

# CLIMATE CHANGE 2014:

IMPACTS, ADAPTATION, AND VULNERABILITY

**Observed regional impacts and projected key regional risks, and potential and opportunities for adaption**

## IPCC WGII

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# Observed regional impacts

- Climate change impacts on natural and human systems are already occurring across all the regions (on all continents and across the oceans)
- Observed human impacts vary within and across regions, linked to differences in vulnerability and exposure
- Heightened vulnerability is linked to multidimensional inequalities often produced by uneven development processes



There are substantial adaptation deficits in some regions, for example in some regions of Australasia to current flood risk, and in parts of Africa for food security linked to high levels of climate variability

Source for image: <http://triplehelixblog.com/2011/03/pakistan-floods-an-analysis-of-revealed-weaknesses/>

Asia	
Snow & Ice, Rivers & Lakes, Floods & Drought	<ul style="list-style-type: none"> <li>Permafrost degradation in Siberia, Central Asia, &amp; Tibetan Plateau (<i>high confidence</i>, Major contribution from climate change)</li> <li>Shrinking mountain glaciers across most of Asia (<i>medium confidence</i>, Major contribution from climate change)</li> <li>Changed water availability in many Chinese rivers, beyond changes due to land use (<i>low confidence</i>, Minor contribution from climate change)</li> <li>Increased flow in four rivers due to shrinking glaciers in the Himalayas &amp; Central Asia (<i>high confidence</i>, Major contribution from climate change)</li> <li>Earlier timing of maximum spring flood in Russian rivers (<i>medium confidence</i>, Major contribution from climate change)</li> <li>Reduced soil moisture in north-central &amp; northeast China (1950-2006) (<i>medium confidence</i>, Major contribution from climate change)</li> <li>Surface water degradation in parts of Asia, beyond changes due to land use (<i>medium confidence</i>, Minor contribution from climate change)</li> </ul> <p>[24.3-4, 28.2, Tables 18-5, 18-6, &amp; SM24-4, Box 3-1; WGI AR5 4.3, 10.5]</p>
Terrestrial Ecosystems	<ul style="list-style-type: none"> <li>Changes in plant phenology &amp; growth in many parts of Asia (earlier greening), particularly in the north &amp; east (<i>medium confidence</i>, Major contribution from climate change)</li> <li>Distribution shifts of many plant &amp; animal species upwards in elevation or polewards, particularly in the north of Asia (<i>medium confidence</i>, Major contribution from climate change)</li> <li>Invasion of Siberian larch forests by pine &amp; spruce during recent decades (<i>low confidence</i>, Major contribution from climate change)</li> <li>Advance of shrubs into the Siberian tundra (<i>high confidence</i>, Major contribution from climate change)</li> </ul> <p>[4.3, 24.4, 28.2, Table 18-7, Figure 4-4]</p>
Coastal Erosion & Marine Ecosystems	<ul style="list-style-type: none"> <li>Decline in coral reefs in tropical Asian waters, beyond decline due to human impacts (<i>high confidence</i>, Major contribution from climate change)</li> <li>Northward range extension of corals in the East China Sea and western Pacific, and of a predatory fish in the Sea of Japan (<i>medium confidence</i>, Major contribution from climate change)</li> <li>Shift from sardines to anchovies in the western North Pacific, beyond fluctuations due to fisheries (<i>low confidence</i>, Major contribution from climate change)</li> <li>Increased coastal erosion in Arctic Asia (<i>low confidence</i>, Major contribution from climate change)</li> </ul> <p>[6.3, 24.4, 30.5, Tables 6-2 &amp; 18-8]</p>
Food Production & Livelihoods	<ul style="list-style-type: none"> <li>Impacts on livelihoods of indigenous groups in Arctic Russia, beyond economic &amp; sociopolitical changes (<i>low confidence</i>, Major contribution from climate change)</li> <li>Negative impacts on aggregate wheat yields in South Asia, beyond increase due to improved technology (<i>medium confidence</i>, Minor contribution from climate change)</li> <li>Negative impacts on aggregate wheat &amp; maize yields in China, beyond increase due to improved technology (<i>low confidence</i>, Minor contribution from climate change)</li> <li>Increases in a water-borne disease in Israel (<i>low confidence</i>, Minor contribution from climate change)</li> </ul> <p>[7.2, 13.2, 18.4, 28.2, Tables 18-4 &amp; 18-9, Figure 7-2]</p>
Australasia	
Snow & Ice, Rivers & Lakes, Floods & Drought	<ul style="list-style-type: none"> <li>Significant decline in late-season snow depth at 3 of 4 alpine sites in Australia (1957-2002) (<i>medium confidence</i>, Major contribution from climate change)</li> <li>Substantial reduction in ice &amp; glacier ice volume in New Zealand (<i>medium confidence</i>, Major contribution from climate change)</li> <li>Intensification of hydrological drought due to regional warming in southeast Australia (<i>low confidence</i>, Minor contribution from climate change)</li> <li>Reduced inflow in river systems in southwestern Australia (since the mid-1970s) (<i>high confidence</i>, Major contribution from climate change)</li> </ul> <p>[25.5, Tables 18-5, 18-6, &amp; 25-1; WGI AR5 4.3]</p>
Terrestrial Ecosystems	<ul style="list-style-type: none"> <li>Changes in genetics, growth, distribution, &amp; phenology of many species, in particular birds, butterflies, &amp; plants in Australia, beyond fluctuations due to variable local climates, land use, pollution, &amp; invasive species (<i>high confidence</i>, Major contribution from climate change)</li> <li>Expansion of some wetlands &amp; contraction of adjacent woodlands in southeast Australia (<i>low confidence</i>, Major contribution from climate change)</li> <li>Expansion of monsoon rainforest at expense of savannah &amp; grasslands in northern Australia (<i>medium confidence</i>, Major contribution from climate change)</li> <li>Migration of glass eels advanced by several weeks in Waikato River, New Zealand (<i>low confidence</i>, Major contribution from climate change)</li> </ul> <p>[Tables 18-7 &amp; 25-3]</p>
Coastal Erosion & Marine Ecosystems	<ul style="list-style-type: none"> <li>Southward shifts in the distribution of marine species near Australia, beyond changes due to short-term environmental fluctuations, fishing, &amp; pollution (<i>medium confidence</i>, Major contribution from climate change)</li> <li>Change in timing of migration of seabirds in Australia (<i>low confidence</i>, Major contribution from climate change)</li> <li>Increased coral bleaching in Great Barrier Reef &amp; western Australian reefs, beyond effects from pollution &amp; physical disturbance (<i>high confidence</i>, Major contribution from climate change)</li> <li>Changed coral disease patterns at Great Barrier Reef, beyond effects from pollution (<i>medium confidence</i>, Major contribution from climate change)</li> </ul> <p>[6.3, 25.6, Tables 18-8 &amp; 25-3]</p>
Food Production & Livelihoods	<ul style="list-style-type: none"> <li>Advanced timing of wine-grape maturation in recent decades, beyond advance due to improved management (<i>medium confidence</i>, Major contribution from climate change)</li> <li>Shift in winter vs. summer human mortality in Australia, beyond changes due to exposure &amp; health care (<i>low confidence</i>, Major contribution from climate change)</li> <li>Relocation or diversification of agricultural activities in Australia, beyond changes due to policy, markets, &amp; short-term climate variability (<i>low confidence</i>, Minor contribution from climate change)</li> </ul> <p>[11.4, 18.4, 25.7-8, Tables 18-9 &amp; 25-3, Box 25-5]</p>
North America	
Snow & Ice, Rivers & Lakes, Floods & Drought	<ul style="list-style-type: none"> <li>Shrinkage of glaciers across western &amp; northern North America (<i>high confidence</i>, Major contribution from climate change)</li> <li>Decreasing amount of water in spring snowpack in western North America (1960-2002) (<i>high confidence</i>, Major contribution from climate change)</li> <li>Shift to earlier peak flow in snow dominated rivers in western North America (<i>high confidence</i>, Major contribution from climate change)</li> <li>Increased runoff in the midwestern and northeastern US (<i>medium confidence</i>, Minor contribution from climate change)</li> </ul> <p>[Tables 18-5 &amp; 18-6; WGI AR5 2.6, 4.3]</p>
Terrestrial Ecosystems	<ul style="list-style-type: none"> <li>Phenology changes &amp; species distribution shifts upward in elevation &amp; northward across multiple taxa (<i>medium confidence</i>, Major contribution from climate change)</li> <li>Increased wildfire frequency in subarctic conifer forests &amp; tundra (<i>medium confidence</i>, Major contribution from climate change)</li> <li>Regional increases in tree mortality &amp; insect infestations in forests (<i>low confidence</i>, Minor contribution from climate change)</li> <li>Increase in wildfire activity, fire frequency &amp; duration, &amp; burnt area in forests of the western US and boreal forests in Canada, beyond changes due to land use &amp; fire management (<i>medium confidence</i>, Minor contribution from climate change)</li> </ul> <p>[26.4, 28.2, Table 18-7, Box 26-2]</p>
Coastal Erosion & Marine Ecosystems	<ul style="list-style-type: none"> <li>Northward distributional shifts of northwest Atlantic fish species (<i>high confidence</i>, Major contribution from climate change)</li> <li>Changes in musselbeds along the west coast of US (<i>high confidence</i>, Major contribution from climate change)</li> <li>Changed migration &amp; survival of salmon in northeast Pacific (<i>high confidence</i>, Major contribution from climate change)</li> <li>Increased coastal erosion in Alaska &amp; Canada (<i>medium confidence</i>, Major contribution from climate change)</li> </ul> <p>[18.3, 30.5, Tables 6-2 &amp; 18-8]</p>
Food Production & Livelihoods	<p>Impacts on livelihoods of indigenous groups in the Canadian Arctic, beyond effects of economic &amp; sociopolitical changes (<i>medium confidence</i>, Major contribution from climate change)</p> <p>[18.4, 28.2, Tables 18-4 &amp; 18-9]</p>

# Projected key regional risks

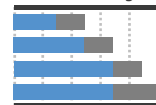
- Key risks are potentially severe impacts relevant to Article 2 of the UNFCCC, which refers to “dangerous anthropogenic interference with the climate system”
- Risks are considered key due to high hazard or high vulnerability of exposed societies and/or systems
- Risks will vary through time across regions and populations, dependent on myriad factors including the extent of adaptation and mitigation
- Many key risks constitute particular challenges for the least developed countries and for vulnerable communities
- For example, few small-scale farmers across Africa are able to adapt to climatic changes, while others are restricted by a suite of overlapping barriers

### POLAR REGIONS

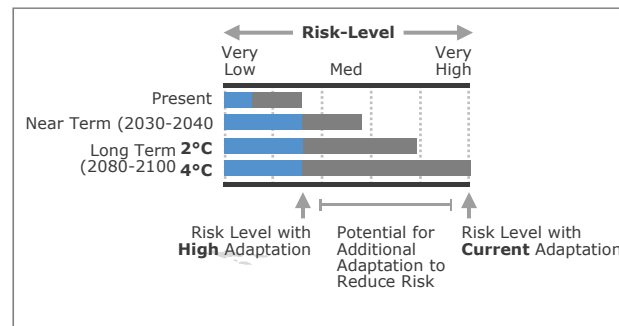
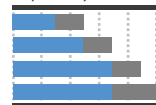
Risks for Ecosystems



Risks for Health and Well-Being



Unprecedented Challenges, Especially from Rate of Change

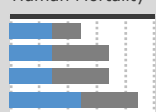


### NORTH AMERICA

Increased Risks from Wildfires



Heat-Related Human Mortality



Damages from River and Coastal Urban Floods

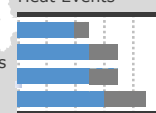


### EUROPE

Increased Flood Losses and Impacts



Increased Losses and Impacts from Extreme Heat Events



Increased Water Restrictions



### ASIA

Increased Flood Damage to Infrastructure, Livelihoods, and Settlements



Heat-Related Human Mortality



Increased Drought-Related Water and Food Shortage

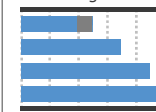


### THE OCEAN

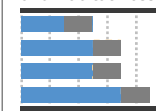
Reduced Fisheries Catch Potential at Low Latitudes



Increased Mass Coral Bleaching and Mortality

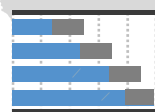


Coastal Inundation and Habitat Loss

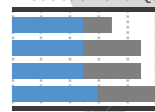


### CENTRAL AND SOUTH AMERICA

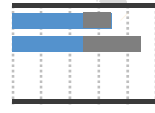
Reduced Water Availability and Increased Flooding and Landslides



Reduced Food Production and Quality



Vector-Borne Diseases

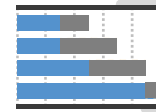


### AFRICA

Compounded Stress on Water Resources



Reduced Crop Productivity and Livelihood and Food Security

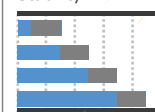


Vector- and Water-Borne Diseases

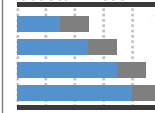


### SMALL ISLANDS

Loss of Livelihoods, Settlements, Infrastructure, Ecosystem Services, and Economic Stability



Risks for Low-Lying Coastal Areas



### AUSTRALASIA

Significant Change in Composition and Structure of Coral Reef Systems



Increased Flood Damage to Infrastructure and Settlements



Increased Risks to Coastal Infrastructure and Low-Lying Ecosystems





Climate-related decreases in **food security** and increased **malnutrition** are rated as high or very high risks in Africa, Asia, Central and South America under current levels of adaptation, should global mean temperature increase by 4°C

# Potential and opportunities for adaptation

- Adaptation experience is increasing across the regions and is becoming embedded in some planning processes, with more limited implementation of responses
- While some regional risks can be reduced through adaptation, others may prove intractable
- There are significant adaptation challenges that are distributed unevenly across and within regions
- Opportunities to facilitate increased resilience of poor and marginalised people lie in insurance programmes, social protection, disaster risk management, and support to community-based adaptation
- Such policies and responses will be effective if they address the underlying causes of poverty and inequality



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# **EFFECTIVE CLIMATE CHANGE ADAPTATION**

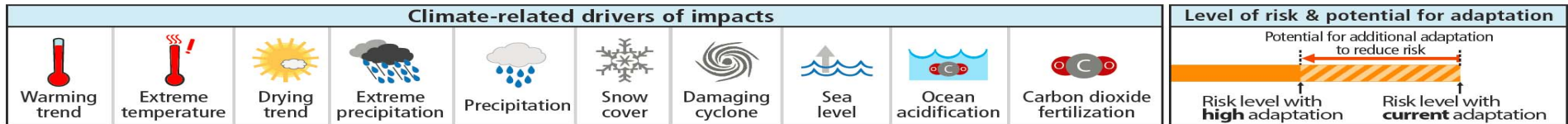
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**A MORE VIBRANT WORLD**

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INTERGOVERNMENTAL PANEL ON climate change

Even under high  
adaptation, some residual  
impacts across regions in  
a 2°C world would be  
significant



### Africa

Key risk	Adaptation issues & prospects	Climatic drivers	Timeframe	Risk & potential for adaptation
<p>Compounded stress on water resources facing significant strain from overexploitation and degradation at present and increased demand in the future, with drought stress exacerbated in drought-prone regions of Africa (<i>high confidence</i>)</p> <p>[22.3-4]</p>	<ul style="list-style-type: none"> <li>Reducing non-climate stressors on water resources</li> <li>Strengthening institutional capacities for demand management, groundwater assessment, integrated water-wastewater planning, and integrated land and water governance</li> <li>Sustainable urban development</li> </ul>		Present Near-term (2030-2040) Long-term (2080-2100) 2°C Long-term (2080-2100) 4°C	
<p>Reduced crop productivity associated with heat and drought stress, with strong adverse effects on regional, national, and household livelihood and food security, also given increased pest and disease damage and flood impacts on food system infrastructure (<i>high confidence</i>)</p> <p>[22.3-4]</p>	<ul style="list-style-type: none"> <li>Technological adaptation responses (e.g., stress-tolerant crop varieties, irrigation, enhanced observation systems)</li> <li>Enhancing smallholder access to credit and other critical production resources; Diversifying livelihoods</li> <li>Strengthening institutions at local, national, and regional levels to support agriculture (including early warning systems) and gender-oriented policy</li> <li>Agronomic adaptation responses (e.g., agroforestry, conservation agriculture)</li> </ul>		Present Near-term (2030-2040) Long-term (2080-2100) 2°C Long-term (2080-2100) 4°C	
<p>Changes in the incidence and geographic range of vector- and water-borne diseases due to changes in the mean and variability of temperature and precipitation, particularly along the edges of their distribution (<i>medium confidence</i>)</p> <p>[22.3]</p>	<ul style="list-style-type: none"> <li>Achieving development goals, particularly improved access to safe water and improved sanitation, and enhancement of public health functions such as surveillance</li> <li>Vulnerability mapping and early warning systems</li> <li>Coordination across sectors</li> <li>Sustainable urban development</li> </ul>		Present Near-term (2030-2040) Long-term (2080-2100) 2°C Long-term (2080-2100) 4°C	

### Europe

Key risk	Adaptation issues & prospects	Climatic drivers	Timeframe	Risk & potential for adaptation
<p>Increased economic losses and people affected by flooding in river basins and coasts, driven by increasing urbanization, increasing sea levels, coastal erosion, and peak river discharges (<i>high confidence</i>)</p> <p>[23.2-3, 23.7]</p>	<p>Adaptation can prevent most of the projected damages (<i>high confidence</i>).</p> <ul style="list-style-type: none"> <li>Significant experience in hard flood-protection technologies and increasing experience with restoring wetlands</li> <li>High costs for increasing flood protection</li> <li>Potential barriers to implementation: demand for land in Europe and environmental and landscape concerns</li> </ul>		Present Near-term (2030-2040) Long-term (2080-2100) 2°C Long-term (2080-2100) 4°C	
<p>Increased water restrictions. Significant reduction in water availability from river abstraction and from groundwater resources, combined with increased water demand (e.g., for irrigation, energy and industry, domestic use) and with reduced water drainage and runoff as a result of increased evaporative demand, particularly in southern Europe (<i>high confidence</i>)</p> <p>[23.4, 23.7]</p>	<ul style="list-style-type: none"> <li>Proven adaptation potential from adoption of more water-efficient technologies and of water-saving strategies (e.g., for irrigation, crop species, land cover, industries, domestic use)</li> <li>Implementation of best practices and governance instruments in river basin management plans and integrated water management</li> </ul>		Present Near-term (2030-2040) Long-term (2080-2100) 2°C Long-term (2080-2100) 4°C	
<p>Increased economic losses and people affected by extreme heat events: impacts on health and well-being, labor productivity, crop production, air quality, and increasing risk of wildfires in southern Europe and in Russian boreal region (<i>medium confidence</i>)</p> <p>[23.3-7, Table 23-1]</p>	<ul style="list-style-type: none"> <li>Implementation of warning systems</li> <li>Adaptation of dwellings and workplaces and of transport and energy infrastructure</li> <li>Reductions in emissions to improve air quality</li> <li>Improved wildfire management</li> <li>Development of insurance products against weather-related</li> </ul>		Present Near-term (2030-2040) Long-term (2080-2100) 2°C	

Under an emissions scenario leading to a long-term 2°C warming, all nine assessed risks for Africa remain **high** or **very high** under current levels of adaptation

**Even under high adaptation, residual impacts in a 2°C world would be significant** - only the migration risk is rated as being capable of reduction to low.

**Opportunities for risk reduction through mitigation and adaptation lie in strengthening governance, reducing non-climate stressors, integrated land and water management, diversifying livelihoods, social protection, behavioural, technological and infrastructural responses, responses that integrate local/traditional and scientific knowledge**

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INTERGOVERNMENTAL PANEL ON climate change

# Key messages

- Climate change impacts are already occurring on all continents and across the oceans, with a particularly strong signal in Arctic ecosystems and warm water coral reefs
- Differential impacts, vulnerability and adaptation responses across the regions are linked to multi-factor inequalities and underdevelopment, as well as climate effects
- Adaptation responses will be therefore be most effective if they address the underlying causes of poverty and inequality
- Despite the range of adaptation opportunities to respond to the risks, they will be difficult to manage with high levels of warming
- Many residual impacts in a 2°C world, even under high adaptation
- Increasing magnitudes of warming increase the likelihood of severe and pervasive impacts that may be surprising or irreversible