The IPCC's Fifth Assessment Report

What's in it for Latin America?

Executive Summary

CDKN

Climate & Development Knowledge Network

Image: Fisherman casts a net | Olivier Lantzendörffer, iStock

Cover image:
Amazon family | Daniel Rosenberg

The IPCC's Fifth Assessment Report offers the following key messages for Latin America

1. Latin America's climate is already changing and the impacts already are being felt
2. Further climate change is inevitable in the coming decades
3. Climate change poses challenges to growth and development in Latin America
4. Adaptation will bring immediate benefits and reduce the impacts of climate change in Latin America
5. Adaptation is fundamentally about risk management
6. Adaptation experience in Latin America is growing and regional cooperation is helping to facilitate adaptation at scale
7. Some low-carbon development options may be less costly in the long run and could offer new economic opportunities for Latin America
8. Latin America stands to benefit from further integration of climate adaptation, mitigation and development approaches
9. International cooperation is vital to avert dangerous climate change and Latin American 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[1]

Latin America'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.[2] Since the 1950s, the rate of global warming has been unprecedented compared to previous decades and millennia.

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.[4] In many parts of the world, including Latin America, changing rainfall is altering freshwater systems, affecting the quality and quantity of water available.[5]

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.[6] Current science provides the clearest evidence yet that human activity is changing our climate.[7]

The impacts of climate change will affect water availability, food production and quality and the incidence of vector-borne diseases in Latin America.[8] 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. Thus, climate change will progressively threaten and economic growth[9] and human security[10] in complex ways, in this region and across the world.

Box 1: How the IPCC's *Fifth Assessment Report* defines scientific certainty[11]

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.

The IPCC finds many observed changes in Latin America's climate, including significant trends in temperature and rainfall (*high confidence):*

Observed temperature trends.[12] Warming of 0.7–1°C has been detected throughout the region since the 1970s, except for off the Chilean coast where cooling of about -1°C has been observed in the same timeframe. Increases in temperature extremes have been observed in Central America and most of tropical and subtropical South America (*medium confidence).*

Observed rainfall trends.[13] Increasing trends in annual rainfall in Southeastern South America contrast with decreasing trends in Central America and Central-Southern Chile. More frequent extreme rainfall in Southeastern South America has led to landslides and flash floods (*medium confidence).*

Observed sea level rise.[14] 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)* at a rate of 1.3–1.7 millimetres (mm) per year over much of the 20th century but increasing to 2.8–3.6 mm per year since 1993. Sea level rise can vary among regions, due to a complex set of interactions.[15] 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. Sediment and tectonic movements in the ocean bed cause additional variations in sea level.

Figure 1: Change in annual average temperature in Latin America, 1901–2012[16]

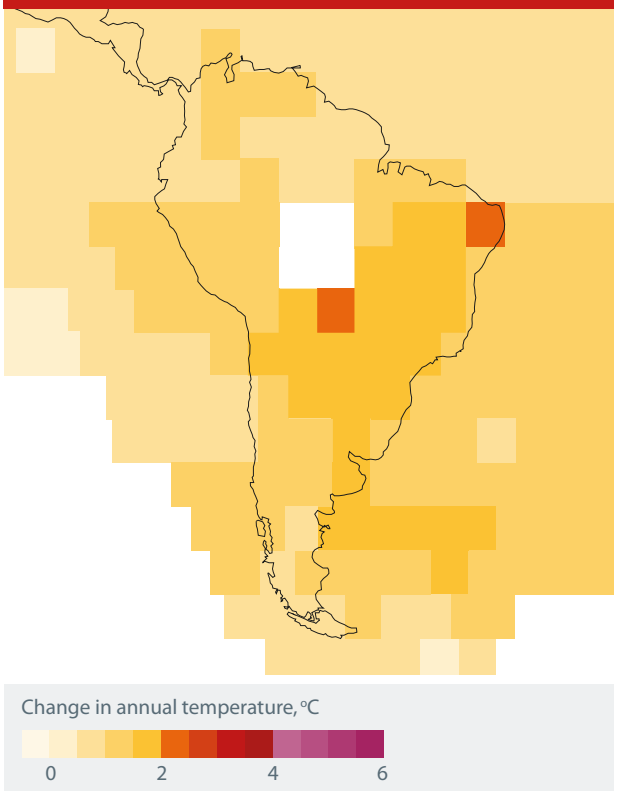
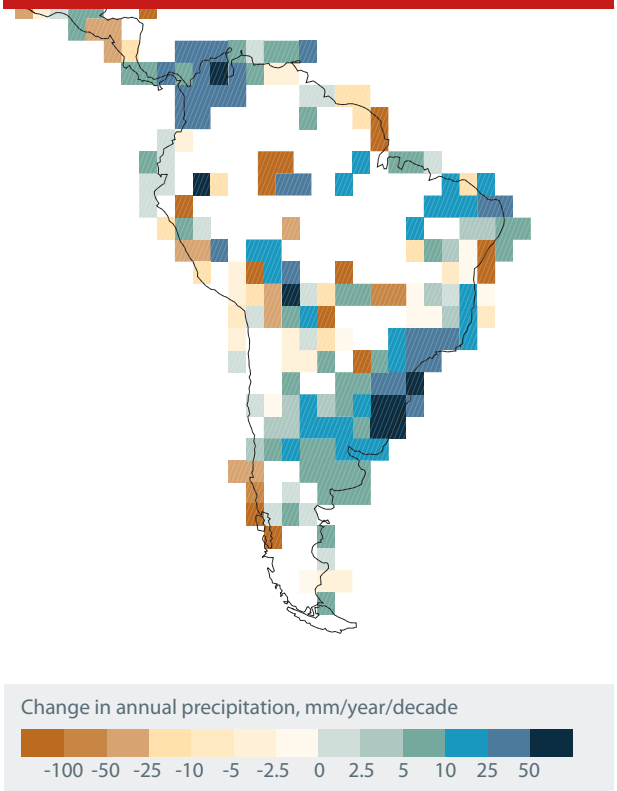


Figure 2: Change in annual average rainfall in Latin America, 1951–2010[17]



The Andean glaciers are retreating, affecting the seasonal distribution of stream flows (*high confidence*).[25]

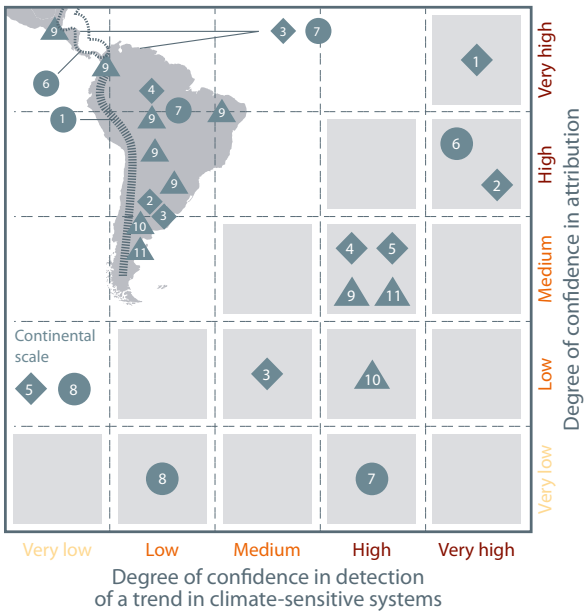
Observed effects of climate change. In recent decades, changes in climate have caused impacts on natural and human systems on all continents and across the oceans, including Latin America.[18] The figure below lists the observed impacts for Latin America that can be attributed to climate change, and the confidence in this causal link between climate and impacts.

Latin America is a region with abundant freshwater resources, but these are unevenly distributed. Existing resources are very important for urban water supply, for the agriculture practiced by the hundreds of millions of people in the region, and for hydropower, which meets 60% of the region's electricity demand.[19] Changes in stream flow and water availability have been observed (*high confidence)*, in the La Plata River basin, spanning parts of Argentina, Bolivia, Brazil, Paraguay and Uruguay, for example.[20] The Andean glaciers are retreating, affecting the seasonal distribution of stream flows (*high confidence)* and changes in surface water run-off in the La Plata River basin and Central Andes have been associated with changes in rainfall *(high confidence)*.[21]

Changes in weather and climatic patterns are negatively affecting human health in Latin America, with by increasing morbidity, mortality and disabilities (*high confidence),* and through the emergence of diseases in new areas (high confidence).[22]

Latin America houses the world's largest biological diversity and wilderness areas, including the Amazon basin. Conversion of natural ecosystems is the main cause of biodiversity and ecosystem loss in the region, and is the second biggest driver of human-induced climate change (*high confidence)* accounting for 17–20% of total greenhouse gas emissions during the 1990s.[23] Climate change is also altering coastal and marine ecosystems, with mangrove degradation due to climate change observed on the north coast of South America, for example.[24]

Figure 3: Role of climate change in shaping natural and human systems[26]



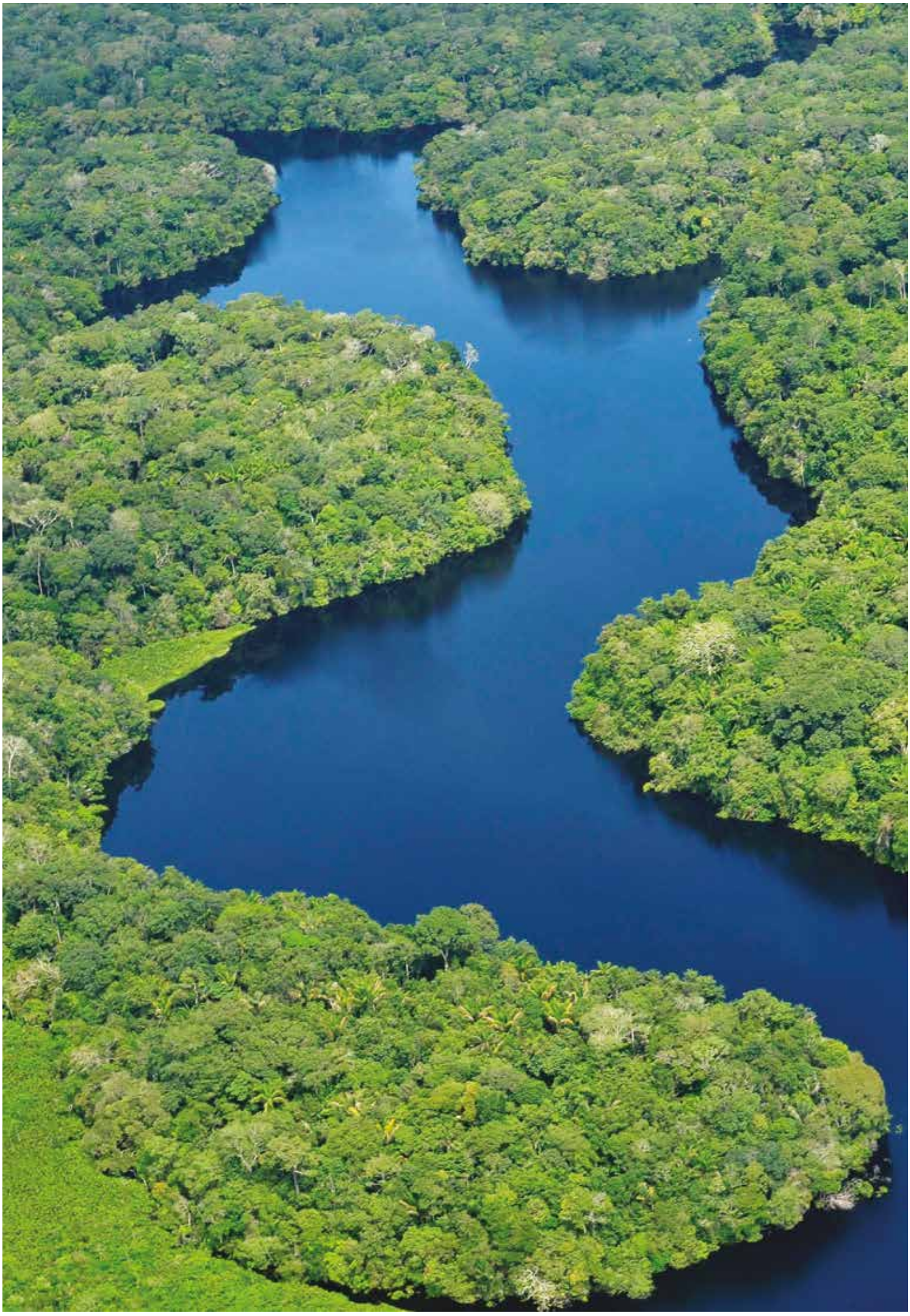
Key

Physical systems	
1	Glacier retreat in the Andes in South America
2	Streamflow increase La Plata Basin
3	Increase in heavy precipitation and in risk of land slides and flooding in southestern South America, and in Central America and northern South America
4	Changes in extreme flows in Amazon River
5	Coastal erosion and other physical sea level impacts
Biological systems	
6	Bleaching of coral reefs in western Caribbean and coast of Central America
7	Degrading and receding rainforest in Amazonia and in Central America and northern South America
8	Reduction in fisheries stock
Human and managed systems	
9	Increase in frequency and extension of dengue fever and malaria
10	Increases in agricultural yield in southeastern South America
11	Shifting in agricultural zoning

Figure 4: Impacts of climate change in Latin America[27]

Table 1: Observed climate impacts in Latin America[28]

Snow & ice, rivers & lakes, floods & drought	• Shrinkage of Andean glaciers (*high confidence*, major contribution from climate change) • Changes in extreme flows in Amazon River (*medium confidence*, major contribution from climate change) • Changing discharge patterns in rivers in the western Andes (*medium confidence*, major contribution from climate change) • Increased streamflow in sub-basins of the La Plata River, beyond increase due to land use change (*high confidence*, major contribution from climate change)
Terrestrial ecosystems	• Increased tree mortality and forest fire in Amazon (*low confidence*, minor contribution from climate change) • Rainforest degradation and recession in the Amazon, beyond reference trends in deforestation & land degradation (*low confidence*, minor contribution from climate change)
Coastal erosion & marine ecosystems	• Increased coral bleaching in western Caribbean, beyond effects from pollution and physical disturbance (*high confidence*, major contribution from climate change) • Mangrove degradation on north coast of South America, beyond degradation due to pollution and land use (*low confidence*, minor contribution from climate change)
Food production & livelihoods	• More vulnerable livelihood trajectories for indigenous Aymara farmers in Bolivia due to water shortage, beyond effects of increasing social and economic stress (*medium confidence*, major contribution from climate change) • Increase in agricultural yields and expansion of agricultural areas in southeastern South America, beyond increase due to improved technology (*medium confidence*, major contribution from climate change)



Box 2: Climate change poses risks to human and natural systems[29]

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.

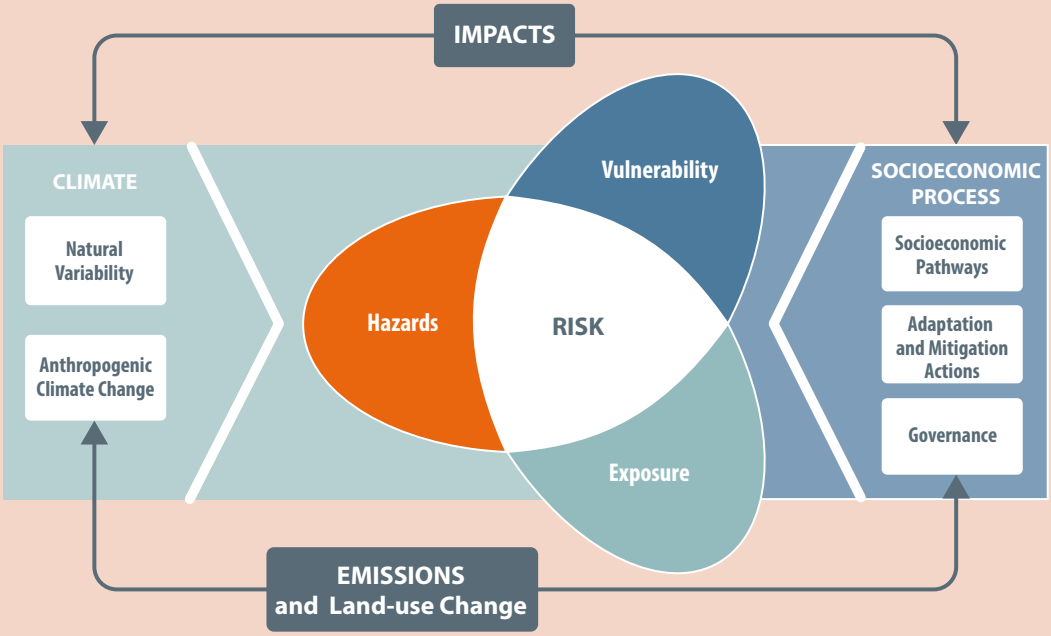


Image:
Aerial view of the Amazon rainforest | Neil Palmer, CIFOR

Regardless of future emissions, we are already committed to further warming.[30]

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. Globally, most greenhouse gas emissions due to human activities have come from few countries. Total emissions since 1970 have continued to rise, and emissions between 2000 and 2010 have been the highest yet.[31]

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).[32]

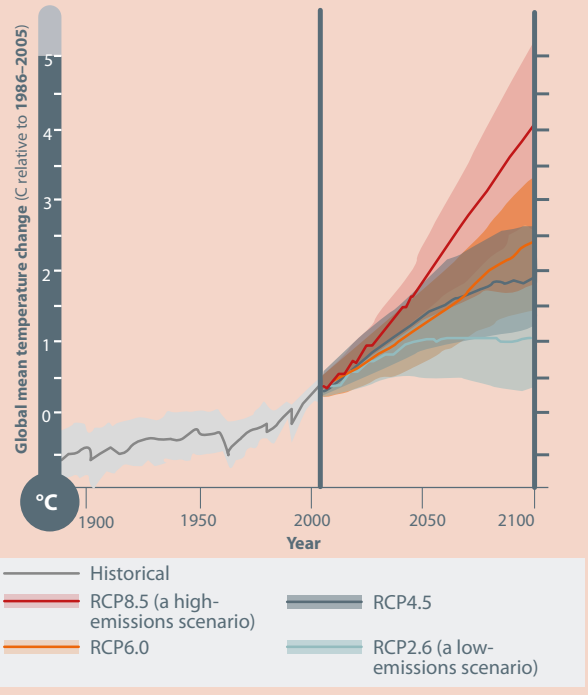
The figure in Box 3, below, illustrates projected warming under a low-emissions scenario, a high-emissions scenario[33] and two intermediate emissions scenarios, and the temperature changes associated with each. Whether global society continues to emit greenhouse gases at today's rate, or cuts greenhouse 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 difference and irreversible difference to the risks in the longer run.

Box 3: What are the IPCC scenarios?[34]

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.

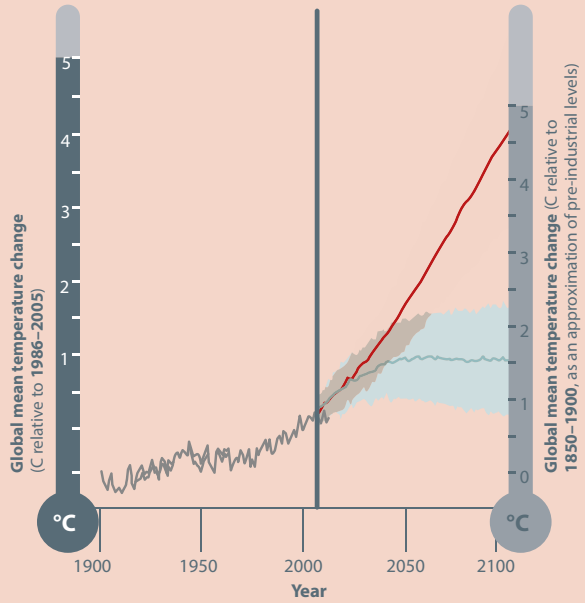
In the next few decades, warming will be the same in all scenarios (see the overlap between the scenarios at right, and in Box 4, opposite). Regardless of action taken now to reduce emissions, the climate will change until around the middle of this century. In the longer term, in all except the low-emissions 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.



Box 4: Impacts of global warming[35]

The diagram below shows global warming in the last century, and projected climate 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 temperatures reach a certain level, are sustained at that level or exceeded. At even relatively low levels of warming of 1 to 2°C, many unique natural systems are 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 for concern will increase risk of flooding and landslides in urban areas due to extreme rainfall, decline in water availability in semi-arid areas and glacier-melting dependent regions, declining food production and food quality, and spread of vector-borne diseases.

Observed and projected global annual average temperature



Global risks under increasing levels of climate change

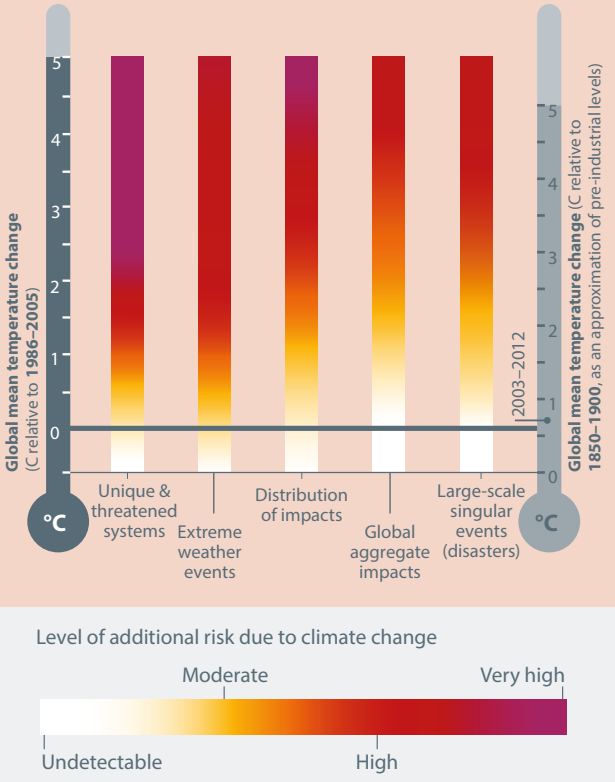


Image: Snowy Huasta, Conchucos in the Peruvian Andes | Thomas Mueller, SPDA

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 21). In contrast, taking action on adaptation today can deliver immediate benefits now and in the future. But, there are limits to adaptation.[36] For this reason, both adaptation and mitigation are needed; they each deliver benefits but over different timeframes.[37]

Projected temperature trends:[38] Climate projections suggest increases in temperature across Latin America by 2100 (*medium confidence)*. Under a range of medium and high emissions scenarios (RCPs 4.5 and 8.5), warming varies from +1.6°C to +4°C in Central America +1.7°C to +6.7°C in South America (*medium confidence)*. Projections show increases in warm days and nights in most of South America by 2100 *(medium confidence)*. Under a low emissions scenario (RCP2.6), warming is projected to increase across the region by +1°C to +1.5°C.[39]

Projected rainfall trends:[40] Increases or decreases in rainfall have been projected for the region (*medium confidence)*. Rainfall changes for Central America range from between -22% to +7% by 2100, while in South America rainfall varies geographically, most notably showing a reduction of -22% in Northeast Brazil, with an increase of +25% in Southeastern South America *(low confidence)*. By 2100, projections show an increase in dry spells in tropical South *America east of the Andes (medium confidence)*.

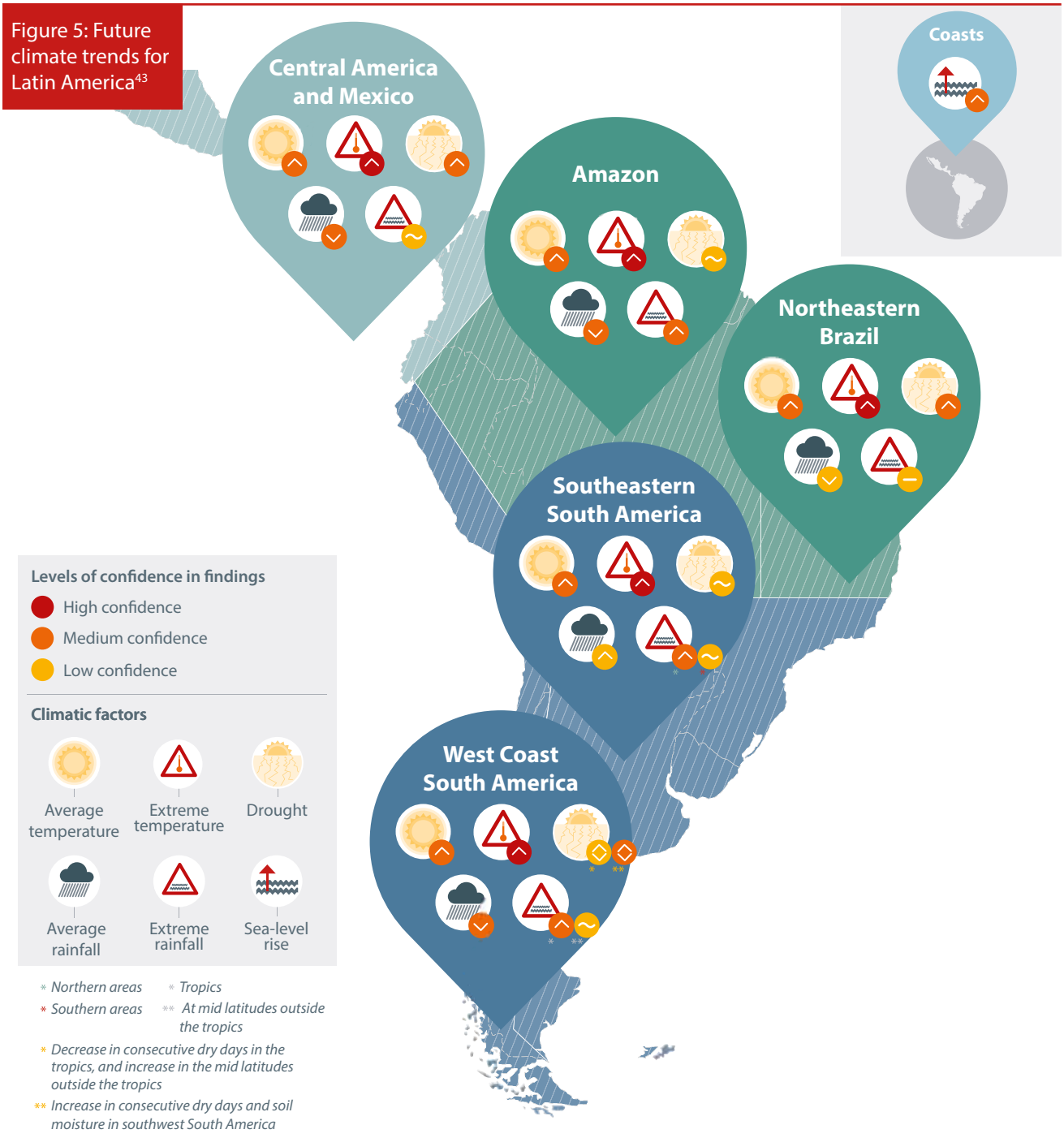
Projected sea level rise: Global average sea level will continue to rise during the 21st century; under all emissions scenarios – low and high – the rate of sea level rise will very likely exceed that observed during the past three decades.[41] Global average sea level rise by the last two decades of the 21st century (as compared to sea levels in 1986–2005) will likely be in the range of 26–55cm under a low-emissions scenario, but 45–82cm for a high-emissions scenario – with total sea level rise of up to 98cm by 2100 under this latter scenario.[42]

Climate change poses challenges to growth and development in Latin America

The *Fifth Assessment Report* identifies a set of climate-related risks for Latin America. These are:

Water availability, flooding and landslides: The availability of water in semi-arid and glacier melt-dependent regions and also across Central America will be affected by reduced

Figure 5: Future climate trends for Latin America[43]



Symbol	Rainfall	Temperature	Extreme rainfall, extreme temperature, sea-level rise
^	up to 25% increasing trend	1–6.7°C increasing trend	increasing trend
◇	both increasing and decreasing trends	–	both increasing and decreasing trends
v	up to 25% decreasing trend	–	decreasing trend
–	no or only slight change	inconsistent trend	inconsistent trend
~	inconsistent trend	inconsistent trend	inconsistent trend

Sugarcane and soy production are likely to respond positively to climate changes. The expansion of sugarcane, soy and oil palm production may increase deforestation and lead to loss of employment in some countries (*medium confidence*).[52]

snow cover, extreme rainfall, rising temperatures and drought (*high confidence).*[44] Urban and rural areas will be affected by flooding and landslides due to extreme rainfall events (*high confidence).*[45] Changes in stream flow are projected to continue in the near future in Latin America, affecting already vulnerable regions (*high confidence).*

Declines in food production and quality: The IPCC finds with *medium confidence* that food production and the quality of food will decrease due to a range of climate factors including extreme rainfall and temperature.[46]

Increases in global demand for food and biofuels led to a sharp increase in agricultural production in Latin America, a trend that is predicted to continue in the future.[47] However, changes in agricultural productivity with consequences for food security are expected to vary considerably across the region (*medium confidence).* In Southeastern South America, where projections indicate more rainfall, average productivity could be sustained or increased until the mid-century (*medium confidence*). But in Central America, northeast of Brazil and parts of the Andean region increases in temperature and decreases in rainfall could decrease agricultural productivity in the short term (by 2030), threatening the food security of the poorest populations. Considering that South America will be a key food-producing region in the future, one of the challenges will be to increase food quality and production while maintaining environmental sustainability in a changing climate.[48]

Spread of diseases: The IPCC finds with *high confidence* that vector-borne diseases will spread across altitudes and latitudes across the region, due to change in average and extreme temperature and rainfall.[49]

The IPCC finds with *very high confidence* that climate change is associated with respiratory and cardiovascular diseases, vector- and water-borne diseases (e.g. malaria, dengue, yellow fever, leishmaniasis, cholera and other diarrheal diseases), hantaviruses and rotaviruses, chronic kidney disease and psychological trauma.[50] Vulnerabilities vary across the region depending on age, gender, race, ethnicity and socio-economic status, and are rising in large cities in particular (*very high confidence).* Climate change will increase current and future risks to health, given the region's population growth rates and vulnerabilities in existing health, water, sanitation and waste collection systems, nutrition, pollution and food production in poor regions *(medium confidence).*[51]

The considerable threats outlined by the IPCC could undermine the progress that Latin American countries have made in tackling poverty in the past decades, together with gains in economic growth. Adaptation can reduce these risks and bring immediate benefits.

Adaptation will bring immediate benefits and reduce the impacts of climate change in Latin America

Adaptation is the only effective option to manage the 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".[53] Through adaptation, societies and communities can moderate the harm of current and future climate risks or to take advantage of new opportunities.

In Latin America, climate change interacts with economic, social and environmental stressors to increase people's vulnerabilities. For example, land use change, particularly high rates of deforestation in the Amazon basin and Cerrado, contributes significantly to environmental degradation, which intensifies the negative impacts of climate change (*high confidence).*[54] There remains a high and persistent level of poverty in most countries of the region, in spite of the sustained economic growth observed in the last decade. Economic inequality is characterised by unequal access to water, sanitation and adequate housing. As a consequence, poorer households are more vulnerable to climate variability and change (*high confidence).*[55]

In many Latin American countries, a first step toward adaptation to future climate changes is to reduce the vulnerability to present climate change.[56] Indeed, effective adaptation can, and should, reduce the risks posed to livelihoods, infrastructure, ecosystem services and economic stability (see Figure 6, overleaf). For example, urban and rural flood management, better forecasting and early warning systems can reduce flood risk from extreme rainfall.[57]

The IPCC emphasises that integrating adaptation into planning and decision-making can create many synergies with development. 'No regrets' or 'low regrets' measures such as safe housing and settlement structures and improved access to education are good for development, irrespective of changes in climate (Table 2).

"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 in the future." *Vicente Barros, Co-Chair of Working Group II*

Image: Bolivian farmer | Thomas Mueller, SPDA

Figure 6: Adaptation can reduce risk[58]

Key risk	Adaptation issues and prospects	Climate drivers	Time frame	Risk and potential for adaptation
Water availability in semi-arid and glacier-melt-dependent regions and Central America; flooding and landslides in urban and rural areas due to extreme precipitation *(high confidence)*.	• Integrated water resource management • Urban and rural flood management (including infrastructure), early warning systems, better weather and runoff forecasts, and infectious disease control		Present Near-term (2030–2040) Long-term (2080–2100)	Very low / Medium / Very high 2°C 4°C
Decreased food production and food quality *(medium confidence)*.	• Development of new crop varieties more adapted to climate change (temperature and drought) • Offsetting of human and animal health impacts of reduced food quality • Offsetting of economic impacts of land-use change • Strengthening traditional indigenous knowledge systems and practices		Present Near-term (2030–2040) Long-term (2080–2100)	Very low / Medium / Very high 2°C 4°C
Spread of vector-borne diseases in altitude and latitude (*high confidence*).	• Development of early warning systems for disease control and mitigation based on climatic and other relevant inputs. Many factors augment vulnerability • Establishing programmes to extend basic public health services		Present Near-term (2030–2040) Long-term (2080–2100)	Very low / Medium / Very high 2°C Not available 4°C Not available

Climatic factors

Average temperature; Extreme temperature; Drought; Average rainfall; Extreme rainfall; Snow cover; Carbon dioxide fertilisation*

Level of risk and potential for adaptation

Potential for additional adaptation to reduce risk

Risk level with **high** adaptation; Risk level with **current** adaptation

** Increased concentrations of carbon dioxide in the atmosphere have been shown to increase plant growth and plants' water use efficiency. This positive effect is called the 'carbon dioxide fertilisation effect' and applies to forests, crops and other vegetation [high confidence]. However, not all plant communities respond positively to increasing levels of carbon dioxide. In some instances, nutrient limitation can impede the fertilisation effect. Significant uncertainties remain on the magnitude of this effect, particularly outside temperate climates. Just as the table in the Fifth Assessment Report (above) indicates that climate change will increase food insecurity, the IPCC also notes elsewhere in its assessment that climate change may increase the incidence of drying and forest fires. These trends indicate that the 'carbon dioxide fertilisation effect' on forests, crops and other vegetation should not be viewed in isolation.*

Image: Cartagena | Mathieu Lacoste, CDKN

Box 6: Women, children and the elderly can be more vulnerable to climate change impacts[59]

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[60]

The IPCC concludes:

- 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.

Table 2: Action on climate change adaptation can bolster development[61]

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.

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 Latin America, 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. The poor level of climate adaptation in Latin American countries is shown by the fact that responses to disasters are mainly reactive rather than preventative.[62] Much can be done to anticipate and reduce risk, rather than reacting after impacts have occurred. Some early warning systems are being implemented, but the capacity to respond to a warning is often limited, particularly among poorer populations.[63]

Support for effective disaster relief and recovery needs to continue, along with proactive efforts to reduce risk. These include integrating comprehensive risk assessments and risk reduction measures into national economic and development policy.

The development and implementation of systemic adaptation strategies, involving institutional, social, ecosystem, environmental, financial and capacity components to reduce vulnerability to present climate extreme events is a key step towards climate change adaptation in Latin America.[64]

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. 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. 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.[65] Measures to reduce climate-related risks for the long-term may include providing adequate housing, infrastructure or services, or mainstreaming climate change into planning processes (see Table 2).

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.[66] Coping with new situations may require new approaches, such as multi-level risk governance associated with decentralisation in decision-making and responsibility.[67]

Adaptation experience in Latin America is growing and regional cooperation is helping to facilitate adaptation at scale

In Latin America, countries are already accumulating practical experience in adapting to climate change at the national and local levels. Experiences of effective adaptation are being documented, as are instances of 'maladaptation' (see Glossary for a full definition of 'maladaptation'). Lessons have already been learned from these first experiences and tools, such as the Index of Usefulness of Practices for Adaptation (IUPA) to evaluate adaptation practices.[68]

Evidenced by these practical experiences, there is a wide range of options to foster adaptation and the capacity to adapt to climate change in the region. Adaptation options highlighted in the *Fifth Assessment Report* for the Latin America region as a whole are presented in Table 3.

Table 3: Options for adapting to climate-related risks in Latin America[69]

Vulnerabilities compounded by climate impacts in Latin America	Options for adaptation or for adaptation and mitigation combined
Changes in stream flow and water availability has been observed and will continue in the future (*high confidence*).	• Ongoing constitutional and legal reform towards more efficient and effective water resources management and coordination (*medium confidence*). • Groundwater pumping, fog capture, reservoirs and irrigation infrastructure in semi-arid areas. • Improved agricultural water management practices. • Flood management practices (*medium confidence*).
Biodiversity and ecosystem loss caused by conversion of natural ecosystems (*high confidence*) increasing exposure to climate risk and greenhouse gas emissions.	• Ecosystem-based adaptation practices are increasingly common across the region, such as the effective management and establishment of protected areas, conservation agreements and community management of natural areas.
Risk of flooding in coastal and low-lying areas.	• Coastal planning to facilitate mangrove restoration and reduce coastal erosion. • Redirecting new settlements to safer locations and promote investments in appropriate infrastructure.
Changes in agricultural productivity with consequences for food security (*medium confidence).*	• Genetic advances and suitable soil and technological management. • Conservation agriculture. • Improved water conservation and management. • Index-based insurance. • Local and indigenous knowledge. • Livelihood diversification.
Vulnerabilities in urban settlements and industry are compounded by climate change.	• Integrating climate policies with disaster risk management and land use and economic development planning.
Renewable energy based on biomass can impact on land-use change and deforestation (*medium confidence*).	• Advances in second-generation bioethanol from sugarcane and other feedstocks will be important as a measure of mitigation. • Integration of biofuel crops with conservation measures.
Negative impacts on human health (*high confidence*).	• Investment in research and development, as well as improved governance and systems for prevention and response.

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 Latin America. Moreover, the characteristics of community or society's capacity to adapt to climate change will differ from place to place, and depend largely on specific contexts.

This is why autonomous adaptation experience is mainly realised at the local level with examples found, for instance, for rural communities in Honduras, indigenous communities in Bolivia and coffee agroforestry systems in Brazil. In certain regions or communities, such as Anchioreta in Brazil, adaptation is part of a permanent process and is actually tackled through a clear objective of vulnerability reduction, maintaining and diversifying a large set of natural varieties of corn and allowing the farmers to diversify their planting.[70]

Another kind of autonomous adaptation is the southward displacement of agriculture activities (e.g. wine, coffee) through the purchase of lands that will become favourable in a warmer climate. In Argentina, the increase of rainfall observed during the past 30 years contributed to a westward displacement of the annual crop frontier. However, local adaptations like these may undermine the long-term resilience of systems when local, short-term strategies designed to deal with specific threats or challenges do not integrate a more holistic and long-term vision.[71]

There can be barriers or limits that impede adaptation. These include competing national priorities challenges of 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.[72]

In Latin America, governments' adaptation policies have been strengthened by participation in international networks, where experience and knowledge can be exchanged. For example, the C40 Cities-Climate Leadership Group includes Bogota, Buenos Aires, Caracas, Curitiba, Rio de Janeiro, Sao Paulo, Lima and Santiago de Chile. Most of these cities have developed related strategies and action plans, e.g. Action Plan Buenos Aires 2030, Plan for Caracas 2020 and Lima's Metropolitan Strategy for Climate Change Adaptation.[73]

The 'Ibero-American Programme on Adaptation to Climate Change' (PIACC), developed by the Ibero-American Network of Climate Change Offices (RIOCC) is an example of a Latin American intergovernmental initiative. For Central America specificially, the Central American Commission for Environment and Development (CCAD) brings together the environment ministries of the Central American Integration System (Sistema de la Integracion Centroamericana (SICA) that released its climate change strategy in 2010.

These initiatives demonstrate Latin American governments' growing awareness of the need to integrate climate change and future climate risks into their policies. At the start of the *Fifth Assessment Report's* publication, a total of 18 Latin American countries had already published their first and / or second National Communication to the UNFCCC providing measurement of the country's emissions and assessing its present and future climate vulnerability. These include Argentina, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Nicaragua, Guyana, Panama, Paraguay, Peru, Suriname, Uruguay and Venezuela.[74]

Beyond the Fifth Assessment Report: Climate compatible development action in Cartagena, Colombia

Cartagena is an iconic World Heritage city in Colombia. It is a magnet for tourists and is also one of the country's most important ports and industrial and commercial hubs. Cartagena is also one of the Colombia's most climate-vulnerable cities and the first city in Latin America to produce a Climate Compatible Development Plan (Plan 4C). To tackle its climate-related risks and create development opportunities, the Colombian Ministry of Environment partnered with the City of Cartagena, the municipal Chamber of Commerce, and other academic and government stakeholders in a project to mainstream climate change and disaster risk management into sectoral and land use planning.

A vulnerability assessment was undertaken to evaluate the city's vulnerability and exposure to climate change and disaster risk. This formed the basis for Cartagena's 'Guidelines for Adaptation to Climate Change', which in turn inform public and private stakeholders involved in Cartagena's newly-launched Plan 4C (2014). Flooding and sea level rise are addressed as long-term and increasing threats to which Cartagena can adapt, and Plan 4C is viewed as a way to promote transformational investments in infrastructure and support sustainable growth and competitiveness in important economic sectors such as tourism, industries and shipping Actions include coastal protection, protection of the town centre, resilient development of the port, and the creation of 'adaptive neighbourhoods' for the poorest urban areas. What is more, these climate planning processes have led to measures to reduce long-term climate risk and drive sectoral competitiveness being included in other municipal planning processes. For example, Cartagena's Development Plan for 2013–2015 includes climate change as a cross-cutting issue and has a specifically assigned budget for climate action.[75]

Image: Cartagena | Mathieu Lacoste, CDKN

image: Wind turbine, Brazil | Lianne Milton, Panos

Without additional mitigation efforts beyond those in place today and even with adaptation, warming by the end of the 21stcentury will lead to high to very high risk of severe, widespread, and irreversible impacts globally (*high confidence*).[83]

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

Ambitious climate change 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.[76] 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 (See Box 8, below), which outlines the magnitude of this challenge.[77]

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 and avoid dangerous climate change. The IPCC states that under this ambitious scenario, emissions would peak in Latin America by 2030 then decline;[78] under such a scenario, Latin American emissions in 2040 would be 1% higher than they are today.

Key drivers of emissions in Latin America include the use of fossil fuel-based energy, population increases and economic growth.[79] Emission growth rates are (relative to the global level) low at 0.8% between 2000 and 2010.[80] Whilst total emission levels are the lowest for all regions in the world, per capita emission levels remain higher than in both Africa and Asia.[81] Mitigation efforts in Latin America would need to concentrate more on keeping emission levels low and less on emission reduction.

In 2010, governmental Parties to the United Nations Framework Convention on Climate Change (UNFCCC) meeting in Cancun[82] 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 actual government 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.[84] 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, Latin American 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, manage livestock sustainably, manage agricultural lands in climate-smart ways, adopt energy efficient transport systems and plan innovative low-carbon towns and cities . Managed carefully for social and environmental impacts, such actions can bring large benefits beyond reducing the impacts of climate change.

Mitigation involves some level of co-benefits and of risks from adverse side effects, which must be managed carefully. These risks do not involve the same possibility of severe, widespread and irreversible impacts as the risks from climate change itself.[85]

Beyond the Fifth Assessment Report: Carbon and water footprinting in Andean Cities[86]

The municipal governments of La Paz, Bolivia; Lima, Peru; and Quito, Ecuador assessed the carbon and water footprints of their own operations and those of the cities for 2012 (2011 in the case of Quito) using internationally-recognised methodologies (Carbon: Global Protocol for community-scale greenhouse gas emissions (GPC), GHG Protocol and ISO 14064:2006 (GHG); and Water: Water Footprint Assessment Manual of the Water Footprint Network).

The analysis clearly identified which main sectors and sources contribute to the municipal governments' and cities' carbon and water footprints and provide the first step to reducing those footprints. For example, at the municipal government level, in the Municipality of Lima, the administrative section was found to contribute more than 70% of the carbon footprint as a result of its materials purchased, which has focused attention on the need for a sustainable procurement policy. In the Municipality of La Paz, two municipal buildings were identified as the main consumers of gasoline and electricity. Measures have been proposed to convert vehicles from gasoline to natural gas, to install efficient lighting, and maintain a registry for electricity consumption, which will track and reduce these significant emissions sources. Meanwhile, the zoo was identified as a significant source of carbon and water pollution, problems which could be tackled in tandem. A proposal has been developed for an integrated energy production and wastewater reuse system deploying animal dung and wastewater to produce thermal energy and liquid fertilizer. The latter is used for organic production of vegetables for animal feed, which are cooked with the thermal energy produced, forming a closed loop that reduces the footprints and intends to convey a message about climate compatible development to visitors.

Image: Street in La Paz | Javarman, Shutterstock

At the city level, across the three cities, the transport sector was found to contribute the most to the carbon footprint, while for the water footprint, the residential sector resulted as the main contributor, mainly due to the grey water footprint – related to water pollution. These findings were the basis for the development of city-wide Action Plans, which are project portfolios oriented to reduce city footprints, set reduction targets for the long-term and, ultimately, promote urban climate compatible development. Already some projects have been prioritised by the cities and are in the process of transitioning to an implementation phase, such as a water footprint offset mechanism for the industrial sector in Quito, and the construction of a wastewater treatment plant for the municipal slaughterhouse in La Paz.

The assessments allowed the cities to comply with international commitments, such as reporting their greenhouse gas inventories to the Cities Climate Registry[87] under the Mexico City Pact.[88] It has also catalysed its participation in a group of 35 cities from around the world, in a project to pilot test the GPC v1.0,[89] led by ICLEI – Local Governments for Sustainability, World Resources Institute and C40 Cities Climate Leadership Group. This translates into an increased international visibility and recognition about a proactive attitude towards climate change issues, while supporting the national processes towards a low-carbon and climate-resilient future.

In expanding economically and meeting their development needs, Latin American countries have abundant opportunities to adopt clean, efficient low-carbon technologies and practices. They can side step the inefficient, fossil fuel-dependent infrastructure that heavily industrialised countries are 'locked into'.[90] At the same time, they can put in place the policies and regulations and develop the markets that value and incentivise the sustainable management of the precious forest and soil resources that act as globally-important carbon stores.

The *Fifth Assessment Report* identifies many low-carbon opportunities and co-benefits.[91] 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. 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."[92] Because emissions in Latin America are driven mainly by energy and given the low emission base, there is scope to produce dual wins by concentrating

Renewable energy technologies have demonstrated substantial performance improvements and cost reductions.[95]

future energy investments into renewable energy (such as hydropower) which can help expand energy supply, meeting growing population needs, but also keeping emissions from the sector low.

Urbanisation strategies for mitigation (such as intelligent urban planning, low carbon transport infrastructure etc.) will be important for the rapidly growing continent. The city of Curitiba in Brazil is already heralded as one of the world's most sustainable cities using well planned transit corridors that make extensive use of public transportation systems,[93] an approach that is also being taken up in Mexico and Guatemala.[94] Such sustainable cities improve lives (reducing pollution) and increase efficiency (reducing traffic and transit times).

Renewable energy is already a cost effective solution for energy production in rural areas if Brazil,[96] wider adoption of such technologies across Latin America could have significant positive impacts for livelihoods and productivity in rural areas whilst maintaining low emission levels. Efficiency measures in industry (i.e. substituting coke with charcoal for iron smelting[97] or improving the energy efficiency of industrial machinery)[98] can be cost efficient and improve productivity in the manufacturing sector across Latin America. Coupled with existing reductions in energy intensity (i.e. in Mexico)[99] these changes can reduce production costs (increasing competitiveness) and maintain (or even lowering) emissions in the continent.

Reducing deforestation is seen as a cost-effective mitigation action which can also help reverse the current decline in forested land,[100] especially through the use of REDD+ incentives.[101] Even though agricultural emissions in Latin America are low and are mainly driven by livestock rearing,[102] emission and efficiency (i.e. yield) improvements can still occur through the increased intensification of agricultural production.[103] Brazilian bioethanol production has shown to be a greater creator of employment than the country's petroleum sector,[104] suggesting that shifts in agriculture towards dual use crops (i.e. for both energy and food) such as sugar cane, can improve the energy supply as well as provide effective livelihood opportunities. Energy efficiency measures can also be applied at the household level i.e. the success of the National Cookstoves Programme in both Mexico and Peru[105] shows that clean energy measures can also have beneficial livelihood impacts.

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 (in the range of 0.04–0.14) percentage points per year over the 21st century.[106]

Latin America stands to benefit from further integration of 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 to support this.[107] Many sustainable development pathways combine adaptation, mitigation and development approaches.

Various examples demonstrate possible synergies between development, adaptation and mitigation planning, which can help local communities and governments to allocate efficiently available resources in the design of strategies to reduce vulnerability.[108]

For example, payment for ecosystem services (or PES) involve conditional payments or compensations to voluntary providers who can secure ecosystem services, which can include regulation of freshwater flows, carbon storage, provision of habitat for biodiversity and scenic beauty.[109] Assigning values to these services and designing conservation agreements based on these can be an effective way of helping local communities to adapt to climate change. Simultaneously, it can help protect natural areas and improve livelihoods and human wellbeing (*medium confidence*).[110]

However, adopting such actions at continental scale requires that Latin American citizens and governments are faced with the challenge of building new governance models, where imperative development needs, vulnerability reduction and adaptation strategies to climate stresses will have to be truly intertwined.[111]

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.[112]

Beyond the Fifth Assessment Report:
Payments for environmental services in Bolivia

In Bolivia and many other Latin American countries, deforestation in upper river basins has caused a host of environmental problems with local to global impacts– from soil erosion and declining water quality to greenhouse gas emissions. The Bolivian Department of Santa Cruz is tackling all these problems at once, by enabling land managers in the upper catchments to receive compensation for conserving forest lands. The Reciprocal Water Arrangements (known as 'ARA' for the Spanish acronym: *Acuerdos Recíprocos por Agua*), commit land managers to a range of eco-friendly practices. These include conserving the forest, stopping polluting livestock practices and enhancing the biodiversity and forest carbon of their land. In exchange, they receive in-kind compensation that boosts their incomes and significantly improves their livelihood prospects.

ARAs are private agreements between water cooperatives and landholders in priority catchment areas that are designed, managed and monitored locally, are nested within and coordinated with appropriate regional and national government policies, and are based on principals of reciprocity and trust. The improved land use practices that have resulted from these agreements are helping to tackle climate change. However, the real reason that the schemes have taken off is that downstream water users are benefitting from better water quality downstream, and upstream participants are reaping material rewards.

Image: Bolivian woman | Thomas Mueller, SPDA

Since the first Bolivian ARA was developed in Los Negros, more than 50 municipal governments and water cooperatives across the Andes have joined the movement, and more than 60,000 downstream users are now compensating 2,500 upstream families for protecting 100,000 ha of forested Water Factories. In the last two years, local and donor funds have compensated landowners' conservation efforts with barbed wire, cement, fruit tree seedlings (such as apples and plums), bee boxes, bee-keeping equipment, plastic piping, water tanks, and roofing materials. The ARA schemes are thus unlocking vital resources for upland farmers who otherwise risked becoming increasingly marginalised by their lack of capital.

In early 2013, state law-makers from Bolivia's Santa Cruz Department produced a draft 'Sustainable Santa Cruz' law to promote watershed protection, climate change adaptation, mitigation and economic development, based on the successful ARA experience. At the time of writing, the law is making its way through various committees and is on track to be passed in 2014 or 2015.

Box 7: 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.[113] 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."[114]

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.[115]

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 required to effectively mitigate greenhouse gas emissions and address other climate change issues… outcomes seen as equitable can lead to more effective cooperation." *IPCC*[116]

International cooperation is vital to avert dangerous climate change and Latin American governments can promote ambitious global action

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.

Box 8: The global carbon budget

What is the global carbon budget?

Multi-model results show that for a two-thirds chance (>66% probability) of limiting total human-induced warming to less than 2°C relative to the period 1861–1880 would require cumulative CO_2 emissions from all human activities since 1870 to remain below around 2,900 $GtCO_2$ (with a range of 2,550–3,150 GtC CO_2). About 1,900 $GtCO_2$ of this 'budget' had already been emitted by 2011.[117]

How much carbon budget is left?

Human society could 'afford' to burn 1,000 $GtCO_2$ more, to have a two-thirds likelihood of limiting temperature rise at or below two degrees. Because one tonne of carbon is equal to 3.667 tonnes of CO_2, that leaves about 270 'tonnes of carbon' in the global 'budget'. The IPCC sets out its best assessment of the facts: it is up to politicians to decide whether they can live with a two-thirds chance or whether they prefer to increase the odds of staying below two degrees and limit remaining net emissions even more than this.[118]

How fast are we burning it?

Greenhouse gas emissions from human activities reached 49 $GtCO_2e$ (carbon dioxide equivalent) per year in 2010, plus or minus 4.9 units.[119] Emissions of CO_2 from fossil fuel combustion and industrial processes contributed about 78% of the total greenhouse gas emissions increase from 1970 to 2010, with a similar percentage contribution for the increase during the period 2000 to 2010 *(high confidence)*. Other emissions come from land use, land use change and industrial processes.[120]

How great are the remaining fossil fuel reserves?

The total fossil carbon available in reserves is 3,670–7,100 $GtCO_2$ (as measured in 2011) – many times greater than the 'carbon budget' human society could afford to burn and still keep temperature rise below two degrees.[121]

Recognising that everyone must share the effort, and making financial resources available for investments in adaptation programmes and low-emissions infrastructure are important in reaching global agreement on climate change. 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 countries of Latin America need resources to build viable adaptation frameworks and capabilities, and critical infrastructure for development. Some of the resourcing will come from domestic sources, including the private sector. Provision of climate finance through the Green Climate Fund or other schemes is one way of mobilising resources to support adaptation and mitigation action.

The IPCC's key messages provide crystal clear implications for the global climate negotiations process. 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 Latin America.[122] As mentioned above, the IPCC states categorically that the Cancun pledges for emissions reduction by 2020 are insufficient,[123] but could be the basis for something more ambitious. This is what the international process must deliver.

Latin America's leaders have an important part to play – with all other international leaders – in forging this commitment to 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 development pathways.

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* (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, vulnerability and adaptation) 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 Policymakers, 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.

The component parts of the Fifth Assessment Report may be accessed on the following websites:

Working Group I: The Physical Science
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/

Synthesis Report
www.ipcc.ch/report/ar5/syr/

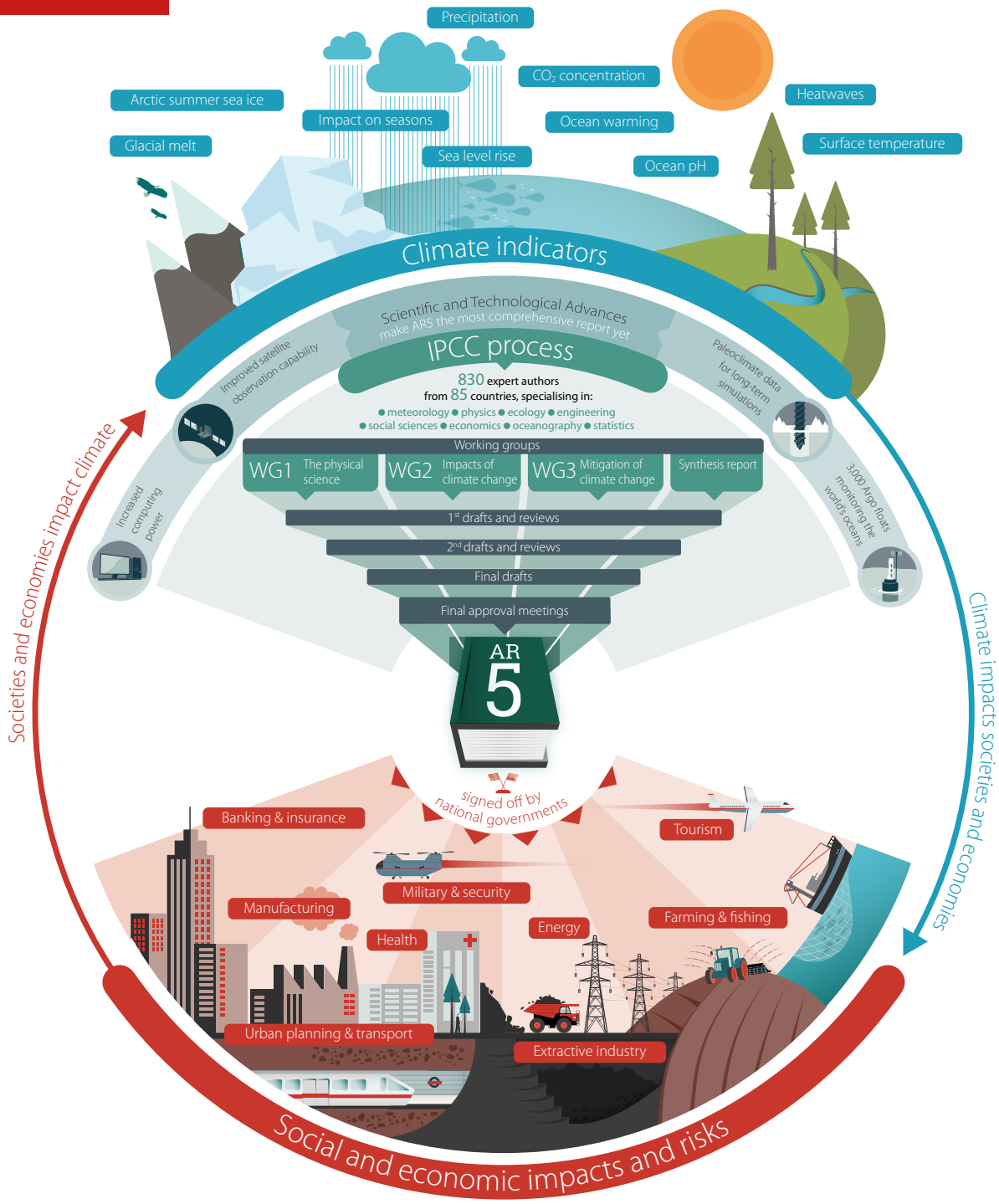
About this report

This report is a guide to the IPCC's *Fifth Assessment Report* prepared for decision-makers in Latin America 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 sources of greenhouse gas emissions and experiences in adaptation and mitigation from the thousands of pages of the *Fifth Assessment Report* for Latin America – pulling out the Latin America -specific data and examples wherever possible. In so doing, we hope to make the IPCC's important material more accessible and usable to Latin American audiences. This report responds to wide demand among CDKN's Latin American partner networks, for region-specific information.

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*).

This report provides an overview of the changes in the climate already affecting Latin America – and the projected climate trends and risks for Latin America in the 21st century. We provide highlights of Latin America's key opportunities and challenges for climate adaptation and mitigation, and summarise the IPCC's findings around some of the synergies and indeed, the trade-offs, among adaptation, mitigation and development goals.Finally, we provide an overall summary of the IPCC's guidance on key issues that Latin American and other governments can pick up in multilateral and bilateral political negotiations – true to the IPCC's mission to avoid being policy prescriptive, but to stay policy relevant.

How the IPCC works[124]



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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 Ibid.
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 IPCC (2013). *Climate Change 2013: The Physical Science Basis. Headline Statements from the Summary for Policymakers*.
7 Ibid.
8 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability. Summary for Policymakers* (Box SPM.2 Table 1, p29).
9 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability*. Chapter 10 (p4).
10 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability*. Chapter 12 (p2).
11 Insert the correct endnote here for box 1
12 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability*. Chapter 27 (p2).
13 Ibid.
14 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability. Summary for Policymakers* (p9).
15 IPCC (2013). *Climate Change 2013: The Physical Science Basis*. Chapter 13.
16 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 precipitation maps are also presented in IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability. Technical Summary* (Figure TS.5, pp64–65).
17 Ibid.
18 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability. Summary for Policymakers* (p6).
19 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability*. Chapter 27 (p14).
20 Ibid.
21 Ibid. (p3).
22 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability*. Chapter 27 (p4).
23 Ibid. (p17).
24 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability. Summary for Policymakers* (Table SPM. A1, p34).
25 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability*. Chapter 27 (p14).
26 Ibid. (Figure SPM.2 p36).
27 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability. Summary for Policymakers* (Table SPM. A1, p34).
28 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability*. Chapter 27 (Figure 27–8).
29 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability. Summary for Policymakers* (TS.1, p60).
30 IPCC (2013). *Climate Change 2013: The Physical Science Basis. Summary for Policymakers* (p27).
31 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).
32 IPCC (2013). *Climate Change 2013: The Physical Science Basis. Summary for Policymakers* (p23).
33 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability. Summary for Policymakers* (Figure SPM.4, p38).
34 All analysis in Box 3 including the figure are derived from IPCC (2013). *The Physical Science Basis. Technical Summary* (Figure TS-15, p89).
35 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability. Summary for Policymakers* (Figure SPM.4, p38).
36 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability*. Chapter 16 (p3).
37 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability. Summary for Policymakers* (p13).
38 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability*. Chapter 27 (pp2–3).
39 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability. Summary for Policymakers* (Figure SPM.4, p10).
40 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability*. Chapter 27 (pp2–3).

41 IPCC (2013). *Climate Change 2013: The Physical Science Basis. Summary for Policymakers* (p9).
42 Ibid.
43 Data in this figure derived from IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Technical Summary* (Table TS.6, pp51–52); also from Chapter 27 (pp2–3).
44 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability. Summary for Policymakers* (Assessment Box SPM.2, Table 1, p29).
45 Ibid.
46 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability. Summary for Policymakers* (Assessment Box SPM.2, Table 1, p29).
47 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability.* Chapter 27 (p22).
48 Ibid. (p4).
49 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability. Summary for Policymakers* (Assessment Box SPM.2, Table 1, p29).
50 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability.* Chapter 27 (pp31–33).
51 Ibid.
52 Ibid. (p4).
53 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability. Technical Summary* (p48).
54 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability.* Chapter 27 (p3).
55 Ibid.
56 Ibid.
57 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability. Summary for Policymakers* (Box SPM.2 Table 1, p29).
58 Ibid.
59 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability.* Chapter 20.
60 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability.* Chapter 20.
61 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability. Summary for Policymakers* (Table SPM.1, p28).
62 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability.* Chapter 27 (p34).
63 Ibid.
64 Ibid. (p33).
65 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability.* Chapter 16 (p27).
66 Ibid. (p2).
67 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability.* Chapter 27 (p34).
68 Ibid. (p34).
69 Ibid. (Section 27.3).
70 Ibid. (p34).
71 Ibid. (p35).
72 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability.* Chapter 14 (pp3–5).
73 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability.* Chapter 27 (p34).
74 Ibid. (p35).
75 Adams, P. and Castro, J. (2013) Embedding climate change resilience in coastal city planning: *early lessons from Cartagena de Indias, Colombia. CDKN Inside Story. London: CDKN. Bahadur, A. et al.* (2014). Mainstreaming dis*aster risk management in key sectors*. London: CDKN.
76 IPCC (2014). *Climate Change 2014: Mitigation of Climate Change. Technical Summary* (p5).
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78 IPCC (2013). *Climate Change 2013: The Physical Science Basis. Summary for Policymakers.*
79 IPCC (2014). *Climate Change 2014: Mitigation of Climate Change*. Chapter 5 (p21).
80 Ibid. (p10).
81 Ibid.
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83 IPCC (2014). *Climate Change 2014: Mitigation of Climate Change. Technical Summary* (p31).
84 IPCC (2014). *Climate Change 2014: Synthesis.*
85 Ibid.
86 Rodriguez, M. (2014, forthcoming). Carbon and water footprinting in Andean Cities. London: CDKN.
87 www.citiesclimateregistry.org
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89 Global Protocol for Community-scale Greenhouse Gas Emissions. The primary aim of GPC is to harmonise greenhouse gas inventories methodologies for cities which will result in a global comprehensive disclosure framework for greenhouse gas emissions.
90 IPCC (2014). Climate Change*2014: Mitigation of Climate Change*. Chapters 5, 6, 7, 8, 10, 11.
91 IPCC (2014). *Climate Change 2014: Mitigation of Climate Change*. Chapters 5, 6.
92 Ibid.
93 Ibid. Chapter 12 (p47).
94 Ibid. Chapter 12 (p48).

95 Ibid. Chapter 7.
96 Ibid. Chapter 07 (p46).
97 Ibid. Chapter 10 (p24).
98 Ibid. Chapter 10 (p37).
99 Ibid. Chapter 10 (p18).
100 Ibid. Chapter 11 (p13).
101 Ibid. Chapter 11 (p71).
102 Ibid. Chapter 11 (p12).
103 Ibid. Chapter 11 (p34 & p50).
104 Ibid. Chapter 11 (p95).
105 Ibid. Chapter 11 (p86).
106 Ibid. Chapter 10.
107 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability*. Chapter 20.
108 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability*. Chapter 27 (p4).
109 Ibid. (p38).
110 Ibid. (p43).
111 Ibid. (p4).
112 IPCC (2014). *Climate Change 2014: Mitigation of Climate Change. Technical Summary* (Section TS 3.1.4, pp33–35).
113 IPCC (2014). *Climate Change 2014: Mitigation of Climate Change*. Chapter 4.
114 IPCC (2014). *Climate Change 2014: Mitigation of Climate Change. Summary for Policymakers* (p5).
115 IPCC (2014). *Climate Change 2014: Mitigation of Climate Change*. Chapter 11.
116 IPCC (2014). *Climate Change 2014: Mitigation of Climate Change. Summary for Policymakers* (p5).
117 IPCC (2014). Synthesis *Report* (SPM8).
118 IPCC (2013). Climate Change 2013*: The Physical Science. Working Group I, Summary for Policy Makers*.
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120 IPCC (2014). *Synthesis Report* (SPM.5).
121 IPCC (2014). *Synthesis Report (*Table 2.2).
122 IPCC (2014). *Climate Change 2014: Mitigation of Climate Change. Technical Summary* (p5).
123 Ibid. (p26, Figure TS.9, p27).
124 Graphic adapted from Information is Beautiful graphic, from a project developed and released by the European Climate Foundation and the Cambridge Institute for Sustainability Leadership.

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IPCC, 2013. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

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IPCC, 2014: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

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