

## **Society must undertake transformative action now to mitigate and adapt to the climate crisis**

*Comprehensive actions to limit and adapt to human-caused climate change are urgently needed to protect current and future life on Earth and promote well-being, global equity, and security.*

### **The Challenge**

The global climate crisis, unequivocally driven by human activities that increase greenhouse gases (GHGs)<sup>i</sup> emissions, is proving increasingly costly and disruptive worldwide.

The responsibility for and impacts of the crisis are distributed unequally among different regions, populations, and sectors. To reduce loss of life, suffering and worsened inequities, faster and more comprehensive actions must be taken to mitigate the causes and adapt to the effects. Inclusive and strategic climate actions can increase the diversity of solutions, lead to greater equity, well-being, and security, and protect the human right to a healthy and sustainable environment.<sup>ii</sup>

### **The Evidence and Projections for Natural Systems**

Since the Industrial Revolution,<sup>iii</sup> human activities, especially the burning fossil fuels, have caused atmospheric GHG concentrations<sup>iv</sup> to rise to levels unprecedented in at least the last 800,000 years (in the case of CO<sub>2</sub>, in at least the last 2 million years).<sup>v</sup> The global average surface temperature reached 1.1°C above 1850–1900 levels in 2011–2020 and has continued to rise.<sup>vi</sup> The 10 warmest years in the 174-year record have all occurred during the last decade (2014–2023) with 2023 being the warmest year.<sup>vii</sup>

The degree of warming that will occur in the coming decades, and the resulting risks to natural systems and humanity, will depend primarily on the choices that governments, organizations, and individuals make now about future GHG emissions and CO<sub>2</sub> removal from the atmosphere. Global average temperatures will only stabilize after CO<sub>2</sub> emissions are matched by the amount removed (net-zero) and emissions decline of non-CO<sub>2</sub> climate pollutants.<sup>viii</sup> Limiting the overall increase in average temperature to 1.5°C above pre-industrial levels, the aspirational target set in the Paris Climate Accord of 2015, requires achieving these goals by around 2050<sup>ix</sup>—or even sooner if warming temperatures reduce the nature’s ability to absorb and retain carbon.<sup>x</sup>

To see a gradual decline in average temperatures after a peak will require both sustained removal of more CO<sub>2</sub> from the atmosphere than is emitted (net negative emissions) and larger reductions of short-lived non-CO<sub>2</sub> climate pollutants.<sup>xi</sup> Even if the global temperature stabilizes, the delayed response of ocean warming and ice sheet melt means sea level will continue to rise for centuries or millennia, although the rise will occur much more slowly than if warming continues.<sup>xii</sup>

Many other changes related to global warming and increased atmospheric GHG concentrations have already been observed and are expected to continue. These include extreme events that are becoming more frequent, more intense or both (heat waves, heavy rainfall, tropical cyclones, droughts, storm surges and wildfires); reduced snow and ice in mountain glaciers, the Arctic sea, Northern Hemisphere, Greenland and West Antarctica; changes in both water quality and availability; increases in harmful algal blooms; coral bleaching; changes in the growth and nutritional value of land plants; and acidification of ocean waters.<sup>xiii</sup>

Further global warming increases the risk of reaching climate tipping points—critical thresholds beyond which a system reorganizes, often abruptly and irreversibly, such as ice-sheet collapse and rainforest dieback.<sup>xiv</sup> Ecosystem responses to further warming, such as increased GHG emissions from thawing permafrost, tropical

wetlands and wildfires, will only exacerbate the problems.<sup>xv</sup> The changing climate is increasingly altering landscapes, severely stressing the world's ecosystems and leading to increasing risks of further extinctions and irreversible biodiversity loss on land and in the oceans.<sup>xvi</sup>

### **The Consequences for Humans**

Humanity faces profound challenges from the current and projected impacts of climate change;<sup>xvii</sup> but the impacts are not uniform across regions and populations.<sup>xviii</sup> Without strategic action, risks will disproportionately affect communities and people who have experienced pre-existing systematic inequities, such as poverty, gender discrimination, settler colonialism and racialized histories of property regimes.<sup>xix</sup> The changing climate, paired with these social inequities, will increasingly threaten food, water and energy security<sup>xx</sup> and further increase deaths, illnesses and injuries related to extreme heat events, forest and other environmental degradation, pollution and climate-sensitive diseases transmitted by water, soil, air and insects.<sup>xxi,xxii</sup> The impacts of climate change on ecosystems and communities will continue to adversely affect mental health and profoundly alter cultural and spiritual traditions of Indigenous and local communities in tangible and intangible ways.<sup>xxiii</sup>

Economic and social disruption will result from major compound shifts in multiple natural and societal systems, such as agricultural and fisheries productivity; submergence and loss of land due to sea-level rise; diminished labor productivity; disruption in education systems; damages to critical infrastructure; collapsing insurance markets and deteriorated air, water and soil quality.<sup>xxiv</sup>

These disruptions will increasingly drive migration and population displacement.<sup>xxv</sup> Insecurity and [compound risks](#), including the potential for conflict and instability, will increasingly stress every region and sector worldwide.<sup>xxvi</sup>

Without countervailing actions, pre-existing inequities will be exacerbated by disparities caused by climate change and by unjust climate mitigation and adaptation actions.<sup>xxvii</sup> Adaptation measures, while critical, cannot alone prevent all losses and damages, which will continue to be unequally distributed and concentrated among the poorest and most vulnerable populations.<sup>xxviii</sup>

### **The Needed Responses**

Addressing the destructive consequences of climate change requires that governments, industry, the financial sector, academia, and other organizations advance transformative mitigation and adaptation actions simultaneously. Many actions have health and economic co-benefits.<sup>xxix</sup> Transformative actions include energy conservation and efficiency; transitioning to energy sources, products and services that do not release GHGs; taking fast action on short-lived climate pollutants;<sup>xxx</sup> implementing technologies and practices to remove and store CO<sub>2</sub> and possibly other GHGs from the atmosphere; improving food and agricultural systems; and adapting to unavoidable changes through, for example, nature-based solutions, resilient infrastructure and sustainable water-management practices.

Other [climate intervention](#) approaches require further research and cautious consideration of risks and cannot substitute for deep cuts in emissions or adaptation measures.<sup>xxxi</sup>

Actions are needed globally, with attention to local variation and tradeoffs, and should alleviate rather than exacerbate pre-existing injustices and inequities.<sup>xxxii</sup> To equitably distribute accountability for action,

greater financial responsibility for mitigation, adaptation and covering the costs of unavoidable losses and damages must fall on those whose historical emissions have been greatest.<sup>xxxiii</sup>

Effective climate risk governance requires continued Earth systems research and monitoring, solutions-oriented and co-produced community-based research and engagement of scientists with policy practitioners, communities, businesses and the public.<sup>xxxiv</sup> Diverse ways of knowing, including Indigenous knowledge and local knowledge, should be brought together to address the crisis.<sup>xxxv</sup> Scientists can provide allyship to community organizing and social movements, including those led by youth, women and Indigenous and ethnic communities, which can foster hope, prioritize climate justice and drive cultural and policy changes.<sup>xxxvi</sup>

Comprehensive actions to mitigate and adapt to the climate crisis are urgently needed to protect natural systems and humanity. If truly transformative and just, these actions can yield significant benefits for current and future generations.

*A position statement on climate change was previously adopted by the American Geophysical Union in December 1998; A new version was adopted December 2003; Revised and Reaffirmed December 2007, February 2012, August 2013, November 2019, September 2024.*

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<sup>i</sup> According to the [IPCC 6th Assessment Report \(2023; Summary for Policymakers\)](#): “Human activities, principally through emissions of greenhouse gases, have unequivocally caused global warming, with global surface temperature reaching 1.1°C above 1850–1900 in 2011–2020.”

<sup>ii</sup> Following the UN Resolution [adopted 2022, The human right to a clean, healthy and sustainable environment](#).

<sup>iii</sup> According to the [IPCC 6th Assessment Report \(2023; Summary for Policymakers\)](#): “Observed increases in well-mixed GHG concentrations since around 1750 are unequivocally caused by GHG emissions from human activities over this period.”

<sup>iv</sup> Including CO<sub>2</sub>, methane, nitrous oxide, halocarbons, and black carbon.

<sup>v</sup> According to the [IPCC 6th Assessment Report \(2023; Summary for Policymakers\)](#): “In 2019, atmospheric CO<sub>2</sub> concentrations (410 parts per million) were higher than at any time in at least 2 million years, and concentrations of methane (1866 parts per billion) and nitrous oxide (332 parts per billion) were higher than at any time in at least 800,000 years.”

<sup>vi</sup> According to the [IPCC 6th Assessment Report \(2023; Summary for Policymakers\)](#): “Human activities, principally through emissions of greenhouse gases, have unequivocally caused global warming, with global surface temperature reaching 1.1°C above 1850–1900 in 2011–2020. Global greenhouse gas emissions have continued to increase, with unequal historical and ongoing contributions arising from unsustainable energy use, land use and land-use change, lifestyles and patterns of consumption and production across regions, between and within countries, and among individuals (high confidence)”

<sup>vii</sup> According to the [Annual 2023 Global Climate Report](#) of the U.S. National Oceanographic and Atmospheric Administration National Centers for Environmental Information: “The year 2023 was the warmest year since global records began in 1850 at 1.18°C (2.12°F) above the 20th century average of 13.9°C (57.0°F). This value is 0.15°C (0.27°F) more than the previous record set in 2016. The 10 warmest years in the 174-year record have all occurred during the last decade (2014–2023).”

<sup>viii</sup> Net zero means the amount of CO<sub>2</sub> that humans emit into the atmosphere is matched by the amount removed by natural or technological means. According to the [IPCC 6th Assessment Report \(2023; Summary for Policymakers\)](#): “...reaching net zero anthropogenic CO<sub>2</sub> emissions is a requirement to stabilize human-induced global temperature increase at any level.” According to [IPCC Special Report: Global Warming of 1.5°C \(2018; Summary for Policymakers\)](#):

“Reaching and sustaining net zero global anthropogenic CO<sub>2</sub> emissions and declining net non-CO<sub>2</sub> radiative forcing would halt anthropogenic global warming on multi-decadal time scales (high confidence). The maximum temperature reached is then determined by cumulative net global anthropogenic CO<sub>2</sub> emissions up to the time of net zero CO<sub>2</sub> emissions (high confidence) and the level of non-CO<sub>2</sub> radiative forcing in the decades prior to the time that maximum temperatures are reached (medium confidence). On longer time scales, sustained net negative global anthropogenic CO<sub>2</sub> emissions and/or further reductions in non-CO<sub>2</sub> radiative forcing may still be required to prevent further warming due to Earth system feedbacks and to reverse ocean acidification (medium confidence) and will be required to minimize sea level rise (high confidence).” The same report defines non-CO<sub>2</sub> radiative forcing as: “Non-CO<sub>2</sub> emissions...are all anthropogenic emissions other than CO<sub>2</sub> that result in radiative forcing. These include short-lived climate forcers, such as methane

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some fluorinated gases, ozone precursors, aerosols or aerosol precursors, such as black carbon and sulphur dioxide, respectively, as well as long-lived greenhouse gases, such as nitrous oxide or some fluorinated gases. The radiative forcing associated with non-CO<sub>2</sub> emissions and changes in surface albedo is referred to as non-CO<sub>2</sub> radiative forcing.”

<sup>ix</sup> According to the [IPCC Special Report: Global Warming of 1.5°C \(2018; Summary for Policymakers\)](#): “In model pathways with no or limited overshoot of 1.5°C, global net anthropogenic CO<sub>2</sub> emissions decline by about 45% from 2010 levels by 2030 (40–60% interquartile range), reaching net zero around 2050 (2045–2055 interquartile range).”/

<sup>x</sup> According to the [IPCC 6th Assessment Report \(2023; Longer Report\)](#): “Limiting human-caused global warming requires net zero anthropogenic CO<sub>2</sub> emissions. Pathways consistent with 1.5°C and 2°C carbon budgets imply rapid, deep, and in most cases immediate GHG emission reductions in all sectors (high confidence). Exceeding a warming level and returning (i.e., overshoot) implies increased risks and potential irreversible impacts; achieving and sustaining global net negative CO<sub>2</sub> emissions would reduce warming (high confidence).”

<sup>xi</sup> According to the [IPCC 6th Assessment Report \(2023; Longer Report\)](#): “Global modelled pathways that reach and sustain net zero GHG emissions are projected to result in a gradual decline in surface temperature (high confidence). Reaching net zero GHG emissions primarily requires deep reductions in CO<sub>2</sub>, methane, and other GHG emissions, and implies net negative CO<sub>2</sub> emissions.”

<sup>xii</sup> According to the [IPCC 6th Assessment Report \(2023; Longer Report\)](#): “Sea level rise is unavoidable for centuries to millennia due to continuing deep ocean warming and ice sheet melt, and sea levels will remain elevated for thousands of years (high confidence).”

<sup>xiii</sup> Observed impacts and changes to climate systems are referenced at length here: [IPCC 6th Assessment Report \(2023; Longer Report, page 12, 2.1.2. Observed Climate System Changes and Impacts to Date\)](#)

<sup>xiv</sup> Definition of tipping points is sourced from the [IPCC 6th Assessment Report \(2023; Annex 1, Glossary\)](#). The recent [Global Tipping Points Report](#) (led by the University of Exeter’s Global Systems Institute with the support of more than 200 researchers from over 90 organizations in 26 countries) identified five major Earth system tipping points already at risk of being crossed due to the present level of global warming (related to the Greenland and West Antarctic ice sheets, warm-water coral reefs, North Atlantic Subpolar Gyre circulation, and permafrost regions), and three more tipping points threatened to be crossed in the 2030s as the world exceeds 1.5°C global warming.”

<sup>xv</sup> According to the [IPCC 6th Assessment Report \(2023; Longer Report\)](#): “In scenarios with increasing CO<sub>2</sub> emissions, the land and ocean carbon sinks are projected to be less effective at slowing the accumulation of CO<sub>2</sub> in the atmosphere (high confidence). While natural land and ocean carbon sinks are projected to take up, in absolute terms, a progressively larger amount of CO<sub>2</sub> under higher compared to lower CO<sub>2</sub> emissions scenarios, they become less effective, that is, the proportion of emissions taken up by land and ocean decreases with increasing cumulative net CO<sub>2</sub> emissions (high confidence). Additional ecosystem responses to warming not yet fully included in climate models, such as GHG fluxes from wetlands, permafrost thaw, and wildfires, would further increase concentrations of these gases in the atmosphere (high confidence).”

<sup>xvi</sup> According to the [IPCC 6th Assessment Report \(2023; Longer Report\)](#): “As warming levels increase, so do the risks of species extinction or irreversible loss of biodiversity in ecosystems such as forests (medium confidence), coral reefs (very high confidence) and in Arctic regions (high confidence).”

<sup>xvii</sup> According to the [IPCC 6th Assessment Report \(2023; Summary for Policymakers\)](#): “Human-caused climate change is already affecting many weather and climate extremes in every region across the globe. This has led to widespread adverse impacts and related losses and damages to nature and people (high confidence).”

<sup>xviii</sup> According to the [IPCC 6th Assessment Report \(2023; Summary for Policymakers\)](#): “Climate change has caused widespread adverse impacts and related losses and damages to nature and people that are unequally distributed across systems, regions and sectors.”

<sup>xix</sup> According to the [IPCC 6th Assessment Report \(Climate Change 2022: Impacts, Adaptation and Vulnerability\)](#):

“Vulnerability at different spatial levels is exacerbated by inequity and marginalization linked to gender, ethnicity, low income or combinations thereof (high confidence), especially for many

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Indigenous Peoples and local communities (high confidence). Present development challenges causing high vulnerability are influenced by historical and ongoing patterns of inequity such as colonialism, especially for many Indigenous Peoples and local communities (high confidence).” And: “The intersection of gender with race, class, ethnicity, sexuality, Indigenous identity, age, disability, income, migrant status and geographical location often compounds vulnerability to climate change impacts (very high confidence), exacerbates inequity and creates further injustice (high confidence). There is evidence that present adaptation strategies do not sufficiently include poverty reduction and the underlying social determinants of human vulnerability such as gender, ethnicity and governance (high confidence).”



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<sup>xx</sup> According to the [IPCC 6th Assessment Report \(2023; Summary for Policymakers\)](#): “Climate change has reduced food security and affected water security, hindering efforts to meet Sustainable Development Goals (high confidence).”

<sup>xxi</sup> According to the [IPCC 6th Assessment Report \(2023; Summary for Policymakers\)](#): “In all regions increases in extreme heat events have resulted in human mortality and morbidity (very high confidence). The occurrence of climate-related food-borne and water-borne diseases (very high confidence) and the incidence of vector-borne diseases (high confidence) have increased.” Also according to the [IPCC 6th Assessment Report \(2023; Summary for Policymakers\)](#): “In the near term, every region in the world is projected to face further increases in climate hazards (medium to high confidence, depending on region and hazard), increasing multiple risks to ecosystems and humans (very high confidence). Hazards and associated risks expected in the near term include an increase in heat-related human mortality and morbidity (high confidence), food-borne, water-borne, and vector-borne diseases (high confidence), and mental health challenges.”

<sup>xxii</sup> According to the [IPCC 6th Assessment Report \(Climate Change 2022: Impacts, Adaptation and Vulnerability\)](#): “It is well established that climate change compounds the impacts of pressures that humans place on the environment (high confidence) and that environmental degradation can undermine options for adaptation and an enabling environment, with poor and natural resource-dependent groups most acutely affected.”

<sup>xxiii</sup> According to the [IPCC 6th Assessment Report \(2023; Summary for Policymakers\)](#): “In assessed regions, some mental health challenges are associated with increasing temperatures (high confidence), trauma from extreme events (very high confidence), and loss of livelihoods and culture (high confidence).”

<sup>xxiv</sup> According to the [IPCC 6th Assessment Report \(2023; Summary for Policymakers\)](#): “Economic damages from climate change have been detected in climate-exposed sectors, such as agriculture, forestry, fishery, energy, and tourism. Individual livelihoods have been affected through, for example, destruction of homes and infrastructure, and loss of property and income, human health and food security, with adverse effects on gender and social equity. (high confidence)”

<sup>xxv</sup> According to the [IPCC 6th Assessment Report \(2023; Summary for Policymakers\)](#): “Climate and weather extremes are increasingly driving displacement in Africa, Asia, North America (high confidence), and Central and South America (medium confidence), with small island states in the Caribbean and South Pacific being disproportionately affected relative to their small population size (high confidence).”

<sup>xxvi</sup> According to the [IPCC 6th Assessment Report \(2023; Summary for Policymakers\)](#): “With further warming, climate change risks will become increasingly complex and more difficult to manage. Multiple climatic and non-climatic risk drivers will interact, resulting in compounding overall risk and risks cascading across sectors and regions. Climate-driven food insecurity and supply instability, for example, are projected to increase with increasing global warming, interacting with non-climatic risk drivers such as competition for land between urban expansion and food production, pandemics and conflict. (high confidence).”

<sup>xxvii</sup> According to the [IPCC 6th Assessment Report \(2023; Longer Report\)](#): “Prioritising equity, climate justice, social justice, inclusion and just transition processes can enable adaptation and ambitious mitigation actions and climate resilient development. Adaptation outcomes are enhanced by increased support to regions and people with the highest vulnerability to climatic hazards. Integrating climate adaptation into social protection programs improves resilience.”

<sup>xxviii</sup> According to the [IPCC 6th Assessment Report \(2023; Longer Report\)](#): “Adaptation does not prevent all losses and damages, even with effective adaptation and before reaching soft and hard limits (high confidence).”

<sup>xxix</sup> According to the [IPCC 6th Assessment Report \(2023; Longer Report\)](#): “Mitigation and adaptation options can lead to synergies and trade-offs with other aspects of sustainable development. Synergies and trade-offs depend on the pace and magnitude of changes and the development context including inequalities, with consideration of climate justice. The potential or effectiveness of some adaptation

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and mitigation options decreases as climate change intensifies. (high confidence) In the energy sector, transitions to low-emission systems will have multiple co-benefits, including improvements in air quality and health. There are potential synergies between sustainable development and, for instance, energy efficiency and renewable energy. (high confidence)”

<sup>xxx</sup> According to the [IPCC 6th Assessment Report \(2023; Summary for Policymakers\)](#): “GHG emissions reductions by 2030 and 2040, particularly reductions of methane emissions, lower peak warming, reduce the likelihood of overshooting warming limits and lead to less reliance on net negative CO2 emissions that reverse warming in the latter half of the century.”

<sup>xxxi</sup> See [AGU Position Statement on Climate Intervention \(revised and reaffirmed April 2023\)](#).



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<sup>xxxii</sup> According to the [IPCC 6th Assessment Report \(2023; Summary for Policymakers\)](#): “Adaptation and mitigation actions that prioritise equity, social justice, climate justice, rights-based approaches, and inclusivity, lead to more sustainable outcomes, reduce trade-offs, support transformative change and advance climate resilient development. Redistributive policies across sectors and regions that shield the poor and vulnerable, social safety nets, equity, inclusion and just transitions, at all scales can enable deeper societal ambitions and resolve tradeoffs with sustainable development goals. Attention to equity and broad and meaningful participation of all relevant actors in decision making at all scales can build social trust which builds on equitable sharing of benefits and burdens of mitigation that deepen and widen support for transformative changes.”

<sup>xxxiii</sup> According to the [IPCC 6th Assessment Report \(2023; Summary for Policymakers\)](#): “Adaptation does not prevent all losses and damages, even with effective adaptation and before reaching soft and hard limits. Losses and damages are across systems, regions and sectors and are not comprehensively addressed by current financial, governance and institutional arrangements, particularly in vulnerable developing countries. With increasing global warming, losses and damages increase and become increasingly difficult to avoid, while strongly concentrated among the poorest vulnerable populations.” According to the [IPCC 6th Assessment Report \(2023; Longer Report\)](#): “There is improved understanding of both economic and non-economic losses and damages, which is informing international climate policy and which has highlighted that losses and damages are not comprehensively addressed by current financial, governance and institutional arrangements, particularly in vulnerable developing countries (high confidence).” See also the decision adopted during COP 28 to operationalize a Loss and Damage fund ([FCCC/CP/2023/L1](#)).

<sup>xxxiv</sup> See also: [AGU Position Statement on Resilience \(revised and reaffirmed August 2022\)](#).

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According to the [IPCC 6th Assessment Report \(Climate Change 2022: Impacts, Adaptation and Vulnerability\)](#): “Enhancing knowledge on risks, impacts, and their consequences, and available adaptation options promotes societal and policy responses (high confidence). A wide range of top-down, bottom-up and co-produced processes and sources can deepen climate knowledge and sharing, including capacity building at all scales, educational and information programmes, using the arts, participatory modelling and climate services, Indigenous knowledge and local knowledge and citizen science (high confidence). These measures can facilitate awareness, heighten risk perception and influence behaviours (high confidence).”

<sup>xxxvi</sup> According to the [IPCC 6th Assessment Report \(2023; Technical Summary\)](#): “Climate-induced changes are not experienced equally across genders, income levels, classes, ethnicities, ages or physical abilities (high confidence). Therefore, participation of historically excluded groups, such as women, youth and marginalised communities (e.g., Indigenous Peoples, ethnic minorities, the disabled and low-income households), contributes to more equitable and socially just adaptation actions.”