The IPCC's Fifth Assessment Report

What's in it for South Asia?

Executive Summary

CDKN

Climate & Development Knowledge Network

Image: Panos I Wind farm, Tamil Nadu, India

Cover image:
Panos I Woman at well during extreme flooding, Satkhira district, Bangladesh

The IPCC's Fifth Assessment Report offers the following key messages for South Asia:

1. South Asia's climate is already changing and the impacts are already being felt
2. Further climate change is inevitable in the coming decades
3. Climate change poses challenges to growth and development in South Asia
4. Adaptation will bring immediate benefits and reduce the impacts of climate change in South Asia
5. Adaptation is fundamentally about risk management
6. South Asia has many adaptation options
7. Some low-carbon development options may be less costly in the long run and could offer new economic opportunities for South Asia
8. South Asia stands to benefit from integrated climate adaptation, mitigation and development approaches
9. International cooperation is vital to avert dangerous climate change and South Asian governments can promote ambitious global action

"Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850."
IPCC[12]

South Asia's climate is already changing and the impacts are already being felt

The *Fifth Assessment Report* of the Intergovernmental Panel on Climate Change (IPCC) finds, beyond reasonable doubt, that the Earth's climate is warming.[1] Since the 1950s, the rate of global warming has been unprecedented compared to previous decades and millennia.[2]

The *Fifth Assessment Report* presents a long list of changes that scientists have observed around the world. Since the mid-19th century, the average increase in the temperature of the Earth's surface has been 0.85 degrees Centigrade (°C).[3]

Globally, sea levels have risen faster than at any time during the previous two millennia – and the effects are felt in South Asia.[4] Changing patterns of rainfall or melting snow and ice are altering freshwater systems, affecting the quantity and quality of water available in many regions, including South Asia.[5] Climate change will have widespread impacts on South Asian society and South Asians' interaction with the natural environment.[6]

The IPCC finds with 95% scientific certainty (Box 1) that increasing concentrations of greenhouse gases in the atmosphere due to human activities have been the dominant cause of the observed warming since the mid-20th century.[7] Current science provides the clearest evidence yet that human activity is changing our climate.[8]

The impacts of climate change will influence flooding of settlements and infrastructure, heat-related deaths, and food and water shortages in South Asia.[9] The following pages explore these risks in more depth.

Given the interdependence among countries in today's world, the impacts of climate change on resources or commodities in one place will have far-reaching effects on prices, supply chains, trade, investment and political relations in other places. Climate change will progressively

Box 1: How the IPCC's *Fifth Assessment Report* defines scientific certainty[13]

The IPCC assigns a degree of certainty to each key finding based on the type, amount, quality and consistency of evidence (e.g., data, theory, models, expert judgment), and the degree of agreement among scientists. The terms to describe evidence are: limited, medium or robust; and to describe agreement: low, medium or high.

When the *Fifth Assessment Report* talks about 'confidence' in a finding, the level of confidence derives from a synthesis of the evidence that exists and the degree of scientific agreement on what the evidence means. The levels of confidence IPCC assigns are: very low, low, medium, high and very high.

IPCC describes the likelihood or certainty of an outcome having occurred or occurring in the future in terms of percentages:

Virtually certain	**99% or more**
Extremely likely	**95% or more**
Very likely	**90% or more**
Likely	**66% or more**
More likely than not	**more than 50%**
About as likely as not	**33–66%**
Unlikely	**33% or less**
Very unlikely	**10% or less**
Extremely unlikely	**5% or less**
Exceptionally unlikely	**1% or less**

On this scale, the world's leading climate scientists consider it extremely likely that human activities have been the dominant cause of observed warming. Scientists consider 95% confidence as the 'gold standard', the standard at which theories are accepted as valid. For example, the theory of evolution, the theory on the age of the Earth and the Big Bang theory all meet this standard of scientific confidence.

threaten economic growth[10] and human security in complex ways, in this region and across the world.[11]

The IPCC finds many observed changes in South Asia's climate:

Temperature trends: Warming has occurred, at a country scale, across most of South Asia over the 20th century and into the 2000s (Figure 1). There were more temperature extremes (*high confidence*).[14] Records indicate that it is likely that the numbers of cold days and nights have decreased and the numbers of warm days and nights have increased across most of Asia since about 1950. Heat wave frequency has increased since the middle of the 20th century in large parts of Asia.[15]

Rainfall trends: Most areas of the Asian region lack sufficient observational records to draw conclusions about trends in annual rainfall over the past century. Rainfall trends, including extremes, are characterised by strong variability, with both increasing and decreasing trends observed in different parts of Asia (Figure 2).[16] Observations also show that there have been more extreme rainfall events and fewer weak rainfall events in the central Indian region.[17]

Sea level rise: Globally, the rate of sea level rise since the 1850s has been larger than the average rate during the previous 2,000 years (*high confidence*). Sea level rise can vary between regions, though. Shifting surface winds, the expansion of warming ocean water, and the addition of melting ice can alter ocean currents which, in turn, lead to changes in sea level that vary from place to place. Past and present variations in the distribution of land ice affect the shape and gravitational field of the Earth, which also cause regional fluctuations in sea level. Additional variations are caused by sediment and tectonics.

Changes of sea level in the Indian Ocean have emerged since the 1960s, driven by changing wind patterns.[18]

Figure 1: Change in annual average temperature in South Asia, 1901–2012[19]

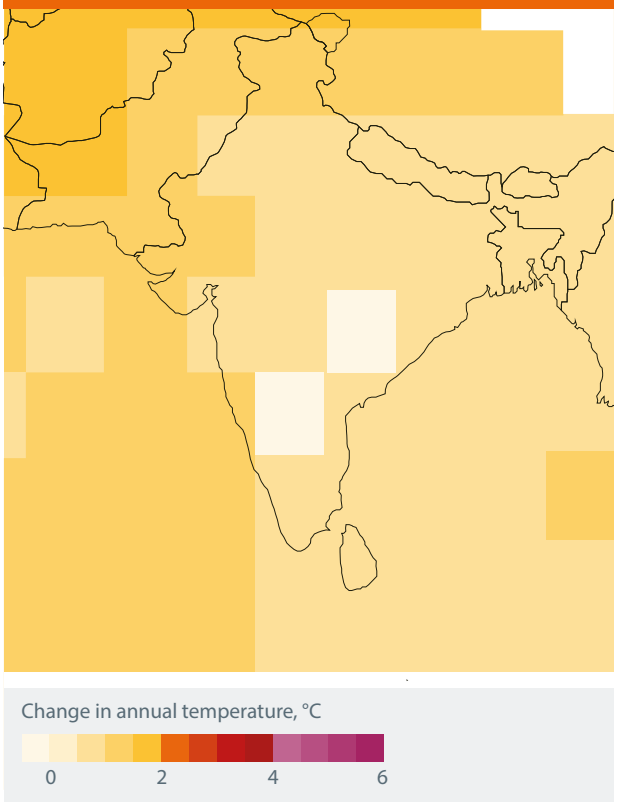
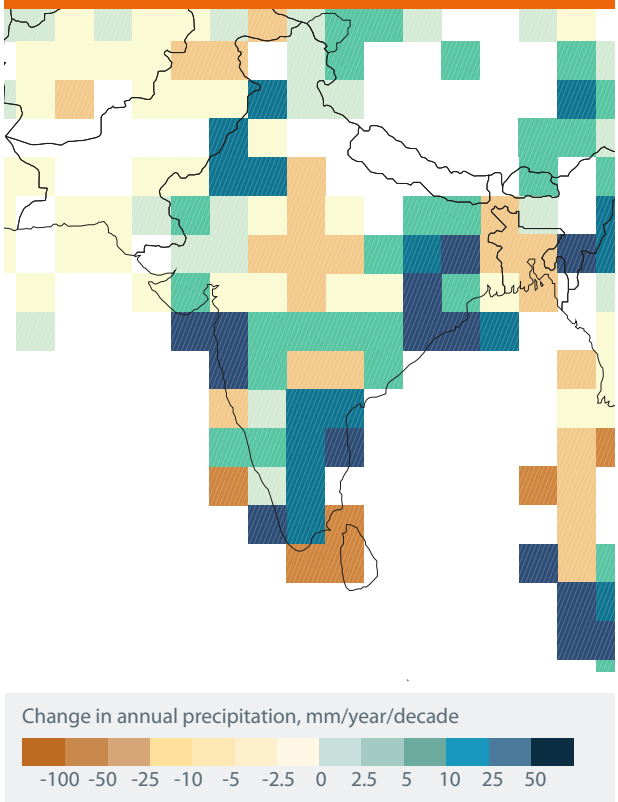


Figure 2: Change in annual average rainfall in South Asia, 1951–2012[20]



Observed effects of climate change: Even today, climate-related risks threaten lives, food security, health and wellbeing across many parts of South Asia. There are clear signs that the impacts of climate change are already being felt.[21]

The Asia region as a whole experienced the most weather- and climate-related disasters in the world between 2000 and 2008 and suffered the second highest proportion (almost 30%) of total global economic losses.[22]

The risk of deaths due to flooding is highly concentrated in Asia. At the same time as sea levels are rising, most Asian deltas are sinking as a result of groundwater extraction, floodplain engineering and trapping of sediments by dams.[23] Severe floods in Mumbai in 2005 have been attributed to both climatic and non-climatic factors, suggesting an interaction between climate change and other stressors.[24]

Extreme rainfall and flooding is causing illnesses, deaths and mass displacement. In 2008, the embankments of the Kosi River, a tributary of the Ganges, broke, displacing over 60,000 people in Nepal and 3.5 million in India, and disrupting transport and power across large areas.[25]

Climate change is impacting on human health in several ways. Contaminated urban flood waters have caused exposure to disease and toxic compounds, for example, in India and Pakistan.[26] The incidence of many diseases increases at higher temperatures: the pathogens and parasites that cause disease multiply faster. Dengue and Japanese encephalitis outbreaks in South Asia have been associated with temperature and rainfall. Malaria prevalence in India and Nepal has been linked to rainfall patterns.[27]

Studies from South Asia have shown an association between diarrheal outbreaks and a combination of higher temperatures and heavy rainfall. Cholera outbreaks in coastal populations in South Asia have been associated with increased temperatures and algal blooms. Climate phenomena, such as the El Niño, have been associated with cholera epidemics in Bangladesh.[28] Also in Bangladesh, people have suffered from heat stress, a condition that often affects urban populations in low and middle income countries. In urban areas where child mortality is high, extreme temperatures have led to more deaths.[29] Mental disorders and post-traumatic stress syndrome have also been observed in disaster-prone areas.[30]

Climate change negatively impacts livelihoods through its effects on natural resources and ecosystems, some of which are highly vulnerable to climate change.[31]

The geographic range, seasonal activities and migration patterns of many terrestrial, freshwater and marine species have shifted in response to ongoing climate change. The abundance of species has changed, as have interactions among species. The pace of change has been rapid. Permafrost degradation has been reported for parts of the Tibetan Plateau and earlier greening has been observed in the boreal forests of the Hindu-Kush-Himalayan region,[32] which could increase vulnerability to wildfires.[33] Coral reefs are bleaching with higher sea temperatures.[34]

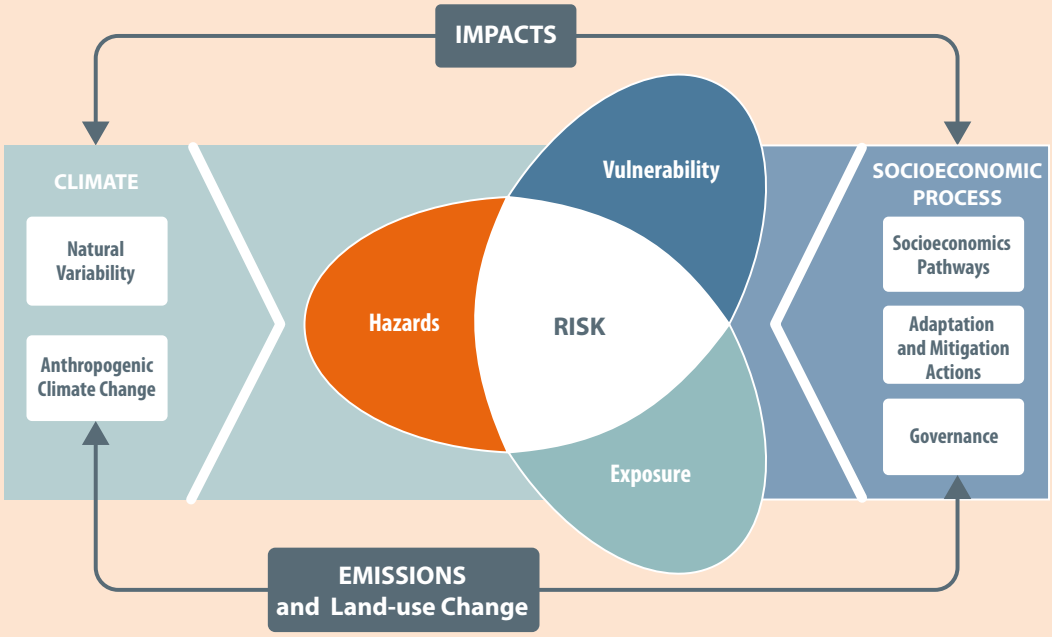
Image:
Panos | Woman constructs sea defence wall. Ghoramara Island, Sunderbans, India

Box 2: Climate change poses risks to human and natural systems[35]

Risks related to climate change arise from climate-related *hazards* (climate trends and extremes) and the *vulnerability* of *exposed* societies, communities or systems (in terms of livelihoods, infrastructure, ecosystem services and governance systems). Effective measures to adapt to climate change and reduce the risks associated with climate change can address all three aspects of risk: hazard, vulnerability and exposure.

The vulnerability and exposure of societies and ecological systems to climate-related hazards vary constantly because of changes in economic, social, demographic, cultural, institutional and governance circumstances.

For example, rapid and unsustainable urban development, international financial pressures, increases in socioeconomic inequality, failures in governance and environmental degradation affect vulnerability. These changes unfold in different places at different times, meaning that strategies to strengthen resilience and reduce exposure and vulnerability need to be locally or regionally specific. For example, countries that are rapidly urbanising are vulnerable to climate change if their economic development is slow. In other countries, urbanisation may present opportunities to adapt to climate change. Poverty is also a critical factor in determining vulnerability to climate change and extreme events.



Regardless of future emissions, we are already committed to further warming.

Further climate change is inevitable in the coming decades

Regardless of future emissions, we are already committed to further warming largely due to past emissions and inertia in the climate system.[36] Globally, most greenhouse gas emissions due to human activities have come from just a few countries. Total emissions since 1970 have continued to rise and, emissions between 2000 and 2010 have been the highest yet.[37]

The IPCC warns that if global society continues to emit greenhouse gases at current rates, the average global temperature could rise by 2.6–4.8°C by 2100 (according to the IPCC's highest emissions scenario see Box 3).[38]

The figure in Box 3 illustrates projected warming under a low-emissions scenario, a high-emission scenario[39] and two mid-range scenarios, and the temperature changes associated with each. Whether global society continues to emit greenhouse gases at today's rate, or cuts greenhouse gas emissions sharply now, does not make a big difference in terms of climate impacts in the next few decades. It does however make a big and irreversible difference to the risks in the longer run.

Box 3: What are the IPCC scenarios?

In assessing future climate change, the *Fifth Assessment Report* presents four scenarios, known as Representative Concentration Pathways (RCPs – see figure at right). The scenarios show the result of different levels of emissions of greenhouse gases, from the present day to 2100, on global warming. IPCC does not indicate which policy and behavioural choices society could make that would lead to the scenarios.

In all scenarios, carbon dioxide concentrations are higher in 2100 than they are today. The low-emissions scenario (RCP2.6) assumes substantial and sustained reductions in greenhouse gas emissions. The high-emissions scenario (RCP8.5) assumes continued high rates of emissions. The two intermediate scenarios (RCPs 4.5 and 6.0) assume some stabilisation in emissions.

In the next few decades, warming will be the same in all scenarios (see the overlap between the scenarios at right, and in Box 4, overleaf). Regardless of action taken now to reduce emissions, the climate will change until around the middle of this century. In the longer term, in all except the low-emissions scenario, global warming at the end of the 21st century is *likely* to be at least 1.5°C. In the two higher emissions scenarios, global warming is *likely* to be 2°C. In the second lowest emissions scenario, global warming is *more likely than not* to be 2°C. Warming will continue beyond 2100 under all emissions scenarios except the lowest and will continue to vary between years and between decades.[40]

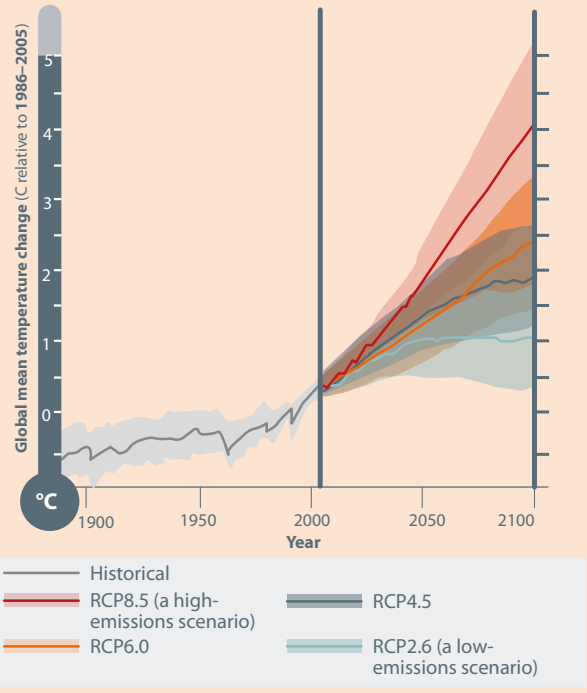


Image: Neil Palmer, CIAT | Planting wheat, Southeast Punjab, India

The emissions already in the atmosphere, together with the greenhouse gases that will be emitted in the future, mean that the climate will continue to change. These changes in climate will create new risks and will amplify existing risks to natural and human systems. The IPCC report finds that for the remainder of this century, climate change will pose further challenges to food security, water supplies, infrastructure, livelihoods, health and wellbeing.[41]

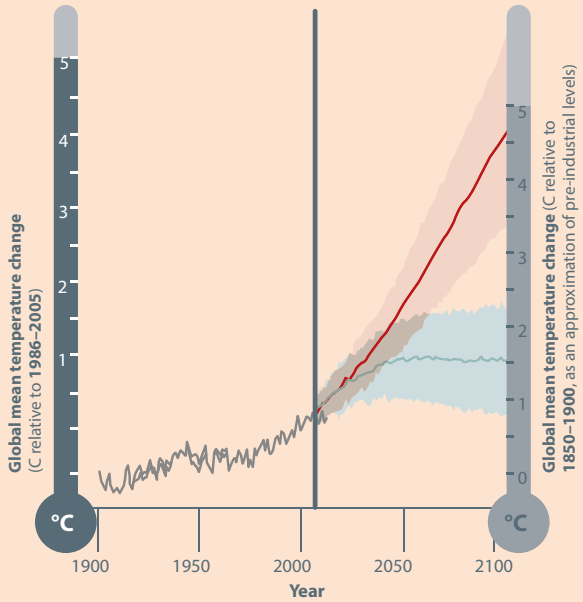
Curbing emissions to maintain global temperatures below 2°C would need urgent action at global level. However, the benefits to the global climate – and societies and ecosystems that depend on it – will only emerge in the latter half of the century. The IPCC lists the many reasons why *mitigation* action must start now and the kinds of immediate benefits it can deliver (see page 23, below). Taking action on *adaptation* today delivers many immediate benefits now and in the future, but, there are limits to adaptation.[42] For this reason, both adaptation and mitigation are needed; they each deliver benefits but over different timeframes.[43]

Box 4: Impacts of global warming[44]

The diagram below shows global warming in the last century, and projected global warming to 2100 according to the IPCC's highest and lowest emissions scenarios. The IPCC identifies five main areas of concern as temperatures rise. The diagram on the right indicates the additional climate-related risks when the temperature reaches a certain level, and is sustained at that level or exceeded. At even relatively low levels of warming of 1 to 2°C, many unique and threatened natural systems are at threat and food productivity, human health and water resources could be negatively impacted in some regions. The IPCC concludes that large-scale warming, of around 4°C or above, will increase the likelihood of severe, pervasive and irreversible impacts to which it will be difficult to adapt.

Climate change impacts across these areas of concern will increase risks of death, injury, ill-health or disrupted livelihoods in low-lying coastal zones due to storm surges, coastal flooding and sea-level rise, and in large urban populations, due to inland flooding. The risk of mortality and morbidity during periods of extreme heat and of food insecurity and the breakdown of food systems are also associated with a range of climate change impacts.[45] Risks due to extreme weather events leading to breakdown of infrastructure networks and critical services such as electricity, water supply, and health and emergency services are also linked to impacts across these areas of concern.

Observed and projected global annual average temperature



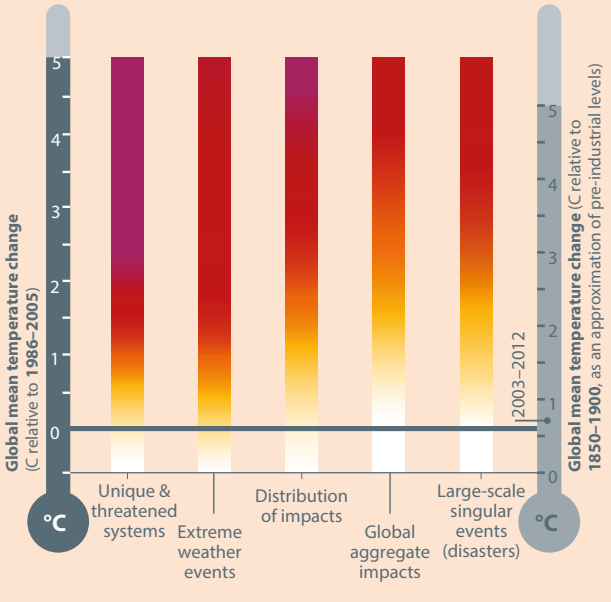
Observed

RCP8.5 (a high-emissions scenario)

Overlap

RCP2.6 (a low-emissions scenario)

Global risks under increasing levels of climate change



Level of additional risk due to climate change

Undetectable — High — Moderate — Very high

Sea levels could rise from 26cm – 98cm by the end of the 21st century, depending on global emissions levels.[51]

Temperature trends: Projections indicate that, compared to the average in the 20th century, average annual temperatures could rise by more than 2°C over land in most of South Asia by the mid-21st century and exceed 3°C, up to more than 6°C over high latitudes, by the late 21st century under a high-emissions scenario[46] (see Figure 3, overleaf). Under a low-emissions scenario,[47] average temperatures could rise by less than 2°C in the 21st century, except at higher latitudes, which could be up to 3°C warmer.[48]

Oceans in subtropical and tropical regions of Asia could warm under all emissions scenarios and would warm most at the surface. The frequency of hot days in South Asia is likely to increase further in the future (*high confidence*).[49]

Rainfall trends: Projections indicate that more rainfall will be very likely at higher latitudes by the mid-21st century under a high-emissions scenario and over southern areas of Asia by the late 21st century. Under a low-emissions scenario, more rainfall at higher latitudes is likely by mid-century but substantial changes in rainfall patterns are not likely at low latitudes.[50] More frequent and heavy rainfall days are projected over parts of South Asia (*low confidence*).

The future influence of climate change on tropical cyclones is likely to vary by region, but there is agreement between models that rainfall will likely be more extreme near the centres of tropical cyclones making landfall in South Asia.[52] An increase in extreme rainfall events related to monsoons will be very likely in the region. More frequent and heavy rainfall days are projected over parts of South Asia *(low confidence)*.[53]

Sea level rise: Global mean sea level will continue to rise during the 21st century; under all emissions scenarios – low and high – the rate of sea level rise will very likely exceed that observed during the past three decades.[54] Global mean sea level rise by the last two decades of the 21st century (as compared to sea levels in 1986–2005) will likely be in the ranges of 26–55cm under a low-emissions scenario, but 45–82cm for a high-emissions scenario – with total sea level rise of up to 98 cm by 2100 under this latter scenario.[55] This magnitude of sea level rise by the century's end implies significantly increased risks for South Asia's coastal settlements, as well as for coastal economies, cultures and ecosystems, particularly if combined with changes in cyclone frequency or intensity.[56] Low lying, densely populated coastal areas in South Asia, including India and Bangladesh, will be at increased risk of storm surges, putting many millions of people at risk. Negligible change or a decrease in average significant wave heights are projected for the trade and monsoon wind regions of the Indian Ocean.

"Climate change will cause declines in agricultural productivity in many sub-regions of Asia, for crops such as rice *(medium confidence)*." IPCC[57]

Climate change poses challenges to growth and development in South Asia

South Asia, reflecting the Asia region as a whole, is a rapidly urbanising region. Around one in every five urban dwellers in Asia lives in large urban areas and almost 50% of these live in small cities. By the middle of this century, Asia's urban population as a whole will increase by 1.4 billion people and alone will account for over 50% of the global population.[58]

In some parts of South Asia, such as the east coast of India, clusters of districts with poor infrastructure and rapid population growth are also the regions of maximum climate vulnerability. Extreme events are expected to be more catastrophic for the people living in such districts.

Although rapidly urbanising, South Asia is still predominantly an agrarian society, where a majority of the population is dependent on agriculture for their livelihoods.[59] Rural poverty is higher than urban poverty, reflecting the heavy dependence on natural resources that are directly influenced by changes in weather and climate. Sectors such as agriculture and fisheries are sensitive to rising temperatures, rising sea levels and changing rainfall patterns.

The *Fifth Assessment Report* identifies a set of key climate-related risks for Asia including South Asia.[60] These are:

Flood damage to infrastructure, livelihoods and settlements: Riverine, coastal and urban floods linked to extreme rainfall events, rising sea level and cyclones could cause widespread damage to infrastructure, livelihoods and settlements (*medium confidence*).[61] The risk of floods, and loss of life and property associated with floods, is highest in India and Bangladesh.[62]

A large proportion of Asia's population lives in low elevation coastal zones that are particularly at risk from climate change hazards, including sea-level rise, storm surges and typhoons.[63] The population and assets exposed to coastal risks will increase significantly in the coming decades due to population growth, economic development and urbanisation (*high confidence*).[64]

Half to two-thirds of Asia's cities with 1 million or more inhabitants are exposed to one or multiple hazards, with floods and cyclones the most important. By the 2070s, the *Fifth Assessment Report* indicates that the Asian port cities that could be most at risk, in terms of population and assets exposed to coastal flooding, will be Kolkata, Mumbai, and Dhaka.[65]

Food and water shortages: Key risks identified for Asia include water and food shortages linked to rising temperatures, extreme temperatures and drying trends (*high confidence*).[66] More erratic rainfall in parts of Asia could lower rice yields and lead to higher food prices and living costs, malnutrition, and worsened rural poverty (see Box 5).

Heat-related mortality: Another key risk for Asia is increased mortality due to rising temperatures and extreme temperatures (*high confidence*).[67] This will become a major public health concern across Asia.

The considerable threats could undermine the progress that South Asian countries have made in tackling disease, malnutrition and early deaths in the past decades, together with gains in improving agricultural productivity.[68] Adaptation can reduce these risks and bring immediate benefits.

Box 5: Climate change will affect food production, with impacts for rural and urban populations

The IPCC finds that on a global level, climate change could affect food security by the mid-21st century andthat most of the food insecure would continue to be in South Asia, where there are currently roughly 300 million undernourished people.[69] This will be exacerbated by declining agricultural productivity in the region. Crop production is likely to shift northwards across Asia as heat stress threatens current cropland (*medium agreement, medium evidence*).[70] Cooler regions are likely to benefit from warmer temperatures leading to an increase in the arable area (*high agreement, medium evidence)*.[71]

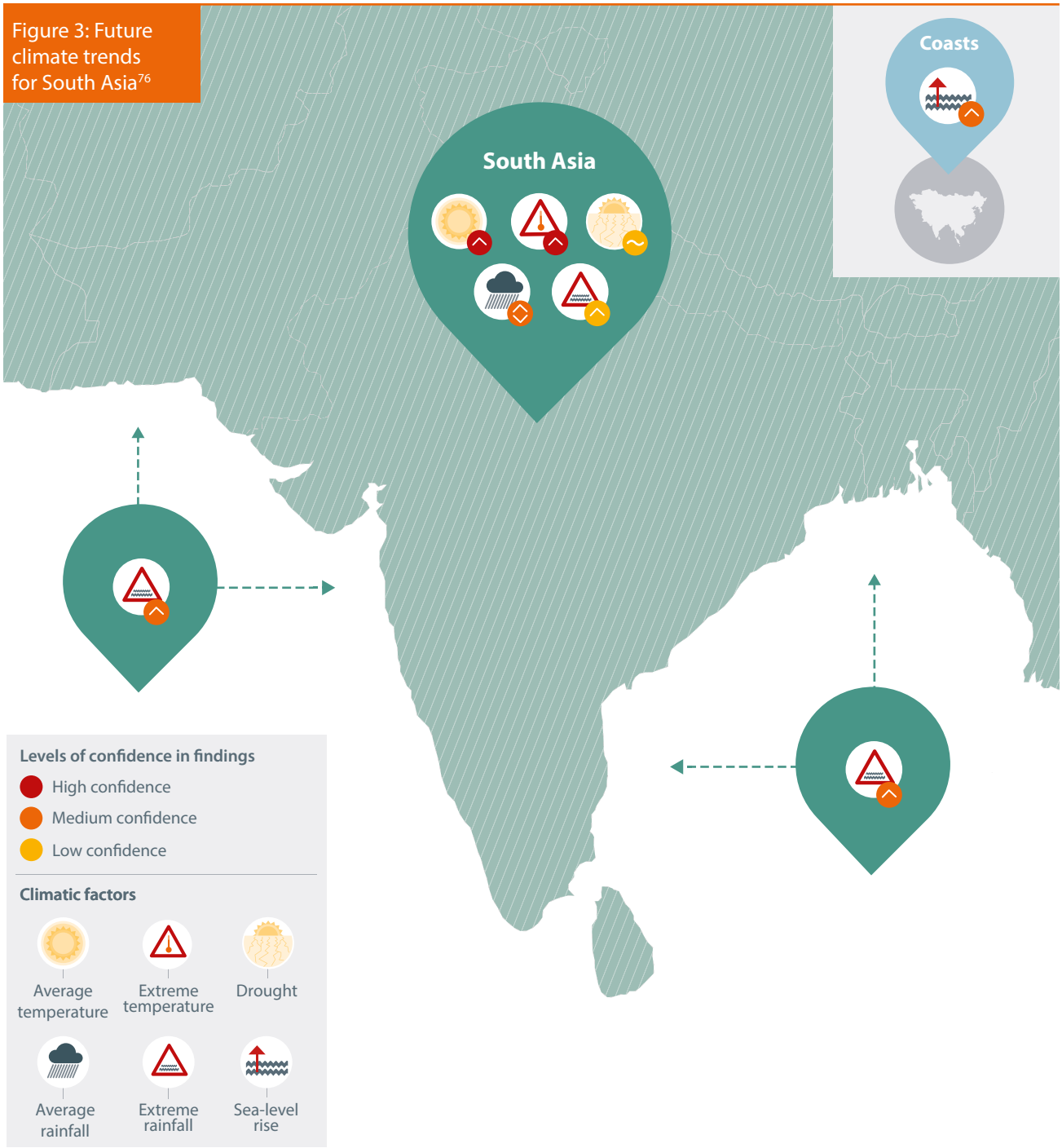
Rice, a key staple in the region, is most vulnerable in the northern part of South Asia, but changes in climate may boost wheat production in parts of Pakistan where warmer temperatures would make it possible to grow at least two crops per year of wheat and maize in mountainous areas.

In the Indo-Gangetic plains, which produce 90 million tons of wheat a year (about 14–15% of global production), projections indicate a substantial fall in yields unless there is a shift to different crop varieties and management practices.[72]

Rural poverty in South Asia is expected to continue to be more widespread than urban poverty for decades to come.[73] Climate-related declines in food productivity will impact on livelihoods and exports, increasing poverty levels. For instance, in Bangladesh, these factors would cause a net increase in poverty of 15% by 2030.[74]

However, food insecurity related to climate change will also affect urbanising South Asia. The urban poor could experience rises in food prices, as happened in 2007–2008. Certain categories of urban dwellers, such as urban wage labourers, could be particularly vulnerable.[75]

Figure 3: Future climate trends for South Asia[76]



Symbol	Rainfall	Temperature	Extreme rainfall, extreme temperature, sea-level rise
	up to 30% increasing trend	1–5 °C increasing trend	increasing trend
	both increasing and decreasing trends	–	both increasing and decreasing trends
	up to 30% decreasing trend	–	decreasing trend
	inconsistent trend	inconsistent trend	inconsistent trend
	no or only slight change	no or only slight change	no or only slight change

"Key risks for Asia are increased riverine, coastal and urban flooding, leading to widespread damage to infrastructure, livelihoods and settlements *(medium confidence)*, increased risk of heat-related mortality *(high confidence)* and increased risk of drought-related water and food shortage causing malnutrition *(high confidence)*"
IPCC[77]

Adaptation will bring immediate benefits and reduce the impacts of climate change in South Asia

Adaptation is the only effective option to manage the inevitable impacts of climate change that mitigation cannot reduce. The IPCC describes adaptation as "the process of adjustment to actual or expected climate and its effects".[78] Through adaptation, societies and communities can seek to moderate the harm of current and future climate risks or to take advantage of new opportunities.

In South Asia, rapid population growth, urbanisation, economic growth and changes in land use could interact with climate change to increase vulnerabilities. The effects of climate change depend as much on the inherent vulnerability of social and ecological systems as on the magnitude of climatic changes. Reducing vulnerability to climate change will be important in securing the health and prosperity of South Asian nations and the region as a whole.

Strengthening the links between development and building resilience could help to improve the level of adaptation in Asia and reduce the risk of 'maladaptation' or causing unintended adverse consequences (*high confidence* – for 'maladaptation' see Glossary).

Effective adaptation strategies can, and should, strengthen livelihoods, enhance wellbeing and human security, and reduce poverty today (Figure 4). 'No regrets' or 'low regrets' adaptation measures such as increasing access to information and resources, improving health services, diversifying cropping systems, strengthening access to land, credit and other resources for poor and marginalised groups, and making water and land management and governance more effective are good for development, irrespective of changes in climate (Table 1; Boxes 6–7).[79]

Adaptation brings benefits both today and in the future. South Asia has much to gain from adaptation actions like disaster risk reduction and social protection that reduce the impacts of warming that are already being felt and build resilience around critical sectors such as water, energy and agriculture. The IPCC emphasises that integrating adaptation into planning and decision-making can create many synergies with development (Table 1).

Levels of capacity to adapt (adaptive capacity) in South Asia are generally low – although this varies within and across countries of the region. Societies' capacity to adapt to climate change impacts is influenced by economic, demographic, health, education, infrastructure, governance and natural factors.

Heavy losses from extreme weather suggest that current strategies are unable to deal with existing climatic threats. National policies can sometimes disregard or undermine cultural or traditional practices that make an important contribution to local climate adaptation. Poorly conceived development programmes and sectoral adaptation strategies can lower resilience in other sectors or ecosystems. Incomplete, under-resourced and fragmented institutional frameworks translate into largely ad hoc projects, which are often donor-driven. Overall, evidence suggests that South Asian countries' adaptive capacity to manage complex social and ecological change, especially at local government level, is weak.

However, South Asia has inherent strengths that will be important for climate adaptation. These include a wealth of natural resources and well-developed social networks. Local and indigenous knowledge underpin longstanding traditional practices for managing climate variability through, for example, diversifying crops and livelihoods, migration and small-scale enterprises. The extent to which such strategies will be sufficient to deal with future changes is uncertain.[80]

In South Asia, successful adaptation to climate change will depend upon developing resilience in the face of uncertainty.

Figure 4: Adaptation can reduce risk[81]

Key risk	Adaption issues & prospects	Climate drivers	Time frame	Risk & potential for adaptation
Increased riverine, coastal, and urban flooding leading to widespread damage to infrastructure, livelihoods and settlements in Asia. *(medium confidence)*	• Exposure reduction via structural and non-structural measures, effective land-use planning, and selective relocation • Reduction in the vulnerability of lifeline infrastructure and services (e.g., water, energy, waste management, food, biomass, mobility, local ecosystems, telecommunications) • Construction of monitoring and early warning systems; measures to identify exposed areas, assist vulnerable areas and households, and diversify livelihoods • Economic diversification		Present Near-term (2030–2040) Long-term (2080–2100)	Very low / Medium / Very high 2°C 4°C
Increased risk of heat-related mortality *(high confidence)*	• Heat health warning systems • Urban planning to reduce heat islands; improvement of the built environment; development of sustainable cities • New work practices to avoid heat stress among outdoor workers		Present Near-term (2030–2040) Long-term (2080–2100)	Very low / Medium / Very high 2°C 4°C
Increased risk of drought-related water and food shortage causing malnutrition *(high confidence)*	• Disaster preparedness including early-warning systems and local coping strategies • Adaptive/integrated water resource management • Water infrastructure and reservoir development • Diversification of water sources including water re-use • More efficient use of water (e.g., improved agricultural practices, irrigation management, and resilient agriculture)		Present Near-term (2030–2040) Long-term (2080–2100)	Very low / Medium / Very high 2°C 4°C

Climatic factors

Average temperature · Extreme temperature · Drought · Cyclone · Average rainfall · Extreme rainfall · Sea-level rise

Level of risk and potential for adaption

Potential for additional adaption to reduce risk

Risk level with **high** adaption · Risk level with **current** adaption

"In many cases, we are not prepared for the climate-related risks that we already face. Investments in better preparation can pay dividends both in the present and for the future." Vicente Barros, Co-Chair of Working Group II

Box 6: Women, children and the elderly can be more vulnerable to climate change impacts[82]

Women often experience additional duties as labourers and caregivers as a result of extreme weather events and climate change, as well as from society's responses to climate change (e.g., male migration). They face more psychological and emotional distress, reduced food intake and adverse mental health outcomes due to displacement, and in some cases, increasing incidences of domestic violence.

Children and the elderly are often at higher risk due to narrow mobility, susceptibility to infectious diseases, reduced caloric intake, and social isolation; young children are more likely to die from or be severely compromised by diarrheal diseases and floods. The elderly face disproportional physical harm and death from heat stress, droughts, and wildfires.

Box 7: Action on climate change and development are inextricably linked

The IPCC concludes:[83]

- People who are socially, economically, culturally, politically, institutionally or otherwise marginalised in society are often highly vulnerable to climate change.
- Climate change impacts are projected to slow economic growth, make poverty reduction more difficult, further erode food security, and prolong existing and create new poverty traps, particularly in urban areas and emerging hotspots of hunger.
- Climate change poses an increasing threat to equitable and sustainable development. Sustainable development and equity provide a basis for assessing climate policies and addressing the risks of climate change.
- Business-as-usual development pathways can contribute to climate risk and vulnerability, and miss out on innovations and opportunities to build resilience in social and economic sectors.

The IPCC underlines South Asia's need to integrate climate action with inclusive and sustainable economic development.

Table 1: Action on climate change adaptation can bolster development[84]

Overlapping approaches	Category	Examples
Vulnerability and exposure reduction through development, planning and practices including many low regrets measures; Adaptation including incremental and transformational adjustments; Transformation	Human development	Improved access to education, nutrition, health facilities, energy, safe housing and settlement structures, and social support structures; reduced gender inequality and marginalisation in other forms.
	Poverty alleviation	Improved access to and control of local resources; land tenure; disaster risk reduction; social safety nets and social protection; insurance schemes.
	Livelihood security	Income, asset, and livelihood diversification; improved infrastructure; access to technology and decision-making fora; increased decision-making power; changed cropping, livestock, and aquaculture practices; reliance on social networks.
	Disaster risk management	Early warning systems; hazard and vulnerability mapping; diversifying water resources; improved drainage; flood and cyclone shelters; building codes and practices; storm and wastewater management; transport and road infrastructure improvements.
	Ecosystem management	Maintaining wetlands and urban green spaces; coastal afforestation; watershed and reservoir management; reduction of other stressors on ecosystems and of habitat fragmentation; maintenance of genetic diversity; manipulation of disturbance regimes; community-based natural resource management.
	Spatial or land-use planning	Provisioning of adequate, housing, infrastructure and services; managing development in flood-prone and other high risk areas; urban planning and upgrading programmes; land zoning laws; easements; protected areas.
	Structural/physical	Engineered and built environment options: sea walls and coastal protection structures; flood levees; water storage; improved drainage; flood and cyclone shelters; building codes and practices; storm and wastewater management; transport and road infrastructure improvements; floating houses; power plant and electricity grid adjustments.
		Technological options: new crops and animal varieties; indigenous, traditional and local knowledge, technologies, and methods; efficient irrigation; water-saving technologies; desalinisation; conservation agriculture; food storage and preservation facilities; hazard and vulnerability mapping and monitoring; early warning systems; building insulation; mechanical and passive cooling; technology development, transfer and diffusion.
		Ecosystem-based options: ecological restoration; soil conservation; afforestation and reforestation; mangrove conservation and replanting; green infrastructure (e.g., shade trees, green roofs); controlling overfishing; fisheries co-management; assisted species migration and dispersal; ecological corridors; seed banks, gene banks and other ex situ conservation; community-based natural resource management.
		Services: social safety nets and social protection; food banks and distribution of food surplus; municipal services including water and sanitation; vaccination programmes; essential public services; enhanced emergency medical services.
	Institutional	Economic options: financial incentives; insurance; catastrophe bonds; payments for ecosystem services; pricing water to encourage universal provision and careful use; microfinance; disaster contingency funds; cash transfers; public-private partnerships.
		Laws and regulations: land zoning laws; building standards and practices; easements; water regulations and agreements; laws to support disaster risk reduction; laws to encourage insurance purchasing; defined property rights and land tenure security; protected areas; fishing quotas; patent pools and technology transfer.
		National and government policies and programmes: national and regional adaptation plans including mainstreaming; sub-national and local adaptation plans; economic diversification; urban upgrading programmes; municipal water management programmes; disaster planning and preparedness; integrated water resource management; integrated coastal zone management; ecosystem-based management; community-based adaptation.
	Social	Educational options: awareness raising and integration into education; gender equity in education; extension services; sharing indigenous, traditional and local knowledge; participatory action research and social learning; knowledge-sharing and learning platforms.
		Informational options: hazard and vulnerability mapping; early warning and response systems; systematic monitoring and remote sensing; climate services; use of indigenous climate observations; participatory scenario development; integrated assessments.
		Behavioural options: household preparation and evacuation planning; migration; soil and water conservation; storm drain clearance; livelihood diversification; changed cropping, livestock and aquaculture practices; reliance on social networks.
	Spheres of change	Practical: social and technical innovations, behavioural shifts, or institutional and managerial changes that produce substantial shifts in outcomes.
		Political: political, social, cultural, and ecological decision and actions consistent with reducing vulnerability and risk and supporting adaptation, mitigation and sustainable development.
		Personal: individual and collective assumptions, beliefs, values, and worldviews influencing climate change responses.

Development planning and practice must reflect the reality of the changing climate.

Beyond the *Fifth Assessment Report*: Migration as a coping mechanism in Bangladesh[85]

Bangladesh is ranked as one of the most climate-vulnerable countries in the world. It is at extreme risk of floods, tropical cyclones, sea level rise and drought, all of which could drive millions of people to migrate. Although climate-related migration in Bangladesh is significant, surprisingly, there have been to date very few empirical studies carried out specifically on how climate change influences migration and its wider implications. This has made it hard to identify adaptation measures to deal with this major issue. As a result current policies and plans in Bangladesh do not sufficiently address the growing problem of climate-induced displacement, especially large-scale migration. The Government of Bangladesh recognised this shortcoming and commissioned a study of the growing migration phenomenon.

The study finds that millions of rural Bangladeshis are affected by climate variability. Many are increasingly resorting to migration as a coping mechanism. It concludes that climate stresses and shocks play an important role in people's decisions on whether to migrate.

While acknowledging that climatic stresses will increase migration, the study finds that instead of looking at migration as a threat, migration can be transformed into an effective adaptation tool through policy reforms. For example, rural-urban migrants are among the most vulnerable social groups who often end up living in disaster-prone urban areas and informal settlements. Future migration policies can be designed to support internal migratory movements and focus on providing safe environments and facilities for migrants in areas of settlement. Policy options could include enhancing access to migration finance, and drafting an internal migration policy.

Image: iStock | Rickshaw caught in flash flood

Beyond the *Fifth Assessment Report*: Economic assessment of climate impacts in Nepal's key sectors

For the Government of Nepal, climate change is a development question of the utmost importance. In a 2014 report they have outlined exactly how much climate change is costing the economy today, and in the future, for three major risk areas: agriculture, hydroelectricity and water-induced disasters. It finds that the equivalent of 2–3% of current GDP/year by mid-century will be lost due to climate change. This will put at risk the Government's development objectives of raising the standard of living for the 25% of the population currently under the poverty line. The Government has therefore committed to mainstream adaptation to climate change into its development plans and policies. The report suggests that to fully address medium-term risks in these three areas, a major increase in investment is required, estimated at US$2.4 billion by 2030 (present value).

Image: Neil Palmer, CIAT | Nepali farmer

Risk assessment must be comprehensive so that development programmes and adaptation strategies in one sector do not lower climate resilience in another.

Adaptation is fundamentally about risk management

In South Asia, governments, businesses and communities will have to take both short- and long-term approaches to managing climate risks. In the short term, integrating climate adaptation and disaster risk reduction will help withstand shocks to human security and economic development from which recovery can be costly. South Asian governments, businesses and communities can do much to anticipate and reduce risk, rather than reacting after impacts have occurred. Support for effective disaster relief and recovery needs to continue, along with proactive efforts to reduce risk, such as integrating comprehensive risk assessments and risk reduction measures into national economic and development policy.

In the longer term, governments, businesses and communities need not only to prepare for the kinds of climate impacts experienced up to now but also for different and more intense climate impacts and extreme events. Measures may include providing adequate housing, infrastructure or services, or mainstreaming climate change into planning processes (see Table 1).

There are good reasons to start now in the process of adapting to these longer-term risks. The IPCC cautions against overemphasising short-term outcomes or insufficiently anticipating consequences.[86] Given that climate change cuts across sectoral boundaries, poorly conceived development programmes or sector-specific adaptation strategies could lower resilience in other sectors or ecosystems. Some development pathways, like rapid urbanisation of coastal zones, can increase the vulnerability of certain groups to future climate change.[87]

Risk-based approaches to decision-making provide a useful foundation for assessing potential opportunities, constraints and limits associated with adaptation of human and natural systems *(high agreement, medium evidence)*. Risk management frames the consequences of climate change and potential adaptation responses in the context of peoples' values, objectives and planning horizons as they make decisions under uncertainty.[88]

South Asia has many adaptation options

South Asian countries are already accumulating practical experience in adapting to climate change at the regional, national and local levels. Best practices from South Asia show the potential for effective climate adaptation approaches that can be enhanced and scaled up in the future (see 'South Asia's first heat-related health action plan', overleaf). In the agriculture sector, for example, South Asian countries are adopting climate adaptation strategies and practices for particular crops and geographic areas. Other options highlighted in the *Fifth Assessment Report* for the Asia region as a whole are presented in Table 2.

Good practice in mainstreaming adaptation into development is most advanced in official development assistance programmes. Donor agencies and international financial institutions have made significant progress in taking climate-change adaptation into account in loan and grant making processes.[89] Regional cooperation could be important in overcoming resource scarcities and conflicts related to climate change.[90]

"By upgrading the drainage system in Mumbai, losses associated with a 1-in-100 year flood event today could be reduced by as much as 70%."
IPCC[91]

Beyond the *Fifth Assessment Report*: South Asia's first heat-related health action plan[92]

Higher daily peak temperatures and longer, more intense heat waves are becoming increasingly frequent in South Asia as a result of climate change. A new scale of coordinated action is essential to protect communities, especially their most vulnerable members, from the dangerous health effects of extreme heat.

Ahmedabad, in India's western province of Gujarat, is the first city in South Asia to comprehensively address these risks through a Heat Action Plan. The city government became convinced of the need for such a plan when the city experienced an intense heat wave in May 2010. Peak temperatures of 46.8°C (116°F)

Image: Indian Institute for Public Health | Health clinic, Ahmedabad

caused a spike in reported heat-related illness and death.

A coalition of academic, health and environmental groups from within and outside government joined together to create an early warning system and heat preparedness plan. The plan is based on robust scientific research, builds public awareness of the risks of extreme heat, trains medical and community workers to prevent and respond to heat-related illnesses, and coordinates an interagency emergency response effort when heat waves occur. The city government now has a dedicated budget and team for implementation of specific actions to help save lives – such as keeping tree-shaded public parks open for longer and moving particularly vulnerable groups such as pregnant women to cooler surroundings.

The Union Minister for Health in India has asked all cities to learn from Ahmedabad and put in place similar adaptation measures for extreme heat. There is growing awareness that extreme heat is not just a way of life in India, but something which needs concerted action.

Beyond the *Fifth Assessment Report*: Energy efficient, climate-resilient construction in Pakistan[93]

Monsoon flooding in 2010 and 2011 caused widespread damage across Pakistan. The Punjab Disaster Management Authority (PDMA) has realised that there is now an annual risk of flooding, and they should be building homes that can withstand the impact of heavy rainfall. In 2012, the PDMA worked with private contractors on climate compatible construction guidelines to use in the design and development of model villages. These guidelines were tested at a village in Mianwali, a highly vulnerable area of Pakistan, and also circulated across provincial departments and sectors for consideration. The guidelines provide instruction on using building material and design practices that make houses energy efficient as well as able to withstand floods and earthquakes. The discussion with multi-sectoral agencies sparked interest in initiating construction codes and by-laws for rural areas in the future.

In an important partnership among the Government of Pakistan, the private sector, and others in the development community, these new guidelines are demonstrating the 'triple wins'

Image: Mott MacDonald | Model climate compatible village, Mianwali, Pakistan

of reducing greenhouse gas emissions, building resilience and promoting development.

Asia has longstanding experience in managing natural resources and biodiversity. Harnessing the experience gained in afforestation, rangeland regeneration, catchment rehabilitation and community-based natural resource management programmes could drive effective and ecologically sustainable local adaptation strategies *(high confidence)*.

Many South Asian countries take a holistic development approach to adaptation. They integrate programmes for managing water and irrigation; promoting sustainable agricultural practices and appropriate technologies; innovating to address shorter growing seasons, extreme temperatures, droughts, and floods; and strategies for dealing with water shortages, food security and loss of livelihoods. In the future, policies for adapting to climate change could build on the local and indigenous coping strategies of farmers who have been adapting to climatic risks for generations. Breeding crop varieties suited to high temperatures could also be a promising option for adapting to climate change in South Asia.[94]

Community-based approaches help identify adaptation strategies that address poverty and livelihoods issues.[95] These techniques capture information at the grassroots, help integrate disaster risk reduction, development and climate change adaptation, connect local communities and outsiders, address the location-specific nature of adaptation, help facilitate community-learning processes and help design location-specific solutions.[96] However, new activities may make some groups become more vulnerable to change if they become 'locked into' specialised livelihood patterns, as with fish farmers in India.[97]

Box 8: Low-regrets adaptation measures

Managing natural resources to improve ecosystem resilience is a low-regrets adaptation strategy for vulnerable rural communities (*high confidence*).[98] Two widespread practices that address desertification – natural regeneration of trees and water harvesting – build resilient ecosystems and help rural communities adapt to changes in climate. Community-based natural resource management groups have the flexibility to incorporate measures to adapt to changing climatic conditions into existing projects. Working on sustainable adaptation through these groups leverages synergies between ecosystem services and poverty reduction.

Given so many uncertainties in Asia, building resilience is a low-regrets route to successful adaptation. Opportunities to build resilience include:

- Improving water and land governance;
- Ensuring security of tenure over land and vital assets;
- Building social protection systems, social services and safety nets;
- Enhancing water storage, water harvesting and post-harvest services; and
- Giving stakeholders more opportunities to get involved in planning.

International cooperation on climate change involves ethical considerations, including equitable effort-sharing.[104]

Table 2: Options for adapting to key climate-related risks in South Asia

Vulnerabilities compounded by climate impacts in South Asia	Adaptation options
• Unsustainable consumption of groundwater for irrigation and other uses is considered to be the main cause of groundwater depletion in several Indian states and will compound any disrupted rainfall that occurs as a result of climate change.	• Water infrastructure development in the Ganges river basin, increasing water productivity in the Indus and Ganges river basins and integrated management between Bangladesh, India, Nepal and Pakistan for the Indus and Ganges-Brahmaputra-Meghna river basins.[99]
• Sea level rise will be a key issue for many coastal areas as rich agricultural lands may be submerged and taken out of production.	• Where possible, agricultural areas can contribute to 'soft' engineering coastal defences, maintaining and restoring natural shorelines in agricultural zones.[100]
• Disruption of basic services such as water supply, sanitation, energy provision and transportation systems caused by flooding have implications for local economies, which can lead to mass migration and reinforce inequalities.	• 'No regrets' solutions to new infrastructure investments, taking advantage of opportunities for climate-resilient design, financing and management.[101]
• Human health is a major area of focus for (South) Asia, where effects depend on socio-economic and demographic factors, health systems, the natural and built environment, land use changes, and migration, in relation to local adaptive capacity. The role of institutions is critical, influencing vulnerabilities arising from gender, caste and ethnicity and wealth inequality.	• Disaster preparedness on a local community level could include a combination of indigenous coping strategies, early-warning systems and adaptive measures. • New working practices to avoid heat stress in outdoor worker, early warning systems for disease and disaster risks. • Livelihood diversification and climate-resilient livelihoods leading to reductions in vulnerabilities, including ecosystem-based adaptations and financial support measures.

Approaches to selecting adaptation options continue to emphasise incremental change to reduce impacts, while achieving benefits. But there is increasing evidence that managing for climate-related risks may involve experimenting with larger scale, new or more transformational adaptation measures than those already tried, and additional planning and investment. Such measures can include, for instance, changes in livelihoods from cropping to livestock or by migrating to take up a livelihood elsewhere.[102]

There can be barriers that impede or limit adaptation. These include challenges related to competing national priorities, awareness and capacity, financial resources for adaptation implementation, institutional barriers, biophysical limits to ecosystem adaptation, and social and cultural factors. Issues with resource availability might not only result from climate change, but also from weak governance mechanisms and the breakdown of policy and regulatory structures.[103]

There is no one-size-fits-all approach to adaptation. No one single adaptation strategy will meet the needs of all communities and contexts in South Asia Moreover, the characteristics of a community or society's capacity to adapt to climate change will differ from place to place, and depend largely on specific contexts. A range of actions that address underlying vulnerabilities, implement specific adaptation measures and instigate transformations may be necessary to reduce climate risks.

South Asian governments can help to promote ambitious global action on climate change mitigation

Ambitious climate mitigation at the global level must start now in order to limit the magnitude of long-term climate change and reduce the risks. Delaying action on mitigation will not only mean that adaptation costs will rise, but will substantially increase the difficulty of transitioning, globally, towards a low-emissions development pathway as countries invest in low-cost but potentially carbon-intensive infrastructure.[105] Between 15% and 40% of emitted carbon dioxide will remain in the atmosphere for more than 1,000

years. This creates a major intergenerational challenge in terms of rights and responsibilities to act on climate change. The *Fifth Assessment Report* provides a global carbon budget: it says that for the world to limit average global warming to less than 2°C, total emissions from human activity should not exceed 800–1,000 gigatonnes of carbon dioxide equivalent. To date, human activity has released 500 gigatonnes.[106]

The world's governments have pledged to limit warming to 2°C above pre-industrial levels. Above the 2°C warming threshold, climate change impacts become severe and unmanageable. Deep cuts in greenhouse gas emissions – at global level – would limit warming to 2°C relative to pre-industrial levels and avoid dangerous climate change. The IPCC states that under this ambitious scenario, emissions would peak in South Asia by 2030 then decline;[107] under such a scenario, Asian emissions in 2030 would be 1% higher than they are today. The need for deep cuts in emissions to limit warming to the 2°C threshold is a central theme of the section of the *Fifth Assessment Report* on climate mitigation. Warming of 2°C alone would pose a significant threat to economic growth and human development in South Asia.

In 2010, governmental Parties to the United Nations Framework Convention on Climate Change (UNFCCC) meeting in Cancun[108] pledged to reduce emissions to achieve the long-term goal of limiting global warming to 2°C above pre-industrial temperatures. The *Fifth Assessment Report* finds that the actual governmental pledges made at and since Cancun fall short of what is needed to achieve the long-term goal.

The IPCC also finds that mitigation efforts and the costs of mitigation vary between countries; developing countries have a significant proportion of the opportunities for low-cost mitigation.[109] To be cost-effective on a global scale, most mitigation needs to take place in countries projected to have the highest emissions in the future. But it is important to recognise that, although deep cuts in greenhouse gas emissions are technically possible, making such cuts will entail substantial technological, economic, institutional and behavioural changes.

As such, South Asian countries can play a role in global climate stabilisation efforts by taking advantage of low-carbon options that bolster their own development needs. For example, there are opportunities to reduce deforestation by adopting sustainable practices, plan innovative low-carbon towns and cities, and develop land-use schemes that intensify agricultural practices and sustainably manage livestock. Such actions can bring large co-benefits beyond reducing the impacts of climate change.

Nevertheless, it is also important to recognise that low-income countries in South Asia such as Nepal have contributed little to world emissions and will need substantial financial support for climate mitigation. It will have to be a shared effort.

The *Fifth Assessment Report* explicitly states that, because the atmosphere is a global commons, we will not achieve effective mitigation if individual countries advance their interests independently. International cooperation is essential to limit greenhouse gas emissions effectively and to address other climate change issues such as building resilience and capacity in regions such as South Asia.[110]

Some low carbon development options may be less costly in the long run and could offer new economic opportunities for South Asia

In expanding economically and meeting their development needs, South Asian countries have abundant opportunities to adopt clean, efficient low-carbon technologies and practices. They can side step the inefficient, fossil fuel-dependent infrastructure that more developed countries are 'locked into'.[111]

The *Fifth Assessment Report* identifies many low-carbon opportunities and co-benefits.[112] Many of the measures to avoid greenhouse gas emissions provide generous gains in economic productivity, human development and quality of life. For example, the development of low-carbon mass transit systems can boost economic productivity, by reducing traffic congestion, and can improve air quality, thus benefiting public health.[113] This is a major opportunity.

The IPCC states, "…in rapidly growing and urbanising regions, mitigation strategies based on spatial planning and efficient infrastructure supply can avoid lock-in of high emission patterns".[114] Because South Asia is urbanising rapidly, urban adaptation provides opportunities for incremental and transformational adjustments towards

Renewable energy technologies have demonstrated substantial performance improvements and cost reductions.[122]

resilient and sustainable systems. Reducing energy and water consumption through greening cities and recycling water, and developing resilient infrastructure systems can reduce the vulnerability of urban settlements in many parts of South Asia.[115]

Other examples where mitigation action aids human development include efforts to decarbonise electricity production in India – such activities are projected to decrease mortality due to reduced particulate pollution.[116] Scaling up renewable energy systems in South Asia would help expand access to energy for those in energy poverty.[117] The *Fifth Assessment Report* and the IPCC's *Special Report on Renewable Energy Sources and Climate Change Mitigation*[118] show that renewable energy technologies have demonstrated substantial performance improvements and cost reductions, and a growing number of renewable energy technologies have matured enough to enable deployment at significant scale.[119]

Improvements in the performance and cost of renewable energy technologies are significant for South Asia, given the renewable energy resource endowment across the region and the need to scale up energy services to meet demand. Encouraged by developments, many countries across South Asia are investing heavily in new energy infrastructure as well as putting in place regulatory and policy measures to persuade the private sector to invest in energy.[120] In addition, decentralised, renewable energy technologies, such as improved cookstoves, can markedly alleviate the workload and enhance the personal security of women and girls. The cookstoves, while reducing greenhouse gas emissions, lessen the need for women and girls to walk long distances to collect firewood, and vastly reduce illness and death from indoor air pollution.[121]

Certain low-carbon development options cost more than 'conventional' options. However, taking the long view, the cost of adopting low-carbon options now is less than the cost of waiting for the development of improvements in renewable technologies or locking infrastructure into high-emissions pathways and then cutting emissions more precipitously, later. Globally, estimates indicate that the growth in economic consumption is 1.6–3% a year. Adopting ambitious climate mitigation measures would reduce this consumption growth by around 0.06 (0.04–0.14) percentage points per year over the 21st century.[123]

South Asia stands to benefit from integrated climate adaptation, mitigation and development approaches

The IPCC points out that there are many complementarities among climate adaptation, mitigation and development and provides a wealth of evidence.[124] Many sustainable development pathways combine adaptation, mitigation and development approaches.

For example, decentralised solar photovoltaic systems provide energy to people not connected to electricity grids in a way that avoids the damaging greenhouse gas emissions of fossil fuel-based alternatives (kerosene stoves, diesel generators or fossil fuel-based power stations).[125] Such decentralised, renewable systems can prove more resilient to climate extremes such as droughts and very high temperatures, which may affect the performance of conventional sources of power such as large hydropower dams or large power stations reliant on water for cooling.

Decarbonising electricity production can reduce pollution-related mortality, as is the case in India.[126] Abandoning the use of biomass fuel or coal for indoor cooking and heating improves indoor air quality and respiratory and cardiac health among, in particular, women and children. Conversely, actions to tackle current environmental and public health issues may often have beneficial mitigation effects, like traffic emissions reduction programmes in India.

Mitigation measures can deliver public health benefits. For example, sustainable cities with fewer fossil-fuel driven vehicles and more green areas will have adaptation and mitigation co-benefits, including reduced urban heat effects. Expansion of urban and peri-urban agriculture and forestry can deliver multiple climate change adaptation, mitigation and development benefits (see opposite page).

On rivers and coasts, the use of hard defences to protect agriculture and human settlements from flooding may have negative consequences for natural ecosystems and means lost opportunities for carbon storage in coastal habitats. Conversely, setting aside buffer zones along coasts and rivers would be positive for both. The very high carbon storage potential of soils in mangroves and peat swamp forests provides opportunities for combining adaptation with mitigation through restoration of ecosystems for flood defences.[127]

Climate mitigation activities, managed carefully so that they do not introduce new risks to development, can provide multiple benefits across energy security and other societal goals.[133]

Beyond the *Fifth Assessment Report*: Urban and peri-urban agriculture and forestry in Sri Lanka[128]

The Western Province in Sri Lanka is the most urbanised province in the country. Rapid urban growth has posed a number of problems. Increasing vehicle traffic and commercial industries have contributed to increased environmental pollution. Food and construction are two major sources of greenhouse gas emissions, including those generated through transport. Large areas of agricultural lands have been converted for residential and commercial land uses, significantly altering natural water flows and drainage. This, coupled with an increase in average rainfall as well as heavy rainfall events, has resulted in recurrent flooding and related damage to infrastructure, utility supplies and the urban economy.

The Western Province is promoting urban and peri-urban agriculture and forestry as a strategy to reduce vulnerability to climate change, while at the same time enhancing urban liveability and livelihoods. It is the first provincial government in Sri Lanka to include urban and peri-urban agriculture and forestry in its climate change adaptation action strategy.

The province is promoting the rehabilitation of flood zones for urban farming as a strategy to improve storm water infiltration and mitigate flood risks. The provincial government also supports local agriculture to reduce dependency on imports, to lower greenhouse gas emissions and energy requirements for food production, transport and storage, and to improve local food security and livelihoods.

Future up-scaling of these interventions will need new urban design concepts and the development of a provincial climate change action plan. In parallel, local and national policies will need to be revised to ensure that they are supportive and not at cross-purposes with local efforts to integrate climate adaptation, mitigation and development. Achieving progress at the policy level will require improved impact monitoring and awareness raising at all levels of government, together with extended partnerships, capacity-building and local financing.

Image: RUAF Foundation | Urban agriculture, Western Province, Sri Lanka

Beyond the *Fifth Assessment Report*: Achieving adaptation, mitigation and development

Conservation agriculture and agroforestry. The IPCC notes that since its last assessment, Asia has accumulated experience in integrating pro-poor adaptation and mitigation into development via carbon-offset schemes that use agroforestry, farmer-assisted tree regeneration and conservation agriculture. These kinds of sustainable land management programmes are particularly useful when it comes to integrating adaptation and mitigation with ongoing development. However, the suitability of on and off farm techniques for integrating adaptation and mitigation depends on environmental, political and institutional factors.

Agroforestry systems store carbon and could prevent soil erosion, build resilience against floods, landslides and drought, increase soil organic matter and soften the financial consequences of crop failure. Agroforestry is also more biodiverse than most other agricultural systems.[129]

Reforestation would need to consider the effects of changes in climate. For example, reforestation relying on one tree species would be more susceptible to changes in climate than reforestation involving several species.

Adaptation measures could support mitigation; for example, a project to prevent fires or restore degraded forests would also prevent the release of greenhouse gases. Growing biofuel crops on abandoned and marginal agricultural land could make a significant contribution to mitigating carbon emissions from fossil fuels.[130] Mechanisms that put an economic value on land use-related emissions, such as the United Nations reducing emissions from deforestation and forest degradation (REDD+) programme, could reduce the risk of negative consequences and incentive structures would need to be worked out carefully.[131] New initiatives aim to deliver multiple benefits – less poverty, restored ecosystems – and profit from carbon markets. However, carbon-offset systems involving community forestry require supportive land-use policies.

Urban planning provides another area for potential synergies among climate mitigation, adaptation and development.[132] Cities in South Asia are expanding rapidly. Many city planners advocate for more compact city structures that would accommodate South Asia's growing urban population while curbing greenhouse gas emissions by reducing the need for transport. However, compact urban development may conflict with adaptation strategies, such as providing urban green spaces to counter urban heat island effects and moderate storm water run-off by increasing water filtration into the soil. Typical adaptation responses in urban heat islands involve installing air conditioning to maintain tolerable indoor comfort levels, but air conditioning contributes to greenhouse gas emissions. Displacement, especially of the urban poor, destruction of property and loss of livelihoods are common impacts of storm surges. Protection against storm surges requires heavy investment in flood defences, sea walls or drainage channels.

Planners need to consider the higher temperatures and changing rainfall patterns that climate change will bring when designing urban infrastructure, in order to prevent damage from extremes, and lessen disruption to businesses and inhabitants. Smart adaptation to current and future climate stresses affecting South Asian cities is an imperative. Plans for low-carbon infrastructure and land use need to harmonise with needs for adaptation.

"International cooperation is required to effectively mitigate greenhouse gas emissions and address other climate change issues…outcomes seen as equitable can lead to more effective cooperation." IPCC[137]

Box 9: Gaining development benefits from climate mitigation and avoiding adverse effects

The IPCC highlights many of the substantial development benefits that low-carbon development can achieve. The *Fifth Assessment Report* also warns that mitigation action can pose risks to development if not managed carefully.[134] It states: "Climate policy intersects with other societal goals creating the possibility of co-benefits or adverse side effects. These intersections, if well managed, can strengthen the basis for undertaking climate action."[135]

For example, new techniques to deliver climate-smart agriculture – especially if they involve changes in land tenure and land-use rights – bear the risk of marginalising smallholder farmers and forest users. However, given appropriate arrangements and incentives to manage these risks, such measures could provide social benefits and promote equity.[136]

Identifying the downside risks of mitigation action and ensuring that low-carbon choices support inclusive, sustainable development requires robust institutions and decision-making processes.

International cooperation is vital to avert dangerous climate change

Since the IPCC's formation in 1992, its work has given us a better understanding of climate science and has provided us with a better picture of vulnerabilities in different parts of the world. The IPCC has reviewed the range of potential policy options and their implementation in a range of country contexts. The *Fifth Assessment Report* provides the strongest scientific evidence of climate change yet. The report also indicates that waiting or doing nothing is no longer an option and makes a compelling case for immediate global action on climate change.

Political processes need to reflect this. Ensuring the right choices now requires every government to participate in global climate negotiations towards a collective solution. South Asian leaders have an important part to play – with all other international leaders – in forging this solution. Cooperating, recognising that everyone must share the effort, and making financial resources available for investment in adaptation programmes and low-emissions infrastructure are important in reaching global agreement.

To this end, developed countries have committed to jointly mobilising US$100 billion a year from various sources by 2020 for adaptation and mitigation in developing countries. As yet, there is no agreed understanding on how to allocate funds between mitigation and adaptation, or between developing countries and regions. What is clear is that the countries of South Asia need resources to build viable adaptation frameworks and capabilities, and critical infrastructure for development. Provision of climate finance through the Global Climate Fund or other schemes is one way of mobilising resources to support adaptation and mitigation action, particularly in low income countries of the region.

The IPCC's key messages have crystal clear implications for the global climate negotiations process. As mentioned above, the IPCC states categorically that the Cancun pledges for emissions reduction by 2020 are insufficient,[138] but could be the basis for something more ambitious. This is what the international process must deliver.

South Asian leaders must join with others in forging an ambitious, collective action. An important part of reaching a global agreement is ensuring that the cooperative spirit is in place, effort-sharing is recognised and financial resources are made available to invest in adaptation programmes and low-emissions infrastructure.

About the IPCC's Fifth Assessment Report

The Intergovernmental Panel on Climate Change (IPCC) has produced the most comprehensive assessment of climate change ever. The *Fifth Assessment Report* (http://www.ipcc.ch), which IPCC is releasing in four parts between September 2013 and November 2014, is the work of 830 expert authors, from 85 countries. The report reviews the scientific evidence on the trends and causes of climate change, the risks to human and natural systems, and options for adaptation and mitigation. The IPCC aims to be – in its own words – "policy relevant but not policy prescriptive". Its findings further our understanding of humankind's interaction with our environment: how we are affecting the global climate and what we can do about it.

The IPCC Working Groups publish the reports comprising the *Fifth Assessment Report* (see figure: How the IPCC works). These groups are: Working Group I (physical science of climate change), Working Group II (impacts, adaptation and vulnerability) and Working Group III (climate change mitigation). The fourth report is a synthesis of findings. Although the collected reports total many thousands of pages, each Working Group produces a *Summary for Policy-Makers,* which presents key findings in a more succinct form. Representatives of more than 190 governments review and negotiate the summaries in detail during a week-long event. Once governments have signed off on each *Summary*, the IPCC publishes it, together with the full scientific report.

You may find the *Fifth Assessment Report* on the following websites:

Working Group I: The Physical Science Basis
www.climatechange2013.org

Working Group II: Impacts, Adaptation, and Vulnerability
www.ipcc.ch/report/ar5/wg2/

Working Group III: Mitigation of Climate Change
www.ipcc.ch/report/ar5/wg3/

About this report

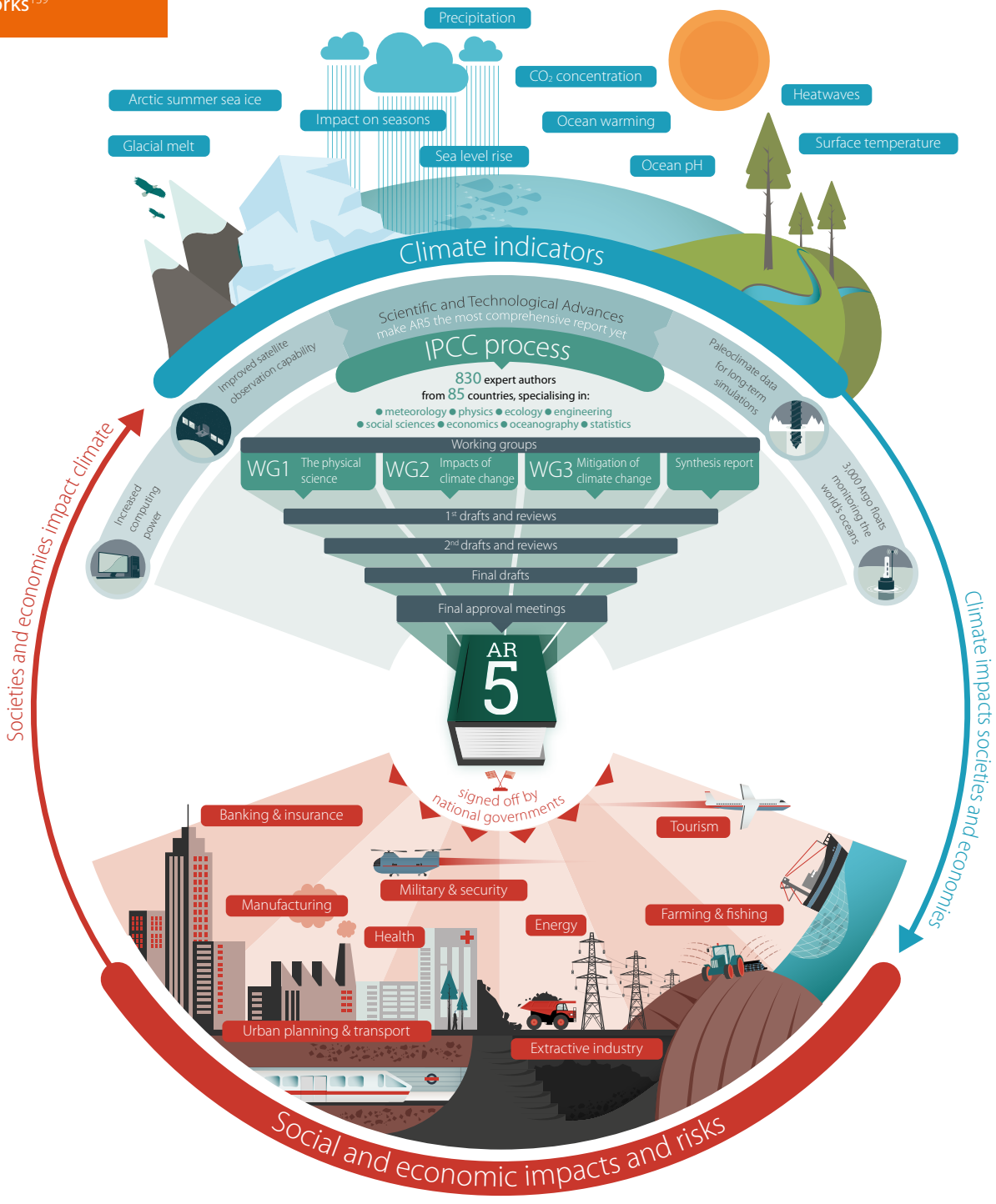
This report is a guide to the IPCC's *Fifth Assessment Report* prepared for decision-makers in South Asia by the Climate and Development Knowledge Network (CDKN) and Overseas Development Institute (ODI). The IPCC *Summaries for Policymakers* focus principally on global issues and trends. This report distils the richest material on South Asian experiences in adaptation and mitigation, from the thousands of pages of the *Fifth Assessment Report*. The publication has not been through the comprehensive governmental approval process that IPCC endorsement requires. However, the expert research team has worked under the guidance of IPCC Coordinating Lead Authors and Reviewers to ensure fidelity to the original (see *Acknowledgements*).

The research team has extracted the Asian and/or South Asian-specific data, trends and analysis, as available, directly and solely from the *Fifth Assessment Report* for this short volume. In so doing, we hope to make the IPCC's important material more accessible and usable to South Asian audiences. This report responds to wide demand among CDKN's South Asian partner networks, for region-specific information.

Our publication is part of a suite of materials to aid understanding of the IPCC's *Fifth Assessment Report*. Companion volumes provide a digest of IPCC findings for: Africa; Latin America; and Small Island Developing States.

Please visit www.cdkn.org/ar5-toolkit

How the IPCC works[139]



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Glossary

Adaptation: The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate harm or exploit beneficial opportunities. In natural systems, human intervention may facilitate adjustment to expected climate and its effects.

Greenhouse gas: Greenhouse gases are those gaseous constituents of the atmosphere, both natural and caused by human activity. Greenhouse gases trap energy from the sun in the atmosphere causing it to warm. Water vapor (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; while hexafluoride (SF_6), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs) are also of concern. Moreover, there are a number of entirely human-made greenhouse gases in the atmosphere, such as halocarbons and other chlorine- and bromine-containing substances.

Maladaptive actions (or maladaptation): Actions that may lead to increased risk of adverse climate-related outcomes, increased vulnerability to climate change, or diminished welfare, now or in the future.

Mitigation (of climate change): A human intervention to reduce the sources of greenhouse gases or enhance the sinks (those processes, activities, or mechanisms that remove a greenhouse gas from the atmosphere).

Representative concentration pathways (RCPs): Scenarios that include time series of emissions and concentrations of the full suite of greenhouse gases and aerosols and chemically active gases, as well as land use and land cover. The word 'representative' signifies that each RCP provides only one of many possible scenarios that would lead to the specific radiative forcing characteristics (i.e., greenhouse gas-related warming). The term 'pathway' emphasises that not only the long-term concentration levels are of interest, but also the trajectory taken over time to reach that outcome.

Resilience: The capacity of a social-ecological system to cope with a hazardous event or disturbance, responding or reorganising in ways that maintain its essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation.

Scenario: A plausible description of how the future may develop based on a coherent and internally consistent set of assumptions about key driving forces (e.g., rate of technological change, prices) and relationships. Note that scenarios are neither predictions nor forecasts, but are useful to provide a view of the implications of developments and actions.

Social protection: In the context of development aid and climate policy, social protection usually describes public and private initiatives that provide income or consumption transfers to the poor, protect the vulnerable against livelihood risks, and enhance the social status and rights of the marginalised, with the overall objective of reducing the economic and social vulnerability of poor, vulnerable, and marginalised groups.

Transformation: A change in the fundamental attributes of a system, often based on altered paradigms, goals, or values. Transformations can occur in technological or biological systems, financial structures, and regulatory, legislative, or administrative regimes.

Vulnerability: The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

Endnotes

1 IPCC (2013). *Climate Change 2013: The Physical Science Basis. Headline Statements from the Summary for Policymakers.*

2 IPCC (2013). *Climate Change 2013: The Physical Science Basis. Summary for Policymakers* (p4).

3 The range shown is 0.65–1.06°C. IPCC (2013). *Climate Change 2013: The Physical Science Basis. Summary for Policymakers* (p5).

4 "The rate of sea level rise has been greater than the mean rate during the previous two millennia (*high confidence*)." IPCC (2013). *Climate Change 2013: The Physical Science Basis. Summary for Policymakers* (p11).

5 IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Summary for Policymakers* (p4).

6 Ibid.

7 IPCC (2013). *Climate Change 2013: The Physical Science Basis. Headline Statements from the Summary for Policymakers*.

8 Ibid.

9 IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Summary for Policymakers* (Box SPM.2 Table 1, p21).

10 IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Chapter 10* (p4).

11 IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Chapter 12* (p2).

12 Ibid.

13 IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Summary for Policymakers* (p6).

14 IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Chapter 24* (p3).

15 IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Chapter 24* (p5).

16 IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Chapter 24* (p6).

17 Ibid.

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19 Observed temperature and precipitation data are given in IPCC (2013). *Climate Change 2013: The Physical Science Basis. Summary for Policymakers* (pp6,8). Observed temperature and observed precipitation maps are also presented in IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Technical Summary* (Figure TS.5, pp64–65).

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24 Ibid.

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26 IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Chapter 24* (pp21–22).

27 Ibid.

28 IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Chapter 24* (pp21–22).

29 Ibid.

30 Ibid.

31 Ibid.

32 IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Chapter 24* (p10).

33 IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Chapter 24* (p13).

34 Ibid.

35 IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability*. Summary for Policymakers (Figure TS.1, p60).

36 IPCC (2013). *Climate Change 2013: The Physical Science Basis. Summary for Policymakers* (p27).

37 During the decade 2000–2010, emissions have been higher "than any previous decade since 1750" and "between 2000–2010, greenhouse gas emissions grew on average 2.2% per year compared to 1.3% per year over the entire period 1970–2000." IPCC (2014) *Climate Change 2014: Mitigation of Climate Change. Technical Summary* (pp9–10).

38 IPCC (2013). *Climate Change 2013: The Physical Science Basis. Summary for Policymakers* (p23).

39 IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Summary for Policymakers* (Figure SPM.4, p38).

40 All analysis in Box 3 including the figure are derived from IPCC (2013). *The Physical Science Basis. Technical Summary* (Figure TS-15, p89).

41 IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Summary for Policymakers*.

42 IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Chapter 16* (p3).

43 IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Summary for Policymakers* (p13).
44 Ibid. (p39).
45 Ibid.
46 RCP 8.5, see Box 3.
47 RCP 2.6, see Box 3.
48 IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Chapter 24* (pp6–7).
49 Ibid.
50 Ibid.
51 IPCC (2013). *Climate Change 2013: The Physical Science Basis. Summary for Policymakers* (p9).
52 IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Chapter 24* (p7).
53 Ibid.
54 IPCC (2013). *Climate Change 2013: The Physical Science Basis. Summary for Policymakers* (p9).
55 Ibid.
56 IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Chapter 24* (p15).
57 Ibid.
58 IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Chapter 24* (p19).
59 IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Chapter 24* (p21).
60 IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Summary for Policymakers.*
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62 IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Chapter 24* (p19).
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67 IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Technical Summary (*p48).
68 IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Chapter 24.*
69 IPCC (2014). Climate Change 2014: Impacts, Adaptation, and Vulnerability. *Chapter 7* (p5).
70 IPCC (2014). Climate Change 2014: Impacts, *Adaptation, and Vulnerability. Chapter 24* (p16–17).
71 Ibid.
72 Ibid.
73 IPCC (2014). Climate Change 2014: Impac*ts, Adaptation, and Vulnerability. Chapter 24* (p21).
74 IPCC (2014). Climate Change 2014: Impac*ts, Adaptation, and Vulnerability. Chapter 24* (p23).
75 Ibid.
76 Data in this figure derived from IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Technical Summary* (Table TS.6, p52); also from *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Chapter 24 (pp6–9, also Figure 24–2, p66).*
77 IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Technical Summary* (p48).
78 Ibid. Glossary. (p1).
79 IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Summary for Policymakers* (Table SPM.1, p28).
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100 IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Chapter 24* (p9).
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103 IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Chapter 14* (pp3–5).
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113 Ibid. *Chapters 5, 6.*
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116 Ibid.
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119 Ibid.
120 Ibid.
121 Ibid.
122 Ibid.
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