CRA. Governments have a significant influence on agricultural practices, through, for example, subsidies, land-use rules and production support programmes. In South Asian countries, agricultural policy and extension support is governed by complex configurations of local, subnational and national governments. The implementation of government policies, programmes and rules is often inadequate. To be sustainable, it is therefore vital that CRA is operationalised in a way that integrates and strengthens government systems.

CRA must be scaled up across South Asia. South Asia will face increased warming, increased extreme temperatures (including heat waves), an increased incidence of extreme precipitation and sea level rise as a result of climate change. This in turn carries the potential for social unrest, political upheaval, economic downturn and threats to local and national food security. Therefore there is an urgent need to scale up climate resilient agriculture across South Asia. ACT's framework provides a range of practical entry points that can operationalise and scale up CRA across the region.

Image: © Neil Palmer, CIAT, Flickr | In Rupandehi District, Western Nepal, farmers are trying to cope with higher temperatures and changing rainfall patterns as a result of climate change.

"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)."[87]

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. These include 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.

Image: © LI-BIRD | Woman using corn sheller, Nepal.

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. [88]

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.

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.[89]

Policy measures should be equitable, providing benefits for women and girls as well as men and boys, and should explicitly address women's barriers to participation. (see Box 7 and Section 6).[90]

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.[91]

"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."[92]

Beyond the IPCC: How the Mahatma Gandhi Guaranteed Employment Programme in India is providing rural jobs and rehabilitating land[93]

Image: © Neil Palmer, CIAT, Flickr| Growing beans, Himachal Pradesh, India

The world's largest public works-based social protection scheme, the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) has been rolled out across India since 2006. It aims to enhance livelihood security in rural areas by providing at least 100 days of guaranteed wage employment in a financial year to every household whose adult members volunteer to do unskilled manual work. It also provides improved productive assets and livelihood resources in rural areas, proactively ensuring social inclusion and strengthening Panchayat Raj (local government) institutions. The types of projects included are public works linked to natural resource management (mostly watershed-related projects), improving the condition of assets for vulnerable sections of society, and building common and rural infrastructure. MGNREGA provides a key example of how payments for ecosystem services (PES) may be conducted, and the programme as a whole demonstrates how social and environmental objectives may be combined to achieve political support, resources and scale.

Key performance results of MGNREGA include:

- **Total expenditure:** Rs 1,666 crore (US$7 billion)
- **Total wage expenditure:** Rs 30,843 crore (US$4.9 billion)
- **Number of households obtaining jobs:** 48.2 million
- **Average number of person/days per household per year:** 49
- **Women's participation rate:** 55%
- **Average wage:** 154 Rs per person per day (US$2.50)
- **Average cost per person:** 211 Rs per person per day (US$3.40) (2017 figures)

Overall, the programme has clear, targeted and popular objectives: to directly tackle unemployment and so increase livelihood security and reduce rural migration, and to promote sustainable development through improving rural assets and restoring the environment. Positive lessons point to strong participation of local institutions in the programme design; direct payments to the bank accounts of beneficiaries reduces leakages and supports financial inclusion for poorer sectors of the economy. In addition, ICT infrastructure plays an important role in improving programme implementation, and the investments provide climate-resilient and livelihood-linked assets in addition to wage guarantees for the poor. Analysis also reveals that more effort should go into output-based monitoring (rather than only a 'jobs-done' approach) and to securing the long-term quality of these environmental investments.

Box 7: Women's empowerment and food security: Evidence from South Asia

Empowering and valuing women increases their capacity to improve food security in a changing climate and to substantially improve 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.

In Nepal, women's empowerment had beneficial outcomes for maternal and child nutrition, thus reducing the negative effects of low diversity in the production of farmed goods.[94]

Image: © Mokhamad Edliadi/CIFOR, Flickr | The village of Nalma in the foothills of the Himalayas.

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

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.[95] 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 sustainable stewardship of land, which will, in turn, be key to successful climate adaptation and mitigation.[96]

Policy responses to land degradation, including desertification, which are widely discussed in the literature in the context of climate change are:[97]

- improving market access
- increasing gender empowerment
- expanding access to rural advisory services
- strengthening land tenure security
- paying for ecosystem services[98]
- 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.

"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)."[99]

Image: © LI-BIRD | Womens' group harvesting bottle gours, Nepal.

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

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 the already-felt impacts of climate change.

"[The] collective action and agency of women, including widows, has led to the prevention of crop failures, reduced workloads, increased nutritional intake, increased sustainable water management, diversified and increased income, and improved strategic planning."[100]

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.'[101] 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 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'.[102]

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. There is a need to explore how local support institutions could be strengthened to extend social protection.[103]

"There is high agreement and medium evidence that one of the greatest challenges is posed by inequalities that influence local coping and adaptive capacity."[104]

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 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.[105]

These socially-defined, gender-specific roles are not static but shaped by factors such as wealth, age, ethnicity and formal education.[106]

Effective climate change adaptation and mitigation strategies recognise and respond to people's differences, and consider how to build on people's strengths.

Beyond the IPCC: The diversity of ways in which people experience climate change impacts and can be part of the solution

According to an analysis by the BRACED programme, intersectional approaches offer a way 'to understand and respond to the ways different factors, such as gender, age, disability and ethnicity, intersect to shape individual identities, thereby enhancing awareness of people's needs, interests, capacities and experiences. This in turn will help in targeting policies and programmes.'[107]

The authors suggest that, for the practical purposes of designing and implementing climate adaptation and resilience programmes, it is not helpful to consider social groups as homogenous (e.g. 'women') or static. Intersectional approaches recognise people's complexity 'by taking historical, social, cultural and political contexts into account.'

A BRACED study in Nepal investigated the experiences of women and men in different ethnic and caste groups who are exposed to flooding. The research was carried out in the socially and ethnically diverse Bardiya district, where flooding is a major recurrent hazard.

The study focused on two intersecting vulnerability factors and aimed to understand the different experiences of women and men within different ethnicities/castes. This included women and men from disadvantaged groups (the ethnicity/caste groups that belong to the categories of Dalits, disadvantaged Janajatis and disadvantaged Madhesis) and women and men from other groups (all caste/ ethnic groups that do not fall under the disadvantaged groups). The research used an index based on four components of resilience – economic, social, infrastructural and institutional – as well as results from focus groups and interviews. It explored the different experiences of the four groups of people, their climate-related concerns, and the policies and processes that build their resilience to climate hazards.[108]

Image: © LI-BIRD | Womens' group making nursery of vegetables, Nepal.

In Nepal, the quantitative study shows a statistically significant difference between women and men within both disadvantaged and other groups, meaning that men are more resilient to natural hazards and climate change than women. In particular, men have better access to and control over financial resources, and a higher capacity to earn cash daily. It appears that circumstances leave women with less ability to cope. They have poorer access to information from official sources and to phones and radios to receive early warning messages. They also reported poor access to leadership roles and opportunities to participate in community decisions and training programmes. The differences between women and men are even larger in the disadvantaged social group.

Tackling these gender inequalities at both the structural (legal, institutional) and behavioural level is not only important in its own right for women's and girls' overall wellbeing, but is inseparable from their ability to adapt and become more resilient to climate change. Women's and girls' empowerment is both a development and a climate change issue.

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 to 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.[109] 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.[110]

A mix of coherent policies helps deliver sustainable development in the midst 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.[111]

Adaptive, iterative decision-making is increasingly in use to explore synergies and trade-offs between goals and targets.[112] 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.[113]

"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."[114]

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.

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.[115]

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.[116]

Bioenergy and afforestation need to be carefully managed to avoid these risks. Desirable outcomes will depend on locally appropriate policies and governance systems.[117]

Lowering greenhouse gas emissions in other sectors and areas of human behaviour can ease the pressure on land.[118]

"Land cannot do it all."[119]

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.

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Image: © Shutterstock | Making the most of vertical space.

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.[120]

Afforestation: Conversion to forest of land that historically has not contained forests.[121]

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.[122]

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.[123]

Aridity: A long-term climatic feature whereby there is low average rainfall or available water in a region.[124]

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.[125]

Bioenergy: Energy derived from any form of biomass (organic matter) or its metabolic by-products.[126]

Bioenergy with carbon dioxide capture and storage (BECCS): Carbon dioxide capture and storage (CCS) technology applied to a bioenergy facility. CCS is what happens 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.[127]

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.[128]

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.[129]

Deforestation: Conversion of forest to non-forest.[130]

Desertification: Land degradation in arid, semi-arid, and dry sub-humid areas resulting from many factors, including climatic variations and human activities.[131]

Drought: A period of abnormally dry weather long enough to cause a serious hydrological imbalance.[132]

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.[133]

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.[134]

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.[135]

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.[136]

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).[137]

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, it applies to all lands, including forested lands, and not only drylands.[138]

Land restoration: Aiding the recovery of land from a degraded state.[139]

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.[140]

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 agreement.[141] 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.[142]

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.[143]

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.[144]

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.[145] Resilience is also defined as the capacity of interconnected social, economic and ecological systems to cope with a hazardous event, trend or disturbance.[146] 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.[147]

Source: Any process or activity which releases a greenhouse gas, an aerosol or a precursor of a greenhouse gas into the atmosphere.[148]

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 to achieve sustainability.) [149]

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. [150]

Vegetation structure: Communities of species (in this case, plant species) and how they interact with each other in a particular area or habitat.[151]

Endnotes

All references are for chapters and pages in the IPCC's *Special Report on Climate Change and Land* unless otherwise stated.

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