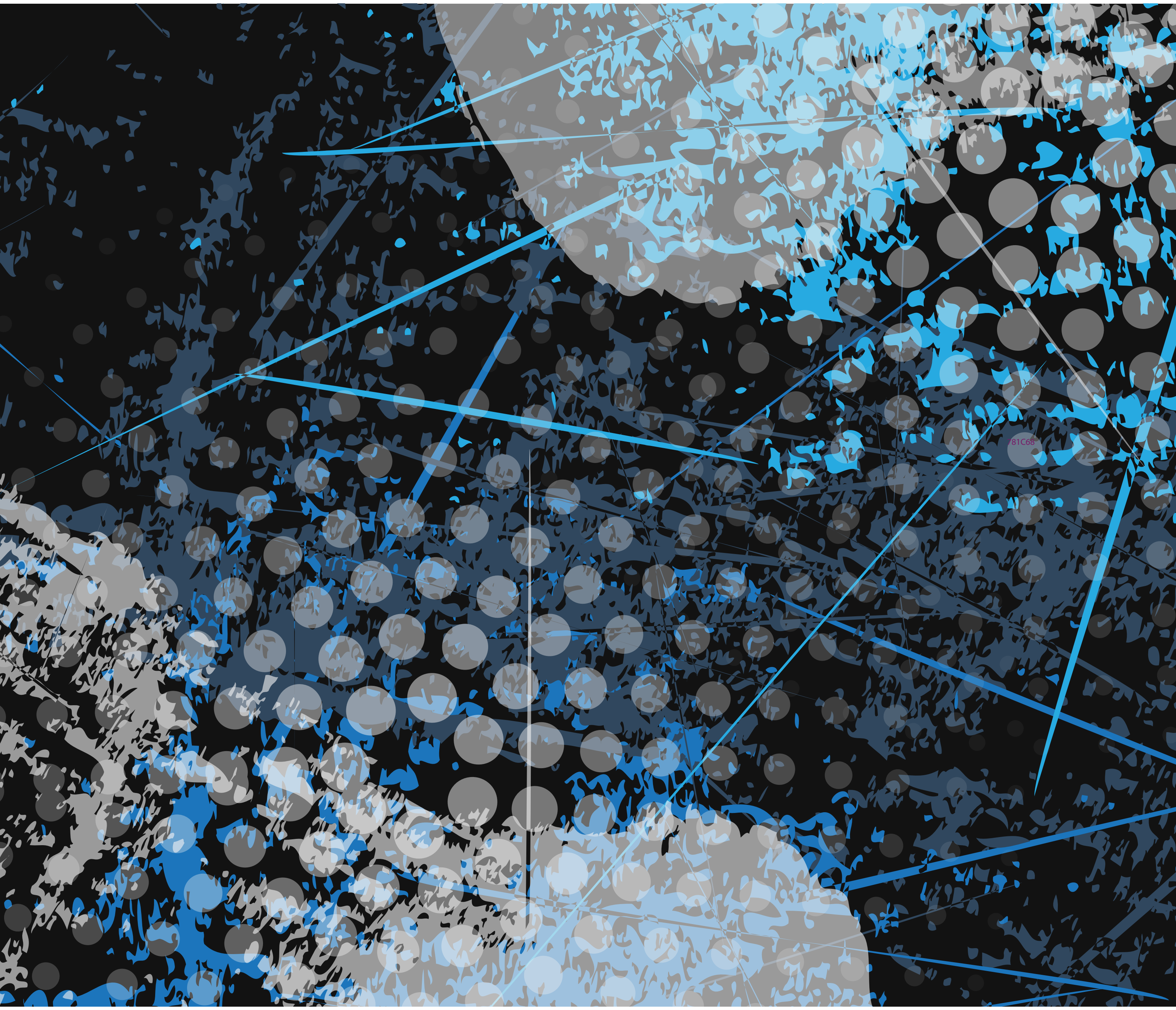
Key findings related to loss and damage

from the Working Group II report of the sixth IPCC assessment of the global climate



Flood Resilience Alliance

Climate Centre

Acknowledgements

This summary has been endorsed by the Technical Expert Group on Comprehensive Risk Management (TEG-CRM) of the Warsaw International Mechanism (WIM) Executive Committee (ExCom) under the United Nations Framework Convention on Climate Change (UNFCCC).

It has been produced by the Red Cross Red Crescent Climate Centre, in collaboration with IIASA and Climate Analytics and with the support of the Zurich Flood Resilience Alliance.

The Zurich Flood Resilience Alliance is a multi-sectoral partnership focusing on finding practical ways to help communities in developed and developing countries strengthen their resilience to flood risk. Find out more: www.zurich.com/flood-resilience

Designed by Eszter Saródy

Introduction

This report summarizes findings in the Sixth IPCC Assessment Report (AR6) of Working Group II on Impacts, Adaptation and Vulnerability, focusing on human aspects of loss and damage. The summarized findings can be translated into actionable information for national and regional policy-makers.

The report is divided into three sections: 1) Evidence of observed loss and damage that has occurred or been documented since the AR5 report was published; 2) Expected loss and damage based on future warming, assessed across eight key risks; 3) Key issues for Loss and Damage negotiations (*see definitions below*).

The AR6 report emphasizes a few core messages related to loss and damage across topics and sectors. Firstly, the need to mitigate emissions to avert loss and damage is urgent; every degree of warming greatly increases the risks of future loss and damage. Furthermore, the scale of loss and damage is staggering, with up to an estimated 3.6 billion people highly vulnerable to climate-related loss and damage. The residual risk reaches all continents and all sectors, but is particularly severe where vulnerabilities and exposure are concentrated, including small island states, East, West, and Central Africa, Central America, coastal cities, informal settlements within cities, rapidly growing small and medium-sized cities, and anywhere with considerable developmental constraints, including where poverty, conflict, and fragile livelihoods exist. Vulnerability and loss and damage are greatly heightened anywhere where natural limits to adaptation have been reached, such as some equatorial, coastal, mountain, and Arctic ecosystems.

The below *Takeaways for policy-makers* further distil these lessons from loss and damage into three key messages: 1) Adaptation does not prevent all loss and damage, even with effective adaptation and before reaching soft and hard limits; 2) Loss and damage is unequally distributed across systems, regions and sectors and is not comprehensively addressed by current financial, governance and institutional arrangements, particularly in vulnerable developing countries; 3) With increasing global warming, loss and damage increases and becomes increasingly difficult to avoid, while remaining strongly concentrated among the poorest vulnerable populations.

Though this synthesis report divides risks into distinct sectors, in practice loss and damage is complex, compound and cascading: for instance, risks of water scarcity can develop into health impacts as diarrhoeal diseases become more common; health impacts can result in a loss of income when productive household members are too ill to work, resulting in the loss of a home as people are forced to migrate away from places where they can no longer secure a sustainable livelihood. Unless averted, minimized, or addressed, loss and damage will cascade into devastating consequences for the world's most vulnerable people.

Methodology

To begin this review, a systematic assessment of the terms loss(es) and damage(s)', and 'Loss and Damage' in IPCC WGII AR6 was conducted. This resulted in a compilation of at least 3,500 occurrences of the terms, from which the findings that are most relevant for humanitarian action, climate finance policy, and development actors have been synthetized and are presented in this paper. To ensure other types of uncategorized loss and damage in the IPCC report were also included, the authors reviewed executive summaries of all chapters and included any relevant information. A full review was carried out of Chapters 1, 4–8, and 16 (Points of Departure and Key Concepts; Water; Food, Fiber and Other Ecosystem Products; Cities, Settlements and Key Infrastructure; Health, Wellbeing and the Changing Structure of Communities; Poverty, Livelihoods, and Sustainable Development; Key Risks across Sectors and Regions). These chapters were selected for their relevance to the types of loss and damage people may face and due to limited researcher time to review all sections of the report beyond all passages and boxes that explicitly mention loss and damage.

Two categories emerged from the IPCC report: existing (already happening) and expected (future risks foreseen) loss and damage. In addition to these, a third category emerged: a type of meta-analysis ofloss and damage policy, which commented on methodological challenges and factors complicating loss and damage. In each of these categories, the findings have been grouped under key messages for policy-makers.

Though the authors have made a concerted effort to best capture key messages regarding loss and damage, the nature of condensing a 3,000-page report into a 20-page policy document required greatly cutting down on detail, removing repetitive information, and ultimately making editorial choices about which information to include. Wherever possible, the report focuses on new information that is not covered in previous IPCC reports. Loss and damage case studies feature in the report, condensed from case studies and data from the report.

Definitions

- loss(es) and damage(s): The IPCC definition of loss and damage (lower case) is 'the harm from (observed) impact and (projected) risks which can be economic or non-economic'.

- Loss and Damage: Loss and Damage (capitalized) refers to the United Nations Framework Convention on Climate Change (UNFCCC) negotiations which aim to solve how to 'address loss and damage associated with impacts of climate change, including extreme events and slow onset events, in developing countries that are particularly vulnerable to the adverse effects of climate change'.

- Adaptation limits: The point at which an actor's objectives (or system needs) cannot be secured from intolerable risks through adaptive actions.

  - Hard adaptation limit – No adaptive actions are possible to avoid intolerable risks. These result in loss and damage.

  - Soft adaptation limit – Options may exist but are currently not available to avoid intolerable risks through adaptive action.

- Transformational adaptation: Adaptation that changes the fundamental attributes of a social-ecological system in anticipation of climate change and its impacts.

- Incremental adaptation: Adaptation that maintains the essence and integrity of a system or process at a given scale. In some cases, incremental adaptation can result in transformational adaptation. Incremental adaptations to change in climate are understood as extensions of actions and behaviours that already reduce the losses or enhance the benefits of natural variations in extreme weather/climate events.

- Confidence: Confidence levels are used in the IPCC report to indicate the level of agreement and evidence related to every finding in the report. They are expressed on a scale going from low confidence (lowest) to very high confidence level (highest).

- Residual risk: The risk that remains following adaptation and risk reduction efforts.

- Climate-resilient development pathways (CRDP): Trajectories that strengthen sustainable development and efforts to eradicate poverty and reduce inequalities while promoting fair and cross-scalar adaptation to and resilience in a changing climate. They raise the ethics, equity and feasibility aspects of the deep societal transformation needed to drastically reduce emissions to limit global warming (i.e. to well below 2°C) and achieve desirable and livable futures and well-being for all.

Definitions are from IPCC Glossary – IPCC, 2022: Annex II: Glossary [Möller, V., R. van Diemen, J.B.R. Matthews, C. Méndez, S. Semenov, J.S. Fuglestvedt, A. Reisinger (eds.)]. In: *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 2897–2930, doi:10.1017/9781009325844.029.

Takeaways for policy-makers

Section 1. Evidence of existing loss and damage

Takeaway 1: ***Loss and damage is already happening*** *and natural systems are nearing hard limits particularly at the poles, mountains and equators. Widespread loss and damage is being experienced through water-related extremes, including droughts or floods that damage agricultural yields and cause losses to health.*

1.1 Impacts on water availability and food production

- Water is a key factor in climate impacts, and loss and damage is often felt through drought or extreme precipitation.
- Currently, half of the world's population lives with severe water-scarcity for at least one month of the year.
- The agriculture sector is particularly vulnerable to water-related loss and damage, with drought and floods causing losses in yields. This contributes to high levels of food insecurity in some parts of the world.
- Marine heatwaves are putting fisheries under stress and contributing to declining productivity that hurts small-scale fishers.
- Pastoral systems are seeing decreasing productivity as drought and rising temperatures stress animals and the ecosystems on which they depend.

1.2 Impacts on health and well-being

- Physical and mental health outcomes are worsening due to climate change, though these losses are not easily quantified or recognized as loss and damage.
- In areas with low adaptive capacity, such as places without adequate water and sanitation infrastructure; climate impacts cause greater losses in health and life.
- Heatwaves and wildfires have increased mortality and morbidity, with vulnerable groups such as outdoor laborers, pregnant women, elderly people, and those with chronic health conditions facing more severe impacts.
- As the climate warms, there are negative impacts on mental health, including trauma experienced through climate extremes as well as loss of livelihoods and culture.
- Climate extremes disrupt access to health services, which has compounding negative health impacts on people with chronic health conditions.

1.3 Impacts on cities, settlements and infrastructure

- People living in informal settlements bear the brunt of climate impacts in cities and are deprived of adaptation investments that could help reduce future loss and damage.
- Cities situated on coasts and deltas are already experiencing loss and damage from sea level rise and climate variability and will eventually face adaptation limits that may require the relocation of millions of people.
- In cities, observed climate impacts cause cascading and compounding impacts, disrupting services and damaging infrastructure.
- Infrastructure, including transportation, water, sanitation, and energy systems have been compromised by extreme and slow-onset events, with resulting economic losses, disruptions of services and negative impacts to well-being.
- Small- and medium-sized cities are least equipped to manage climate impacts.

Takeaway 2: ***There is a deficit of incremental and transformational adaptation efforts required to avert and minimize loss and damage.*** *Since the AR5 report, climate risks are appearing faster than expected, increasing the urgency of supporting and implementing transformational adaptation. Without greater mitigation efforts, adaptation limits will be reached more quickly than projected, leaving residual risk. To date, most adaptation efforts have been incremental.*

- Adaptation does not prevent all loss and damage.
- Most observed adaptation is fragmented, small in scale, incremental, sector-specific, designed to respond to current impacts or near-term risks, and focused more on planning rather than implementation. Research on transformational adaptation is largely focused on managed retreat from high-risk locations and changing livelihoods.
- Adverse climate impacts can reduce the availability of financial resources by incurring loss and damage and through impeding national economic growth, thereby further increasing financial constraints for adaptation, particularly for developing and least developed countries.
- Though there is more adaptation planning at the city level than AR5, there remains an implementation gap.

Section 2. Risks of future loss and damage is expected to increase in the near and midterm

Takeaway 3: ***The effectiveness of adaptation efforts decreases drastically at higher levels of warming, leaving greater loss and damage.*** *Loss and damage is projected to increase in the near future.*

Representative Key Risk 1: low-lying coastal ecosystems

- At 1.5°C of warming, coastal communities reach adaptation limits, in which nature-based solutions are no longer effective and people are expected to experience economic damage, water insecurity, and loss of life.
- Coastal ecosystems are threatened by accelerating coastal erosion, sea-level rise, and extreme events, which are endangering the habitability of coastal communities.
- Coastal communities will lose ecosystem services on which their livelihoods and food security depend.

Representative Key Risk 2: terrestrial and marine ecosystems

- Even below 2°C of warming, biodiversity loss is projected to be significant and to take place increasingly quickly, creating economic losses for those relying on ecosystems for livelihoods. It will also negatively impact interconnected processes like water supply.

Representative Key Risk 3: critical infrastructure and networks

- Both direct and indirect loss and damage to critical infrastructure and networks is anticipated to be severe, particularly under high warming levels which can impact health, livelihoods, and economies, and will require significant financial investment to repair, rebuild and/or adapt.
- The transport sector is particularly at risk because of flooding, heat stress and sea-level rise, with damage expected to infrastructure like roads and ports, especially along coasts and rivers, which can negatively impact food security by interrupting food supply chains.
- Losses are expected to the energy sector; however, adaptation potential remains high to minimize damage.

Representative Key Risk 4: risk to living standards

- Economic losses are expected globally, negatively impacting living standards, particularly in developing countries and places where economic activity and livelihoods are heavily reliant on exposed and climate sensitive industries like agriculture and fishing, and along coastlines.
- With an increase in the frequency and intensity of disasters, it is expected that tens of millions more people will end up in poverty. Income inequality will widen unless adaptation improves to minimize loss and damage to living standards.

Representative Key Risk 5: risk to human health

- An increase in loss of life because of heat is predicted globally, particularly in Asia, especially in areas with poor infrastructure, urban settings, and other areas with high population density.
- Vector-borne and water-borne diseases are acute risks, particularly in the Africa region, especially for children, because of changing temperatures and increasing frequency of heavy rainfall and flooding in some regions.
- Mental-health challenges are expected to increase in all regions with warming.
- Loss of life because of health risks depends on socio-economic development and the effectiveness of health intervention programmes, such as those for malaria.

Representative Key Risk 6: risk to food security

- Food insecurity is expected to rise from impacts on food production due to compounding factors like soil health and declining water availability, pollination, and damage to food supply chains. The higher the warming, the more widely felt the impacts will be.
- Impacts are likely to be felt most acutely in Sub-Saharan Africa, South Asia, Central and South America and in small island states.
- Quality of food is also expected to decrease without adaptation, leading to rising numbers of people with micronutrient deficiencies.
- With high levels of warming and vulnerability, it's expected that the number of undernourished people will increase by tens to hundreds of millions of people, particularly in low-income populations.

Representative Key Risk 7: risk to water security

- Water scarcity is expected to increase even under low warming, creating significant loss and damage to health, livelihoods, and socio-economic development. Changes in water availability is also expected to have a significant impact on important cultural practices. Water-scarcity risks are particularly pronounced in larger parts of the southern US and Mexico, North Africa, parts of the Middle East, northern China, southern Australia and parts of north-west India and Pakistan.

- Water-related disasters like flooding are likely to increase, resulting in loss of life, livelihoods and property, loss of access to fresh water and serious health implications.

- The number of people affected by water security risks ranges from hundreds of millions to several billion depending on warming levels and will primarily be felt amongst vulnerable populations in areas with significant exposure.

Representative Key Risk 8: risks to peace and human mobility

- The risk to peace increases along with warming levels, centralized amongst populations with pre-existing risks, with the potential to cause loss of life and negative impacts on livelihoods and well-being.

- Risks to peace can be considered severe when pre-existing armed conflict has compounding and cascading impacts which amplify vulnerabilities to climate-related risks.

- Both direct and indirect losses and damage will increase mobility-related risks from extreme-event-related displacement, as well as in places where there is low adaptive capacity.

- Rural communities are particularly vulnerable to migration where a combination of factors, including climate change, are drivers for displacement.

Section 3. Key issues for loss and damage policy

Takeaway 4: ***There remains an evidence gap for assessing and accounting for non-economic loss and damage.*** *Methodological challenges, language barriers, and an absence of systematic assessments hamper vulnerable countries from accounting for loss and damage that is already occurring.*

- Though their absolute economic losses are lower than in high-income countries, people in highly vulnerable countries and contexts suffer disproportionately from climate-related disasters in terms of loss of well-being.
- Systematic risk-assessments of climate-related loss and damage are rare, with vulnerable countries lacking data that could support effective risk management. Limits to adaptation are also still not well understood.
- Non-economic loss and damage (NELD) remains overlooked in vulnerability assessments and adaptation planning, though more evidence of NELD is emerging from developing countries, with researchers developing categories for NELD.
- There is a knowledge gap for assessing loss and damage as the language is not commonly used in disaster and climate risk management literature. The report highlights Asia as one area where loss and damage has a knowledge gap, but expert review of this report confirms this gap exists across all regions.

Takeaway 5: ***Loss and damage is unevenly distributed across geographies and groups of people.*** *Residual risks are much higher for marginalized people. The loss and damage they experience span from loss of income, food insecurity and malnutrition and permanent impacts to health and labor productivity, loss of life and loss of homelands, amongst others.*

- Between 3.3 and 3.6 billion people are considered highly vulnerable to climate change.
- Climate-related loss and damage are likely to be concentrated in hotspots of vulnerability, such as East, Central and West Africa, South Asia, Micronesia, Melanesia, and Central America, as well as people living in informal settlements, people living in small and medium sized cities, people living in coastal areas, and anywhere with considerable developmental constraints, including where poverty, conflict, and fragile livelihoods exist.
- Within these hotspots, marginalized people such as the poor, women, children, indigenous peoples, the elderly, and displaced peoples bear the heaviest loss and damage from climate-related impacts.
- People in Africa have particularly high vulnerabilities and there is robust evidence of climate-related losses spanning a number of loss and damage categories.

- Fragile and conflict-affected populations face the most climate-related risks themselves, as they cannot count on adaptation investments by government, private sector, or other institutions.

Takeaway 6: ***Compound risks exacerbate loss and damage.*** *Concurrent and cascading climate hazards are taking place in all regions, which compounds overall risk. Pre-existing vulnerabilities and non-climatic risks are important factors that determine whether an extreme event becomes a disaster. Minimizing these is important to reduce loss and damage.*

- Multiple climate hazards interact with different climate and non climate-related risks, creating compounding impacts across sectors and regions and increasing the likelihood of loss and damage.

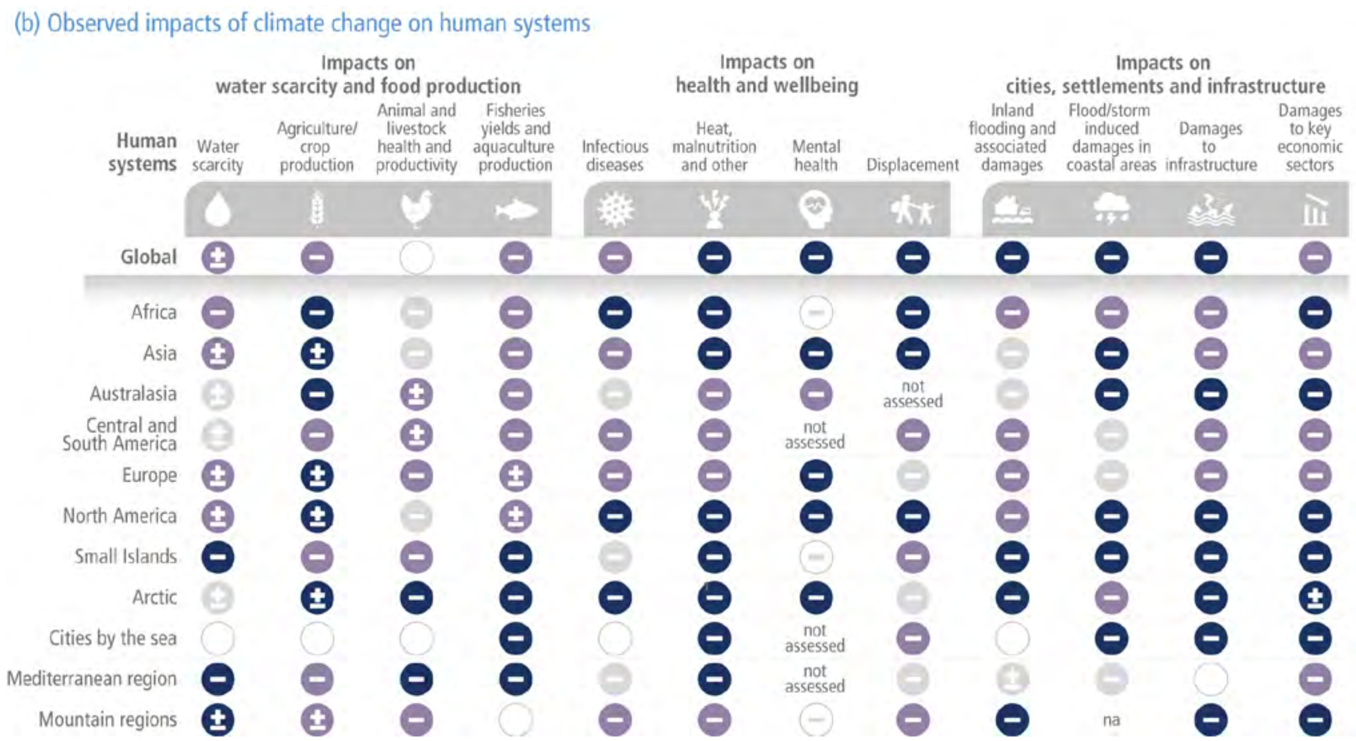
- Intersecting risks of inequality and poverty create adaptation limits for those in vulnerable situations, and regions with high levels of these risks have the most urgent need to improve adaptive capacity. Measures to address compound risks like social safety nets and comprehensive disaster risk management approaches, can avoid and minimize the burden of loss and damage by limiting intersecting and secondary vulnerabilities.

Long summary

Section 1: Evidence of existing loss and damage

*Takeaway 1. **Loss and damage is already happening***

Widespread and severe loss and damage is already occurring in human and natural systems, driven by human-induced climate change that increases the frequency, intensity, and/or duration of extreme-weather events.[1] These extremes, which include droughts, wildfires, terrestrial and marine heatwaves, cyclones (high confidence) and floods (low confidence) are surpassing the resilience of ecological and human systems, creating impacts with irreversible consequences (high confidence). In some places, particularly at the poles, along the coasts, in the mountains, and at the equator, natural systems are near or exceeding hard adaptation limits.[2] This has caused loss of plant and animal species that are more climate-sensitive and cannot regenerate between events or adapt, mainly due to large increases in heatwave events and hotter annual temperatures (very high confidence.)[3] These losses cascade onto human systems, affecting livelihoods, food security, health, and settlements.



Adapted from Figure TS.3: Observed global and regional impacts on ecosystems and human systems attributed to climate change.

1 2.3, 2.3.1, 2.3.1, 2.3.3, 2.4.2, 2.4.5, 2.6.1, 3.2.2, 3.4.2, 3.4.3, 3.5.2, 3.5.3, 4.2.4, 4.2.5, 10.1, 11.2, 12.3, 13.1, 14.1, 15.1, 16.2.3, CCB EXTREMES, WGI AR6 SPM, WGI AR6 9, SROCC SPM

2 2.3.1, 2.3.3, 2.4.2, 2.4.3, 3.2.2, 3.4.2, 3.4.3, 3.5.3, 9.6.1, 10.4.3, 11.3.2, 11.3.11, 12.3.1, CCP1.2.4, CCP3.2.1, CCP3.2.2, CCP4.3.2, CCP5.2.1, CCP6.1, CCP6.2, CCB EXTREMES

3 2.3.1, 2.3.3, 2.4.2, 2.4.4, 2.6, Table 2.2, Table 2.3, Table 2.S. 1, 3.4.2, 3.4.3, 3.5.2, 11.3.2, Figure 12.8, 12.4, Table 11.4, 13.3.1, 13.4.1, CCB EXTREMES

Impacts on water availability and food production

In their daily life, most people experience climate change through water-related impacts. These range from increased frequency and intensity of precipitation, accelerated melting of glaciers, changes in the magnitude of flooding, and more frequent and severe droughts, declines in groundwater storage, and poor water quality due to extreme events.[4] Half of the world's population lives with severe water scarcity for at least one month of the year, and nearly half of them live in India or China.[5] The main climate change contribution to water insecurity is the potential for reduced water availability, with a secondary contribution from increased flooding risk (medium confidence). Water insecurity disproportionately impacts the poor, women, children, Indigenous Peoples and the elderly in low-income countries (high confidence) and occurs disproportionately in small island and mountain regions.[6]

Geographical distributions of current water scarcity and levels of challenge for policies addressing future change

(a) Number of months per year with severe water scarcity

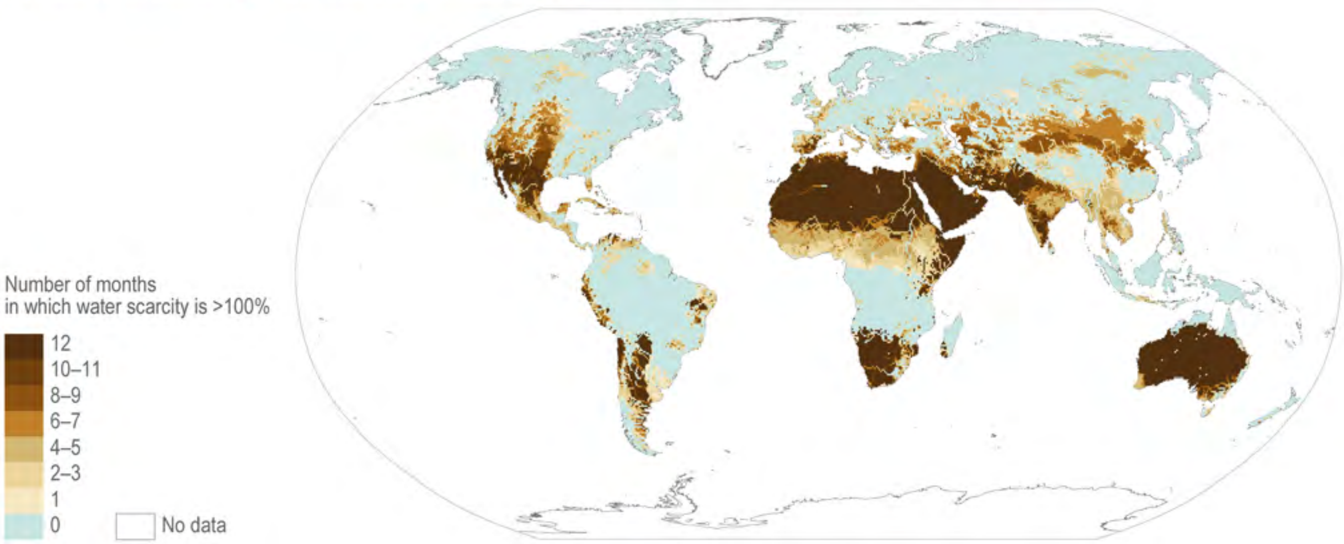


Figure from Box 4.1

Vulnerability to water-related loss and damage is particularly high for the agriculture sector, which accounts for 50–90 per cent of global water use.[7] Floods, droughts and increased rainfall variability are already disrupting agricultural production. Changes in precipitation have caused losses in yields for maize, soybeans, rice, and wheat since 1981. These impacts differ by region. While rice and wheat have had positive impacts from climate in northern Europe and eastern Asia, the effects of climate have been negative for rice and wheat production in Sub-Saharan Africa, South America and the Caribbean, southern Asia, and western and southern Europe. In West Africa, increased heat and rainfall extremes have reduced yields by 10–20 per cent for millet and 5–15 per cent for sorghum.[8] Direct damage to crops by floods have caused astronomical losses, such as 4.5 billion US dollars in losses in Pakistan's 2010 flooding and 572 million US dollars in the 2015 floods in Myanmar.

4 4.2.1.1, 4.2.2, 4.2.4, 4.2.7)

5 (TS.B.4)

6 2.3.1, 2.3.3, 2.4.4, 4.1.1, 4.2.1, Box 4.1, 4.2.4, 4.3.6, 5.12.2, 5.12.3, 6.2.2, 6.2.3, 7.2.7, 9.7.1, 10.4.4, 12.5.3.1, 13.8.1, 15.3.3, 15.3.4, CCP5.2.2, CCB EXTREMES

7 4.1, 4.4

8 5.4.1.1

Major drought events across the world have reduced crop yields, caused drinking water shortages, and in the case of wildfires, caused the deaths of people and large numbers of animals (4.2.5). Droughts induced by the 2015–2016 El Niño, partially attributable to human influences (medium confidence), caused acute food insecurity in eastern and southern Africa and the Dry Corridor of Central America (high confidence). Anthropogenic climate change was found to have increased both the likelihood and severity of most of such events in event attribution studies.

Globally, there has been a loss of 9–10 per cent of total cereal production due to droughts and other weather extremes.[9] Wildfires, which have been fuelled by drought conditions, are particularly severe for loss of life.

Fisheries are under stress, with a doubling in marine heatwaves since the 1980s. With changing pH and loss of dissolved oxygen, climate change has caused a range of new physical, chemical and biological conditions that are affecting the distribution and ecology of marine organisms. Climate-induced fish migration has had significant impacts on fishers living below the poverty line. For instance, in Tanzania 75 per cent of small-scale fishers have reported shifting fishing grounds to offshore areas in the last ten years as distribution of fisheries changed. Inland aquatic systems have had substantial productivity reductions too, as freshwater ecosystems are highly exposed to eutrophication and rising temperatures. Warming in Lake Tanganyika has stratified the water column, with cascading impacts on the productivity of the fisheries it sustains.[10]

Pastoral systems are being negatively affected by changing seasonality, increasing frequency of drought, and rising temperatures (high confidence). These and other drivers are reducing herd mobility, decreasing productivity, increasing incidence of vector-borne diseases and parasites, and reducing access to water and feed (high agreement, medium evidence).[11] In high mountain areas, glacier retreat is altering pasture quality and water availability; pastoralists in India, Tibet, China and Bolivia have already been negatively affected, leading some to diversify livestock or alter their routes in response to local water scarcity.[12]

Current levels of food insecurity are already high in some parts of the world, exacerbated by short-term food shortages and price spikes caused by weather extremes partly linked to climate change (Sections 5.2.1, 5.12.3, 16.5.2). Climate change will increase malnourished populations through direct impacts on food production with cascading impacts on food prices and household incomes, all of which will reduce access to safe and nutritious food (high confidence) (Figure 5.2, 5.12).

9 3.3
10 5.8.1
11 5.5.1.1
12 4.3.8

Impacts on health and well-being

Climate change is worsening people's physical and mental health outcomes across the globe (very high confidence), though this happens in indirect ways that are not always easily quantified as loss and damage. For instance, the geography of vector-borne diseases is changing, exposing new populations to infectious diseases. Higher global average temperatures are making wider geographic areas more suitable for transmission of dengue fever, malaria, and other mosquito borne diseases, despite global efforts to reduce the disease burden over the last 20 years (very high confidence) [7.2.2.1]. Changing climatic patterns are facilitating the spread of CHIKV, Zika, Japanese encephalitis and Rift Valley Fever in Asia, Latin America, North America, and Europe. Climate change is also contributing to the spread of Lyme disease vectors across North America and Europe. Additionally, the incidence of food-borne diseases has increased across the globe, with a strong association with high temperatures and longer summer seasons (very high confidence).

In areas where water and sanitation facilities are deficient, higher temperatures, heavy rainfall, flooding, and drought are associated with an increase in diarroheal diseases. Increases in temperature were associated with increases in diarrhoea in (alphabetically) Bangladesh, Cambodia, China, Ethiopia, Mozambique, Pacific island nations, the Philippines, and Senegal. During the 2015–2016 El Niño, sensitive regions of Africa experienced a threefold increase in cholera after experiencing natural disasters. The causal linkages between climate change and these diseases occur through cascading risk pathways, from storm run-off transporting pathogens and contaminating infrastructure, low water availability decreasing water quality of existing resources, and extended transmission seasons from increased temperatures, amongst others.

Heatwaves and wildfires have increased mortality and morbidity (very high confidence), and health impacts have been partially attributed to observed climate change (high confidence).[13] People working outdoors, such as farmers or construction workers, are at particular risk and face the double burden of losing productive work hours. Extreme heat is also associated with higher rates of pre-term birth, stillbirth, and neonatal stress.[14]

Beyond direct heat stress, higher temperatures and wildfires are increasing the burden of non-communicable diseases, including non-infectious respiratory disease, cardiovascular disease, cancer and endocrine diseases including diabetes.[15] Certain populations with high exposure to wildfire smoke, such as firefighters, face significant increases in cardiovascular disease morbidity and mortality risks. Other mechanisms that increase risk include reductions in physical activity related to hot weather, sleep disturbance and dehydration. Excess deaths during extreme heat events occur predominantly in older individuals and are overwhelmingly cardiovascular in origin (very high confidence).[16]

---

13 7.2.1, 7.2.4 8.2.1, 9.1.5, 9.10.1,
14 .2.4.3
15 7.2.3.1
16 7.2.4.1

Mental health is declining with warming temperatures (high confidence), trauma associated with extreme weather (very high confidence) and loss of livelihoods and culture (high confidence). Distress sufficient to impair mental health has been caused by climate-related ecological grief and climate-related loss of livelihoods and food insecurity (very high confidence). Vulnerability to mental health effects of climate change varies by region and population, with evidence that Indigenous Peoples, agricultural communities, first responders, women and members of minority groups experience greater impacts (high confidence).[17]

Lastly, health services are disrupted by extreme events, leaving chronically ill and vulnerable patients at risk. People with chronic illnesses are at particular risk during and after extreme weather events, due to treatment interruptions and lack of access to medication. Extreme-weather events are also associated with reduced access to prenatal care and unattended deliveries.[18]

Impacts on cities, settlements and infrastructure

Evidence shows that climate impacts are felt disproportionately in urban communities, with the most economically and socially marginalized feeling the largest effects (high confidence).[19] The most rapid growth in urban vulnerability has been in unplanned and informal settlements, as well as in smaller to medium urban centres in low and middle income nations where adaptive capacity is limited (high confidence). In informal settlements, there is limited evidence of adaptation investments such as prioritizing affordable housing in less exposed areas and upgrading informal and precarious settlements. Such investments would need to be done in combination with physical infrastructure, nature-based solutions, and social policy. As cities and settlements continue to grow at rapid rates, more people and key assets are exposed to climate-induced impacts and loss and damage (high confidence). Migrants face a disproportionate risk as they tend to have inadequate housing, less access to air conditioning, and have occupations such as manual labour and waste-picking that exacerbate heat exposure.[20]

People living in coastal and deltaic cities are particularly exposed and are already experiencing severe negative impacts from sea-level rise and climate variability. Sea-level rise is already manifesting as chronic flooding at high tides, water-table salinization, increased erosion and coastal flood damage (medium confidence). Infrastructure, including transportation, water, sanitation and energy systems have been compromised by extreme and slow-onset events, with resulting economic losses, disruptions of services and impacts to well-being.[21] Coastal settlements with high inequality, including a high proportion of informal settlements, as well as deltaic cities prone to land subsidence (e.g. Bangkok, Jakarta, Lagos, New Orleans, etc.) and small island states, are highly vulnerable and have experienced impacts from severe storms, floods, and accelerating sea-level rise (high confidence). Currently, coastal cities that are dependent on extensive protective works face the prospect of ever-increasing costs to maintain current protection levels. When adaptation limits are reached, systemic changes, such as relocation of millions of people, will be necessary (medium confidence).

17 7.2.5, 7.4.2, 8.3.4, Box 8.6, 9.10.2, 11.3.6, 13.7.1, 14.5.6, Figure 14.8, 15.3.4, CCP5.2.5, CCP6.2.6, CCP6.3}
18 7.2.4.3
19 6.2.4
20 6.2.2.1
21 .1.5

Since AR5, observed climate losses in cities have extended beyond single-hazard events to compound and cascading impacts, which can severely disrupt services and damage infrastructure. Sea-level rise, heatwaves, droughts, changes in run-off, floods, wildfires and permafrost thaw cause disruptions of key infrastructure and services such as energy supply and transmission, communications, food and water supply and transport systems in and between urban and peri-urban areas (high confidence). Compound losses occur when climate hazards interact with other hazard drivers, such as heat with poor air quality, or flooding with poor water quality. Cascading impacts occur when damage in one place generates impacts elsewhere, such as when flood waters damage energy infrastructure and cause blackouts.[22] Compound risks to key infrastructure in cities have increased from extreme weather (medium evidence, high agreement), such as extreme precipitation or storm surges disrupting transportation infrastructure.[23] Single hazard events also generate negative impacts, such as the direct impacts of heat stress on human health, which is exacerbated in urban areas due to the urban heat island effect.

CASE STUDY 1. Urbanization in small towns in the Himalayas: Increasing water insecurity for low-income communities

Climate change is projected to affect urban centres differently, with small and medium-sized cities less equipped to handle climate impacts than major metropolises that have higher revenue, investment, and access to technical expertise. Sprawling towns in the Himalayas exemplify this problem; though these towns are expected to become major urban centres within a decade, they are not currently equipped to manage climate loss and damage.

In these cities, unplanned urbanization is causing changes in land use and land cover, which is reducing the recharge areas of springs. These springs are vital for meeting the water needs of towns, which is driving a major water security challenge. This water security challenge is exacerbated by two impacts of climate change: 1) increased rainfall variability, in which heavy rains are becoming more frequent and leading to more landslides, 2) global warming is increasing the temperature of the Himalayas, causing glacier melt and changes in the hydrological regimes.

The combination of climatic and non-climatic stressors is adversely affecting low-income households in urban areas. Water availability is smaller, while demand has increased greatly. Some towns are tourist centres, creating competing needs for water use in peak season. Distribution of water through public water supply becomes highly inequitable during the peak season. Without long term strategies or options, people are being forced to ration intra-household water access and groundwater extraction.

Adapted from Case Study 6.1

Rapidly growing small- and medium-sized cities are becoming a locus of climate vulnerability (8.3.1). These rapidly growing cities do not have the same financial, technical, and institutional resources to adapt urban structures to climate change as megacities. The same applies for informal settlements in low and middle-income nations. There are key gaps in knowledge for how smaller settlements, despite the constraints they face, can accelerate sustainable and equitable adaptation, as most accumulated scientific knowledge on urban climate risk has been generated from studies in larger cities.[24]

22 Figure 6.2; 6.2.6; 6.3.4.1; 6.4.5; Cross-Chapter Paper 2; Cross-Working Group Box URBAN in Chapter 6
23 6.2.5
24 6.1.3

Takeaway 2. There is a deficit of transformational adaptation efforts required to avert and minimize

To date, most adaptation efforts have been incremental, modifying existing systems without challenging their fundamental characteristics.[25] The most common water-related adaptation responses are incremental, in that they may improve crop production and incomes in the short run, but will not lead to transformative outcomes, such as a shift to from livelihoods less exposed to climate hazards (4.7.1.1). Mountain ecosystems, which are particularly vulnerable to climate change, have been the site of incremental adaptation measures which primarily focus on early warning systems and diversifying livelihood strategies for agriculture and pastoralism. However, there is limited evidence of the feasibility and long-term effectiveness of these measures in addressing loss and damage (CCP5.2.4; CCP5.2.7.2).

Since the AR5 report, climate risks are appearing faster than expected, increasing the urgency of implementing transformational adaptation. Adverse climate impacts can reduce the availability of financial resources by incurring loss and damage and through impeding national economic growth, thereby further increasing financial constraints for adaptation, particularly for developing and least developed countries.[26] Without greater mitigation efforts, adaptation limits will be reached more quickly than projected, leaving residual loss and damage. For instance, implementing nature-based adaptation measures to mitigate risks of sea-level rise will reach hard limits beginning at 1.5°C of global warming, as coral reef, mangrove, and marsh ecosystems become severely stressed.[27] Similarly, water-related adaptations, which are the most common adaptation responses since 2014, are more effective at lower-levels of global warming (below 1.5°C).[28] Transformative adaptation will be essential under high emissions scenarios (high confidence). Incremental approaches such as building sea walls cannot fully address the adaptation challenges that coastal communities face. Transformative changes in coastal development and settlement are required (3.5.4.1.1). Importantly, mainstreaming adaptation can perpetuate development-as-usual, locking in structural causes of marginalization and vulnerability (6.2.6).

Research on transformative adaptation tends to focus on managed retreat from high-risk locations and changing livelihoods. Where soft adaptation limits have been reached, relocation of assets and communities and supporting shifts in livelihoods is a growing area of attention in Loss and Damage research. These options for more transformational adaptation can still incur losses, as people lose social and cultural connections and incur losses in well-being. Morbidity associated with migration and displacement, especially in the context of small island states, has been identified as a non-material form of loss and damage (7.1.5). Key considerations for protecting the rights and well-being of people that might need to be resettled include proactive communication and participation of affected communities, availability of compensation, livelihood protection, and permanent land security at relocation destination. In Bangladesh, researchers have suggested creating 'migrant-friendly towns' to encourage autonomous relocation from hazardous areas (7.4.4.4).

25 See FAQ 1.4
26 C.3.2
27 1.4.4.1
28 4.7.1

Though more cities have developed adaptation plans since AR5, there remains a large implementation gap (medium confidence).[29] Many of these plans focus narrowly on climate risk reduction, missing opportunities to advance co-benefits of climate mitigation and sustainable development, compounding inequality and reducing well-being (medium confidence).
The greatest gaps between policy and action are in failures to manage adaptation of social infrastructure (community facilities, services, and networks) and failure to address complex interconnected risks for example in the nexus between food, energy, water and health, or the inter-relationships of air quality and climate risk (medium confidence). In cities, the lack of transformative adaptation can be exacerbated by land use decisions where short-term fiscal and commercial interests conflict with long term vulnerability reduction.[30]

29 6.3.1, 6.4.3
30 6.4.7

Section 2: Risks of future loss and damage is expected to increase in the near- and midterm

Takeaway 3. ***The effectiveness of adaptation efforts decreases drastically at higher levels of warming, leaving greater risk of loss and damage.*** *Adaptation does not prevent all loss and damage, and the concept of residual risk is the risk that remains after adaptation and risk reduction efforts are implemented. With increasing global warming, loss and damage will increase and additional human and natural systems will reach adaptation limits (high confidence).*[31] *Already, adaptation gaps exist between current efforts and the level needed to effectively respond, with the largest gaps being in lower income population groups (high confidence).*[32] *Residual risks rise with increasing global temperatures from 1.5°C to 2°C (SR 1.5) and emerge from irreversible forms of land degradation.* ***Nature-based adaptation measures reach hard limits beginning at 1.5°C of global warming.*** *In specific systems already affected by high exposure and vulnerability, significant adaptation efforts will not be sufficient to prevent severe risks from occurring under high warming (limited evidence, medium agreement). This is particularly the case for some ecosystems and water-related risks.*[33] *The level and rate of climate change risks depend significantly on near-term mitigation and adaptation efforts, with projected loss and damage escalating with each increment of warming (very high confidence).*[34]

AR6 identifies eight key representative risks[35] that could create severe loss and damage under certain conditions of climate hazards, exposure, and vulnerability.[36] These include low-lying coastal systems; terrestrial and ocean ecosystems; critical physical infrastructure, networks and services; living standards; human health; food security; water security; and peace and human mobility (high confidence). Most of these risks become severe in the case of high warming, in combination with high exposure/vulnerability, low adaptation or both (high confidence). Under these conditions, there would be severe and pervasive risks to critical infrastructure (high confidence) and to human health from heat-related mortality; to low-lying coastal areas; aggregate economic output and livelihoods (all medium confidence); of armed conflict (low confidence); and to various aspects of food security.[37] Even in cases of medium or low warming, if exposure/vulnerability is high and adaptation efforts are low, the global and systemically pervasive risks would still be severe for some of the eight representational risks.[38] Severe risks interact through cascading effects, potentially causing amplification of the identified risks over the course of this century (limited evidence, high agreement).

31 Figure TS.7, 1.4, 2.4, 2.5, 2.6, 3.4, 3.6, 4.7, Figure 4.30, 5.5, Table 8.6, Box 10.7, 11.7, Table 11.16, 12.5, 13.2, 13.5, 13.6, 13.10, 13.11, Figure 13.21, 14.5, 15.6, 16.4, Figure 16.8, Table 16.3, Table 16.4, CCP1.2, CCP1.3, CCP2.3, CCP3.3, CCP5.2, CCP5.4, CCP6.3, CCP7.3, CCB SLR

32 1.1, 1.4, 5.6, 6.3, Figure 6.4, 7.4, 8.3, 10.4, 11.3, 11.7, 13.11, Box 13.1, 15.2, 15.5, 16.3, 16.5, Box 16.1, Figure 16.4, Figure 16.5, 17.4, 18.2, CCP2.4, CCP5.4, CCB FINANCE, CCB SLR

33 16.5.2.3, 16.5.2.4, 16.5.3

34 (Figure SPM.3) 2.5, 3.4, 4.4, 5.2, 6.2, 7.3, 8.4, 9.2, 10.2, 11.6, 12.4, 13.2, 13.3, 13.4, 13.5, 13.6, 13.7, 13.8, 14.6, 15.3, 16.5, 16.6, CCP1.2, CCP2.2, CCP3.3, CCP4.3, CCP5.3, CCP6.3, CCP7.3

35 A key risk is defined as a potentially 'severe' risk that is relevant to the interpretation of dangerous anthropogenic interference (DAI) with the climate system.

36 16.5.2.2

37 16.5.2.3, 16.5.2.4, 16.5.4, Figure 16.10

38 16.5.2.3, 16.5.2.4

Representative Key Risk 1: low-lying coastal ecosystems

Severe risks to low-lying coasts involve irreversible long term loss of land, critical ecosystem services, livelihoods, well-being or culture from increasing combined drivers, including climate hazards, as well as exposure and vulnerability.[39] With population change in low-lying cities and settlements, a billion people are projected to be at risk from coastal specific climate hazards under all warming scenarios in the mid-term (high confidence).[40] Regardless of the level of warming and socio-economic developing, low-lying cities, settlements, small islands, Arctic communities, and remote Indigenous communities will experience severe consequences by 2100 and in some cases, by 2050 (very high confidence).[41] Risks seen with Hurricane Sandy in 2012 and Super Typhoon Haiyan in 2013 and the associated loss and damage, including loss of life, infrastructure and housing, are examples of what can be expected to happen more frequently over this century.[42] Arctic communities and those that rely on warm water coral reefs, will face severe risks from the loss of ecosystem services (high confidence). In areas dependent on fish production, significant losses of up to 35 per cent have already been experienced due to warming, and this is projected to translate into 11 per cent of the global population facing rising nutritional risks if this current pattern continues.[43] Across the globe, accelerating rates of coastal erosion continue to lead to loss of land. Such losses will be amplified by increased sea-level extremes and permanent flooding (high confidence). It is estimated that globally approximately 28,000 square kilometres of land (an area about the size of Belgium) has been lost due to coastal hazards and anthropogenic factors. Looking forward, a further 6,000–17,000 square kilometres of coastline is anticipated to be lost to erosion by the end of the century.[44]

Within this century, the habitability of many coastal communities in developing and developed countries will be endangered by high warming, continued coastal development and low adaptation levels (limited evidence, high agreement).[45] A projected increasing risk of high-intensity extreme events will likely pose a significant risk to the livelihoods, infrastructure and well-being of coastal communities by mid-century (high confidence).[46] In certain contexts, climate risks are already thought to be severe (medium evidence, medium agreement), and in others, severe risks to habitability will be triggered, which may not be possible to mitigate by ambitious adaptation even at lower levels of warming (limited evidence, medium agreement). Taking the example of flooding, under high warming models, projections show that 90–380 million additional people will be exposed to annual flood levels by the mid- to end-of-century across the world. This is in addition to the 250 million people exposed today.[47]

39 16.5.2.3.1
40 .2, 9.9, 10.4, 13.6, 13.10, 15.3, 16.5, CCP2.1, CCP2.2, CCP5.3, CCP6.2, CCB SLR, SROCC 2.3, SROCC CCB9
41 TS.C.5.3; Box 4.2, 5.13, 9.12, 9.9.1, 9.9.4, 11.4.1, 11.4.2, Box 11.6, 14.5.2, Box 14.4, CCP2.2, CCB SLR
42 .2.2; 6.3.5.1
43 16.5.2.3.1
44 16.5.2.3.1
45 16.5.2.3.1
46 16.5.2.3.1; 16.5.2.3.3
47 16.5.2.3.1; 16.5.2.3.3

As they reach soft and hard limits to adaptation, coastal communities will experience multiple forms of loss and damage. Soft limits will be reached as sea-level rise continues and extreme events become more intense, with financial and socio-economic constraints making coastal protection less effective, leading to loss of life and economic damages (medium confidence.)[48] Under 1.5°C of warming, hard limits to adaptation will be reached where coastal communities are relying on nature-based coastal protection (medium confidence). When it comes to agricultural production in these areas, soft and hard limits will be related to water availability and the adoption of effective climate resilient crops and any prevailing socio-economic and political challenges (medium confidence).[49]

Representative Key Risk 2: terrestrial and marine ecosystems

A substantial loss of biodiversity is likely even with low warming levels that will have severe impacts on livelihoods, infrastructure, and ecosystem services.[50] The potential for adaptation is low due to the anticipated rate and magnitude of change. The risk of biodiversity loss is significantly higher in biodiversity hotspots because of increased vulnerability, even under low warming projections (high confidence). Evidence points to an increased risk of losing more than 10 per cent of terrestrial biodiversity, which negatively impacts human livelihoods reliant on ecosystem services (medium confidence).[51] The risk of biodiversity loss in the near term is moderate to high in forest ecosystems (medium confidence), and high to very high in Arctic sea ice and terrestrial ecosystems (high confidence), as well as warm water coral reefs (very high confidence).[52]

Sudden ecological changes are increasing in frequency leading to biodiversity loss. Examples of this phenomenon include wildfires and warming of water bodies. Extreme weather events and storm surges made worse due to climate change also have sudden adverse impacts on coastal systems like mangrove forests (high confidence).[53] Expected changes in ecosystems will damage interconnected processes, such as hydrological processes, resulting in a negative impact on water supplies.[54]

48 16.4.2; 16.4.3

49 16.4.2, 16.4.3

50 Chapter 2 Table SM2.5, Cross Chapter Box: EXTREMES in Chapter 2,2.4.4.3.1, 2.4.2.3.3

51 16.5.2.3.2

52 2.5, 3.4, 4.6, 6.2, 7.3, 8.7, 9.2, 9.9, 11.6, 12.5, 13.6, 13.10, 14.6, 15.3, 16.5, 16.6, CCP1.2, CCP2.1, CCP2.2, CCP5.3, CCP6.2, CCP6.3, CCB MIGRATE, CCB SLR

53 3.4.2.7, 3.4.2.8, Cross-Chapter Box EXTREMES in Chapter 2.

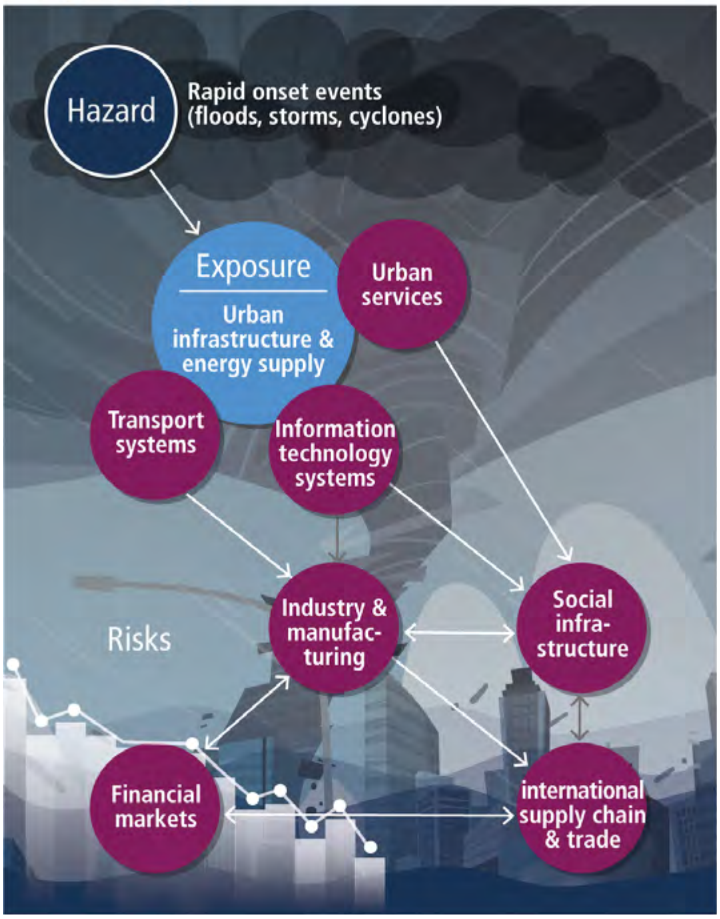
54 16.5.2.3.2

Representative Key Risk 3: critical infrastructure and networks

Direct loss and damage to critical infrastructure and networks is projected to be high. Under high warming models, with minimal adaptation, risks to critical infrastructure would be severe (high confidence). In some contexts, even under low warming predictions direct impacts are expected to be severe (medium confidence). Urban infrastructure is a growing source of compounding and cascading risks (high confidence). This is due in large part to rapid unplanned urbanization with infrastructure not designed to withstand climate hazards or stressors.[55] Direct impacts will put pressure on the financial capacity of countries to maintain, repair, rebuild and adapt infrastructure (medium evidence, high agreement).[56] It will require a rapid increase in demand for investment to either repair/rebuild, or to adapt infrastructure to minimize the risk. In Africa, damage to transport and energy infrastructure is expected to be a significant financial burden with medium to high warming (high confidence).

Indirect loss and damage to critical infrastructure and networks will be severe in many contexts under high warming models and no additional adaptation (medium confidence).[57] While there is less information on indirect loss and damage from infrastructure failure on lives, livelihoods and economies, there is agreement that risks connected to infrastructure can be particularly severe when it undermines emergency response capacity in disaster situations (limited evidence, high agreement). Power outages as a result of floods or droughts also have significant health impacts among low-income populations.[58] Another study has found that the indirect impact of power outages on the local economy in Europe from the interruption to daily economic activity, is six to eight times greater than the economic impact of the flood damage and repair costs alone.[59]

(e) Urban infrastructure failures cascade risk and loss across and beyond the city



Projected risks for damage to transport and energy infrastructure are expected to grow. Along coasts, in polar regions and along rivers are areas that are particularly vulnerable and face severe risks even with medium warming (high confidence). In Europe, under medium warming with current levels of adaptation, damages from multiple climate hazards to transport, energy, and other critical infrastructure may increase by 2080 to ten times the current €3.4 billion annually, and could be 15 times higher for transport infrastructure.[60] In the United States, it's expected that the number of roads requiring rehabilitation from high temperatures and precipitation will increase 23–33 per cent under high warming levels.[61] In Africa by 2050, under high

55 TS.C.9.3; 6.2.2, 9.9.4, 10.4.6, 13.6.1, 13.6.2, 13.11.3, 14.5.5, CCP2.2, SMCCP2.1
56 16.5.2.3.3
57 16.5.2.3.3
58 16.5.2.3.3
59 16.5.2.3.3
60 16.5.2.3.3
61 16.5.2.3.3

warming models, with current levels of adaptation, there is a projected 250 per cent increase in disruption time of the transport network because of extreme temperatures, precipitation and flooding.[62] Ports are especially vulnerable to damage and under high warming levels, the number of ports at high risk will increase from 3.8 per cent to 14.4 per cent by 2100 because of increased coastal flooding, sea-level rise and heat stress.[63]

While there are projected losses to resources for electricity generation, there is also a high potential for adaptation and mitigation in the energy sector. Globally it is expected that there will be significant reductions in hydropower and thermoelectric capacity by 2050 under different warming models. However, if potential is harnessed to engage in adaptation and mitigation policies for electricity generation, it is anticipated that there could be at least a two-thirds reduction in the projected impacts.[64]

Representative Key Risk 4: living standards

Economic losses are expected to be severe globally and regionally where there is high warming and minimal adaptation (medium confidence). In general, projected global economic damage typically increases with warming and some estimates are larger than previously thought (high confidence).[65] If adaptation continues at historical levels and warming is around 4°C by 2100, this has the potential to result in a 10–23 per cent declines in annual global GDP, just from temperature impacts.[66] Under the same warming model, by 2050 economic losses in Sub-Saharan Africa may be up to 80 per cent of GDP by 2100.[67] Contexts more exposed to economic losses are developing countries, places where much of the workforce is in highly exposed industries, when most of the economic activity is on coastlines and where there is an increasing frequency and intensity of disasters.[68]

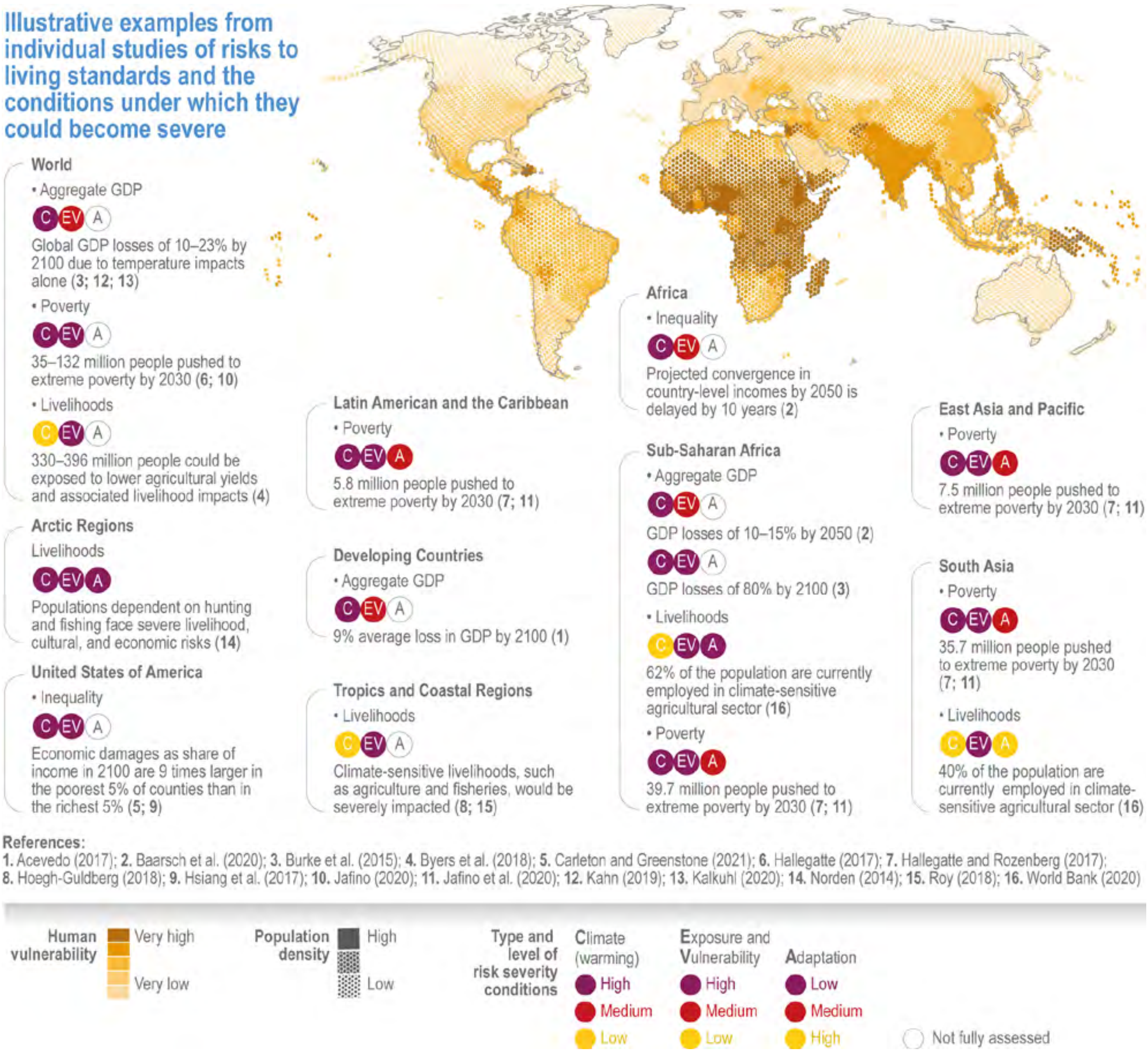
The potential risks from climate change to poverty rates may become severe. This is particularly true under medium warming models if vulnerability is high and adaptation is low (limited evidence, high agreement).[69] If vulnerability remains high, up to 132 million people could be pushed into extreme poverty due to climate change by 2030.[70] In South Asia alone, 35.7 million people could be pushed to extreme poverty by 2030, and in Sub-Saharan Africa 39.7 million people could fall into extreme poverty before the end of the decade. Predictions on climate impacts to poverty are supported by observations from previous disasters and crises, compounded by the projection that such events will become more frequent or intense in some places and on the low levels of adaptive and coping capacity of those in poverty. As a result, it's thought that the impacts of climate change will keep many in poverty and may cause more than tens of millions to enter into poverty (limited evidence, high agreement).

Livelihoods face severe loss and damage even at low warning levels, where there is high vulnerability and low adaptation (high confidence). The risks become more severe where warming levels increase. Regions most vulnerable are highly exposed locations such as small island developing states, low-lying coastal areas, arid or semiarid regions, the Arctic and urban informal settlements; as well as areas where there is high dependence on climate sensitive livelihoods like agriculture and fishing in tropical and coastal regions. Without adaptation

62 16.5.2.3.3
63 16.5.2.3.3
64 16.5.2.3.3
65 TS.C.10.2; 4.4.4, 4.7.5, 9.11.2, 10.4.6, 13.10.2, 13.10.3, 14.5.8, Box 14.6, 16.5.2, 16.6.3, CWGB ECONOMIC
66 16.5.2.3.4
67 16.5.2.3.4
68 16.5.2.3.4
69 16.5.2.3.4
70 16.5.2.3.4

measures, projections show that these would be severely impacted even at low levels of warming (high confidence).[71] Even at warming levels of 1.5°C, there are estimations of significantly diminished agricultural and fishing yields from climate impacts, affecting both food security and livelihoods. This could result in enormous loss and damage in Sub-Saharan Africa, where 62 per cent of the population are currently employed in climate sensitive sectors, as well as South Asia, where 40 per cent of the population are currently employed in agriculture.[72]

Income inequality is expected to increase both between (high confidence) and within countries (medium evidence, high agreement) as a result of impacts from economic and livelihood losses and rising poverty. Rising inequality will pose challenges for coping and adaptation capacities, as well as meeting established global development goals.[73] Certain populations such as the poor, women, children, the elderly and Indigenous populations are particularly vulnerable because of factors like gendered pay inequality and barriers to accessing information, services and resources (high confidence).[74]



71 16.5.2.3.4
72 16.5.2.3.4
73 16.5.2.3.4
74 16.5.2.3.4

Loss and damage to living standards could be moderated to minimize the severity of risk. Equitable socio-economic development and inclusive development will help to reduce exposure to risk.[75] For instance, by improving adaptive capacity, creating livelihoods in less climate sensitive sectors, and enabling sustainable migration to less climate sensitive locations. These efforts will require the avoidance of maladaptation related risks.[76]

Representative Key Risk 5: human health

Where vulnerability is already high, severe health impacts are projected. Some of the most acute risks to human health include heat related mortality, as well as vector and waterborne diseases. By 2050, projected climate change could lead to an excess of around 250,000 deaths because of heat (94,000 primarily in Asia and high-income countries), childhood undernutrition (85,000 primarily in Africa and Asia), malaria (33,000 mainly in Africa) and diarrhoeal disease (33,000 primarily in Africa and Asia).[77] Mental health issues like anxiety and stress are also anticipated to increase with warming in all regions, especially for youth, elderly and those with underlying health conditions (very high confidence).[78]

Heat-related mortality and morbidity are projected to increase globally (very high confidence) and with high levels of warming, the risk of heat related mortality would be severe (medium confidence).[79] If there is no adaptation, most parts of the world would see a 2 to 10 per cent rise in deaths from heat by the end of the century.[80] Rising temperatures in general are expected to increase the frequency and intensity of harmful health conditions. Depending on the level of warming and population distribution, the global population exposed to deadly heat stress would rise from the current 30 per cent to 48–74 per cent by the end of the century.[81] If populations are ageing or facing rising inequality, and there is limited adaptation due to poor infrastructure and limited health resources, the projected health impacts are even larger.[82] In urban settings and highly dense settlements with other environmental hazards including air pollution, risks are also expected to be higher.[83]

75 TS.C.10; 4.4.4, 4.7.5, 9.11.2, 10.4.6, 11.5.2, 13.10.2, 13.10.3, 14.5.8, Box 14.6, 16.5.2, 16.5.3

76 16.5.2.3.4

77 Figure 7.8; 7.3.1.1

78 4.5, 5.12, Box 5.10, 7.3, Figure 7.9, 8.4, 9.10, Figure 9.32, Figure 9.35, 10.4, Figure 10.11, 11.3, 12.3, Figure 12.5, Figure 12.6, 13.7, Figure 13.23, Figure 13.24, 14.5, 15.3, CCP6.2

79 TS.C.63; 6.2.2, 7.3.1, 8.4.5, 9.10.2, Figure 9.32, Figure 9.35, 10.4.7, Figure 10.11, 11.3.6, 11.3.6, Table 11.14, 12.3.4, 12.3.8, Figure 12.6, 13.7.1, Figure 13.23, 14.5.6, 15.3.4, 16.5.2

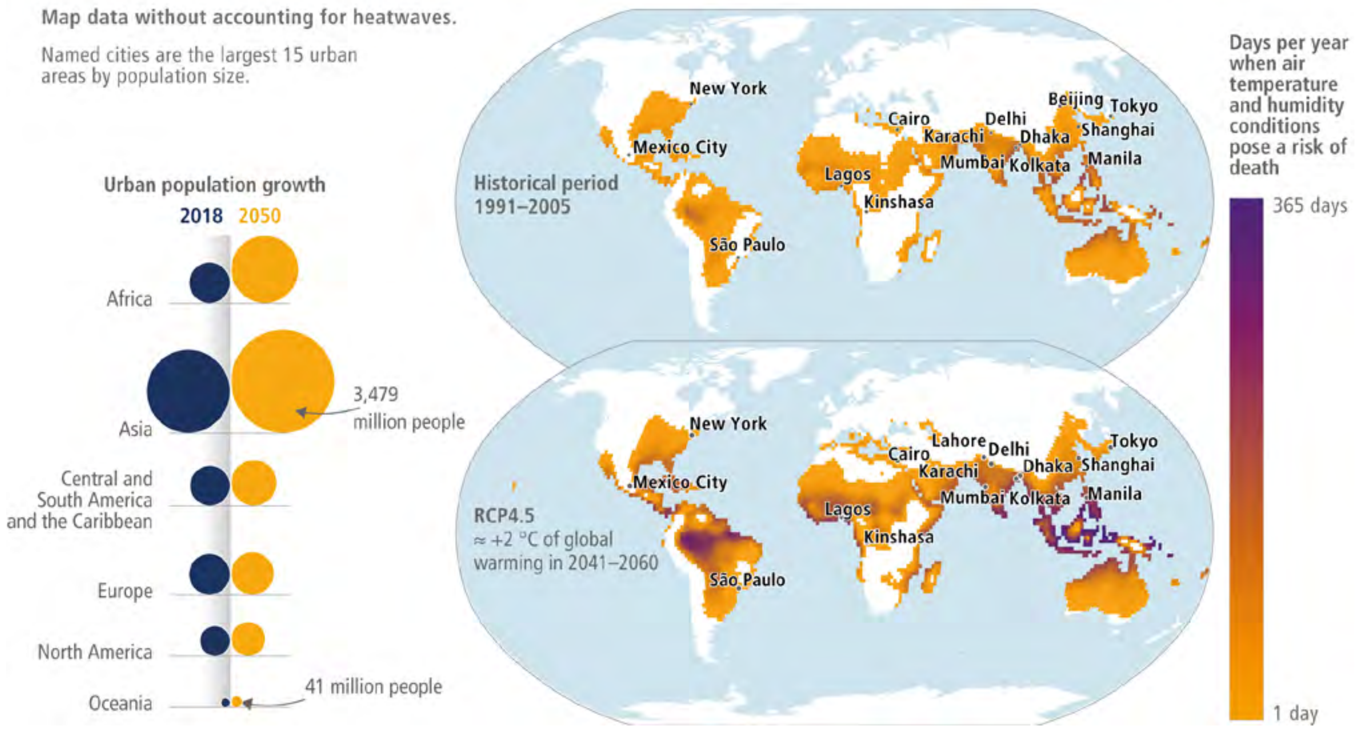
80 16.5.2.3.5

81 16.5.2.3.5

82 16.5.2.3.5

83 16.5.2.3.5

(b) Global distribution of population exposed to potentially deadly conditions from extreme temperatures and relative humidity.



Under high warming scenarios, the risk of vector-borne disease is severe, especially for children and sensitive regions (medium confidence). In Africa, this would mean a net increase of 70–130 million more people potentially exposed to disease transmission from high warming climate change models.[84] There is a particular risk in East Africa, with projections of a doubling of the population exposed to vector-borne disease. Projections are dependent on socio-economic development in the region and the effectiveness of malaria intervention programmes. Globally, dengue risk will increase due to longer seasons and a wider geographical spread throughout Asia, Europe, Central and South America and Sub-Saharan Africa (very high confidence).[85] Dengue cases could even double under high warming scenarios due to warming and population growth.[86]

The risk of water-borne diseases is severe, particularly for children in lower- and middle-income countries where vulnerability is high (medium confidence). Diarrhoea for instance rises with heavy rainfall and flooding events, which is expected in some regions.[87] Risks will depend on levels of development, adaptation to flood and drought and interactions with other risks like cholera, food insecurity and infrastructure damage. Climate change poses a risk to progress made in reducing morbidity and mortality from diarrhoea. In China by 2030, climate change could delay progress in efforts to reduce waterborne disease by eight months to seven years.[88]

84 16.5.2.3.5

85 4.5, 5.12, Box 5.10, 7.3, Figure 7.9, 8.4, 9.10, Figure 9.32, Figure 9.35, 10.4, Figure 10.11, 11.3, 12.3, Figure 12.5, Figure 12.6, 13.7, Figure 13.23, Figure 13.24, 14.5, 15.3, CCP6.2

86 16.5.2.3.5

87 16.5.2.3.5; WGI

88 16.5.2.3.5

Representative Key Risk 6: food security

Loss and damage to food security and food systems from climate change is wide-ranging, from impacts on food production, to weather extremes disrupting food supply chains.[89] Increasing food insecurity will be connected to more frequent and intense droughts, floods, and heatwaves, as well as sea-level risk (high confidence). This is particularly true in regions with no or low levels of adaptation, even in warming between 1.5°C to 2°C (medium confidence).[90] Under high warming and high vulnerability scenarios, climate change will increase the number of undernourished people, affecting tens to hundreds of millions of people, particularly in low-income populations in developing countries (high confidence). In this scenario, nearly 200 million additional people would be expected to become undernourished by 2050. The impacts are likely to be felt most acutely in Sub-Saharan Africa, South Asia, Central and South America and small islands (high confidence). Extreme weather events will further increase risks of undernutrition from spikes in food prices, reduced food diversity and loss of income (high confidence).[91]

Decreases in the quality of food because of micronutrient deficiency will be a severe risk without adaptation with increased carbon dioxide levels (high confidence).[92] This is particularly true in countries that already have high levels of nutrient deficiency low access to diverse foods. For instance, in this scenario there will be a decrease of zinc content which would mean an additional 150–220 million people would be affected with zinc deficiencies. There would also be a decrease in protein and micronutrient content in rice with higher concentrations of carbon dioxide, which would result in micronutrient deficiency by 2050 for approximately 600 million people that rely on rice as a staple food.[93] In general, climate change impacts on food quality and availability are expected to result in approximately 54 deaths per million people under 2°C warming by 2050, primarily in South and East Asia.[94]

Projected decreases in the quantity of food from impacts on agriculture due to changes in water availability are also severe. Rain fed crops like maize are expected to have yields decline by one fifth to one third by the end of the century. Other areas that support multiple crops may become unsuitable for rain-fed crops, or only support one crop per year. Changes in water availability due to groundwater depletion in India, north China and north-west US are expected to negatively impact irrigation, a common adaptive strategy against water-induced agricultural stress. Changes to the intensity and frequency of droughts and floods will result in a major risk to agriculture, with impacts more severe in places which are already food insecure.[95] In the fishing sector, climate justice issues will emerge, as higher-latitude countries with higher GHG emissions will likely benefit from poleward migrating resources from poorer and low GHG-emitting tropical countries. Bilateral and multilateral agreements may be useful to allocate resource sharing of quotas and permits to compensate and/or prevent losses.[96]

89 16.5.2.3.6

90 (Figure SPM.3) 1.1, 3.3, 4.5, 5.2, 5.4, 5.5, 5.8, 5.9, 5.12, 7.3, 8.3, 9.11, 13.5, 15.3, 16.5, 16.6, CCB MOVING PLATE, CCB SLR

91 FAO et al., 2018, Hickey and Unwin, 2020; Mbow et al., 2019); 4.5.1, 4.6.1, 5.2.2, 5.4.3, 5.4.4, 5.5.3, 5.8.3, 5.9.3, 5.12.4, 7.3.1, 9.8.2, 9.8.5, 13.5.1, 14.5.4, 16.5.2, 16.6.3, CCB MOVING PLATE

92 TS.C.3.4; 3.5.3, 5.2.2, 5.4.2, 5.4.3, 5.5.2, 5.12.1, 5.12.4, 7.3.1, 9.8.5, 16.5.2, CCP6.2.3, CCP6.2.4, CCP6.2.5, CCP6.2.6, CCP6.2.8, CCB MOVING PLATE

93 16.5.2.3.6

94 16.5.2.3.6

95 Box FAQ 4.4

96 16.5.2.3.6, (Cross-Chapter Paper Polar 6.2.). (CROSS CHAPTER BOX: MOVING PLATE)

Representative Key Risk 7: water security

Water scarcity may become severe with estimations of large numbers of people having diminished access to water resources (high confidence). With 2°C global warming, the number of people with chronic water scarcity is likely to increase from 800 million to 3 billion, and up to 4 billion for 4°C global warming.[97] Where regional patterns of climate change result in severe reductions in precipitation in highly populated areas, researchers expect particularly severe outcomes, including competition and conflict between water users, damage to livelihoods and socio-economic development, and health impacts.[98] At 2°C warming, where irrigation depends on snowmelt to river basins, water availability is likely to decline by 20 per cent.[99] To avoid some of these consequences, transformational adaptation would be necessary. By approximately 2050 at 2°C global warming, there is a risk of a significant adaptation gap. This means the likelihood of severe impacts of water scarcity are relatively high in larger parts of the southern US and Mexico, North Africa, parts of the Middle East, northern China, southern Australia and parts of north-west India and Pakistan.[100] Small islands are also particularly vulnerable to decreasing groundwater availability (high confidence).[101] Starting at 3°C, water management measures are expected to reach hard limits, resulting in decreased water quality and availability, as well as negative impacts on health and well-being, economic losses in water and energy dependent sectors and potential migration of communities (medium confidence).[102]

Climate-related changes that will result in extreme events like flooding are projected to increase with global warming. These events result in loss of life, livelihoods and property, loss of access to fresh water, vector-borne diseases, and mental health impacts. With no additional adaptation, at 2°C global warming, approximately 50 to 150 million people are projected to be impacted by flooding, and between 110 to 330 million with 4°C global warming. From health impacts alone, flood risk is anticipated to result in an additional 48,000 deaths of children under 15 because of diarrhoea by 2030, particularly in Sub-Saharan Africa.[103] In Europe, if warming reaches above 3°C, this may double the cost of damage and the number of people affected by heavy rainfall and river flooding.[104] The consequences of extreme water events will depend on the presence or absence of adaptation measures such as infrastructure services, insurance or community support to reduce exposure and/or vulnerability.

Changes in water can lead to a loss of community cultures including loss of areas of ice or snow with spiritual meanings, loss of culturally importance places of access to such areas, and loss of culturally important subsistence practices.[105] For example, changes in streamflow can affect the availability of species for traditional hunting, negatively impacting Indigenous communities.

97 16.5.2.3.7
98 16.5.2.3.7
99 2.3, 4.4, 4.5, Box 4.2, Figure 4.20, 15.3, CCP5.3, CCB DISASTER, SROCC 2.3
100 16.5.2.3.7
101 2.3, 4.4, 4.5, Box 4.2, Figure 4.20, 15.3, CCP5.3, CCB DISASTER, SROCC 2.3
102 2.4.2, 3.4.2, 3.5.5, 3.6.3, 4.7.4, Box 4.2, Box 4.3, 4.7.2, 4.7.3, 6.4.3, 6.4.5, 6.4.5, 6.4.5
103 16.5.2.3.7
104 TS.C.4.5; 4.4.1, 4.4.4, 4.5.4, 4.5.5, 6.2.2, 7.3.1, Box 4.1, Box 4.3, 9.5.3, 9.5.4, 9.5.5, 9.5.6, 9.5.7, 9.7.2, 9.9.4, 10.4.6, Box 10.2, Box 11.4, 12.3, 13.2.1, 13.2.2,13.6.2, 13.10.2, Box 13.1, 14.2.2, 14.5.3, CCP2.2, CWGB URBAN
105 Chapter 4, 16.5.2.3.

Representative Key Risk 8: peace and human mobility

Risks to peace will increase with warming, particularly in communities with low resilience to climate risks and a larger number of underlying risks (medium confidence).[106] A breakdown of peace has the potential to cause losses to life, livelihoods and well-being. While the influence of climate on conflict is thought to be relatively weak (high confidence), this changes with higher levels of warming.[107] Climate change does strengthen climate sensitive drivers of conflict, which increases the risk of primarily intrastate conflict (medium confidence).[108] With 4°C warming levels, it is projected that this will have severe and widespread effects on armed conflict under current societal conditions.[109] However, risks to peace will depend on political and socio-economic development (limited evidence, high agreement), meaning that such risks are more likely for highly vulnerable populations under limited development scenarios and can be reduced with socio-economic development. Where armed conflict already exists, risks can be considered severe where it has cascading and compounding impacts and amplifies vulnerabilities to other climate risks.[110] In the Philippines, socio-economic vulnerability is connected to armed conflict and both climate change and conflict have increased vulnerability for communities in Mindanao because of lost livelihoods and financial assets, decreased agricultural yields and growing debt challenges. In places such as Colombia, conflict-related displacement pushes communities to relocate into high-risk areas, for instance steep slopes prone to landslides and flood-prone regions.[111]

Mobility related risks will increase with warming, particularly for densely populated hazard prone regions, small islands and low-lying coastal zones, and where populations have limited coping capacities (high confidence).[112] Direct and indirect loss and damage from climate risks such as physical harm, loss and damage of property and infrastructure, as well as loss of livelihoods, can impact human mobility. Involuntary mobility can lead to economic losses and increased exposure to impacts from other key risks. Anticipated increases in the frequency and intensity of extreme events, in addition to population growth in hazard prone regions, indicate that there will be increased risks to mobility from future global warming.[113] For instance, global levels of flood displacement are estimated to increase by 50 per cent with every 1°C of warming.[114] Without sufficient adaptation, even moderate sea-level rise will increase involuntary migration and displacement from small islands and densely populated low-lying coastal areas (high confidence).[115] As migration is largely dependent on socio-economic development, projected displacements range widely. For example, by 2050, projected climate-related displacement in Central and South America, Sub-Saharan African and South Asia ranges from just over 30 to more than 140 million people (high confidence).[116]

106 16.5.2.3.8
107 TS B.7.4, 7.3, 16.5, CCB MIGRATE
108 TS.C.8.3; 4.5.6, 7.3.3, 16.5.2
109 16.5.2.3.8
110 16.5.2.3.8
111 Chapter 17, Box 17.2 Climate Risk Management in Conflict-Affected Areas
112 RKR-A; Section CCP2.2.2; Chapter 7
113 16.5.2.3.8
114 16.5.2.3.8
115 15.3.4, 16.4
116 TS.C.7.2; (Figure TS.9 URBAN) 4.5.7, 7.3.2, 7.3.2, 7.3.2, 9.9.4, CCP2.2.1, CCP2.2.2, CCB MIGRATE, CCB SLR, Figure AI.42

CASE STUDY 2. Climate change as driving factor for migrants to cross the Mediterranean

Migrations through the Mediterranean have caused over 20,000 deaths since 2014, a humanitarian tragedy driven by complicated dynamics of climate, mobility, and political instability. These dangerous migrations highlight the urgent need for transformational adaptation efforts, as people incur devastating loss of life and livelihoods on their journey over the Mediterranean.

Climate change is one of the multiple economic, social and political factors affecting decisions leading to migration, in most cases internally – within the country – but also internationally, as in the case of migrants crossing the Mediterranean. A large proportion of migrants are from Sub-Saharan Africa, a region that is highly vulnerable to climate impacts (see section 3.3). Direct climate change attribution to migration is currently not possible to establish. However, as the impacts of climate change on conflicts and security are increasingly documented, there is a high agreement that food insecurity and land degradation, which are exacerbated by climate change impacts, are major drivers of political instability in Sub-Saharan Africa, ultimately contributing to migration flows across the Mediterranean.

Adapted from FAQ CCP4.3: What is the link between climate change and human migration in the Mediterranean basin?

Section 3. Key issues for loss and damage policy

Takeaway 4. There remains an evidence gap for assessing and accounting for non-economic loss and damage

For both economic and non-economic loss and damage, systematic risk assessments of climate-related loss and damage are rare. Vulnerable countries lack comprehensive data on economic and non-economic loss and damage, hampering effective risk management. Academics have proposed a loss and damage inventory, which can monitor how technologies mitigate risks and shift adaptation limits. In terms of NELD, there have not yet been attempts to explicitly link these to attribution science and existing evidence is concentrated amongst certain groups. NELD remains overlooked in vulnerability assessments and adaptation planning (8.3.4.2). Particularly in low-income and most vulnerable regions, it is not the absolute economic loss, but the combination of economic and especially non-economic losses that should be informing adaptation strategies.

The AR6 report brings new focus on NELD, supported by the emergence of small-scale evidence in the global south, particularly for Indigenous Peoples, agro-pastoralists, women and girls, low-income groups, children and youth, and ethnic and religious minorities. Non-economic losses such as loss of identity and emotional distress are often associated with displacement, especially in the aftermath of extreme flooding, droughts, and hurricanes. Researchers have defined categories of NELD, which include human life, sense of place and mobility, cultural artefacts, biodiversity and ecosystems, communal and production sites, agency and identity, and psychosocial and emotional distress. Human deaths are increasingly associated with loss and damage from tropical cyclones and typhoons. NELD can also include loss of social networks, which can have lasting implications for psychological health and for coping with future crises.

Losses in terms of well-being are significantly higher than actual asset losses experienced.[117] Though their absolute economic losses are significantly lower, low-income countries account for more disaster-related mortality than high income countries. These differences can be explained by significant wealth differences and monetary value of assets exposed. There is a need to critically reflect on the measures used to assess loss and damage, as the number of people affected by droughts, floods, and storms as a percentage of the total population and per hazard event points to the disproportionate suffering of the most vulnerable countries.

Limits to adaptation is still a largely under-researched topic globally. Financial constraints are key determinants of adaptation limits in human systems, particularly in low-income settings (high confidence). In urban areas, limits to adaptation are most pronounced in rapidly growing cities and smaller settlements without dedicated local government.[118] Still, while there is greater agreement on the existence of hard and soft adaptation limits, conceptual frameworks that can support methods of assessment remain scarce.

117 8.3.2.5
118

There remains a major knowledge gap for assessing past and future loss and damage, because the terminology is not used prominently in disaster management and climate risk literature (Box 10.6). Where evidence does exist, attribution studies linking climate change and loss and damage are more focused on rapid-onset events, and evidence on loss and damage from slow-onset events, such as drought and water scarcity, is low.

Takeaway 5: Loss and damage is unevenly distributed across geographies and groups of people

'Residual risks' are much higher for marginalized people, such as the poor, women, children, Indigenous Peoples, the elderly, and people living in specific marginal geographies, such as mountain regions, frozen regions and small island states.[119] The loss and damage they experience span from loss of income, food insecurity and malnutrition, permanent impacts to health and labor productivity, loss of life and loss of homelands, amongst others. These impacts amplify inequalities and undermine sustainable development across all regions (high confidence).[120] Under more unequal future scenarios, the projected number of people living in extreme poverty may increase by more than 120 million by 2030 (medium confidence).[121]

Based on an analysis of vulnerability indices, the most vulnerable areas remain in developing countries, with a relative vulnerability analysis highlighting some regions as more vulnerable including: East, Central, and West Africa, South Asia, Micronesia, Melanesia (the south-west Pacific) and Central America.[122] These regions are characterized by high poverty, low access to basic services, gender and income inequalities and governance challenges. Mortality from floods, drought and storms is on average 15 times higher for regions and countries ranked as very highly vulnerable compared to very low vulnerable regions and countries. Furthermore, the average number of people adversely affected by a hazard event (e.g. loss of the house) is 11 times higher in regions and countries categorized as having very high vulnerability compared to very low vulnerability.[123] Several of these highly vulnerable regions are likely to experience a further increase in climate hazards such as sea-level rise in Melanesia and Micronesia and in coastal zones of West Africa and more severe droughts in Africa.[124] Beyond this relative vulnerability analysis, vulnerability is also concentrated in people living in informal settlements, people living in small and medium sized cities, people living in coastal areas, and anywhere with considerable developmental constraints, including where poverty, violent conflict, and fragile livelihoods exist.

119 8.2.1.3; 4.3.1
120 8.2.1, 8.3.3
121 8.2, 8.3.4, 8.4.1, 8.4.5, Figure 8.6, Box 8.5, 16.5.2.3.4
122 8.3, 8.4, Box 8.6
123 8.3.2.1
124 8.3.2.5

Despite being one of the lowest contributors (both historical and current contributions) to greenhouse gas emissions, Africa provides robust evidence of climate-related losses, particularly in terms of crop yields, destroyed homes, food insecurity, increased food prices, displacement, and loss of life.[125] Agricultural productivity growth has been reduced by 34 per cent since 1961 due to climate change, more than any other region.[126] To cope with extreme events, such as floods and droughts, people most commonly sell livestock and land. This reduces the asset base, creates long term vulnerabilities to future events, and can trigger chronic poverty (high confidence). Future warming will create more severe loss and damage, negatively affecting food systems through shortening growing seasons and increasing water stress. Livestock productivity is threatened by declining rangeland productivity, increasing heat stress, and more prevalent vector-borne livestock diseases, with rangeland productivity projected to decline by 42 per cent in West Africa by 2050 at 2°C global warming.[127] Furthermore, human mortality and morbidity will escalate above 2°C as tens of millions of more people are exposed to vector-borne diseases and tens of thousands more cases of diarrhoeal disease in West, East, and Southern Africa. Alarmingly, risk of heat-related deaths rises sharply above 1.5°C, with at least 15 additional deaths per 100,000 annually across large parts of Africa, reaching 50–180 additional deaths per 100,000 people annually in regions of North, West, and East Africa for 2.5°C, and increasing to 200–600 per 100,000 people annually for 4.4°C.[128]

Indigenous people are more acutely impacted by the loss of ecosystem functions driven by climate change. Their tangible heritage, such as traditional harvesting sites, and intangible heritages, such as festivals and unique insights about plants and animals are being lost (high confidence). In addition to threatening the adaptive capacity of indigenous people, there is a risk of intergenerational trauma and a loss of sense of belonging, culture, and home.[129] Intangible loss and damage are particularly severe in the Artic, where negative impacts from climate change range from livelihoods to spirituality to solastalgia (distress caused by environmental change). Permafrost thaw and sea-level rise put socio-cultural assets like burial grounds, nomadic camp sites, graveyards, seasonal dwellings, and routes in danger of loss and damage (high confidence).[130]

In Central and South America, indigenous people in the mountains and small and medium-sized farmers are expected to experience food insecurity, as climate change negatively impacts their agricultural production, reduces the suitable farming area and constrains water availability (high confidence).[131] Similarly, people living in the Andes, north-eastern Brazil, and in the northern countries in Central America are highly sensitive to climate-related migration and displacement, a phenomenon that has accelerated since AR5 (high confidence).[132] Likewise, in the Amazon basin, climate change hazards of severe droughts and floods (high confidence) are revealing limits to adaptation among the majority of riverine communities and smallholder farmers, who are experiencing losses of income, declining fisheries and agricultural productivity, as well as the ability to attend school and losses of place and identity through forced migration.[133]

125 8.3.4.1

126 9.4.5, 9.6.1, 9.8.2

127 9.8.2

128 9.10.2

129 2.2, Table 2.1, 2.6.5, 3.5.6, 4.3.5, 4.3.8, 5.4.2, 6.3.3, Box 9.2, 9.12.1, 11.4.1, 11.4.2, 12.5.8, 13.8.1, Box 13.2, 14.4, 15.3.4, CCP5.2.5, CCP5.2.7, CCP6.2, Box CCP7.1

130 CCP6.2.5

131 12.2, 12.3, 12.4

132 12.3.1.4, 12.3.2.4, 12.3.3.4, 12.3.5.4, 12.5.8.4

133 8.4.5.3

People living on small islands are being severely impacted by tropical storms that are increasing in intensity (high confidence).[134] Small islands are already reporting loss and damage from increases in sea-level rise and intense tropical storms of Categories 4 and 5 (high confidence). For instance, Tropical Cyclone Maria in 2017 destroyed nearly all of Dominica's infrastructure and losses amounted to over 225 per cent of annual GDP. Winston in 2016 exceeded 20 per cent of Fiji's GDP. Among 29 Caribbean islands, 22 were affected by at least one Category 4 or 5 storm in 2017. These small islands also face threats to freshwater systems due to sea-level rise, with increasing drought trends apparent in the Caribbean. In one stark example, the El Niño-related drought in 2015–2016 in Vanuatu forced people to rely on small amounts of contaminated water at the bottom of household tanks.[135]

Across Asia, climate change is contributing to food insecurity, damaging infrastructure, and driving migration. In South and South-East Asia, climate change is causing a decline in productivity of fisheries, aquaculture, and crop production.[136] Across Asia, climate change has caused direct losses due to damage to infrastructure, disruption in services, and affected supply chains. Asian urban areas are considered high risk locations from projected climate change and extreme events, with the largest share of people in the world living in informal settlements.[137] Furthermore, increased climate variability and extreme events are driving migration in Asia, where one in three of the world's migrants originate. In 2019, Bangladesh, China, India, and the Philippines each recorded more than four million disaster displacements. In South-East Asia and East Asia, cyclones, floods, and typhoons were responsible for the internal displacement of 9.6 million people.[138]

*Takeaway 6: **Compound risks exacerbate loss and damage***

Concurrent and cascading climate hazards are taking place in all regions, such as increasing occurrences of heat and drought together, or sea-level rise combined with storms and heavy precipitation.[139] Cascading and compounding risks increase the likelihood of falling into extreme poverty for low-income people experiencing repeated and successive climatic events, in which people still recovering from one disaster must immediately face another impact.[140] This is a particular challenge for slow and rapid-onset events related to drought causing multiple consequences for agriculture, as well as for the urban and rural low-income households who face difficulties rebuilding assets following a series of shocks. In addition, a single climate hazard can create multiple impacts, which results in compounding consequences for food security, livelihoods, and human health (high confidence).[141]

---

134 15.2.1, 15.3.3.1, 15.3.3.3, 15.3.4.1, 15.3.4.2, 15,3.4.4, 15.3.4.5

135 15.3.3.2, 15.3.4.3

136 10.4.5

137 10.4.6

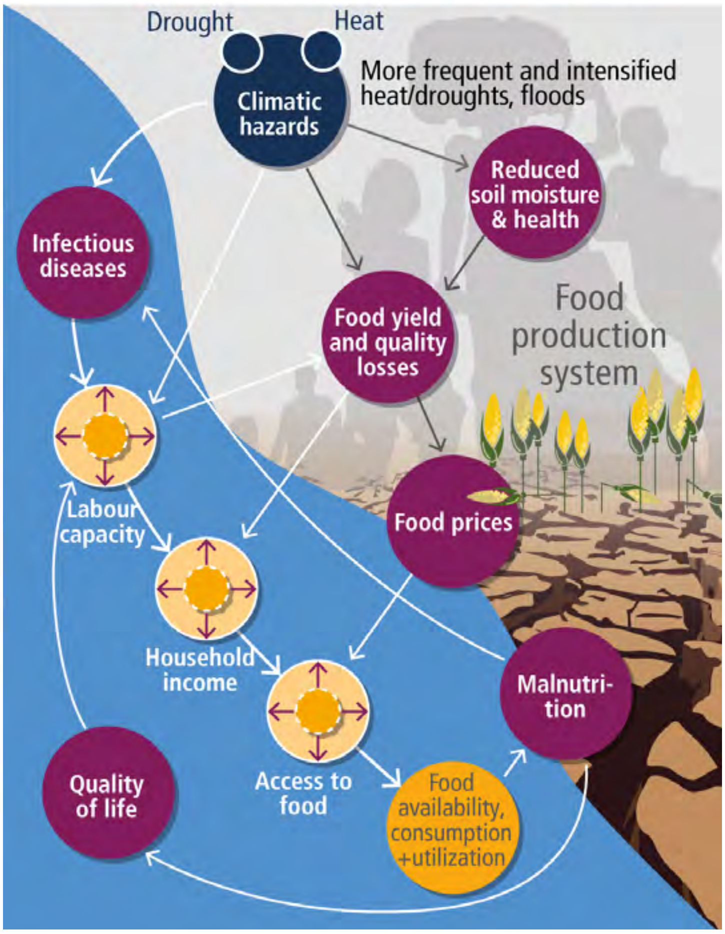
138 Box 10.2

139 Figure TS.10c, 5.2, 5.4, 5.8, 5.9, 5.11, 5.12, 7.2, 7.3, 9.8, 9.11, 10.4, 11.3, 11.5, 12.3, 13.5, 14.5, 15.3, Box 15.1, 16.6, CCP1.2, CCP6.2, , WGI AR6 SPM A.3.1, WGI AR6 SPM A.3.2, WGI AR6 SPM C.2.7

140 8.2.1.1

141 (Figure TS.10 COMPLEX RISK) 4.5.1, 5.2.2, 5.4.3, 5.8.1, 5.8.3, 5.11.1, 5.12, Figure5.2, 5.12.4, Box5.10, 7.3.1, 9.10.2, 9.8.2, 9.8.3, 14.5.6, CCP5.2.3, CCP6.2.3, CCB ILLNESS

(c) Cascading impacts of climate hazards on food and nutrition



The underlying context and non-climatic risks are important factors that determine whether an extreme event becomes a disaster. Multiple climate hazards are and will occur at the same time, with different climate and non climate-related risks interacting, compounding overall risks and risks that cascade across sectors and regions (high confidence).[142] Under high emissions scenarios, without strong adaptation measures, loss and damage will be concentrated amongst low-income households.[143] This is because intersecting risks of inequality and poverty create adaptation limits for those in vulnerable situations including women, youth, elderly, ethnic and religious minorities, indigenous people and refugees.[144] Vulnerabilities of ecosystems and people to climate change differ within and between regions due to overlapping patterns of socio-economic development, unsustainable land/ocean use, marginalization and current and historical patterns of inequity (high confidence).[145]

CASE STUDY 3. Climate change as driving factor for migrants to cross the Mediterranean Sea

In 2017, 22 of the 29 Small Island Developing States in the Caribbean have been affected by at least one Category 4 or 5 tropical cyclone. Numerous economic and NELD were experienced during the disasters and subsequent recovery phases, increasing vulnerability in the region.

The impact of the tropical cyclones coupled with the existing vulnerabilities caused 'cascading public health consequences' resulting in NELD including: mortality, physical injury during the clean-up and recovery phase, increased risk of chronic, vector-borne, contaminated water-related diseases, as well as mental health consequences. The destruction of cultural landmark buildings and the prolonged displacements experienced in some countries (the Bahamas and Barbados) induced additional NELD due to significant loss of tangible (e.g. museums) and intangible (e.g. traditional artistry) cultural heritage.

Economic losses also occurred as the result of losses of mangroves and forests as sources of livelihood for communities, exacerbating the cyclone-induced economic crisis. The Covid-19 pandemic caused a sudden drop in tourism, a key sector of the economy in the region, creating compounding crises for some communities that were still recovering from the cyclones.

Adapted from Box 15.1: Key Examples of Cumulative Impacts from Compound Events: Maldives Islands and Caribbean Region

142 1.3, 2.4, Box 2.2, Box 9.5, 11.5, 13.5, 14.6, Box 15.1, CCP1.2, CCP2.2, CCB COVID, CCB DISASTER, CCB INTEREG, CCB SRM
143 8.2, 8.3.4, 8.4.1, 8.4.5, Figure 8.6, Box 8.5, 16.5.2.3.4
144 Section 8.2,2.3; CCB GENDER in Chapter 18
145 2.3, 2.4, 3.5, 4.3, 6.2, 8.2, 8.3, 9.4, 9.7, 10.4, 12.3, 14.5, 15.3, CCP5.2, CCP6.2, CCP7.3, CCP7.4, CCB GENDER

Averting, minimizing, and addressing loss and damage: where to go from here?

The AR6 WGII report identifies urgent challenges now and in the near future, with serious consequences for loss and damage and loss and damage negotiations. There are three clear messages that emerge as essential to minimizing loss and damage.

1. First, to limit loss and damage, **mitigation** is essential to reduce levels of warming. All emissions avoided will contribute to averting loss and damage. This is particularly urgent, as every degree of increased average temperature will have exponential impacts.

2. Secondly, **transformative locally-led adaptation** is critical to effectively cope with the consequences of climate change and minimize compounding risks. It will require designing effective adaptation strategies that address local drivers of vulnerability and that are coherent with **climate-resilient development pathways**.

3. Third, across the report, equitable **socio-economic development** is emphasized as a solution for reducing the potential for loss and damage. Ambitious social protection measures can help address some of the loss and damage experienced.

Transformational risk management is highlighted in this report as being an important avenue to minimize loss and damage. This includes systematically integrating adaptation efforts across sectors and regions to reflect the interconnectedness and compounding nature of climate risks. This should also include intersecting non-climatic vulnerability factors which impact the severity of loss and damage to improve climate resilient development.[146] As discussed in Section 3.1, this should also entail undertaking systematic risk assessments of both economic and non-economic climate-related loss and damage and adaptation limits, which can support comprehensive risk management decision making.[147] Finally, improve national monitoring and evaluation systems essential aspect of transformational risk management to track adaptation success and learnings.[148]

A vital enabling factor for transformational risk management is improving access to climate finance. This can be done by expanding both access to climate finance sources and options, to address loss and damage and manage climate risks. As highlighted in the IPCC report, to support transformational risk management and adaptation, regions, communities and lower income households most affected and marginalized by climate change, need to have better access to financial support for adaptation.[149]

Finally, inclusiveness and localization are key factors to ensure transformative adaptation is successful. The report suggests that engaging systematically in participatory decision making with different types of stakeholders, including indigenous and local community groups, improves the effectiveness of decision making and approaches for risk management.[150]

146 7.6; Cross-Chapter Box DEEP Chapter 17
147 Cross-Chapter Box LOSS Chapter 17
148 17.5.2, Cross-Chapter Box PROGRESS Chapter 17
149 17.4.2; Cross-Chapter Box FINANCE Chapter 17
150 17.3.1.3.2

Reducing loss and damage arising from the climate crisis is an urgent global challenge requiring commitment for action at all levels, from communities to cities, and at national and global level. The observed loss and damage and risks of future loss and damage documented in this report must be translated into actions to avert, minimize and address loss and damage and create a pathway towards transformative climate resilience.