CLIMATE CHANGE 2022

HOW TO ADAPT TO A **CHANGING CLIMATE** SUMMARY FOR ALL

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

Dear Reader,

"**Adapting to climate change**" is a phrase that has made its way into our everyday language but not everybody knows precisely what it means. In climate science, the term "adaptation" refers to various actions that help to reduce the risks associated with climate change. For example, risks can be caused by rising temperatures and more frequent and intense extreme events such as droughts or floods. The IPCC is more specific. The IPCC glossary from the Sixth Assessment Cycle states:

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

Why focus on adaptation? In a heating world, adaptation is a priority alongside reducing greenhouse gas emissions to secure a liveable future for all and enable development initiatives. This includes taking action today and planning for future action. But what does successful adaptation look like, which actions are feasible and most effective, and for how long and up to which degree of climate change will we be able to adapt? The Working Group II report of the Sixth IPCC Assessment Cycle provides answers to these questions, based on the best available science, and also indicates the gaps in current knowledge. The report looks at what adaptation has taken place, what is possible and what can be implemented – for different sectors such as agriculture and fisheries, as well as for the different regions of our world.

The report shows that there has been some adaptation progress but also that adaptation cannot prevent all losses and damages, particularly if greenhouse gas emissions are not reduced and global warming continues.

This "Summary for All" presents the report's key findings on how adaptation can help reduce current climate impacts and prepare for future risks. It also highlights that actions to reduce the risks of climate change, when carefully planned and implemented, have additional and widespread benefits for people and ecosystems.

Sincerely,

Your Working Group II team of the Sixth IPCC Assessment Cycle

Urgency of Adaptation

CLIMATE CHANGE IMPACTS AND RISKS CAN BE REDUCED, WITHIN LIMITS, IF HUMANS AND NATURE ADAPT TO THE CHANGING CONDITIONS

1 The climate is changing and we need to adapt

Due to climate change, the world is experiencing higher temperatures, rising sea levels, and increased extreme events such as heatwaves, storms, floods and droughts that impact life on land and in the oceans. However, there are ways that nature and people can cope with and adjust to these changes, to varied and limited extents, and thereby reduce climate risks and avoid drastic losses and damages.

For plants and animals, this could mean spontaneously adjusting to the changing climate and its effects, for example by spending more time and energy on life-sustaining measures like maintaining their body temperature, changing their daily and seasonal activity patterns, or, if possible, shifting to areas where climatic and other environmental conditions are still in the range where they can survive and thrive. Adaptation measures for nature also include human interventions, for example, through the restoration and conservation of ecosystems (*more on page 8, Solutions: Strengthening nature for climate risk reduction and improved services*).

For people and society, adaptation to climate change means many things and is carried out by individual people, households, communities, private organisations and across all levels of government. For example, we can adapt by changing our lifestyle and behaviour – where we choose to live, which time of the day we spend or work outside, or which crops or vegetables we grow on our fields to secure enough food. Another example is changing or adjusting our infrastructure to deal with current impacts and future climate risks. Here we are talking about actions such as establishing heat-resistant energy and water supply networks, or creating green roofs and walls and planting trees in cities. These actions would moderate the impacts of heatwaves, capture rainwater, lessen pollution and soil erosion with positive outcomes for people's health and well-being.

The phrase **losses and damages** has been taken to refer broadly to harm from observed impacts of climate change and projected risks, and can be economic or non-economic. Losses and damages can occur despite effective adaptation and before limits to adaptation have been reached. Losses and damages are unequally distributed and are strongly concentrated among the poorest vulnerable populations.

Green roofs in cities are a way of adjusting our infrastructure to deal with current impacts and future climate risks.

Photo by Unsplash.com/@chuttersnap

Urgency of Adaptation

CLIMATE CHANGE IMPACTS AND RISKS CAN BE REDUCED, WITHIN LIMITS, IF HUMANS AND NATURE ADAPT TO THE CHANGING CONDITIONS

2 Action on adaptation has increased, but progress is uneven and we are not adapting fast enough

The scale and scope of actions to reduce climate risks have increased worldwide. Individuals and households along with communities, businesses, social movements and governments are already taking actions to adapt to climate change. Growing adaptation knowledge in public and private sectors, as well as public and political awareness of climate impacts and risks, have resulted in at least 170 countries and many cities so far including adaptation in their climate policies and planning. Pilot projects and local experiments are being implemented in different sectors to test which adaptation actions work and where, and which don't. However, the adaptation progress we see is uneven across regions, sectors and societal groups and we are not adapting fast enough. Our report identifies large gaps between ongoing adaptation efforts and what is needed to cope with current levels of warming and climate impacts (so-called 'adaptation gaps'). The scale of these gaps varies in different regions and is influenced by factors such as ecosystem degradation, poverty, inequity, socio-economic conditions and financial constraints. In addition, in many locations people and ecosystems have limited capacity to adapt.

For example, decision-makers in many cities and settlements have developed climate change adaptation plans since 2014, but a limited of these have been implemented. This has resulted in urban adaptation gaps that exist in all world regions, and for all hazards including severe flooding, heatwaves, wildfires, storms, and droughts. These adaptation gaps are largest among lower-income populations. Many low-income people live in informal settlements which lack basic infrastructure, such as clean water, sanitation facilities, drainage and electricity, making people extremely vulnerable to climate change – especially women and children, who make up the majority living in these settlements. Adaptation gaps will continue to grow if adaptation planning and implementation rate do not increase. And such gaps will affect the poor, marginalized and vulnerable the most.

Adaptation gaps are defined as the difference between actually implemented adaptation and a societally set goal or adaptation needs of a system. In society, the size of those gaps is determined largely by preferences related to tolerated climate change impacts and reflecting resource limitations and competing priorities.

The scales of adaptation gaps are influenced by factors such as ecosystem degradation, poverty, inequity, socio-economic conditions and financial constraints.

Photo by Unsplash.com/@loverhythm

Urgency of Adaptation

CLIMATE CHANGE IMPACTS AND RISKS CAN BE REDUCED, WITHIN LIMITS, IF HUMANS AND NATURE ADAPT TO THE CHANGING CONDITIONS

3 The warmer it gets, the fewer options we have

Our report also highlights the fact that the number of feasible adaptation options, and their effectiveness in risk reduction, decrease with every fraction of a degree of global warming. Responding to climate change requires urgent, more ambitious and accelerated adaptation action, and, at the same time, rapid and deep cuts in greenhouse gas emissions. The quicker and further emissions decrease, the more opportunities there are for people, livestock and nature to adapt to climate change.

In other words: Limiting emissions reduces the extent of adaptation needed to keep climate risk within tolerable levels.

Adaptation to heat-stress on livestock includes switching from large ruminants like cattle to more heat-resilient goats for dairy production.

Photo by Unsplash.com/@alexas_fotos

Solutions

THERE ARE FEASIBLE, EFFECTIVE OPTIONS WE CAN TAKE TO REDUCE THE RISKS TO PEOPLE AND NATURE

1 Opportunities

There are many opportunities to expand and increase current adaptation efforts as well as opportunities for innovation. Our report also shows that many adaptation actions can bring wider benefits – meaning that adaptation implemented in one sector or place can bring additional benefits for nature and people.

2 Strengthening nature for climate risk reduction and improved services

Nature offers significant untapped potential, not only to reduce climate risks and deal with the causes of climate change, but also to improve people's lives and livelihoods. For instance, conserving, protecting, and restoring coastal wetlands such as mangroves, seagrass meadows, and salt marshes can reduce coastal erosion and flooding associated with storms and sea level rise, and strengthen the ocean's ability to provide food and income for millions of fishermen and -women. In addition, forests, grasslands and other ecosystems absorb carbon dioxide from the atmosphere and store it below ground, thus helping us to reduce global warming.

However, nature itself is vulnerable to climate change but there are actions that can be taken to strengthen nature. For example, the climate risk to managed forests can be reduced by planting a mix of tree species and managing pests and diseases as well as wildfire risks. In our cities and elsewhere, trees provide shade so parks and other green areas have a cooling effect. They can also soak up rainwater, reduce flood risks, contribute to sustainable urban drainage and provide a habitat for wildlife. Gardens and urban farms can provide food. In a nutshell: The healthier and more diverse our world's ecosystems are, and the more space we provide for them, the more they can help us to cope with climate change.

However, adverse changes to previously healthy ecosystems and biodiversity are already happening. Further harmful changes are inevitable, unless we manage to reduce our greenhouse gas emissions drastically, limit global warming as close as possible to 1.5°C and implement ambitious conservation and restoration efforts. Managing the consequences of inevitable changes and prioritising investments in effective and equitable conservation and restoration actions will be an increasingly necessary component of adaptation.

Green areas in cities can soak up rainwater, reduce flood risks, contribute to sustainable urban drainage and provide a habitat for wildlife.

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3 Managing water sustainably is key

Water features prominently in many national adaptation plans, and adequate and safe access to clean water is critical for meeting many of the Sustainable Development Goals. Worldwide, and especially in developing countries, agriculture is the largest water user, accounting for 50–90% of all water use. That's why it is not surprising that most of our current water-related adaptation measures are found in this sector. Farmers are adapting to changing rainfall patterns by capturing and storing rainwater, deploying water-saving technologies and increasing soil quality and thus its ability to keep water and moisture. Climate risk can also be reduced by selecting drought-resistant crop varieties, shifting crop planting dates, or adopting livestock species that are more tolerant to heat and drought.

Irrigating fields and gardens is a widely used and effective approach to avoid drought-related losses. Approximately 40% of global yields come from irrigated agriculture. The area irrigated has doubled over the last 50 years and now constitutes around 20% of the total harvested area. However, without smart management, irrigation can result in adverse outcomes such as accelerated depletion of groundwater and other water sources, increased salinisation of the soil and land degradation. Large-scale irrigation can also alter local to regional temperature and rainfall patterns, including both alleviating and exacerbating temperature extremes. While expanding irrigated systems is a commonly proposed adaptation response, there are constraints to further increases in water use, as many regions are already facing water limitations under current climatic conditions. *More information on adaptation limits can be found on page 19.*

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The **Sustainable Development Goals** are a universal call to action to end poverty, protect the planet and improve the lives and prospects of everyone, everywhere. The 17 Goals are interconnected and were adopted by all UN Member States in 2015, as part of the 2030 Agenda for Sustainable Development which set out a 15-year plan to achieve the Goals. *Source: United Nations*

Photo by Rwanda Green Fund Investment. CC BY-ND 2.0

Capturing rainwater on rooftops is one of the many options already used to reduce risks from droughts.

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Many places are already highly vulnerable to water-related risks, and roughly half of the world's population currently experiences severe water scarcity for at least part of the year. For example, Small Islands already regularly experience droughts and freshwater shortages. Freshwater supply systems on islands vary from household and small community methods such as rainwater harvesting and private wells, to large public water supply systems using surface water, groundwater, and, in some cases, desalinated water. Observed adaptation actions include community water sharing as well as purchasing water from private companies, desalination units, and accessing deeper or new groundwater resources. However, the effects of temperature increase, changing rainfall patterns, sea level rise, growing population pressure, and, on many islands, limited resources to implement adaptation, mean that more adaptation options will reach limits and Small Islands become highly water-insecure above 1.5°C.

Other options for sustainable water management around the world involve securing access to drinking water, especially in urban areas, effective flood and drought risk management, the reuse of treated wastewater for irrigation and urban uses as well as working with nature. Letting nature take its course, such as restoring wetlands and rivers and creating no-build zones, can reduce flood risk and enhance water availability and quality. In coastal areas, no-build zones are shorefront areas where development is prohibited in order to protect coastal ecosystems and reduce the risks of climate hazards, such as coastal storms, flooding, coastal erosion, tsunamis, and sea level rise, that threaten lives and property.

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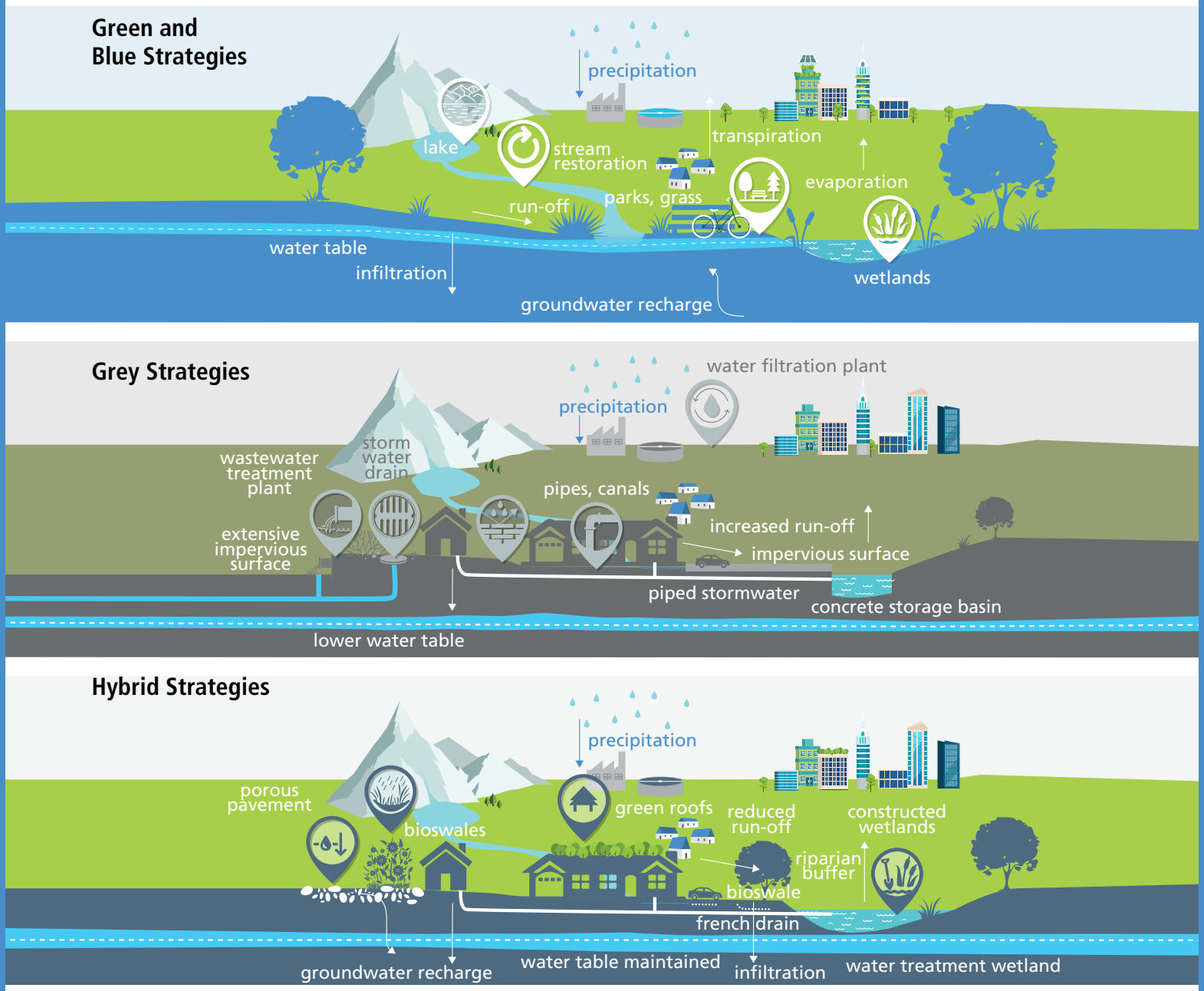
Strategies for urban water adaptation

Water-related climate risks in cities can be reduced by various adaptation measures. Experts distinguish between green, blue, grey, and hybrid strategies of urban water adaptation. **Green and blue strategies** prioritise nature, such as wetland restoration. **Grey strategies** are hard engineering approaches, including infrastructure such as pipes and canals, with extensive areas of impervious surfaces. **Hybrid approaches** combine green, blue and grey adaptation strategies, such that ecosystem functions are complemented by engineered infrastructure.



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Adaptation barriers: What prevents successful reductions in climate risk?

Our options to implement adaptation measures in sectors, regions and social groups vulnerable to climate change are constrained by a number of barriers. Key barriers include: limited resources; lack of private-sector and citizen engagement; insufficient mobilisation of finance (including for research); reactive (rather than proactive) governance and a lack of political leadership and commitment; limited research or slow and low uptake of adaptation science; lack of knowledge sharing and capacity development; and a low sense of urgency. In addition, most of the adaptation options needed to reduce key risks depend on the limited availability of water and land resources.

Current global financial flows for adaptation are insufficient, especially in developing countries. Annual finance flows targeting adaptation for Africa, for example, are billions of US dollars less than the lowest adaptation cost estimates for near-term climate change. The overwhelming majority of globally tracked climate finance is targeted to emissions reductions, while a small proportion is targeted to adaptation. Climate impacts that result in higher levels of losses and damages, are more costly and also impede economic growth, thus reducing the availability of financial resources.

Overcoming such barriers is crucial for the adaptation and transformation needed to secure a liveable future for all. For example, in cities, a lack of governance capacity, financial support and the legacy of past urban infrastructure investment constrain progress in climate risk reduction. Critical urban capacity gaps include a limited ability to identify social vulnerability and community strengths, the absence of integrated planning to protect communities, the lack of access to innovative funding arrangements, and a limited capability to manage finance and commercial insurance.

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4 Improving food security

Adaptation strategies to enhance food security vary from farm-level interventions to national policies and international agreements. For the production of crops, adaptation strategies include field and farm-level options such as crop management, the diversification of planted crops and fruits, and social protection such as crop insurance. The most common field management options are changes in planting schedules, in crop varieties, and the use of fertilizers and irrigation. For example, farmers can shift their planting schedules in response to the early or late onset of the rainy season. Moreover, there are new crop insurance schemes that are based on changes in weather patterns. Community-based resource management, such as network building and financial support, can also help farmers to adapt to changing climate conditions.

For livestock farmers, adaptation options include: matching the number of animals with the production capacity of pastures; adjusting water management based on seasonal and spatial patterns of forage production; managing animal diets; more effective use of fodder; rotational grazing; fire management to control woody thickening of grass; using more suitable livestock breeds or species; migratory pastoralist activities; and activities to monitor and manage the spread of pests, weeds and diseases. Women, often responsible for household food provision, face gender-specific barriers in accessing resources and decision-making. Incorporating their knowledge and priorities in adaptation strategies is crucial for equitable outcomes and enhanced resilience in agricultural and fisheries sectors.

For ocean and inland fisheries, adaptation options are concentrated at the governance and management level. In general, eliminating overfishing can often help rebuild fish stocks and reduce ecosystem disruption, which strengthens fisheries against climate impacts. Expanding aquaculture is sometimes considered an adaptation to address wild fisheries declines but is also vulnerable to climate change impacts. However, there are also adaptation strategies specific to aquaculture, including the appropriate selection of species and strain, such as the cultivation of brackish species (shrimp, crabs) in inland ponds during dry seasons, and rice in combination with freshwater finfish in wetter seasons.

Mixed farming systems use a combination of crops, livestock, fish and trees and provide a solid platform for adaptation given their inherent diversity. A good example is agroforestry, meaning the purposeful integration of trees or shrubs with crops or livestock, which increases resilience against climate risks. Other agroecological practices include intercropping (the practice of growing two or more crops in proximity); increasing biodiversity; crop and pasture rotation; adding organic amendments; integration of livestock into mixed systems; cover crops; and minimising toxic and synthetic inputs that have adverse health and environmental impacts. Overall, nature-based strategies such as agroecology can be useful adaptation methods to increase wild and cultivated food sources.

Incorporating women's knowledge and priorities in adaptation strategies is crucial for equitable outcomes and enhanced resilience.

Photo by CIFOR/Fiston Wasanga. CC BY-NC-ND 2.0

Agroforestry is the collective name for land-use systems and technologies where woody long-living plants such as trees, shrubs, palms, bamboo, and others are deliberately used on the same piece of land as agricultural crops and/or animals. For instance, farmers might grow fruit trees on the same patch of land where they also graze their sheep or cows.

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5 Transforming cities

By the year 2050, cities are expected to be home to two-thirds of the world's population, making urban areas and their informal settlements a hotspot for climate change risks and impacts. However, the constant development of cities also offers opportunities to transform them and strengthen their adaptive capacities. This capacity largely depends on the resilience of their natural, social and physical infrastructure. We will be most successful in retrofitting, upgrading, and redesigning existing urban places or planning new cities when we combine knowledge on social policy, ecosystem-based adaptation and grey infrastructure to build inclusive processes of adaptation into everyday urban planning and development.

Using a combination of adaptation approaches, such as ecosystem-based adaptation, engineering and social policy, brings greater flexibility and wider benefits for people and nature. To manage flood risk, for example, it might be appropriate to install floodproofing on buildings, improve drainage along roads, and create space for water within a city, at the same time as constructing flood defences. Establishing or restoring green and blue spaces – parks, green corridors, ponds and wetlands – as well as providing opportunities for urban agriculture, can all be woven into the built environment. Social safety nets for disaster management can help people overcome the impacts of climate change and can provide financial security.

The constant development of cities also offers opportunities to transform them and strengthen their adaptive capacities.

Photo by Unsplash.com/@thisisengineering

In informal settlements, climate risks can be reduced successfully when policymakers and residents work together to combine local and expert knowledge. Adequate funding, skills, and tools are required too. The installation of water tanks or community sanitation facilities, for instance, can change the lives of the people living in informal settlements for the better and effectively decrease their vulnerability to hazards such as heat and drought. However, accountability, transparency, and commitment from the government are also important.

Adaptation actions in urban areas will be more effective if they are implemented in partnership with local communities, national governments, research institutions, the private sector and non-profit organisations or voluntary groups. Cities are already coming together through international networks to share good practices about adaptation actions, which is speeding up the transfer of knowledge.

The term **informal settlement** is used for settlements or residential areas that fall outside official rules and regulations. Most informal settlements have poor housing (with the widespread use of temporary materials) and are developed on land that is occupied illegally with high levels of overcrowding. In most such settlements, provision for safe water, sanitation, drainage, paved roads and basic services is inadequate or lacking. The term 'slum' is often used for informal settlements, although it is misleading as many informal settlements develop into good-quality residential areas, especially where governments support such development.

The term **ecosystem-based** adaptation describes the use of ecosystem management activities to increase the resilience and reduce the vulnerability of people and ecosystems to climate change.

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6 Securing and strengthening people's health

Our report shows that with proactive, timely and effective adaptation, many risks for human health and well-being could be reduced or avoided. Strengthening health systems, for instance, can reduce the impacts of infectious diseases, heat stress and other climate-related health risks, as well as the trauma associated with extreme events. This is particularly effective if it is combined with other measures such as disease surveillance, the installation of early warning systems, improving access to water, sanitation and hygiene, or implementing heat action plans.

In addition, people's health and well-being benefit from many actions taken in other sectors to address the risks of climate change. So-called adaptive urban design, that provides greater access to parks and other green and natural spaces, simultaneously enhances nature, improves air quality and moderates the water cycle. It also helps reduce health risks associated with heat stress and respiratory illnesses and offers people places to exercise, relax and recover from mental health challenges associated with congested urban living.

Reducing greenhouse gas emissions by transitioning to renewable energy sources, away from vehicles with combustion engines and fossil fuel-powered generating stations, also improves air quality and lowers the risks of respiratory illnesses.

Photo by Unsplash.com/@jordanbrierley

Policies and designs that facilitate active urban transport reduce greenhouse gas emissions, and generate physical and mental health benefits for residents.

Policies and designs that facilitate active urban transport (walking and bicycling) increase efficiency in that sector, reduce greenhouse gas emissions, and generate physical and mental health benefits for residents. Improved building and urban design that foster heat or flood-resilient architecture, energy efficiency, and the use of renewables improve indoor air quality and reduce risks of heat stress and respiratory illness.

7 No one-size-fits-all solution

There is no one-size-fits-all approach to ensure that climate adaptation efforts have positive results and include the concerns of everyone. Ecosystems and local communities in cities or rural areas are diverse, and thus they have diverse perspectives on what responses to prioritise. The feasibility of adaptation actions also depends on local circumstances. Moreover, adaptation efforts may impact people's lives in very different ways. Planning and decision making must respond to marginalised voices and future generations, focusing on the benefits for the children and youth.

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THERE ARE FEASIBLE, EFFECTIVE OPTIONS WE CAN TAKE TO REDUCE THE RISKS TO PEOPLE AND NATURE

Key enablers for adaptation

What is needed to adapt successfully to climate change? This has been a key question for all regions in our assessment report.

Here we show, as an example, the six key enablers for adaptation and related examples compiled by the authors for the region Australasia.

Governance frameworks	• A clear climate change adaptation mandate • Measures that inform a shift from reactive to anticipatory decision-making (e.g., decision tools that have long time frames) • Institutional frameworks integrated across all levels of government for better coordination • Revised design standards for buildings, infrastructure and landscape such as common land use planning guidance and codes of practice that integrate consideration of climate risks to address existing and future exposures and vulnerability of people and physical and cultural assets
Building capacity for adaptation	• Provision of nationally consistent risk information through agreed methodologies for risk assessment that address non-stationarity • Targeted research including understanding the projected scope and scale of cascading and compounding risks • Education, training and professional development for adaptation under changing risk conditions • Accessible adaptation tools and information
Community partnership and collaborative engagement	• Community engagement based on principles that consider social, cultural and Indigenous Peoples' contexts and an understanding of what people value and wish to protect • Use of collaborative and learning-oriented engagement approaches, tailored for the social context and informed by the cultural context • Community awareness and network building • Building on Indigenous Australian and Māori communities' social-cultural networks and conventions that promote collective action and mutual support

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Dynamic adaptive decision-making	• Increased understanding and use of decision-making tools to address uncertainties and changing risks, such as scenario planning and Dynamic Adaptive Policy Pathways to enable effective adaptation as climate risk profiles worsen
Funding mechanisms	• Adaptation funding frameworks to increase investment in adaptation actions • New private-sector financial instruments to support adaptation
Reducing systemic vulnerabilities	• Economic and social policies that reduce income and wealth inequalities • Strengthening social capital and cohesion • Identifying and redressing rigid or fragmented administrative and service delivery systems • Reviewing land use and spatial planning to reduce exposure to climate risks • Restoring degraded ecosystems and avoiding further environmental degradation and loss

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Adaptation solutions for ocean and coastal ecosystems

Comprehensively adapting to climate change depends on society's ability and willingness to anticipate the change, recognise its effects, plan to accommodate its consequences and implement a coordinated portfolio of informed solutions. This figure lists adaptation options for ocean and coastal ecosystems that were assessed in our report and shows how feasible and effective they are. The confidence level indicates how confident we are that this option will really advance adaptation.

Socio-Institutional Adaptation

	Knowledge diversity	Socially inclusive policies	Participation	Livelihood diversification	Mobility	Migration	Finance & market mechanisms	Disaster response programs	Multi-level ocean governance	Institutional transboundary agreements
Feasibility:	High	High	Medium	Low	Medium	Low	Medium	High	High	Medium
Effectiveness:	Low	Low	High	Medium	Medium	Medium	High	Low	High	High
Confidence:	High	High	Medium	Medium	Medium	Low	High	High	High	Medium

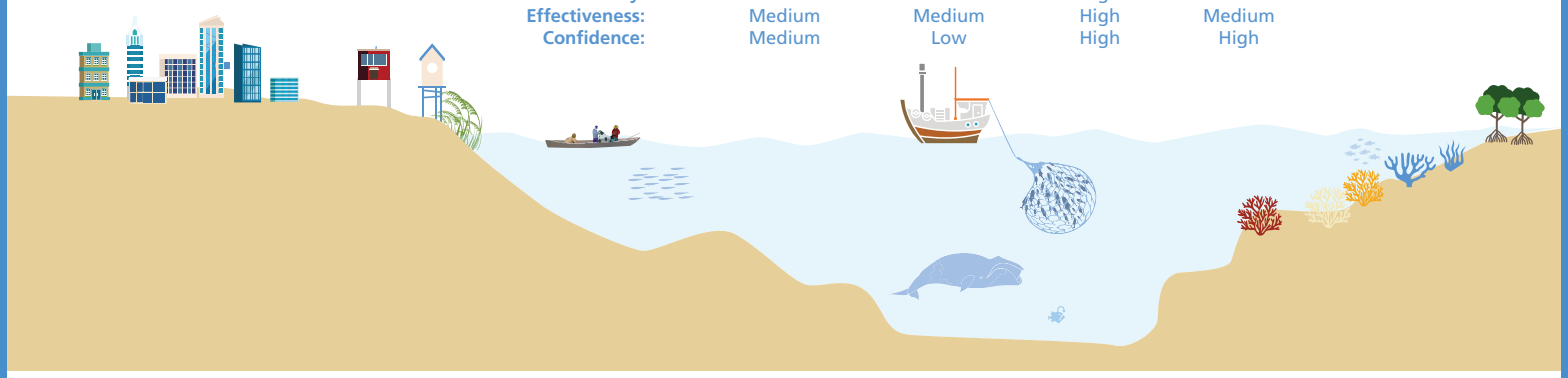
Marine and coastal nature-based solutions

	Habitat restoration	Marine protected areas & OECMs *	Conservation of climate refugia	Transboundary spatial planning	Sustainable harvesting	Climate-adaptive management	Ecosystem-based management
Feasibility:	Medium	High	Medium	High	High	Medium	Medium
Effectiveness:	High	Medium	High	High	Medium	High	High
Confidence:	High	High	Medium	Low	High	High	High

Built infrastructure and technology

	Accommodation & relocation	Protection and beach & shore nourishment	Early warning systems	Seasonal & dynamic forecasts	Monitoring systems	Habitat development	Active restoration	Assisted evolution
Feasibility:	Low	Medium	High	High	Medium	Medium	High	Medium
Effectiveness:	High	Medium	High	High	Medium	Medium	High	Medium
Confidence:	High	Medium	High	High	Medium	Low	High	High

* Other effective area-based conservation measures (OECMs) are areas other than officially designated protected areas that are achieving long term and effective in-situ conservation of biodiversity.



Adaptation Limits

WE ONLY HAVE A LIMITED SET OF OPTIONS TO REDUCE CLIMATE RISKS. THEIR NUMBER AND EFFECTIVENESS DECREASE WITH EVERY FRACTION OF A DEGREE OF ADDITIONAL WARMING

1 Even effective adaptation cannot prevent all losses and damages

To avoid mounting losses, urgent and ambitious action is required to adapt to climate change while at the same time making rapid, deep cuts in greenhouse gas emissions. However, our report also shows that adaptation to climate change cannot prevent all harm (economic and non-economic). When particular adaptation actions cannot effectively prevent climate change induced losses and damages anymore, they have reached their limit – the so-called 'adaptation limit'. As warming increases, more and more adaptation limits will be reached.

2 Some limits might be overcome, but many others won't

Barriers to adaptation, which may have biophysical, institutional, financial, social and cultural causes, can lead to so-called 'soft and hard adaptation limits'.

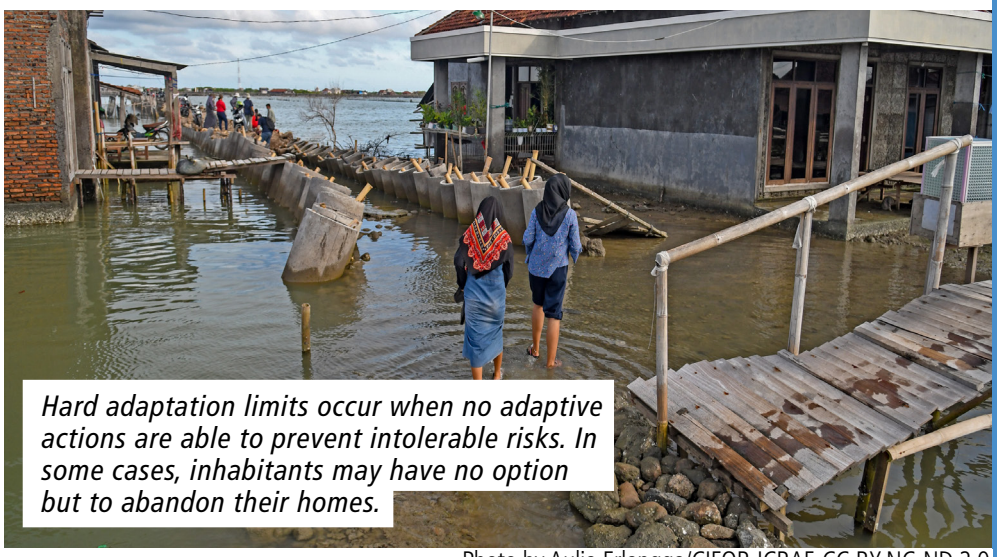
Hard adaptation limits occur when no adaptive actions are able to prevent intolerable risks. One example is when Small Islands become uninhabitable due to sea level rise and lack of sufficient freshwater. In that case, inhabitants may have no option but to abandon their homes. In nature, reaching hard limits leads to local and global species extinctions, such as mass tree mortality or mass coral bleaching and mortality.

Soft adaptation limits, in contrast, are reached when adaptation options may exist but are currently not available to avoid intolerable risks. Soft limits can often be overcome if additional financial, institutional or technological support becomes available. For instance, with sufficient funding cities can invest in new parks and lakes, creating new spaces for citizens to find shade and cool down during heatwaves.

3 Adaptation limits already reached

Our report finds that many species and ecosystems are already near or beyond their hard adaptation limits. People who rely on these species and ecosystems for their livelihoods or survival are therefore near or beyond their soft adaptation limits. For instance, many mountain-top species have suffered population losses along lower elevations, leaving them increasingly restricted to smaller high-elevation areas and at higher risk of extinction. Another example: the growing area for Californian almonds was predicted to increase under climate warming, yet a trend of increasing drought has already resulted in trees being removed due to a lack of water for irrigation. This has impacted small-scale farmers the hardest.

We already see some households in low-lying coastal areas in Australasia and on Small Islands that, perhaps for financial reasons, are no longer able to adapt to sea level rise and increasing coastal flooding, but could stay in their homes with the right support. In other situations, smallholder farmers in Central and South America, Africa, Europe and Asia, who rely on rainfed agriculture, may not be able to take advantage of technologies that could help them adapt because of policy constraints.



Hard adaptation limits occur when no adaptive actions are able to prevent intolerable risks. In some cases, inhabitants may have no option but to abandon their homes.

Photo by Aulia Erlangga/CIFOR-ICRAF. CC BY-NC-ND 2.0

Adaptation Limits

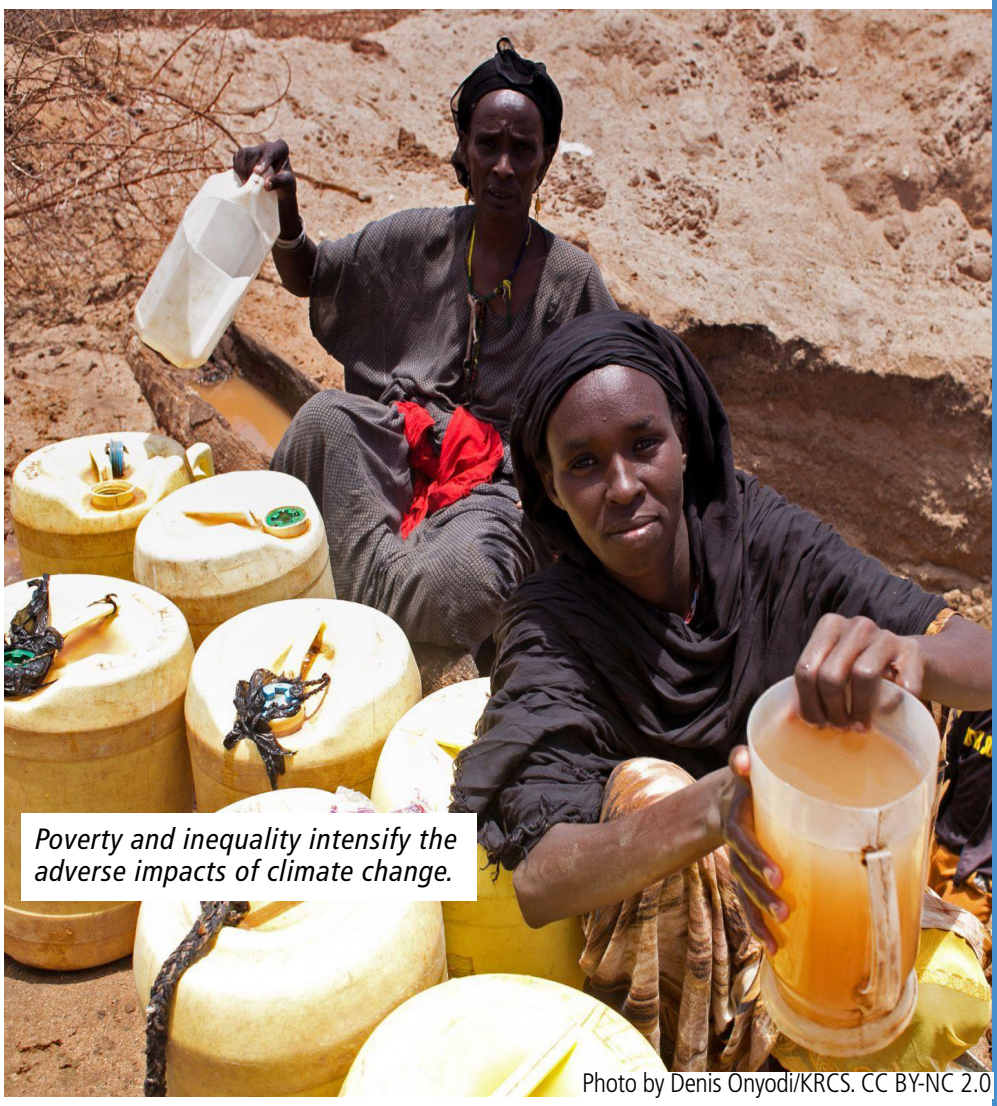
WE ONLY HAVE A LIMITED SET OF OPTIONS TO REDUCE CLIMATE RISKS. THEIR NUMBER AND EFFECTIVENESS DECREASE WITH EVERY FRACTION OF A DEGREE OF ADDITIONAL WARMING

4 Poverty and inequality impede successful adaptation

People living in locations with poverty, governance challenges, violent conflict, high levels of climate-sensitive livelihoods and limited access to basic services and resources are highly vulnerable to climate change. Many case studies from around the world show that both poverty and inequality intensify the adverse impacts of climate change. This leads to significant adaptation limits and disproportionate impacts for the most vulnerable groups including women, children, the elderly, ethnic and religious minorities, Indigenous Peoples, and refugees. For instance, among the poorest groups, the adverse impacts of climate change on agricultural productivity are likely to force households to switch from agriculture as the main source of income to other forms of wage labour, with consequences for food security, labour migration and urbanisation.

5 More limits will be reached with increasing temperatures

As global temperatures increase, more and more hard adaptation limits will be reached and surpassed. Adapting to climate change is especially challenging if hazards or impacts interact or appear in combination, which will occur more frequently as global warming continues. For example, at 1.5°C of global warming, lack of fresh water could mean that people living on Small Islands, and those dependent on glaciers and snowmelt, can no longer adapt. On land, up to 14% of animals and plants will face very high risks of extinction. In addition, more ecosystems will no longer be able to cope with climate change, which is why some ecosystem-based adaptation options may not work anymore. By 2°C it will be especially challenging to farm multiple staple crops in many current growing areas, particularly in tropical regions. Food security risks will become more severe, leading to increased malnutrition.



Poverty and inequality intensify the adverse impacts of climate change.

Photo by Denis Onyodi/KRCS. CC BY-NC 2.0

Adaptation Limits

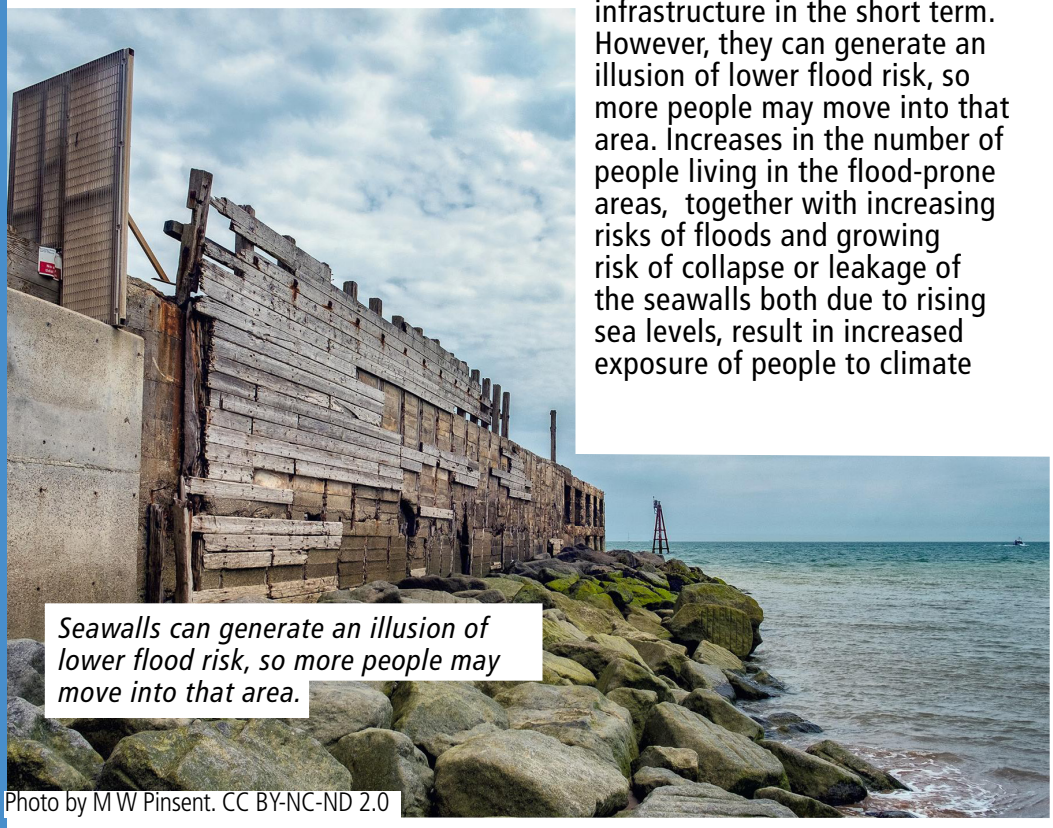
WE ONLY HAVE A LIMITED SET OF OPTIONS TO REDUCE CLIMATE RISKS. THEIR NUMBER AND EFFECTIVENESS DECREASE WITH EVERY FRACTION OF A DEGREE OF ADDITIONAL WARMING

6 Maladaptation: Climate risk reduction with unintended adverse side effects

There is increased evidence of maladaptation – a term that describes adaptation actions that have unintended adverse side effects. For example, the high energy demands of air conditioning, currently the world's main adaptation approach for reducing the health effects of high temperatures, may result in increased greenhouse gas emissions.

Maladaptation often stems from poor planning and implementation of adaptation responses and from not addressing the root causes of vulnerability. Maladaptation may also arise from carefully deliberated decisions where decision makers either place greater emphasis on singular or short-term outcomes ahead of broader, longer-term threats, or where they fail to consider the full range of interactions arising from the planned actions.

Maladaptive responses are difficult and expensive to change. For example, seawalls erected along the ocean's shore can reduce the impacts of storm-caused coastal flooding and sea level rise to coastal people and infrastructure in the short term. However, they can generate an illusion of lower flood risk, so more people may move into that area. Increases in the number of people living in the flood-prone areas, together with increasing risks of floods and growing risk of collapse or leakage of the seawalls both due to rising sea levels, result in increased exposure of people to climate risks. In addition, hard-engineered defences can also fragment or destroy coastal ecosystems, for example through increased erosion or reduced sediment supply, reducing their capacity to naturally protect coastlines.



Seawalls can generate an illusion of lower flood risk, so more people may move into that area.

Photo by M W Pinsent. CC BY-NC-ND 2.0

While maladaptive outcomes are often based on collective decision making, individual decisions and actions can also create unintended outcomes. For example, in times of drought, severe health impacts may arise if people have to walk further to get safe drinking water, decide to use unsafe water sources, prioritise drinking and cooking over personal or household hygiene, or reduce their food and water intake.

Actions to reduce or prevent greenhouse gas emissions may also cause harmful side effects if large areas of land are devoted to growing plants for bioenergy such as maize in monocultures, without considering adverse impacts on biodiversity, food production and water resources. Planting trees for carbon uptake in places where they do not naturally grow can have serious environmental impacts too, including potentially exacerbating the effects of climate change.

Indigenous Peoples, ethnic minorities and disadvantaged groups such as low-income households and those living in informal settlements, are some of the most affected by maladaptation. This reinforces and entrenches existing inequalities.

Adaptation Limits

WE ONLY HAVE A LIMITED SET OF OPTIONS TO REDUCE CLIMATE RISKS. THEIR NUMBER AND EFFECTIVENESS DECREASE WITH EVERY FRACTION OF A DEGREE OF ADDITIONAL WARMING

Adaptation actions need constant monitoring and evaluation

In our assessment we show that in a warming world, adaptation actions that are effective now in one place, might cease to be effective within a decade or are not transferable to other regions. This is why careful planning, monitoring and evaluation of actions is so important. Adaptation strategies might have to be revised constantly, and those revisions will be most efficient if they are fact- and data-driven. Only very few nations currently have operational frameworks in place to track and evaluate implementation and results, to determine if, when and how much additional adaptation is needed.
The Working Group II Report emphasises that the earlier the adaptation and mitigation measures are implemented together, the more the world will benefit. This is because the potential to reduce climate risks through adaptation is higher until mid-century, and for global warming levels below 1.5°C. At higher levels of warming, the effectiveness of most land- and water-based adaptation options starts declining, and the extent of residual risks increases, as do the chances of future unintended consequences.

Photo by Partnership for the Delaware Estuary/Danielle Kreeger. CC BY-NC-ND 2.0

Global Perspective

ADAPTATION PLANS, IMPLEMENTATION AND PROGRESS HAVE BEEN ASSESSED IN ALMOST EVERY CHAPTER OF OUR REPORT

In our report, the authors listed various adaptation actions that have taken place in cities and agriculture. On the following pages we highlight a few examples.

Climate adaptation actions in **cities**

Climate adaptation actions in **agriculture**

1 Quebec, Canada
Citizens collaborated with the municipal authority to bring together climate science and 'ordinary' urban management and design solutions.

2 USA
Early participation of stakeholders in adaptive planning for aquaculture has promoted action and ownership of results.

3 Mexico
Rainwater harvesting and the use of local–traditional varieties of maize have promoted food security.

4 Costa Rica
Farmers started to grow sugarcane and rice to diversify their businesses and reduce climate risks.

5 Andes/South America
To adapt to the drying of grasslands, Andean herders increased livestock mobility, accessed new grazing areas, and created new and expanded existing wetlands. Furthermore, fields managed by Indigenous farmers in several South American countries seem to pose a lower level of vulnerability to drought than fields cultivated by non-Indigenous farmers thanks to the use of the traditional knowledge of specific management techniques and the tendency to conserve species or varieties of crops tolerant to water scarcity.

6 San Juan, Puerto Rico
Hundreds of non-profit and grassroots organisations became active in disaster recovery after two powerful hurricanes hit in 2017. They are now catalysing actions to advance social transformation and sustainable development.

7 New York City, USA and Rotterdam, The Netherlands
In Rotterdam and New York City, local authorities adopted long-term objectives and conditions for adaptation action, bringing together a multiplicity of actors across sectors to orient contributions, share knowledge and coordinate actions.

Continues on next page…

Global Perspective

ADAPTATION PLANS, IMPLEMENTATION AND PROGRESS HAVE BEEN ASSESSED IN ALMOST EVERY CHAPTER OF OUR REPORT

Climate adaptation actions in **cities**

Climate adaptation actions in **agriculture**

…Continued from previous page.

7 **New York City, USA and Rotterdam, The Netherlands**
In Rotterdam and New York City, local authorities adopted long-term objectives and conditions for adaptation action, bringing together a multiplicity of actors across sectors to orient contributions, share knowledge and coordinate actions.

8 **Czech Republic**
Across three cities, stakeholder participation exercises were used to prioritise climate change risks, provide impetus and opportunity for knowledge co-production, and support adaptation planning.

9 **The Mediterranean**
Switching from large ruminants to more heat-resilient goats for dairy production is one option for livestock keepers to adapt to increasing heat stress for animals.

10 **Ghana**
Fishermen and women affected by declining fish stocks are developing aquaculture as an alternative source of food and income.

11 **Durban, South Africa**
Meaningful partnerships, long-term financial commitments and significant political and administrative support will have supported the city's adaptation action

Continues on next page…

Global Perspective

ADAPTATION PLANS, IMPLEMENTATION AND PROGRESS HAVE BEEN ASSESSED IN ALMOST EVERY CHAPTER OF OUR REPORT

…Continued from previous page.

Climate adaptation actions in **cities**

12 India
Heat Action Plans in various Indian cities are policy instruments that focus on providing early warnings on heat risk, altering outdoor labour hours, setting up water kiosks and shade, and guiding the public on heat management.

13 Xi'xian New Area, China
By the end of 2020, the municipality had built 2.4 million square metres of modern garden cities, more than 50 km of water-absorbing sponge roads, 1.4 million square metres of park space and established a green coverage of more than 50% of the urban space. The target of becoming a green city in which everyone can "see green in 100 metres, step into a garden every 300 metres" was realised.

Climate adaptation actions in **agriculture**

14 Mekong Delta
Inshore aquaculture farms in low-lying areas prone to sea level salinity intrusion have adapted by building dams and dykes, turning land into mixed plant–animal systems and intensifying their shrimp or fish pond culture to reduce water and land usage.

15 Vietnam
Irrigation improvement had the highest positive impact on crop yield among all farm-level adaptive practices.

16 Seoul, South Korea
The demolition of a major expressway and the restoration of the Cheonggyecheon Stream reorganised the downtown part of the city. It also significantly contributed to climate change adaptation through stormwater management and reducing the urban heat island effect.

17 Small Islands
Planting trees and shrubs in combination with crops has been used to increase the resilience of crops to droughts or excessive rainfall run-off.

18 Australia
Heatwave early-warning and adaptation systems that operate in the cities of Adelaide, Melbourne, Sydney and Brisbane have reduced potential death rates.

19 Hamilton, New Zealand
Restoring the urban forest in Hamilton is reducing heat stress in the city.

Adaptation Benefits

REDUCING CLIMATE RISK IS ONLY ONE OF MANY ADAPTATION BENEFITS

1 Successful adaptation actions can create multiple benefits for people and nature

By investing in adaptation now, alongside mitigation, the world will avoid higher investments in the future, because the potential benefits of adaptation activities outweigh their costs in the long term. In addition, adaptation can generate multiple benefits for people and nature.

For example, if we consider the 3.4 billion people living in rural areas, many of whom are highly vulnerable to climate change, resilience can be improved by providing social safety nets, improved roads, reliable energy, clean water and improved food security. These measures not only build climate resilience but also go hand in hand with helping to lift people out of poverty and achieving the United Nations Sustainable Development Goal 1 (end poverty in all its forms everywhere, *see page 9*).

And there is even more to gain. Through various combined mitigation and adaptation actions, we may be able to secure the productivity of fisheries, agriculture and companies, foster innovation, health and well-being, strengthen food security and peoples' livelihoods, and rebuild and strengthen nature, while at the same time reducing climate risks and damages.

In rural areas, many of whom are highly vulnerable to climate change, resilience can be improved by providing social safety nets, improved roads, reliable energy, clean water and improved food security.

Photo by FAO/Luis Tato

Adaptation Benefits

REDUCING CLIMATE RISK IS ONLY ONE OF MANY ADAPTATION BENEFITS

2 When adaptation actions turn into a transformation of human life

Current adaptation actions are dominated by small incremental, reactive changes to usual practices – such as increasing irrigation on fields or in gardens to prevent additional drought losses, or building houses made of stone to reduce future storm damage. However, such incremental adaptation is insufficient for addressing the large-scale global challenge of climate change.

What is needed instead are larger-scale, system-wide changes. These are actions and efforts that lead to shifts in our culture, norms, and worldviews, reduce injustice and social inequalities including gender-specific issues, change the way we live and treat nature for the better, and make our communities, infrastructure, food, water, and energy resources more climate-resilient. Such widespread changes are called transformative adaptation because, in the long run, these changes transform our way of life and make it more sustainable.

Our report highlights five systems where fundamental changes are needed to enable the adaptation required for our health and well-being, and to secure a just and climate-resilient future. These are changes in the way we manage, protect and conserve our land, ocean, coastal and freshwater ecosystems; the way we produce, distribute and use energy; the way our industries function; the structure of our society and the way decisions are made; and, how we plan, construct, manage and maintain and govern our cities and rural settlements.

By implementing these changes, we will be able to initiate urgently needed shifts in most aspects of society. For example, growing trees or fruits and vegetables in urban rooftop or community gardens, for instance, can improve nutrition and food security for urban dwellers. It can also improve their household income and mental health, while reducing some climate change impacts and risks, like flooding and landslides (by stabilising the soil and reducing runoff, for example), heat (by providing shade and through evapotranspiration) and diversifying food sources in case of drought.

Community gardens can improve nutrition and food security for urban dwellers, and improve their household income and mental health, while reducing some climate change impacts and risks.

Photo by Unsplash.com/@kevindous

Due to its manifold benefits, adaptation to climate change can help us achieve multiple Sustainable Development Goals.

Adaptation Benefits

REDUCING CLIMATE RISK IS ONLY ONE OF MANY ADAPTATION BENEFITS

3 Successful adaptation helps to reduce our greenhouse gas emissions

By fundamentally changing the way we live, we not only reduce climate risks for people and nature but also help to limit global warming. Healthy, restored and well-managed forests, grasslands and coastal ecosystems, for example, not only provide food and other services to people, they also absorb carbon dioxide from the atmosphere and store its carbon in biomass and underground – locking it away for tens to thousands of years.

Emissions will also be avoided and our planet's overall climate resilience enhanced when we reduce food loss and improve agricultural practices; eat more plant-based products and less meat; improve and expand our public transport system as well as bike and walking path networks; and restore degraded land and ecosystems, wherever possible.

At the same time, successful emission reductions might offer multiple benefits for well-being and health. For example, buildings certified as 'Leadership in Energy and Environmental Design' (a green building rating system) in the USA, Brazil, China, India, Germany and Turkey saved an estimated USD 7.5 billion in energy costs and averted 33 million tons of carbon dioxide from 2000–2016. According to our report, these energy-saving building practices can increase health benefits through better indoor air quality, reduction of the heat island effect, improved social well-being through the alleviation of energy poverty, creation of new jobs, increased productive time and income, increased thermal comfort, and reduced noise impact. The value of these multiple co-benefits associated with climate actions in buildings is equal to or greater than the costs of energy savings.

The multiple co-benefits of adaptation to climate change in combination with ambitious reduction of greenhouse gas emissions form the foundation for a solution framework that is an important new concept in our report - it is called Climate Resilient Development and aims at providing a sustainable and liveable future for all. Learn more about it in our Summary for All: *How to Secure a Liveable Future for All.*

Eating more plant-based products and less meat, reducing food loss and improving agricultural practices are beneficial for our planet's overall climate resilience enhancement.

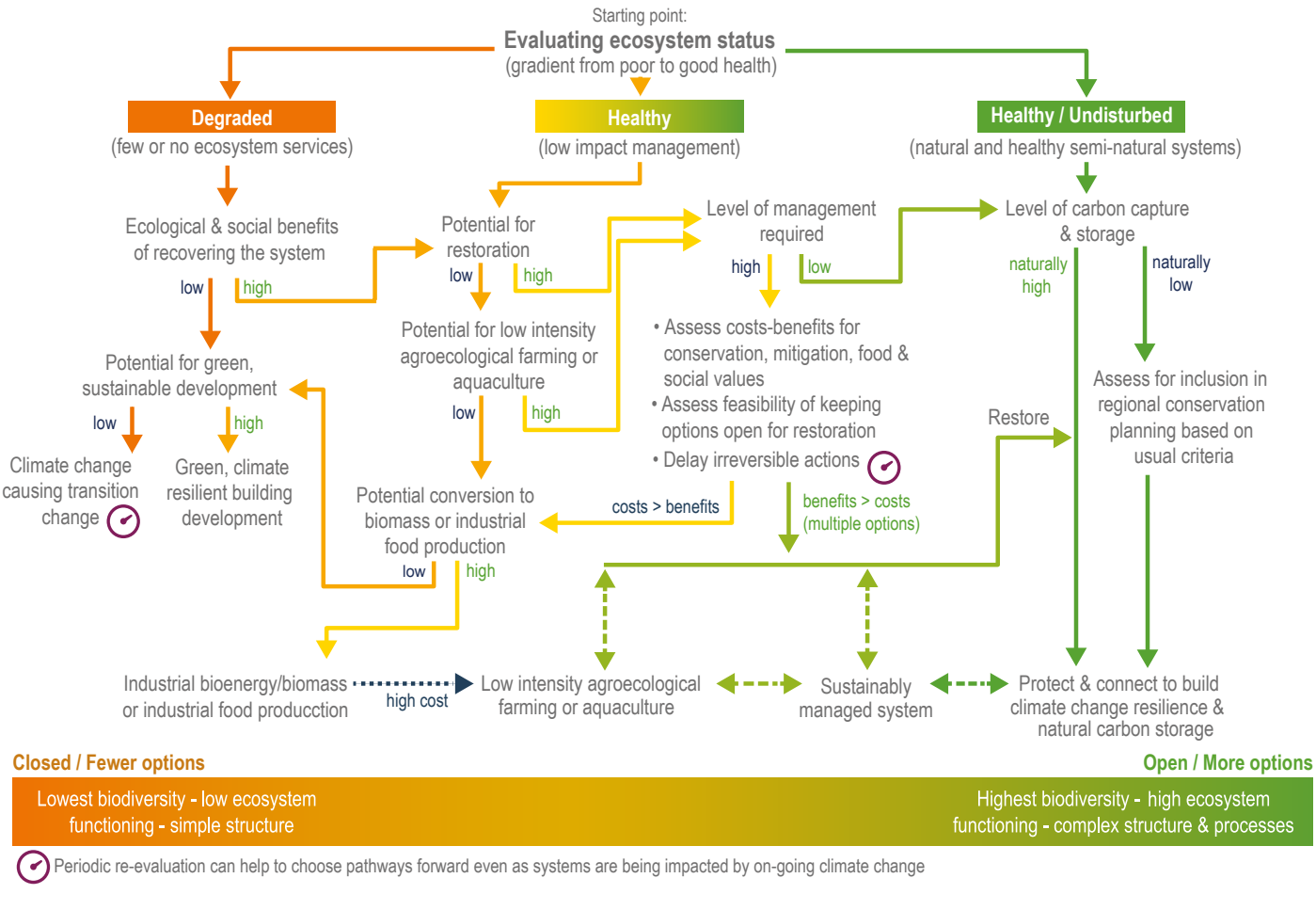
Photo by Jacquelyn Turner/CCAFS

Adaptation Benefits

REDUCING CLIMATE RISK IS ONLY ONE OF MANY ADAPTATION BENEFITS

A decision-making framework to co-maximise adaptation and mitigation benefits from natural systems

Protecting, conserving and restoring nature are essential elements of tackling climate change and creating many co-benefits. Healthy ecosystems protect us from weather extremes such as heat and flooding. They provide food to billions of people, and they absorb carbon dioxide from the atmosphere and store it. The following decision-making pathways illustrate how to develop and (re-)evaluate ecosystem-based approaches in the face of uncertainty about future climate change and its impacts, based on local context and conditions. These pathways emphasize the overarching goal of keeping open as many options as possible, for as long as possible, while at the same time recognising that ecosystems are being impacted by ongoing climate change.



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 here.

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This summary is based on the work of Working Group II Authors, who devoted their knowledge, expertise and time to the production of the WGII Contribution to the Sixth Assessment Report.

We thank everybody involved for their commitment.