CLIMATE CHANGE 2022

HOU CIMATE CHANGE IS **IMPACTING LIFE ON EARTH** SUMMARY FOR ALL









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The Science is Clear:

Climate change is a threat to human well-being and the health of the planet. Any further delay in concerted global action will miss a brief and rapidly closing window to secure a liveable future for all.

Key message of the Working Group II report in the Sixth IPCC Assessment Cycle (AR6), published in February 2022

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Dear Reader,

As we write these lines (August 2023), millions of people and ecosystems around the world are experiencing searing heat. June and July 2023 are the hottest summer months ever recorded by meteorologists in countries across the Arab world, southern Europe and Asia. Meanwhile, North America is suffering from destruction and pollution caused by unprecedented wildfires in Canada, and in Mexico health officials are registering rising death tolls from a lengthy heatwave.

Scientists are working tirelessly to determine how human-made climate change contributed to each of these extreme events and their devastating consequences. This year, they have already looked at the extreme heat at the end of April 2023, when multiple temperature records were broken over a large area of Southwestern Europe and North Africa while a deadly drought affected the Horn of Africa. Neither of these events would have happened without human-caused climate change. The bitter reality is: Climate change and its increasingly frequent and severe weather extremes are already causing widespread and pervasive impacts on nature, people, communities and infrastructure everywhere on our planet.

Some losses are already irreversible such as the first global species extinctions on record caused by human-made climate change. Once a species is gone, it is gone forever. Other impacts are approaching irreversibility - for example, rapidly shrinking and disappearing glaciers. These are key sources of water for millions of people, cities, farms and ecosystems.

The following pages summarize the key findings of our Working Group II report on observed and future climate change impacts, and what we can do to reduce the harm they cause. One finding, in particular, stands out: The poorest people in every region are hit the hardest because they are the least able to cope. This means, they have neither the money, tools, or expertise, nor the urgently needed political support to cope with the risks caused by increasing temperature, sea level rise, and more frequent and intense extreme weather events such as floods and droughts. This result underlines growing awareness that all responses addressing climate change interact with issues of justice and social development.

To avoid mounting losses for all of us, urgent action is required to adapt to climate change, at the same time as making rapid, deep cuts in greenhouse gas emissions. Sincerely,

Your Working Group II team of the Sixth IPCC Assessment Cycle

Escalating Impacts Everywhere

ALL LIFE ON EARTH – FROM ECOSYSTEMS TO HUMAN CIVILIZATION – IS VULNERABLE TO A CHANGING CLIMATE

Climate change is increasingly affecting nature and people everywhere

We know without doubt that our world is warming. Dangerous climate change and extreme climatic and weather events are increasingly impacting nature and people's lives everywhere. This can be seen from the depths of the ocean to the top of the highest mountains: in rural areas as well as in cities. The extent and magnitude of climate change impacts are causing severe and widespread disruption in nature and in society, including reducing our ability to grow nutritious food and access clean drinking water, thus affecting people's health and well-being and damaging livelihoods. In summary, the impacts of climate change are affecting nature and billions of people in many different ways, despite efforts to adapt.

New knowledge: Impacts were caused or made worse by humanmade climate change

Since the first IPCC Report published in 1990, the evidence for climate change impacts has become progressively stronger. Our report, the IPCC's Sixth Assessment Report, contains new knowledge that climate change has already caused a wide range of impacts to date, or made them more likely. For example, the mass coral bleaching and coral death during marine heatwaves is now a frequent event in many tropical regions. In the Western USA, climate change is identified as a major driver of increases in area burned by wildfires. In many regions of the world, climate change has also caused range expansions of diseases transmitted by mosquitoes, flies, ticks and other insects such as dengue, Lyme disease or malaria, into areas from where they were previously absent or occurred rarely (see also 4. Climate change is affecting human health in many different ways on page 17).

3 Impacts interact with other risks and reinforce them

Climate change impacts are interacting with multiple other societal and environmental challenges. These include a growing world population, unsustainable consumption, a rapidly increasing number of people in cities, large inequalities, continuing poverty, land degradation, biodiversity loss due to land-use change, over-exploitation and habitat destruction, pollution of land, waterways and the ocean, as well as a global pandemic (2019-2023). Where these trends intersect they can reinforce each other, intensifying risks and impacts, which affect the poor and most vulnerable people the hardest.

For example, heatwaves have intensified in cities. As well as directly impacting people, particularly the elderly, sick and children, they also aggravate air pollution and disrupt the functioning of key infrastructure such as transportation, water, sanitation and energy systems. Observed impacts are concentrated amongst economically and socially marginalized urban residents, including those in informal settlements, which are often overcrowded with poor housing and a lack of basic services.



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Escalating Impacts Everywhere

ALL LIFE ON EARTH – FROM ECOSYSTEMS TO HUMAN CIVILIZATION – IS VULNERABLE TO A CHANGING CLIMATE



The impacts of our changing climate are felt across all regions, which means everyone and everything is affected. However, the extent to which harm is caused differs, because ecosystems as well as people have different capacities to cope with the ongoing change. In other words: Their vulnerability to climate risks and hazards varies – across the world as well as within regions and nations (*more information on vulnerability to climate change can be found on page 20*). The overarching bad news is: Current unsustainable lifestyles and increasing greenhouse gas emissions put additional pressure on ecosystems and people especially on those who are poor and marginalized – thereby increasing their vulnerability to climate change and other societal and environmental challenges.



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CLIMATE CHANGE AND INCREASES IN EXTREME WEATHER EVENTS ARE DRASTICALLY AND PROGRESSIVELY IMPACTING NATURE, WEAKENING THE STRUCTURE, FUNCTIONING AND RESILIENCE OF ECOSYSTEMS

Healthy ecosystems and rich biodiversity underpin human survival

The world's ecosystems on land, in freshwater and in the ocean provide a wide array of essential services to humans. They produce the food we eat and the oxygen we breathe and play a critical role in climate regulation. They filter our water, recycle nutrients and store large amounts of carbon, thereby slowing down global warming. Furthermore, healthy coral reefs, mangroves and seagrass meadows are the most effective ecological protection against extreme sea levels. Ecosystems cool the air and offer "green" or "blue" spaces such as parks and lakes for fun, adventure and relaxation, thus improving our health and mental well-being. They are integral to the culture and heritage of many Indigenous and traditional communities. In short, healthy ecosystems are essential for human survival and make our Earth liveable.

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Impacts are more disruptive and more widespread than previously expected

Climate change is drastically and progressively affecting our world's plants, animals and microbes and their ecosystems. Increasing temperatures and extreme events such as droughts, floods and heatwaves are exposing plants and animals to climatic conditions not experienced for at least tens of thousands of years. Observed increases in the frequency and intensity of extreme events are starting to exceed the ability of many species to cope or adapt.

Our report shows that the extent and magnitude of climate change impacts on nature are greater than previously assessed, based on increased observations and a better understanding of processes. The impacts we see today are appearing much faster, are more disruptive and widespread than we expected them to be 20 years ago. And we know that climate change is strongly adding to, and even amplifying other stressors: Many of our world's ecosystems are already facing a biodiversity crisis due to human impacts such as deforestation, pollution, overfishing and land-use change. For numerous of them, climate change impacts are even a deadly burden.



Photo by Pacific Southwest Forest Service, USDA. CC BY 2.0

CLIMATE CHANGE AND INCREASES IN EXTREME WEATHER EVENTS ARE DRASTICALLY AND PROGRESSIVELY IMPACTING NATURE, WEAKENING THE STRUCTURE, FUNCTIONING AND RESILIENCE OF ECOSYSTEMS

B Growing evidence for impacts on nature

We see a growing number of scientific studies that present multiple lines of evidence showing diverse impacts of climate change. Increasing temperatures and extreme events are changing the seasonal timing of key biological events such as flowering, spawning, hatching, when animals emerge from hibernation or undertake migrations. This is causing mismatches with important seasonal food sources. Examples include the timing of fish spawning and the plankton blooms that fish larvae depend on for food, and insect availability at the time when birds are breeding.

Changing climatic conditions, including warming, are also progressively shifting plants and animals toward the poles, to higher elevations or into deeper and cooler ocean waters. Approximately half of the many thousands of species studied on land and in the ocean already show such responses, leading to local losses of species, and shifts in vegetation zones, diseases and pests. In the ocean, marine plants and animals including entire communities of multiple species – have shifted their distributions poleward at an average speed of 59 km per decade, due to increasing water temperatures. Ocean acidification and decreasing oxygen in the water also play a part. Together, all three processes are driving a reorganisation of marine biodiversity. Those species that cannot adjust or move fast enough are at high risk of disappearing locally or becoming extinct.



Changing biodiversity patterns and consequences for food supply

As a result of these increasing impacts, the geographic patterns and the regional and local abundance of plants and animals are changing. This has potentially severe impacts for herders, farmers, fishers, hunters, foragers and other people who directly rely on nature's services. As an example, the global sustainable potential for fishery catches of several marine fish and shellfish is estimated to have decreased by 4.1% in the 70 years between 1930 and 2010 due to ocean warming. Some regions, such as the northeastern Atlantic Ocean, have experienced even stronger decreases in fisheries productivity, primarily due to warming. However, other human activities such as overfishing have also played an important role. On land, subsistence farmers are repeatedly losing their crops due to erratic rainfall patterns.

Although there have been some positive impacts on agricultural productivity in some high-latitude regions, with ongoing warming these could be transient. In addition, climate change is driving the spread and outbreaks of diseases and pests – affecting plants and animals as well as food production and human health.



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Weather extremes exceed what organisms can tolerate

Increases in frequency and severity of extreme weather events such as heatwaves, droughts and heavy rain are occurring across all continents and all oceans, pushing environmental conditions past the levels that organisms can tolerate. The more often ecosystems are impacted by extreme events and the more intense the event, the further they are pushed towards so-called tipping points. Beyond such tipping points, abrupt and in some cases irreversible changes can occur – such as species going extinct. Risk is especially high for Arctic and high mountain ecosystems, where climate change impacts are unfolding rapidly, due to increasing temperatures, ice melt, thawing of frozen ground (permafrost) and changes in water distribution and movement. Prominent examples of species being pushed beyond their temperature limits include reef-building warm-water corals that are dying due to the increasing frequency of marine heatwaves causing mass coral bleaching. The global decline of warm-water corals shows that we don't need to look into the future to recognize the urgency of climate action.



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Species' extinction risk is increasing as the world warms and extreme weather events become more frequent, longer and more intense

The following conceptual illustration shows how species' extinction risk is affected by changes in the frequency, duration and magnitude of extreme weather or climate events (e.g., drought, fire, flood and heatwaves). Many organisms have adapted to cope with long- and short-term climate variability, but as the magnitude and frequency of extreme events increases, superimposed on longterm warming, the threshold between survivable extreme weather events (orange zone), and extremes that carry a high risk of causing population or species extinctions (red zone), is crossed more frequently. This can lead to local extinction events with insufficient time in between to enable recovery, resulting in long-term, irreversible changes to the composition, structure and function of ecosystems. When an extreme event occurs over a large area relative to the distribution of a species (e.g., a hurricane impacting an island which is the only place a given species occurs), a single extreme event can drive the global extinction of a species.



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6 Weakening nature's potential to store carbon

Impacts will continue to increase with warming, weakening the structure, functioning and resilience of ecosystems and thus the services they provide, including their ability to regulate our world's climate. At present, vegetation and soils on land remove and store more carbon from the atmosphere than they emit. Thus, tropical rainforests, Arctic permafrost and other ecosystems provide the global ecosystem service of naturally preventing carbon from contributing to climate change.

However, in some regions, the balance is starting to shift to more carbon being emitted than stored because these ecosystems themselves are vulnerable to climate change and destruction by humans, and impacts are larger than the ecosystems' capacity to withstand and recover. Deforestation and drought impacts on the Amazon, the draining and burning of peatlands in Southeast Asia, and the thawing of Arctic permafrost due to climate change have caused these ecosystems to emit more carbon into the atmosphere than they naturally remove through vegetation growth.

This and other trends can still be reversed by restoring, rebuilding and strengthening ecosystems and by managing them sustainably. These actions will also support the wellbeing and livelihoods of people. To help achieve this, drastic greenhouse gas emissions reductions are required now to avoid further global warming and its deadly impacts on ecosystems around the world. For indeed, humans are just one of the many living species in our beautiful and complex world.







Photo by Unsplash.com/@RayHennessy



Photo by Ocean Image Bank/Santanu Majumdar

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CLIMATE CHANGE AND INCREASES IN EXTREME WEATHER EVENTS ARE DRASTICALLY AND PROGRESSIVELY IMPACTING NATURE, WEAKENING THE STRUCTURE, FUNCTIONING AND RESILIENCE OF ECOSYSTEMS

Illustrative summary of observed impacts of climate change on ecosystems

Climate change has already altered ecosystems on land, in the ocean and in lakes and rivers worldwide. This figure shows an overview of multiple global and regional impacts and summarises the level of confidence that we have that these changes are caused, or partly caused, by climate change.

Three types of observed impacts are shown. **Changes in ecosystems structure** include, for example, vegetation changes such as expansion of woody plants into grasslands and savannahs. This is caused by an interaction between changes in rainfall, drought and the fertilizing effect of increased carbon dioxide concentration in the atmosphere. An example from marine ecosystems is the degradation and loss of coral reefs and seagrass meadows due to ocean warming and marine heatwaves, with associated declines of other plants and animals that rely on the reefs/ meadows for habitat and food.

Climate change, in particular warming, leads to **species range shifts**, which describes changes in geographical distributions of where species live. This might entail a range expansion into new areas of habitat or a range contraction when species disappear from the area where they were previously found. Examples include fish populations shifting their distribution towards the poles into previously colder water or mountain species shifting upslope as air temperatures warm and glaciers and snow cover retreat.

Observed changes have also been recorded in the **seasonal timing** of animal and plant species cycles such as migration, breeding or flowering (so-called 'phenology').



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INCREASINGLY FREQUENT AND SEVERE CLIMATE EXTREMES HAVE CAUSED WIDESPREAD, PERVASIVE IMPACTS TO PEOPLE, COMMUNITIES AND INFRASTRUCTURE



Climate change has made feeding the world's people more difficult

Most of our food comes from crops, livestock, aquaculture and fisheries. Global food supply increased dramatically in the last century, but ongoing climate change has begun to slow that growth, reducing the gains that would have been expected without climate change. Negative effects are especially apparent in regions closer to the equator, with some positive effects further north and south.

Climate impacts are also negatively affecting the quality of produce, from changes in micronutrient content to texture, colour and taste changes that reduce marketability. With warmer and more humid conditions, many food pests thrive, food spoils more quickly, and food contains more toxic compounds produced by fungi and bacteria.

Warming of the oceans, often in combination with overfishing, has reduced potential fish catch. The increased carbon dioxide in the atmosphere has led to ocean acidification, which is already impacting the production of farmed fish and shellfish. Changes in local climate have forced producers to shift to new locations, changing what they grow or where they work (e.g., poleward shifts in fishing grounds).

Climate hazards have increased over the past 50 years and are a major cause of sudden losses of production (so-called food production shocks). Food production shocks occur following droughts, heatwaves, floods, storms and outbreaks of climaterelated pests, and combine to cause multiplying impacts. Climate hazards sometimes disrupt food storage and transport, which impairs the food supply.

All of these adverse impacts can lead to increased food prices and reduced income for producers and retailers as fewer products are sold. Together, these impacts threaten to reduce the supply of varied, nutrientrich foods to poor populations that already suffer significant food insecurity and ill health.

Climate change is affecting food security through pervasive water impacts



The frequency of sudden food production losses has increased on land and sea since at least the mid-20th century.

INCREASINGLY FREQUENT AND SEVERE CLIMATE EXTREMES HAVE CAUSED WIDESPREAD, PERVASIVE IMPACTS TO PEOPLE, COMMUNITIES AND INFRASTRUCTURE



Water is essential for all societal and ecosystem needs. However, when experts talk about "water security" they mean more than water availability. Water needs to be available in sufficient quantity and quality, and it needs to be accessible in an acceptable form. Accordingly, a situation of water security indicates the availability and accessibility of sufficient clean water to allow a community to sustainably ensure its livelihoods, health, socioeconomic development and political stability. Many socioeconomic factors, such as population growth and food consumption patterns, play an important role in determining water security. Still, climate change is increasingly shown to be an important contributor to water insecurity worldwide, with some regions more at risk than others.

Climate change can affect these different dimensions of water security in different ways. Most directly, climate change is affecting the overall availability of water across regions and during important seasons. More extended periods of dry spells and droughts are already reducing water availability, especially in the arid areas of India, China, the USA and Africa. Other extremes, such as heavy precipitation and flooding, can affect water quality, making water unsafe for drinking, for example. In coastal regions and small islands, the combined effects of higher sea levels and more intense storms affect water security by increasing the salinisation of groundwater resources. Indirect effects of climate change on water security include impacts on infrastructure for the provision and recovery of water resources, which can affect the safe access to adequate water resources, both in terms of quality and quantity.

As an essential component of water security, climate change will affect water quality in different ways. Drier conditions lead to a reduction in water availability, causing a potential increase in the concentration of contaminants. Increasing runoff and floods can wash pollutants into water bodies. With climate change projected to increase the variability of rain over space and time, such impacts on water quality are becoming increasingly likely. Higher temperatures add to deteriorating water quality by reducing oxygen levels.

Another critical component to ensure secure access to water resources is adequate water infrastructure for access, disposal and sanitation. Unfortunately, increasing extremes due to climate change, especially floods and increasing storm activity, have great potential to damage such infrastructure, especially in developing world regions, where infrastructure is much more susceptible to damage and pollution.

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INCREASINGLY FREQUENT AND SEVERE CLIMATE EXTREMES HAVE CAUSED WIDESPREAD, PERVASIVE IMPACTS TO PEOPLE, COMMUNITIES AND INFRASTRUCTURE

Climate change is affecting food security through pervasive water impacts

Climate change is affecting our Earth's water cycle and thus changing our ability to grow crops, raise livestock and provide sufficient amounts of drinking water. Nowadays, nearly half a billion people live in areas that have become wetter and where the long-term average rainfall is now as high as was previously seen in only about 1 in 6 years. The map below is showing these wetter regions with high population density in green.

In contrast, approximately 163 million people now live in unfamiliarly dry areas compared to 50 years ago. Those dry and densely populated areas can be found in West and South East Africa, in South America, parts of Asia and in the Mediterranean as the following map shows in a brownish colour.



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INCREASINGLY FREQUENT AND SEVERE CLIMATE EXTREMES HAVE CAUSED WIDESPREAD, PERVASIVE IMPACTS TO PEOPLE, COMMUNITIES AND INFRASTRUCTURE

Cities and settlements: especially vulnerable

The world is increasingly urban: Mid-2023 approximately 4.6 billion of the more than 8 billion people worldwide lived in towns or cities. This represents 57% of the global population. Hardly anyone, even in remote rural locations, is separated from the flows of trade that connect the world and are held together by networks of transport and communication infrastructure systems. Disruptions to these networks can cascade out, multiplying impacts across urban and rural areas. When major manufacturing centres or regionally important ports are impacted by such disruptions, global trade suffers. For example, flooding in Bangkok in 2011 led to a global shortage in semiconductors and a slowdown in global computer manufacturing.

Additional vulnerability to climate change is being created in urban areas every day. Demographic change, social and economic pressures, and governance failures that drive inequality and marginality mean that increasing numbers of people who live in towns and cities are exposed to flooding, temperature extremes and water or food insecurity. This leads to an adaptation gap, where rich neighbourhoods can afford strategies to reduce vulnerability while poorer communities are unable to do the same. Although such inequalities exist even without a changing climate, climate change

increases the variability and extremes of weather, exposing more people, businesses and buildings to floods and other events. The combination of rising vulnerability and increasing exposure translates to a growth in the number of people and properties at risk from climate change in cities worldwide.

Around the world, vulnerability is rising but differs considerably between and within urban areas. Settlements of up to 1 million people are the most rapidly expanding and also among the most vulnerable. These settlements often have limited community-level organisation and might not have a dedicated local government. Coping with rapid population growth under conditions of climate change and constrained capacity is a major challenge. For large cities, multiple local governments and well-organised community-based organisations interact with large businesses

and national political parties in a complicated mix of interests, that can interfere with planning and action to reduce vulnerability.

For the poorest living in urban slums, informal settlements or renting across the city, lack of secure tenure and inadequate access to basic services compound vulnerability. But even the wealthy in large cities are not fully protected from climate change-related shocks. Just like breaks in infrastructure between towns and rural settlements, big city infrastructure can be broken or disrupted by local landslides, floods or heatwaves, with consequences cascading across the city. Electricity blackouts are the most common outcome, and can affect water pumping, traffic regulation and streetlights, as well as hospitals, schools and homes. Still, it is the urban poor and marginalised who experience the greatest exposure, most vulnerability and least capacity to cope.



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INCREASINGLY FREQUENT AND SEVERE CLIMATE EXTREMES HAVE CAUSED WIDESPREAD, PERVASIVE IMPACTS TO PEOPLE, COMMUNITIES AND INFRASTRUCTURE

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Climate change is affecting human health and well-being in many different ways

In every region of the world, climate change has already affected people's health and well-being and climate hazards are increasingly contributing to a growing number of adverse health outcomes. Since 2008, over 20 million people have been displaced within nations each year by weather-related extreme events, with storms and floods being the most common drivers. Extreme weather can cause physical harm or kill people.

In addition, exposure to extreme events can induce trauma and negatively impact people's mental health, well-being, life satisfaction, happiness and cognitive performance, especially when they lose their homes and livelihoods or are exposed to extreme events several times a year due to climate change. Vulnerability to the 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.

Extreme weather events have also been key drivers of rising malnutrition of millions of people, primarily in Africa and Central and South America. Malnutrition can, in turn, increase susceptibility to other health problems, including mental health problems, and impair cognitive and work performance, with resulting economic impacts.

Due to increasing temperatures and heatwaves, a growing number of people are suffering and even dying from extreme heat. Scientists can link a significant proportion of warm-season heat-related mortality in temperate regions to observed human-made climate change. Highly vulnerable groups experiencing health impacts from heat stress include anyone working outdoors, in particular, those doing outdoor manual labour (e.g., construction work, farming). In regions such as southern Asia, northern and sub-Saharan Africa, and the Middle East, outdoor workers are already exposed to heat stress conditions in which working outside becomes unbearable and life-threatening. Vulnerable groups have also been losing an increasing number of work hours due to heat over the past two decades. The impacts of climate change on well-being

can have long-term negative effects on people's health and well-being. For example, in rural Zimbabwe, experiencing drought conditions during the first few years of life has been associated with fewer grades of completed schooling in adolescence, which translates into a 14% reduction in lifetime earnings.

Climate change has resulted in increases and spread of various diseases. Higher temperatures combined with land use changes are making more areas suitable for the transmission of diseases by flies, ticks, mosquitoes and other insects. For instance, climate change is facilitating the spread of chikungunya virus in North, Central and South America, Europe and Asia; tickborne encephalitis in Europe; Rift Valley fever in Africa; West Nile fever in southeastern Europe, western Asia, the Canadian prairies and parts of the USA; Lyme disease in North America and Europe: malaria in eastern and southern Africa; and dengue globally. Higher temperatures, heavy rainfall and flooding are also associated with increased water-borne diseases, particularly diarrhoeal diseases, including cholera and other gastrointestinal infections in all countries.

INCREASINGLY FREQUENT AND SEVERE CLIMATE EXTREMES HAVE CAUSED WIDESPREAD, PERVASIVE IMPACTS TO PEOPLE, COMMUNITIES AND INFRASTRUCTURE

Illustrative summary of observed impacts of climate change on human systems

Climate change has already had various harmful impacts on human communities. This figure shows selected global and regional impacts and the confidence we have that these are caused by climate change. Impacts are observed on water security and food production, e.g. in agriculture and fisheries. There is also increasing evidence for impacts on health and well-being, for example increases in diseases transmitted by insects such as dengue as well as diarrhoeal diseases (e.g. cholera caused by bacterial infection) that spread due to higher temperature, heavy rainfall and flooding. Cardiovascular heat effects, malnutrition and impacts on mental health and displacement are observed in most regions of the world. Climate change has also caused worldwide impacts on cities, settlements and infrastructure, such as to train tracks, roads, bridges and buildings that get damaged during periods of extreme heat, wind or flooding. Adverse impacts on key economic sectors such as tourism or the energy sector, have also occurred.



- not implying that the impacts do not exist

When Climate Change Risks Cascade

CLIMATE IMPACTS AND RISKS ARE BECOMING INCREASINGLY COMPLEX AND MORE DIFFICULT TO MANAGE



When weather extremes happen simultaneously

One key message from our Working Group II report is that in most parts of the world, weather extremes, such as heatwaves and droughts, coincide and are occurring more frequently, compounding the overall risks for people and nature, and making it more difficult to manage those risks.

An example of a compound event might be a long drought followed by a flood. The impacts of the flood are made worse by the preceding drought because very dry soil acts similar to a hard surface leading to greater surface runoff. Risks also cascade if an agricultural area is hit by heat and drought simultaneously. The combination of high temperatures, lack of rain, and low soil moisture reduces crop yields. At the same time, farm workers might not be as productive as usual because of heat stress and having to avoid working outside in the hottest periods of the day. In turn, reduced crop yields lead to reductions in household incomes, increased local food prices, and, in some cases, even global food price increases. Together, these increase the risk of malnutrition for farmer families, making them even more vulnerable to climate change.

Another example of a cascade of compounding climate impacts and risks has been observed in coastal cities and settlements, which are especially vulnerable to climatic and ocean impacts. This can be explained by the large concentration of people, infrastructure and economic activities in the narrow coastal zone. Around a tenth of the world's population lives in coastal zones less than 10 metres above sea level.

Rising sea levels combined with severe storms cause increased temporary or even chronic coastal flooding at high tides, salinisation of groundwater, increased coastal erosion and damage to coastal ecosystems, agriculture, buildings, infrastructure and thus to people. Again, these impacts hit hardest the poorest and most vulnerable people living in informal settlements which tend to have poor housing, high overcrowding and lack of basic services.

Some compounding and cascading impacts occur locally, some have impacts spread across sectors or regions, while others can drive impacts in distant regions, for instance through trade and flows of commodities and goods via supply chain linkages. Climate change impacts are not restrained by national boundaries. In addition, compound climate hazards can overwhelm people's and nature's capacity to adapt to climate change and substantially increase damage. For example, heat and drought are projected to substantially reduce agricultural production, and although irrigation can reduce this risk, its feasibility is limited by drought.



Example of how heat and drought combine to cause reductions in crop yields, made worse by reduced productivity because of heat stress among farm workers. Reduced yields lead to reductions in household incomes, increased food prices locally and, potentially, globally.

No Equity: Impacts Hit Many Harder Than Others

WORLDWIDE 3.3 TO 3.6 BILLION PEOPLE LIVE IN AREAS THAT ARE CONSIDERED HIGHLY VULNERABLE TO CLIMATE CHANGE

Why the poorest suffer the most

Climate change and related hazards (e.g., droughts, floods, heat) affect many aspects of people's lives – such as their health, access to food and housing, or their source of income such as crops or fish stocks – and many will have to adapt their way of life in order to deal with these impacts. People who are poor and have few resources with which to adapt are thus much more seriously negatively affected by climate-related hazards.

"Vulnerability to climate change" is high when a person or community is not able to cope and adapt to climate-related hazards. For example, if someone who is very rich has their house washed away in a flood, this is terrible and can be traumatic, but they often have more resources to rebuild, have insurances that support recovery and maybe even build a house that is not in a flood-prone area. Whereas for someone who is very poor and who does not live in a state that provides support, the loss of their house in a flood could mean homelessness. This example shows that the same climate hazard (flood) can have a very different impact on people depending on their capacity to cope and adapt to hazards.

It is not just poverty that can make people more vulnerable to climate change and climate-related hazards. Disadvantage due to discrimination, gender and income inequalities and lack of access to resources (e.g., those with disabilities or of minority groups) can mean these groups have fewer resources with which to prepare and react to climate change and to cope with and recover from its adverse effects. They are therefore more vulnerable. This vulnerability can then increase due to climate change impacts in a vicious cycle unless adaptation measures are supported and made possible.

2 Where people are hit the hardest

Studies estimate that around 3.3 to 3.6 billion people, almost half the World's population, live in regions classified as highly vulnerable to climate change impacts. A country or region is considered 'vulnerable' to climate change if climate hazards have, or are likely to have, disproportionately large negative impacts, because the region contains large numbers of people who lack the ability or opportunity to cope with and adapt to such events due to factors such as extreme poverty, inequality and lack of institutional support.

Vulnerability is determined by many different development challenges that all come together and interact, such as poverty, lack of access to basic infrastructure services (particularly for education and health), high numbers of uprooted people, state fragility, low or below-average life expectancy and biodiversity degradation. These structural social issues often affect regions for many decades, and make it difficult for the state and for individuals to respond to climate change and climate-related hazards. For example, if a region is already characterised by poverty, struggling to feed its population and to provide adequate access to basic infrastructure services, such as water and sanitation, this makes the people living in that area highly vulnerable. If this region is then faced with prolonged drought, for instance, it will make things even harder, resulting in more hunger, poverty and worsened health. The most vulnerable regions include East, Central and West Africa, South Asia, Micronesia and Melanesia, and Central America.

No Equity: Impacts Hit Many Harder Than Others

WORLDWIDE 3.3 TO 3.6 BILLION PEOPLE ARE CONSIDERED HIGHLY VULNERABLE TO CLIMATE CHANGE

The principles of climate justice

The different levels of damage caused by climate change and differing vulnerabilities and capacities to deal with climate change, raise questions of climate justice. This term is used in different ways in different contexts by different communities.

In our Working Group II report, climate justice is understood as justice that links development and human rights to achieve a human-centered approach to addressing climate change. It is based on three principles:

- distributive justice: the allocation of burdens and benefits among individuals, nations and generations;
- *procedural justice*: who decides and participates in decision-making; and
- recognitional justice: entails basic respect and robust engagement with and fair consideration of diverse cultures and perspectives and the recognition of historical inequality.

In our report, issues of climate justice are approached with an increased focus on social justice – that is fair relations in society (e.g., access to resources and opportunities). Single and multi-criteria approaches consistent with the principles of justice are used to assess adaptation effectiveness. A particular focus is inequity in climate vulnerability and responses.

Furthermore, the report also assesses the role of power and participation in implementing climate action, because climate action can have tradeoffs for equity and justice. Poorly planned and implemented nature-based solutions, agricultural intensification and urban greening projects can lead to climate injustice. In contrast, insurance, equitable access to climate finance and social protection to assist with coping during times of crises, increase climate justice. Climate justice is enhanced by using all sorts of knowledge (Indigenous, local, scientific, practical) and by a sound, inclusive governance system.

Monitoring and evaluating climate action is critical to achieve effective and equitable adaptation to climate change.



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EXAMPLES OF REGIONAL KEY FINDINGS ON CLIMATE CHANGE IMPACTS FROM AROUND THE WORLD HIGHLIGHTED IN OUR AR6 WORKING GROUP II REPORT

North, Central and South America



- Extreme events and climate hazards are adversely affecting economic activities across North America and have disrupted supply chain infrastructure and trade. Larger losses and adaptation costs are observed for sectors with high climate exposures, including tourism, fisheries, and agriculture and outdoor labour.
- Central and South American countries are at highest risk globally of being impacted by extreme events. The number of these events has increased 3% per year over the last 30 years. Hydro-meteorological events, such as storm surges and Tropical Cyclones, are the most frequent extreme events and have the highest impact.



 Food production is increasingly affected by climate change, with immediate impacts on the food and nutritional security of Indigenous Peoples. Climate change has generally reduced agricultural productivity by 12.5% since 1961, with progressively greater losses moving south from Canada to Mexico and in drought-prone rain-fed systems, while favourable conditions increased yields of maize and soybeans in regions like the USA Great Plains. Loss of availability and access to marine and terrestrial sources of protein has impaired food security and nutrition of subsistence-dependent Indigenous Peoples across North America. Climate change has impacted aquaculture and induced rapid redistribution of species, and population declines of multiple key fisheries.



 Food insecurity is a serious impact of climate change in Central and South America – a region where 10% of the Gross Domestic Product depends on agriculture, livestock and fisheries. Crop losses largely result from highly variable rainfall and seasonal droughts, which have increased significantly in recent decades. Small and subsistence farmers experience the highest impact because they practice rainfed agriculture.





• The Amazon forest in South America was highly impacted by the unprecedented droughts and higher temperatures observed in 1998, 2005, 2010 and 2015/2016, which are attributed partly to climate change. This resulted in high tree mortality rates and basin-wide reductions in forest productivity, momentarily turning pristine forest areas from a carbon sink into a net source of carbon to the atmosphere.

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EXAMPLES OF REGIONAL KEY FINDINGS ON CLIMATE CHANGE IMPACTS FROM AROUND THE WORLD HIGHLIGHTED IN OUR AR6 WORKING GROUP II REPORT

North, Central and South America (continued from previous page)



• In the Andes in South America the distribution of terrestrial species has changed due to increasing temperature. Species have shifted upslope, leading to range contractions for highland species and range contractions and expansions for lowland species, including crops and vectors of diseases.





 Climate change has impaired North American freshwater resources and reduced supply security. Reduced snowpack and earlier runoff have adversely affected aquatic ecosystems and freshwater availability for human uses. Recent severe droughts, floods and harmful algal and pathogen events have caused harm to large populations and key economic sectors. Heavy exploitation of limited water supplies, especially in the western USA and northern Mexico, and deteriorating freshwater management infrastructure, have heightened the risks.



 North American cities and settlements have been affected by increasing severity and frequency of climate hazards and extreme events, which has contributed to infrastructure damage, livelihood losses, damage to heritage resources and safety concerns. Impacts are particularly apparent for Indigenous Peoples for whom culture, identity, commerce, health and well-being are closely connected to a resilient environment.

EXAMPLES OF REGIONAL KEY FINDINGS ON CLIMATE CHANGE IMPACTS FROM AROUND THE WORLD HIGHLIGHTED IN OUR AR6 WORKING GROUP II REPORT

Europe



• Precipitation has increased river flood hazards in Western Central Europe and the UK by 11% per decade from 1960 to 2010 and decreased those hazards in Eastern and Southern Europe by 23% per decade. The most recent three decades had the highest number of floods in the past 500 years, with increases in summer. Economic flood damages increased strongly, reflecting increasing exposure of people and assets.



- Combined with land use, climate change has increased large-scale forest mortality since the 1980s. Extreme events, such as the 2018 drought in Western-Central Europe, caused widespread leaf shedding and tree mortality as well as bark beetle outbreaks, resulting in felling and cutting of more than 1 million ha of spruce forest and disrupting timber markets.
- Energy
 The energy sector in Europe already faces impacts from climate extremes. Significant reductions and interruptions of power supply have been observed during exceptionally dry and/or hot years over the last 20 years, for example, in France, Germany, Switzerland and the UK during the extremely hot summer of 2018, which led to water-cooling constraints on power plants.



• Fire hazard conditions, including heatwaves, increased throughout Europe from 1980 to 2019, with substantive increases in Southern and Western Central Europe.

EXAMPLES OF REGIONAL KEY FINDINGS ON CLIMATE CHANGE IMPACTS FROM AROUND THE WORLD HIGHLIGHTED IN OUR AR6 WORKING GROUP II REPORT

Africa

Ecosystems

• Shifts in demography, geographic ranges, and abundance of plants and animals consistent with expected impacts of climate change are evident across Africa. These include uphill contractions of elevational range limits of birds, changes in species distributions and the death of many of the oldest and largest African baobabs (solitary growing trees native to savannahs and scrublands).



- Extreme climate events have been key drivers in rising acute food insecurity and malnutrition of millions of people who require humanitarian assistance in Africa. Between 2015 and 2019, an estimated 45.1 million people in the Horn of Africa and 62 million people in eastern and southern Africa required humanitarian assistance due to climate-related food emergencies.
- Climate change has reduced total agricultural productivity growth in Africa by 34% since 1961, more than in any other region. Maize yields have decreased 5.8% and wheat yields 2.3%, on average, in sub-Saharan Africa due to climate change in the period 1974–2008.



- Climate-related displacement is widespread in Africa. Increased migration to urban areas in sub-Saharan Africa is linked to decreased rainfall in rural areas, increasing urbanisation and affecting household vulnerability.
- Africa has the highest rates of death due to diarrhoeal diseases in the world and many children have repeated diarrhoeal episodes resulting in impaired growth, stunting, immune dysfunction and reduced cognitive performance. High land and sea temperatures and precipitation extremes increase transmission of bacterial and protozoal diarrhoeal disease agents through contamination of drinking water and food preparation and preservation practices.

EXAMPLES OF REGIONAL KEY FINDINGS ON CLIMATE CHANGE IMPACTS FROM AROUND THE WORLD HIGHLIGHTED IN OUR AR6 WORKING GROUP II REPORT

Asia



• Higher energy demand for cooling due to hotter temperatures has become a major challenge in the energy sector in all countries. Furthermore, decreased water levels due to lower precipitation reduce hydroelectric output. This is particularly the case for countries such as Syria and Iraq with large hydroelectric capacity. In East Asia, wet snow accretion enhanced by global warming often causes damage to electric power lines.





Hindu Kush Himalaya region



 With climate change resulting in the shrinking and melting of snow, ice, glacier and permafrost, and correspondingly causing an increase in meltwater, the incidences of flash floods, debris flow, landslides, snow avalanches, livestock diseases and other disasters in the Hindu Kush Himalaya region have become more frequent and intense.

Agriculture



 Major climate change impacts to agricultural production, such as those observed by the farmers in the Philippines and Indonesia, include delays in crop harvesting, declining crop yields and quality of produce, increasing incidence of pests and diseases, stunted growth, livestock mortality and low farm income.

EXAMPLES OF REGIONAL KEY FINDINGS ON CLIMATE CHANGE IMPACTS FROM AROUND THE WORLD HIGHLIGHTED IN OUR AR6 WORKING GROUP II REPORT

Australasia



 Marine species abundance and distributions have shifted polewards, and extensive coral bleaching events and loss of temperate kelp forests have occurred due to ocean warming and marine heatwaves across the region.



 In New Zealand's southern Alps, from 1978 to 2016, the area of 14 glaciers declined 21%, and extreme glacier mass loss was at least 6 times more likely in 2011 and 10 times more likely in 2018 due to climate change.



 Extreme heat has led to excess deaths and increased rates of many illnesses. Nuisance and extreme coastal flooding have increased due to sea level rise superimposed upon high tides and storm surges in low-lying coastal and estuarine locations, including impacts on cultural sites, traditions and lifestyles of Aboriginal and Torres Strait Islander Peoples in Australia and Tangata Whenua Māori in New Zealand.



 Climate impacts are cascading and compounding across sectors and socioeconomic and natural systems. Complex connections are generating new types of risks, exacerbating existing stressors and constraining adaptation options. An example is the 2019–2020 southeast Australia wildfires, which burned 5.8 to 8.1 million hectares, with 114 listed threatened species losing at least half of their habitat and 49 losing over 80%; over 3,000 houses destroyed, 33 people killed, and the resulting air pollution led to a further 429 deaths and 3,230 hospitalisations due to cardiovascular or respiratory conditions.

Small Islands



Fresh-

water

- The intensity and intensification rates of tropical cyclones have increased in the past 40 years globally. Intense cyclones, including Categories 4 and 5 cyclones, have threatened human life and destroyed buildings and infrastructural assets in small islands in the Caribbean and the Pacific. Among 29 Caribbean islands, 22 were affected by at least one Category 4 or 5 cyclone in 2017.
- Lakes, rivers, streams and groundwater reservoirs on small islands are among the most threatened freshwater systems on the planet. An 11–36% reduction is estimated in the volume of fresh groundwater lens of the small atoll islands of the Maldives due to sea level rise. The El Niño-related 2015–2016 drought in Vanuatu led to reliance on small amounts of contaminated water left at the bottom of household tanks.

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The Only Way Out: Reducing Emissions and Adapting Faster and More Effectively to Ongoing Change

Climate change-induced losses and damages to nature and people will increase with every increment of additional warming. This spiral of destruction will only be stopped by reducing human-made greenhouse gas emissions to net zero, and by keeping global warming to the lowest level possible.

Some remaining climate risks can be reduced, within limits, by adapting to climate change (see our "Summary for all: How to adapt to a changing climate") and by reducing all other non-climatic human-made stressors, such as habitat destruction, biodiversity loss, growing urbanization, inequity and marginalization of people. Unsustainable use of natural resources, deforestation, ecosystem degradation and destruction, and pollution not only present

threats to ecosystems and the people who rely on them, but also reduce the capacities of nature, communities and individuals to adapt to climate change.

The science is clear: Climate change is a threat to human well-being and the health of the planet. Any further delay in concerted global action will miss a brief and rapidly closing window to secure a liveable future.



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Learn More

WHERE TO FIND MORE FACTS AND FIGURES FROM THE WORKING GROUP II REPORT

Our full Working Group II report on Climate Change Impacts, Adaptation and Vulnerability is almost 3,100 pages long and contains 18 chapters and 7 cross-chapter papers, which is a lot to read. To make its findings more accessible, IPCC authors and other organizations have provided various summary and derivative products, which you can download from our report's website. There you will find, for instance

- Our 15 Working Group II Fact Sheets [download here]
- Our compiled FAQs and their answers from the report's chapters [download here]
- Our six overarching FAQs and their answers [download here]
- A selection of derivative products that summarise our report's key findings on climate change and nature, climate change and health, and climate change impacts and adaptation in Africa [download here]
- Three Summaries for All: How is Climate Change Impacting Life on Earth, How to Adapt to a Changing Climate, and How to Secure a Liveable Future for All [download here]

The full report as well as its individual chapters and official summary products such as the Technical Summary or the Summary for Policymakers can be found <u>here</u>.



CLIMATE CHANGE 2022 | SUMMARY FOR ALL | HOW CLIMATE CHANGE IS IMPACTING LIFE ON EARTH

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