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MISTIC MIZORAM
MIZORAM SCIENCE, TECHNOLOGY & INNOVATION COUNCIL

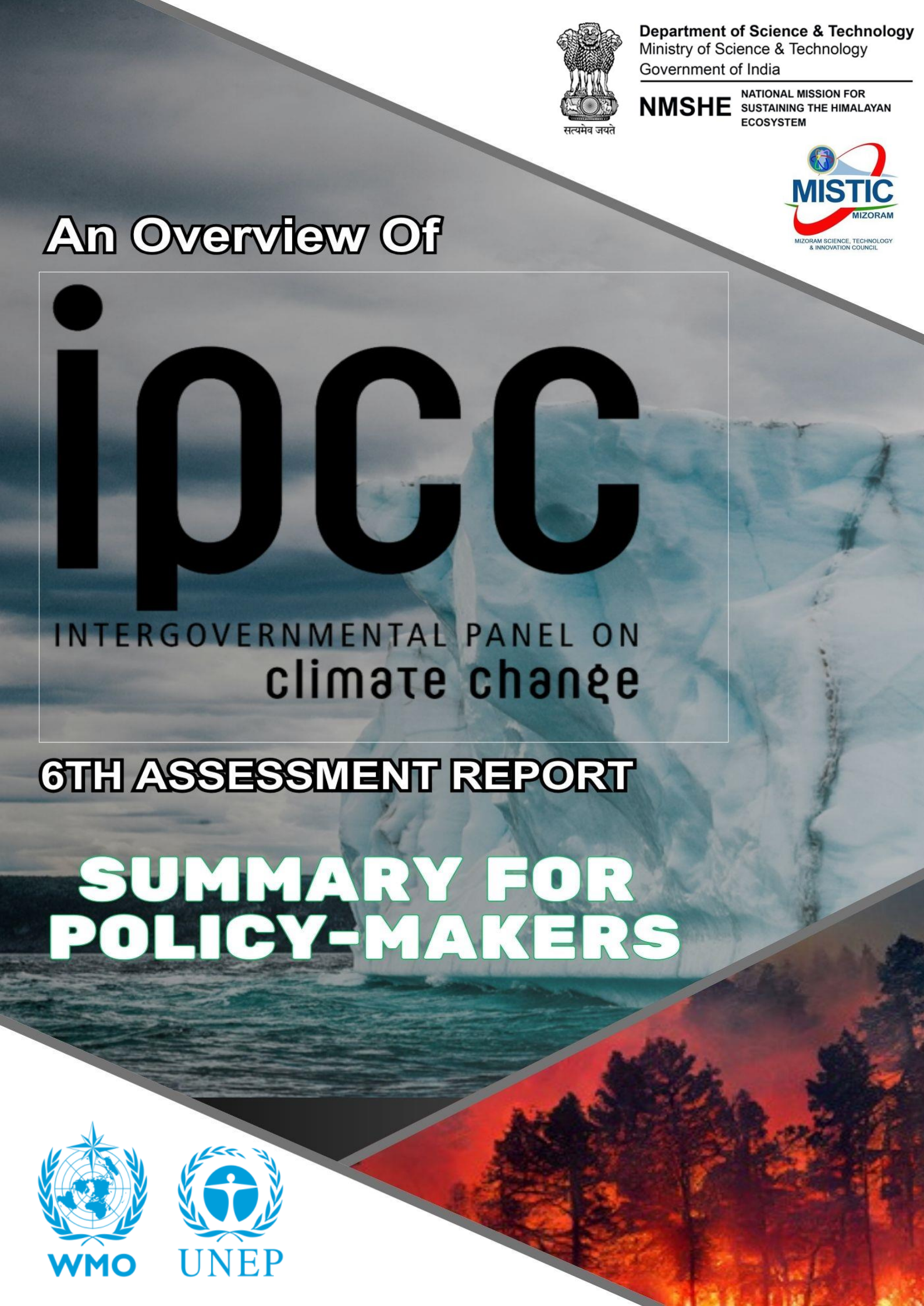
An Overview Of

IPCC

INTERGOVERNMENTAL PANEL ON climate change

6TH ASSESSMENT REPORT

SUMMARY FOR POLICY-MAKERS



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AN OVERVIEW OF
IPCCs 6TH ASSESSMENT REPORT

SUMMARY FOR POLICYMAKERS

MIZORAM STATE CLIMATE CHANGE CELL

MIZORAM SCIENCE, TECHNOLOGY & INNOVATION COUNCIL

CONTENTS

PREFACE

Intergovernmental Panel on Climate Change (IPCC) is a premier body of the United Nations on climate change which plays an important role in evaluating the state of scientific evidence on climate change. It provides guidelines for policymakers in their efforts to tackle climate change via its assessment reports and special publications. It was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP).

The IPCC released its assessment report every 5-6 years and their latest Sixth Assessment Report (AR6) published as "Summary for Policymakers" was released in several parts between 2021 and 2022 which provides a comprehensive overview of the state of climate science, impacts and response strategies. It emphasizes on how climate change is widespread and intensifying, driven by human activities, with urgent action needed to limit global warming to 1.5°C to avoid catastrophic impacts on ecosystems and human societies.

The State Climate Change Cell under the Mizoram Science Technology and Innovation Council (MISTIC), Government of Mizoram have decided to publish an overview of the Sixth Assessment Report (AR6) by the IPCC. This is to acquaint the public with the latest findings and status of current climate change reported by an organization at the forefront of global climate change. The text on the handbook has been summarized and made more legible from the original report for easier comprehension by readers, however all the data, figures and tables are by any means not altered.

Place: Aizawl

Date: 28.10.2024

(Er. H. LALSAWMLIANA)
Chief Scientific Officer & Member Secretary
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EXECUTIVE SUMMARY

The IPCC AR6 details the devastating consequences of rising greenhouse gas (GHG) emissions around the world but it also offers hope, highlighting different mitigation and adaption strategies to avoid the dreading consequences of it. It suggested readily available and highly cost-effective actions that can be undertaken now to reduce GHG emissions, scale up carbon removal and build resilience.

While the window to address the climate crisis is rapidly closing, the IPCC affirms that we can still secure a safe, liveable future. Listed below are a few information-of-interest from the report:

1. Human activities cause increasing rise of global temperature by 1.1℃ that are unprecedented in recent human history (1850-1900).
2. About 35% of the global population emits 9 tCO_2-eq per capita, while 41% emits below 3 tCO_2-eq per capita mainly due to limited access to modern energy.
3. Current emission levels shows that we are likely to deplete the remaining carbon budget by 2030 (only 500 GtCO2 of the carbon budget left for a 50% likelihood of limiting global warming to 1.5°C.)
4. Cutting 43% of emissions to limit warming to 1.5°C by 2030 (6 years away).
5. Projections show that if we do not increase our efforts to reduce emissions, global warming could reach 3.2°C by 2100.
6. Global temperature is rising, glaciers are melting and sea-level are rising rapidly threatening small Island nations and coastal cities.
7. Frequency and intensity of extreme weather events are increasing at an alarming rate threatening food and water security.
8. Oceans acidification is accelerating, water is becoming increasingly scarce and coral reefs are threatened.
9. Climate change related human health risk is likely to increase with rising temperature.
10. Adaptation measures are included in their climate policy by 170 countries, however more finance is needed to scale the progress.
11. Urgency to cut fossil fuels and shift to green technology to secure net zero emissions and build a resilient future.
12. Climate change is disproportionately affecting vulnerable and developing nations.
13. International cooperation is required to fight the on-going climate crisis.

A. Current Status and Trends

i). Observed Warming and its Causes

Excessive greenhouse gas emissions from humans are the main cause of current global warming, with the Earth's surface temperature rising to an alarming 1.1°C. Since the 1970s, this temperature increase has been faster, especially over land compared to the ocean. The rise in temperature from human activities between 1850-1900 and 2010-2019 is estimated to be between 0.8°C and 1.3°C. This warming is mostly due to greenhouse gases (GHGs) released by humans, along with some contributions from natural processes like radiation and volcanic eruptions.

In 2019, global human-caused GHG emissions were estimated at 59±6.6 gigatons of CO_2, which is about a 12% increase since 2010 and a 54% increase since 1990. Atmospheric CO_2 levels reached about 410 parts per million (ppm) in 2019, the highest in at least the last 2 million years. Methane (CH_4) levels were around 1,866 parts per billion (ppb), and nitrous oxide (N_2O) levels were about 332 ppb, both at their highest in the last 800,000 years. The majority of global GHG emissions come from CO_2, mainly from burning fossil fuels and industrial activities. Methane emissions and fluorinated gases have also increased significantly since the 1990s. Agriculture, forestry and other land use (AFOLU) accounted for about 22% of global emissions.

Historical CO_2 emissions differ greatly by region, both in total amounts and their sources, such as fossil fuel burning and net emissions from land use, land-use change and forestry (LULUCF). In 2019, 35% of the global population lived in countries where emissions were more than 9 tCO_2-eq (tons of CO_2-equivalent) per capita. Meanwhile, 41% lived in countries with emissions below 3 tCO_2-eq per capita/person, many of which have limited access to modern energy. Least developed countries (LDCs) and small island developing states generally have much lower per capita emissions compared to the global average (not counting CO_2 from LULUCF), reflecting their limited industrial activities and use of less carbon-intensive energy sources.

The richest 10% of household (nations) account for a large portion of global household GHG emissions, contributing between 34% and 45%, while the bottom 50% are estimated to contribute only 13% to 15%.

ii). Observed Changes and Impacts

Human-caused climate change is greatly affecting weather and extreme climate events around the world, causing serious problems for both nature and people. Vulnerable groups,

who have contributed the least to climate change, are negatively affected the most. Human activities have clearly warmed the atmosphere, oceans and land, with global sea levels rising by 0.20 meters from 1901 to 2018. The rate of this rise increased from 1.3 mm per year (1901-1971) to 3.7 mm per year (2006-2018), showing a strong human impact since at least 1971 (SPM.1 a,b,c).

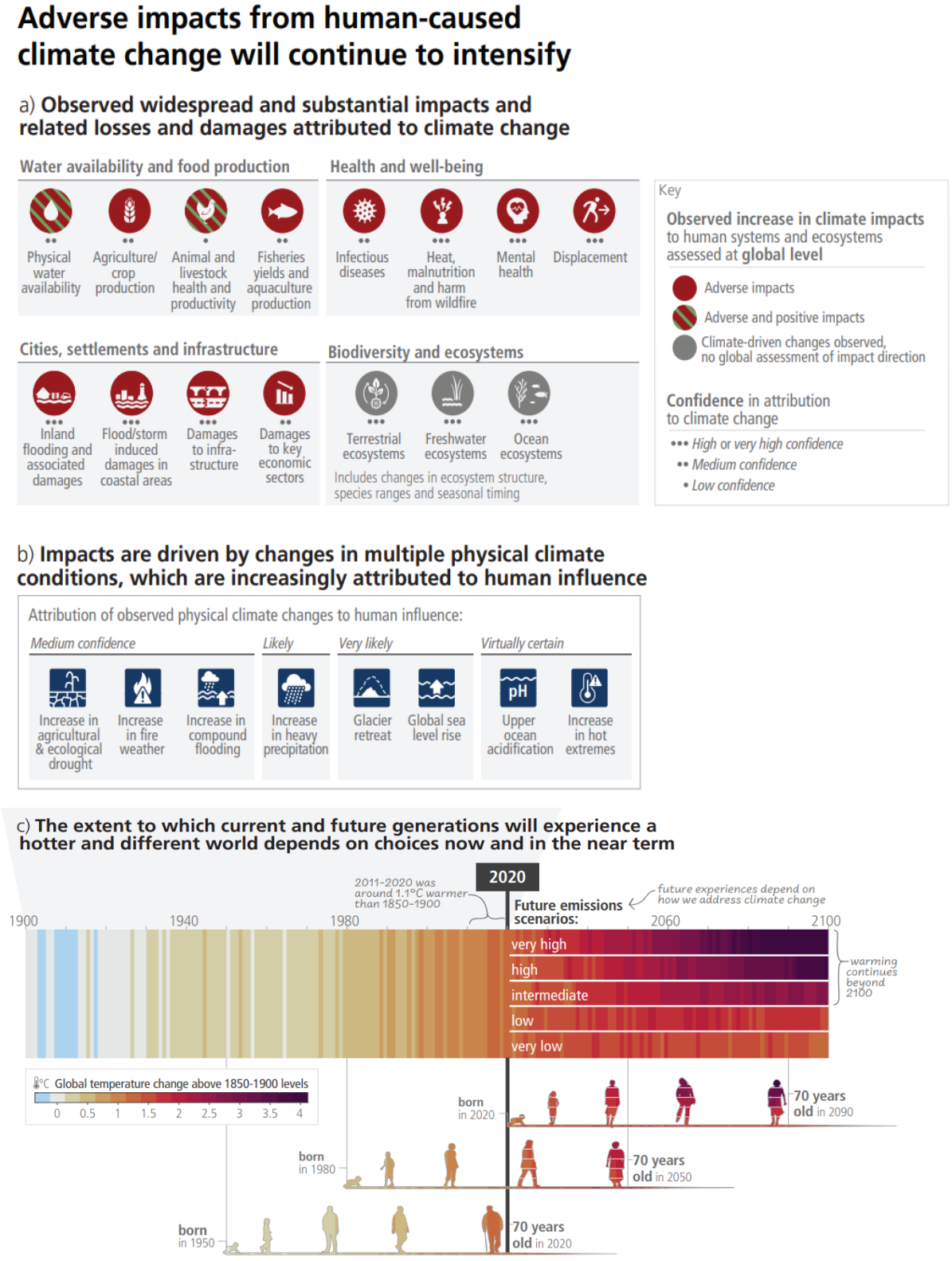
Recent evidence shows that extreme weather events—like heatwaves, heavy rain and droughts—have increased due to human actions, with a significant rise in combined extreme events since the 1950s. About 3.3 to 3.6 billion people settle in areas very vulnerable to climate impacts, especially in regions like Africa, Asia and small island nations. These vulnerabilities are worsened by development challenges, leading to severe food and water insecurity, which affects low-income households and Indigenous communities the most. From 2010 to 2020, death rates from climate-related disasters were 15 times higher in very vulnerable regions compared to less vulnerable areas.

Climate change has caused serious and often irreversible harm to the ecosystems, especially those impacted by melting glaciers and thawing permafrost. It has also reduced food and water security, making it harder to meet Sustainable Development Goals (SDGs). Economic losses are noticeable in agriculture, fisheries and city infrastructure, affecting marginalized communities the most. Overall, climate change increases health risks, leads to displacement and worsens inequalities, especially in urban area.

iii) Current Progress in Adaptation and Gaps and Challenges

Adaptation planning and action have made progress in different sectors and regions, showing benefits, with varying levels of success. However, there are still major gaps in adaptation efforts and these gaps are likely to grow if implementation rates stay the same. Some ecosystems have reached their limits for adapting and signs of maladaptation are showing in certain areas. Financial resources for adaptation are not enough, especially in developing countries, making it hard to implement important strategies.

Increased public and political awareness of climate impacts has led over 170 countries and many cities to include adaptation in their climate policies. Effective strategies include improving crop varieties, managing water on farms, conserving soil moisture and community- based adaptations. Approaches that focus on ecosystems, like creating green spaces in cities and restoring wetlands, have successfully lowered flood risks and reduced urban heat. A mix of structural measures and non-structural measures, such as early warning systems, has been effective in saving lives during floods.



SPM.1 (a). Observed widespread and substantial impacts and related losses and damages attributed to climate change.

(b). Observed impacts are connected to physical climate changes

(c). Observed (1900–2020) and projected (2021–2100) changes in global surface temperature

Adaptation options like disaster risk management and climate services can be useful for many people, but there are still big gaps in adaptation, especially for lower-income groups and marginalized communities are increasingly facing problems due to poor adaptation efforts. Small-scale farmers and households in low-lying coastal areas struggle with financial and governance issues, leading to clear limits on their ability to adapt, while some ecosystems have reached their maximum capacity to adapt.

Key barriers hindering successful adaptation include a lack of resources, limited involvement from the private sector and the public and lack of understanding climate issues. The growing gap between the estimated costs of adaptation and the actual funds available makes things harder too, with negative climate effects further reducing the financial resources available, especially for developing countries.

iv) Current Mitigation Progress, Gaps and Challenges

Emissions predicted for 2030, based on Nationally Determined Contributions (NDCs) announced in October 2021, suggested that warming could go beyond 1.5°C, making it harder to keep it under 2°C. The gap between projected emissions from current policies and those outlined by the NDCs is worsened by a lack of funding to achieve climate goals across various sectors and regions.

International agreements like the UNFCCC, Kyoto Protocol and Paris Agreement have helped countries set climate goals and improve their policies. Many nations have made progress in areas like energy efficiency, reducing deforestation and using new technologies, with at least 18 countries achieving significant cuts in greenhouse gases and CO_2 over the last decade.

Cost-effective solutions like solar and wind energy, electrifying cities and better land management are becoming more practical and widely supported. However, many developing countries struggle to adopt low-emission technologies because they lack financial resources and capacity, even though the costs of renewable technologies have dropped significantly.

Projections show that if we do not increase our efforts to reduce emissions, global warming could reach 3.2°C by 2100. Additionally, funding for climate adaptation and mitigation is still not enough, with both public and private investments in fossil fuels exceeding those for climate initiatives. In 2018, financial support from developed to developing countries fell short of the UNFCCC goal of mobilizing USD 100 billion each year by 2020, making global climate action even more difficult.

B. FUTURE CLIMATE CHANGE, RISKS AND LONG-TERM RESPONSES

i). Future Climate Change

Increased greenhouse gas (GHG) emissions are likely to cause even more global warming with a chance of reaching 1.5°C very quickly. Each increase in temperature will make various hazards worse, highlighting the urgent need for strict policy that will rapidly and deeply cuts in emissions. Taking these actions could slow global warming within 20 years and improve air quality in just a few years (SPM.1c).

In the near future (2021–2040), warming will mainly result from CO_2 emissions from different sources. By 2081 to 2100, warming could range from 1.4°C with very low emissions scenario to 4.4°C with high emissions scenario, a noticeable change in 20 years. Immediate improvements in air quality can happen with focused efforts to reduce air pollutants, but lasting benefits will come from broader actions to lower both pollutants and greenhouse gases.

Ongoing emissions will impact all major climate systems, leading to more extreme weather events such as changes in the water cycle and stronger monsoons. Natural carbon sinks like forests and oceans, will becomes less effective in absorbing CO_2 as warming continues. This will result in more frequent heatwaves and droughts, with projections suggesting that extreme sea level events could happen every year in many places by 2100.

Additionally, regional climates will see stronger tropical storms and drier conditions. While natural changes will still affect the climate, they won't significantly alter long-term warming trends. Understanding these natural variations is crucial for effective planning, especially at regional levels and in the near future.

ii). Climate Change Impacts and Climate-Related Risks

Climate change related risk is much higher than what was reported in AR5 and as it gets warmer, these risks and negative effects will increase with each small rise in temperature, with even more complicated challenges that are harder to manage.

In the near future, every region will face more climate-related problems, affecting both nature and people. These problems may include more heat-related health issues, diseases from food and insects, mental health struggles, flooding in coastal cities, loss of biodiversity and scarcity of food. Melting glaciers will cause rising sea level, frequent localised flooding and landslides will threaten buildings and economies, especially in mountainous regions.

Food insecurity caused by climate change will mix with other issues like city growth and conflict, increasing overall risks. The level of risk for different warming scenarios will

depend on the vulnerability of the people and the ecosystems. Social issues like migration, inequality and urban growth are making people more exposed to climate hazards worldwide. Vulnerability will be especially high in informal and rapidly growing settlements, while rural areas that rely on climate-sensitive livelihoods will face greater risks. The health of ecosystems will be affected by unsustainable consumption and rising population, which will have lasting effects on communities that depend on these ecosystems, especially Indigenous Peoples.

iii). Likelihood and Risks of Unavoidable, Irreversible or Abrupt Changes

Some changes are unavoidable and irreversible, but we can reduce their impact by making consistent cuts in global greenhouse gas emissions. However, limiting global surface temperature does not prevent continued changes in the climate system components that have a much longer timescales of response.

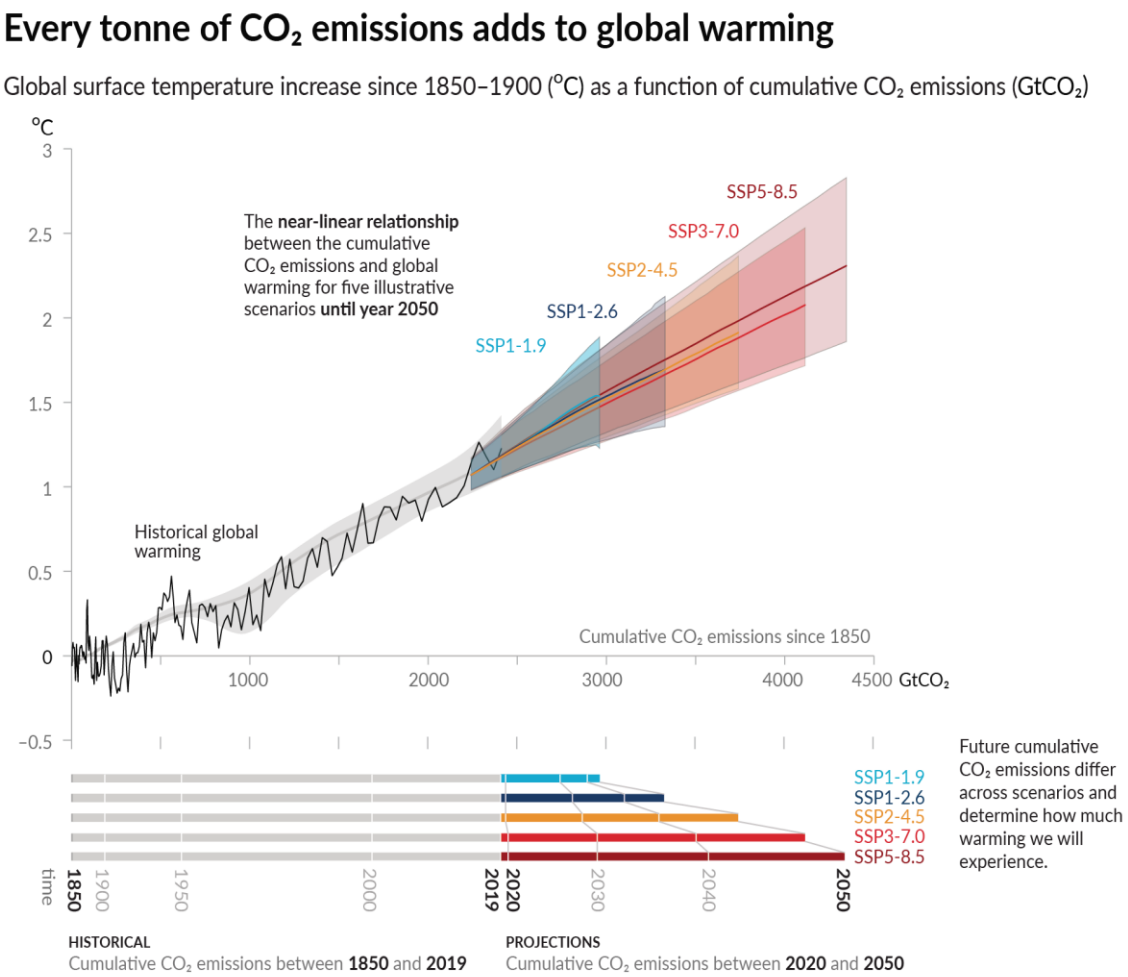
Unavoidable sea-level rise due to ongoing deep ocean warming and melting ice sheets will remain elevated for thousands of years. However, significant reductions in greenhouse gas emissions will likely slow down further sea level rise.

According to different scenarios, if we follow the low emissions path (SSP1-1.9), global mean sea level could rise by about 0.15–0.23 meters by 2050 and 0.28–0.55 meters by 2100. In contrast, the high emissions scenario (SSP5-8.5) could lead to a rise of 0.20–0.29 meters by 2050 and 0.63–1.01 meters by 2100. Over the next 2000 years, if we limit warming to 1.5°C, global mean sea level could rise by about 2–3 meters, and if we limit it to 2°C, it could rise by 2–6 meters (SPM.2).

The chances and effects of sudden and irreversible changes in the climate system increase as global warming continues, especially when critical tipping points are reached. As temperatures rises, so do the risks of species extinction and irreversible loss of biodiversity in ecosystems like forests, coral reefs and Arctic regions. If warming stays between 2°C and 3°C, the Greenland and West Antarctic ice sheets will likely be lost almost completely and irreversibly over thousands of years, leading to several meters of sea level rise.

There is also an increased risk of rare but very significant outcomes as warming levels rise. Due to uncertainties on how ice sheets behave, we cannot rule out global mean sea level rise exceeding the expected range—approaching 2 meters by 2100 and over 15 meters by 2300 under the high emissions scenario (SSP5-8.5). There is moderate certainty that the Atlantic Meridional Overturning Circulation will not collapse before 2100, but if it does, it

could lead to abrupt changes in regional weather patterns and major impacts on ecosystems and human activities.



SPM.2: Different greenhouse gas (GHG) emission scenarios

iv). Adaptation Options and their Limits in a Warmer World

Current adaptation strategies that are feasible and effective will become less effective as global warming increases. As temperatures rises, losses and damages will grow and more human and natural systems will reach their limits for adaptation. To avoid maladaptation, we need flexible, inclusive and long-term planning that involves multiple sectors and provides benefits across different areas. The effectiveness of adaptation measures, especially those related to ecosystems and water, will decline as warming increases. The best results come from integrated solutions that respond to climate risks, connect different systems and tackle social inequalities. Since adaptation options usually take a long time to implement, careful long-term planning is necessary to make them more effective.

When temperatures rise above 1.5°C, limited freshwater resources could create tough adaptation challenges for small islands and areas that rely on glacier and snow melts. At higher warming levels, ecosystems like certain coral reefs, coastal wetlands, rainforests, polar and mountain ecosystems will reach or exceed their adaptation limits, making ecosystem-based adaptation measures less effective.

Focusing on specific sectors or short-term benefits can lead to maladaptation in the long run, creating ongoing vulnerabilities and risks that are hard to change. For instance, seawalls can provide immediate protection for people and property, but if not part of a long-term adaptive strategy, they may increase exposure to climate risks over time. Maladaptive approaches can worsen inequalities, particularly for Indigenous Peoples and marginalized groups, while also harming ecosystem resilience and biodiversity. To avoid maladaptation, we need flexible, inclusive and long-term planning that involves multiple sectors and provides benefits across various areas.

v). Carbon Budgets and Net Zero Emissions

To limit global warming caused by humans, we need to reach net zero CO_2 emissions. The total amount of CO_2 we emit until we achieve net zero, and the reductions we make in greenhouse gases this decade will determine if we can limit warming to 1.5°C or 2°C.

To keep warming within safe limits, we must reduce total CO_2 emissions, reach net zero CO_2 emissions and cut down on other greenhouse gases. Achieving net zero greenhouse gas (GHG) emissions mainly involves significant reductions in CO_2, methane and other gases, along with efforts to remove CO_2 from the atmosphere. Carbon dioxide removal (CDR) will be necessary to achieve net negative CO_2 emissions. If we maintain net zero emissions, global temperatures are expected to slowly decline after peaking.

For every 1000 gigatons of CO_2 released by human activities, the temperature rises by about 0.45°C. As of early 2020, we had roughly 500 gigatons left to emit for a 50% chance of limiting warming to 1.5°C and 1150 gigatons for a 67% chance of limiting it to 2°C. The greater the cuts in non-CO_2 emissions, the cooler the temperatures will be for a specific carbon budget or that more carbon budget will be available for the same temperature increase.

If CO_2 emissions from 2020 to 2030 stay the same as in 2019, we would almost use up the amount of carbon allowed to keep warming below 1.5°C and over a third of what's left for 2°C. Current estimates show that emissions from existing fossil fuel sources already exceed the limit for 1.5°C. If we keep emitting as we have in the past, future CO_2 emissions

from these sources could reach the remaining allowance for 2°C with an 83% chance of happening.

vi). Mitigation Pathways

To keep global warming to 1.5°C or 2°C, we need to quickly and significantly reduce greenhouse gas emissions across all areas this decade. For pathways aiming for 1.5°C, we should reach net zero CO_2 emissions by the early 2050s, with negative emissions following that. For pathways targeting 2°C, net zero CO_2 emissions should be achieved by the early 2070s. These global modelled pathways show how we can limit warming based on specific sector and regional assumptions.

Both the 1.5°C and 2°C pathways require fast, deep and often immediate cuts in emissions. The model predicts that global greenhouse gas emissions will peak between 2020 and 2025 if we act now. Achieving these targets is crucial to avoid excessive temperature rises, and the strategies depend on various factors outlined in specific assumptions (Table SPM.1).

Table SPM.1: Greenhouse gas and Co2 emission reduction from 2019

		Reductions from 2019 emission levels (%)			
		2030	2035	2040	2050
Limit warming to1.5°C (>50%) with no or limited overshoot	GHG	43 [34-60]	60 [49-77]	69 [58-90]	84 [73-98]
	CO_2	48 [36-69]	65 [50-96]	80 [61-109]	99 [79-119]
Limit warming to 2°C (>67%)	GHG	21 [1-42]	35 [22-55]	46 [34-63]	64 [53-77]
	CO_2	22 [1-44]	37 [21-59]	51 [36-70]	73 [55-90]

To achieve net zero CO_2 or greenhouse gas emissions, we must rapidly reduce CO_2 and significantly cut non-CO_2 gases. For instance, to limit warming to 1.5°C, methane emissions should decrease by 34% by 2030 compared to 2019 levels. However, emissions from challenging sectors like agriculture and shipping will still occur. To counterbalance these remaining emissions, we will need carbon dioxide removal (CDR) methods. As a result, net zero CO_2 is usually reached before net zero for all greenhouse gases, since some emissions are harder to eliminate. Global strategies for achieving these targets include transitioning from fossil fuels to low- or zero-carbon energy sources, improving efficiency and using CDR. Typically, the land-use and energy sectors reach net zero before buildings, industry and transport (SPM.5).

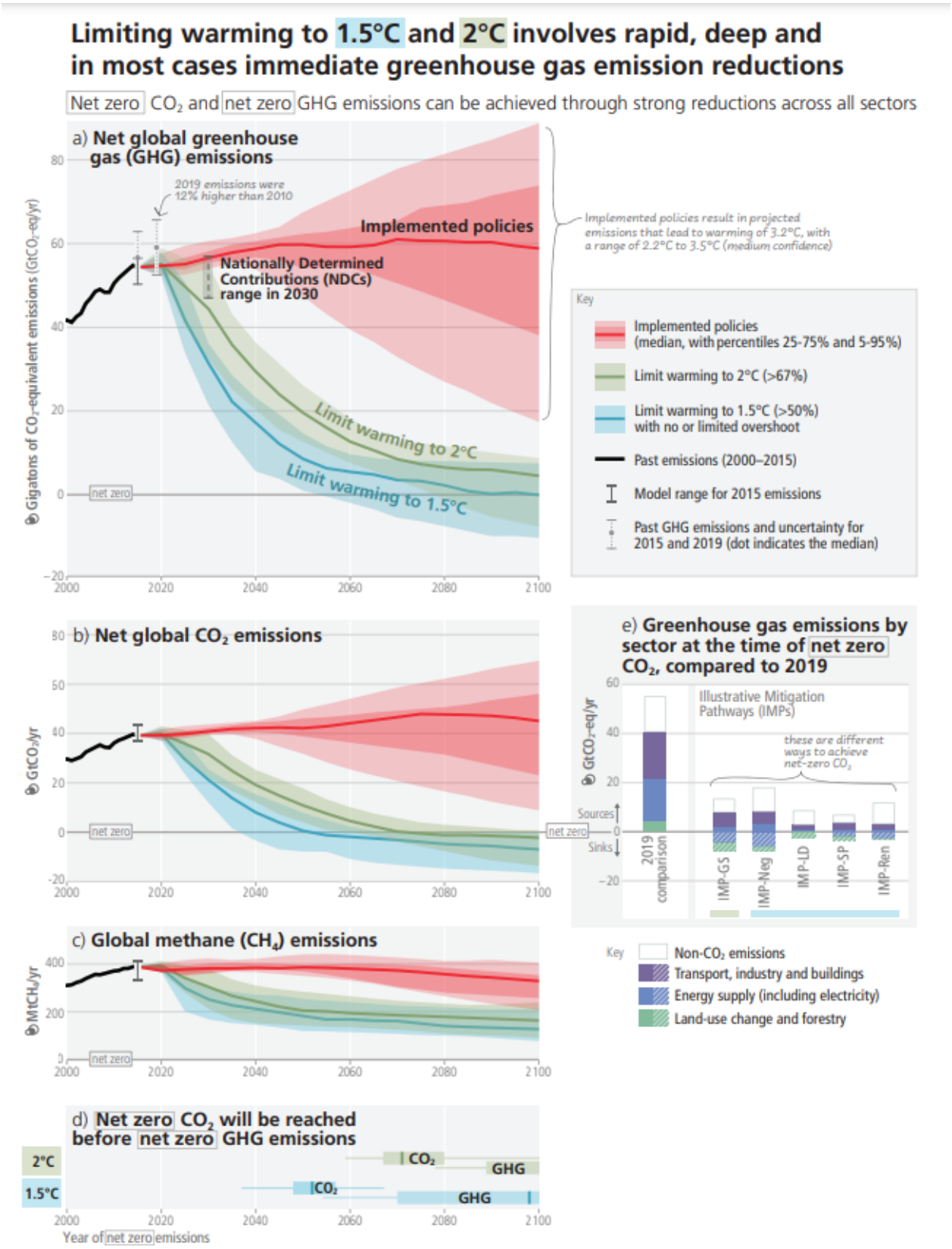
Mitigation options can support sustainable development, but they may also have trade-offs. For example, improving energy efficiency and using renewable energy can benefit

sustainability. Biological carbon dioxide removal (CDR) methods like reforestation and soil carbon storage can boost biodiversity, local jobs and livelihoods. However, large-scale afforestation or biomass crop production could inadvertently harm biodiversity, food and water security and the rights of Indigenous Peoples if land ownership is unclear. Pathways that promote efficient resource use or sustainable development face fewer challenges, as they rely less on carbon removal methods and put less pressure on land and biodiversity.

vii). Overshoot: Exceeding a Warming Level and Returning

If global warming goes above 1.5°C, we might be able to lower it again by removing more carbon dioxide (CO_2) from the atmosphere than we emit. This would require more carbon dioxide removal (CDR) effort compared to situations where we stay below this limit, raising its feasibility and sustainability concerns. Only a few ambitious plans can keep warming under 1.5°C by 2100 without any temporary increases in between. To lower the temperature, we will need to take out more CO_2 than we produce each year. However, during this time of overshooting, problems like more wildfires, dying trees, drying peatlands and melting permafrost can release even more greenhouse gases, making it tougher to reduce warming later.

The longer and more significant we exceed the 1.5°C warming limit, the more harm it will cause to ecosystems and societies. This increases risks for natural systems and human communities, especially for infrastructure and low-lying coastal areas. Exceeding this temperature can lead to permanent damage in fragile ecosystems, like those in polar and coastal regions, due to melting ice and rising sea levels. The bigger the increase in temperature above 1.5°C, the more carbon dioxide (CO_2) we will need to remove from the atmosphere to get back down to that level by 2100. If we can quickly reach net-zero CO_2 emissions and cut down on other greenhouse gases like methane, we can keep temperatures from rising too much. This would lessen the need for large-scale carbon removal efforts, making it easier and safer for people and the environment.



SPM.5: Global emissions pathways consistent with implemented policies and mitigation strategies. Panels (a), (b) and (c) show the development of global GHG, CO_2 and methane emissions in modelled pathways, while panel (d) shows the associated timing of when GHG and CO_2 emissions reach net zero.

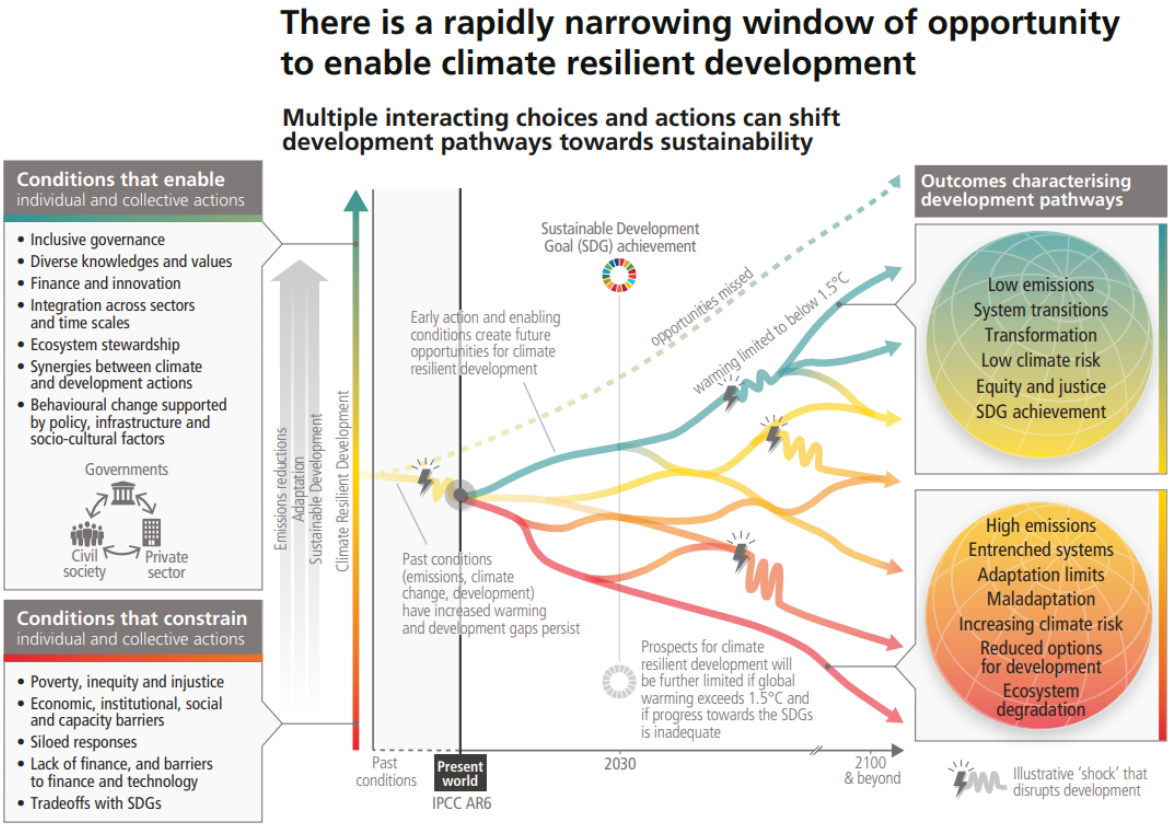
C. RESPONSES IN THE NEAR TERM

i). Urgency of Near-Term Integrated Climate Action

Climate change is a serious threat to both people and the planet. We have a limited time to create a safe and sustainable future for everyone. Climate-resilient development combines efforts to adapt to changes and reduce greenhouse gas emissions, helping to achieve sustainable growth for all. This requires better global cooperation and access to financial resources, especially for vulnerable areas and groups, along with inclusive governance and coordinated policies. The choices we make this decade will have lasting effects for thousands of years (SPM.1 & 6).

Evidence shows that taking urgent action for climate resilience is more critical now than before. Past development and emissions have limited our ability to adapt and every increase in temperature beyond 1.5°C makes it even harder to address these challenges.

Government actions at local, national and international levels, along with input from civil society and businesses, are essential for promoting sustainable and climate-resilient development. This kind of development happens when these groups make inclusive choices that focus on reducing risks and ensuring fairness. It is important that decision-making, funding and actions are connected across all levels of governance and sectors. Although, conditions for success vary based on local, regional and national circumstances. Key factors include strong political commitment, coordinated policies, cooperation among different groups, responsible management of ecosystems, inclusive governance, diverse knowledge, technological advances, and better access to financial resources, especially for vulnerable communities (SPM.6). Ongoing emissions will continue to impact all major climate systems, with many changes becoming permanent over hundreds to thousands of years and worsening as global temperatures rise. If we do not take urgent, effective and fair actions to reduce emissions and adapt, climate change will definitely endanger ecosystems, biodiversity and the health and livelihoods of both current and future generations.



SPM.6: The illustrative development pathways (red to green) and associated outcomes (right panel) show that there is a rapidly narrowing window of opportunity to secure a liveable and sustainable future for all.

ii). The Benefits of Near-Term Action

To fight climate change, we need to act quickly and consistently by both cutting emissions and adapting to new conditions. Acting now will reduce future risks, protect ecosystems and bring extra benefits like cleaner air and better health. Delaying action will make things worse, locking us into polluting technologies, increasing costs and causing more damage. Although early action may require big investments and major changes, smart policies can make the transition smoother. Many adaptation efforts take a long time to work, so speeding them up this decade is crucial to close existing gaps. If we wait, global warming will increase, making it harder and more expensive to adapt. Some systems may reach their limits, especially affecting vulnerable regions like Africa, small island nations and developing countries, which will struggle the most with climate impacts.

Combining emission cuts and adaptation efforts will maximize benefits. Reducing emissions can improve health by cutting air pollution, encouraging walking and cycling, and supporting healthy, sustainable diets. Cutting methane emissions quickly can slow near-term

warming and improve air quality. Adaptation efforts can also boost farming, innovation, health, food security, jobs, and biodiversity.

Traditional cost-benefit analyses often underestimate the full value of avoiding climate damage. In many cases, the health benefits from cleaner air alone can be as large or even larger than the costs of reducing emissions. Studies show that the overall economic and social benefits of keeping global warming below 2°C outweigh the costs of mitigation.

Acting sooner and peaking emissions earlier will unlock more benefits and reduce long-term risks and costs, though it will require significant upfront investments. Ambitious climate goals may also lead to big changes in economies, with varying impacts across and within countries. However, these challenges can be managed with supportive policies—such as financial and regulatory reforms, climate-resilient social protections and better access to funding for green technologies, especially in developing countries.

iii). Mitigation and Adaptation Options Across Systems

To secure a sustainable and liveable future, we need fast and large-scale changes across all sectors. These changes require expanding a variety of solutions to both reduce emissions and adapt to climate impacts. Many affordable and effective options already exist, though they may vary by region and system (SPM.7).

Key actions include adopting low- or zero-emission technologies, designing infrastructure that reduces demand, encouraging behavioural shifts, boosting efficiency, providing social protections and climate-related services and protecting or restoring ecosystems. The potential and practicality of these solutions vary between regions and sectors, but many are already within reach.

Energy systems

To reach net-zero CO_2 energy systems, we need to reduce and rely less on fossil fuels and use carbon capture and storage. This also involves shifting to carbon-free electricity, expanding electrification, using alternative energy sources where electrification is not feasible, conserving energy and improving efficiency. Integrating all parts of the energy system is essential.

Low-cost emissions cuts (under $20 per ton) can come from solar and wind power, energy efficiency and cutting methane emissions from coal, oil, gas and waste. Adapting energy systems to climate challenges includes using diverse power sources like solar, wind, small hydro and improving energy storage and efficiency.

In industry, reducing emissions requires more efficient production and cleaner processes. In transport, sustainable biofuels, low emission hydrogen and electric vehicles can cut emissions, supported by better batteries and sustainable mineral use. We can reduce the environmental impact of battery production and concerns about critical minerals by using diverse materials and suppliers, improving energy and material efficiency and promoting recycling. (SPM.7).

Cities, Settlements and infrastructure

Cities play a key role in reducing emissions and building climate resilience. To adapt and mitigate climate change, urban planning must consider climate risks when designing infrastructure and settlements. Important strategies include compact city layouts, placing jobs and homes close together, promoting public transport, walking and cycling and designing energy-efficient buildings. Reducing energy and material use, switching to sustainable materials, and electrifying systems with low-emission energy sources are also essential.

Inclusive, long-term planning that integrates physical, social and environmental infrastructure can help cities achieve benefits in many areas—lower emissions, better health, improved ecosystems, and reduced risks for vulnerable communities. Green spaces (like parks) and blue infrastructure (like rivers and wetlands) help capture carbon, reduce energy demand and protect against extreme weather events such as heatwaves, floods and droughts. These natural solutions, alone or combined with traditional infrastructure, also provide added benefits for health, well-being and local livelihoods.

Land, Ocean, Food and Water

Agriculture, forestry and land use (AFOLU) strategies offer significant benefits for both adapting and mitigating climate change. Protecting, managing, restoring forests and ecosystems can greatly reduce emissions by curbing deforestation in tropical areas. However, balancing land use for restoration and food production requires integrated planning to meet goals like food security.

Adopting sustainable diets, cutting food waste and enhancing farming practices can reduce emissions, protect ecosystems and create space for restoration. Sustainable agricultural and forest products can replace more polluting materials in other sectors. Adaptation strategies include improved crop varieties, agroforestry, community engagement, farm diversification and urban agriculture. While protecting peatlands, wetlands and mangroves offers immediate benefits, restoring ecosystems can take decades. Successful efforts need to consider environmental, social and economic factors.

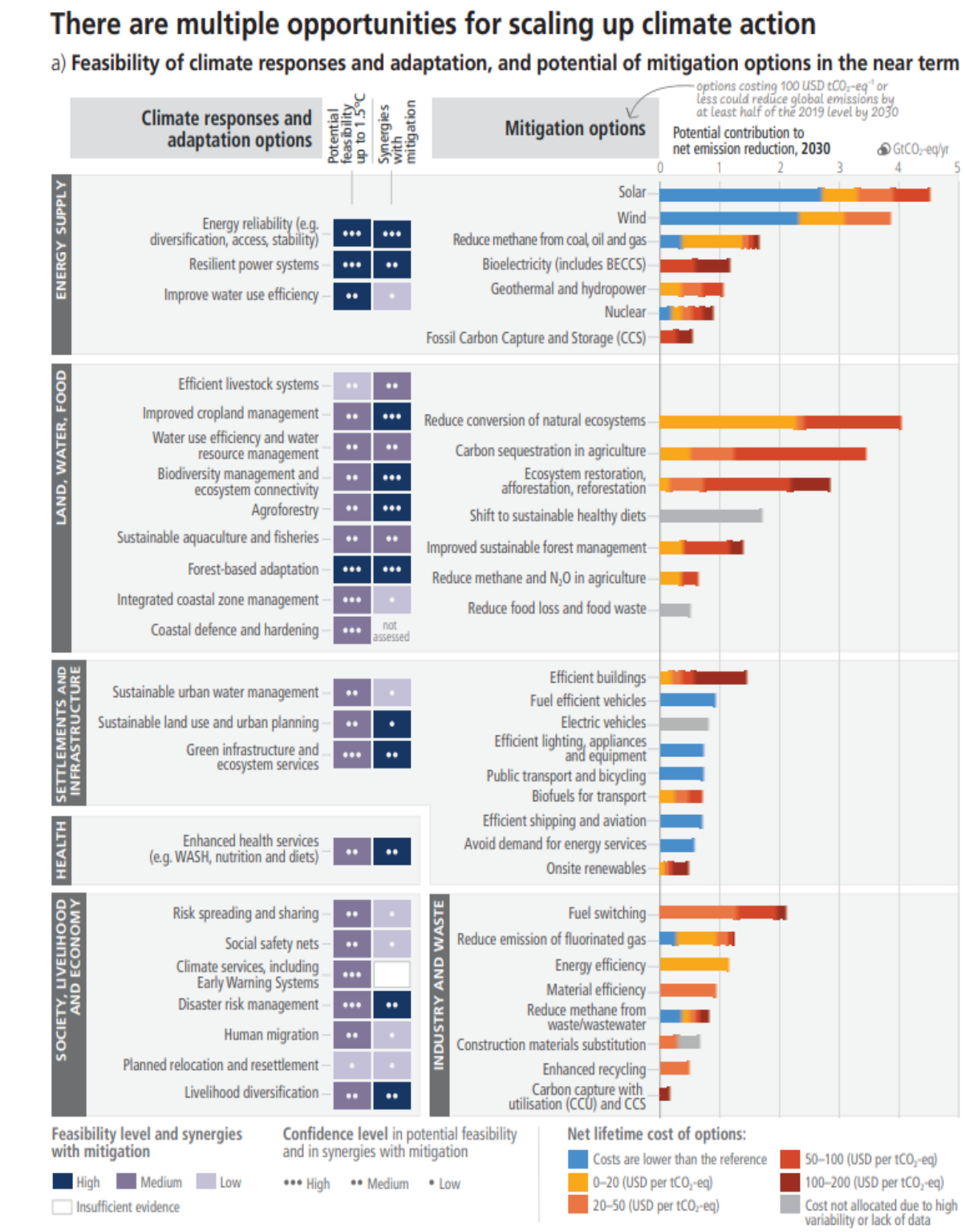
To protect biodiversity and ecosystem services globally, we need to effectively and fairly conserve about 30% to 50% of the Earth's land, freshwater and ocean areas, including natural ecosystems. Conserving, protecting and restoring these ecosystems helps reduce their vulnerability to climate change, decreases coastal erosion and flooding, and can increase carbon storage if global warming is limited. Rebuilding overfished populations supports food security and improves human health and well-being. Restoring land aids in climate change mitigation and adaptation while benefiting local economies and reducing poverty. Cooperation and inclusive decision-making with Indigenous Peoples and local communities are essential for successful environmental efforts.

Health and Nutrition

Human health can improve by combining health concerns with policies about food, infrastructure, social support and water. To protect health, we should focus on strengthening public health programs for diseases affected by climate change, making health systems more resilient, and improving the health of our ecosystems. It is important to provide clean water, lower the risk of flooding affecting sanitation, and create better systems to monitor and warn about health issues. Additionally, reducing food waste and promoting healthy diets can enhance nutrition, overall health and biodiversity.

Society, Livelihood and Economies

Combining policies like weather and health insurance, social protection, and adaptive safety nets can help reduce people's vulnerability to risks. Having emergency funds and universal access to early warning systems, along with effective backup plans, can protect communities. Disaster risk management, early warning systems and climate services can be used in many sectors. Improving education, building skills and increasing climate knowledge through community programs can raise awareness of risks and encourage better planning and behaviour.



SPM.7: Multiple Opportunities for scaling up climate action. Panel (a) presents selected mitigation and adaptation

options across different systems. The left-hand side of panel a shows climate responses and adaptation options assessed for their multidimensional feasibility at global scale, in the near term and up to 1.5°C global warming.

iv). Synergies and Trade-Offs with sustainable Development

Taking quick and fair action to address climate change is essential for sustainable development. Mitigation (reducing emissions) and adaptation (adjusting to climate impacts) can often work well together with the Sustainable Development Goals, though their effects can vary based on the situation and scale of efforts.

Incorporating mitigation into broader development goals can lead to faster and more effective emissions reductions. Countries at different economic levels all aim to improve their citizens well-being, but their priorities vary based on their unique social, economic, environmental and political situations. For regions reliant on fossil fuels for income and jobs, promoting sustainable development requires policies that encourage diversification in the economy and energy sectors while ensuring fair transitions.

Eliminating extreme poverty, energy poverty and providing decent living standards in low-emission countries can be achieved without causing significant global emissions growth, contributing to sustainable development goals in the near term.

Many actions to cut emissions and adapt to climate change align well with the Sustainable Development Goals (SDGs) and promote sustainable development. Although some actions may have drawbacks, the benefits of collaboration generally outweigh the negatives. The balance between benefits and drawbacks depends on how fast and how much change occurs, as well as the social and economic context, including issues of inequality and climate justice.

To reduce drawbacks, we should focus on building skills, providing financial support, ensuring good governance, transferring technology, addressing gender and social equity. It is also essential to involve Indigenous Peoples and local communities. Combining efforts to reduce emissions and adapt can lead to added benefits, like improved access to clean energy, which enhances health, especially for women and children. Transitioning to low-emission energy and encouraging public transport can improve air quality, create jobs and promote fairness.

v). Equity and Inclusion

Focusing on fairness, climate justice, social justice, inclusion and fair transitions is essential for effective climate adaptation and ambitious efforts to reduce emissions. Supporting the regions and people most at risk from climate impacts improves how well they can adapt. Including climate adaptation in social protection programs helps build resilience.

There are many ways to cut down on high-emission consumption, such as changing lifestyles and behaviours which also improve community well-being.

Equity is a fundamental part of the UN climate approach, even though relationships between countries change and determining fair contributions can be challenging. Significant efforts to reduce emissions often need major changes in economic structures, which can shift income and jobs as we move from high to low emissions.

Prioritizing fairness and social justice lead to better long-term outcomes, reduces conflicts and encourages transformative changes. Policies that redistribute resources and provide social safety nets can protect vulnerable groups and promote broader community goals, while involving more people in decision-making helps build trust and support for these changes.

Regions and people with major development challenges are particularly vulnerable to climate hazards. To help those most at-risk adapt better, it is important to focus on fairness, inclusion and respect for rights. Vulnerability worsens due to inequalities related to gender, ethnicity, income and historical injustices, which especially impact Indigenous Peoples and local communities. Adding climate adaptation to social protection programs, like cash transfers, can strengthen resilience, especially when there is good infrastructure. Giving low-income urban communities better access to financial resources can greatly improve their well-being. Policies that promote fairness and encourage lifestyle changes can lower emissions and benefit society. Moreover, developing and sharing technology can help areas transition to low-emission systems, leading to climate-resilient development through teamwork that considers different interests and values.

vi) Governance and Policies

Effective climate action depends on strong political will, organized governance and supportive laws and policies. Having clear goals, coordinating different policy areas and including diverse voices in decision-making helps climate initiatives succeed. Using regulations and economic tools widely can lower emissions and strengthen climate resilience.

Climate-resilient development benefits from various sources of knowledge. Good climate governance helps set goals and incorporates climate actions at all levels based on each country's needs and international collaboration. It also makes monitoring and decision-making clearer, which helps people access funding and technology.

Local, national, and regional organizations are key to building agreement on climate action among different groups. Civil society, including businesses, youth, women, and Indigenous communities, plays an important role in shaping policies. By addressing specific risks and vulnerabilities through well-planned laws and inclusive processes, we can reduce inequalities related to gender, ethnicity, disability, age and income.

The impacts of carbon pricing tools like carbon taxes and emissions trading can be managed by using the revenue to help low-income households. Eliminating fossil fuel subsidies can lower emissions and improve public revenue and sustainability. However, removing these subsidies might negatively affect economically vulnerable groups, though this can be lessened by redistributing saved revenue, depending on the country's situation. Comprehensive policy packages, including public spending and pricing reforms, can achieve short-term economic goals while promoting sustainability. Engaging diverse knowledge and cultural values, including Indigenous and local insights, supports climate-resilient development and creates suitable, socially accepted solutions.

vii). Finance, Technology and Internation Cooperation

Finance, technology, and teamwork between countries are important for speeding up efforts to fight climate change. To reach climate goals, funding for both adapting to and reducing climate impacts needs to increase significantly. While there is enough global money available to cover investment gaps, there are obstacles that prevent funds from being directed toward climate projects. Improving technology systems is key to encouraging the use of effective technologies and practices.

Better access to funding can help address needs and promote fairness in financial support, speeding up adaptation and mitigation efforts. Funding for adaptation and mitigation must grow significantly to handle rising climate risks and increase investments in reducing emissions, particularly in developing countries and vulnerable areas. Public funding is crucial for supporting adaptation and mitigation while also bringing in private investments. However, barriers still exist that need to be addressed to improve funding flow for climate initiatives, including government support and better organization of public funds to lower risks and boost returns on investments.

The current finance available is not enough to achieve the goals for adapting to and reducing climate change, especially in developing countries. This shortfall creates both challenges and opportunities. To improve adaptation and mitigation efforts, it is crucial to get more financial support from developed countries and ensure fair access to funding. Increasing

public grants for vulnerable areas, particularly in Sub-Saharan Africa, can be effective and help provide basic energy. To improve mitigation efforts, we can increase public funding, use guarantees to lower risks, develop local financial markets, and build trust in international cooperation. Working together for a sustainable recovery after the pandemic can help speed up climate action in developing areas with economic difficulties.

Improving technology innovation systems can help lower emissions and provide social and environmental benefits while also supporting other Sustainable Development Goals (SDGs). Customized policy packages have effectively encouraged low-emission technologies and innovation. Public policies can enhance training and research and development (R&D) through regulations and incentives. However, new technologies can sometimes lead to environmental issues, social inequalities, and dependence on foreign resources, so it is important to have good governance to address these challenges.

Many developing countries, especially the least developed ones, face difficulties in adopting low-emission technologies because of limited funding and resources. International cooperation is crucial for boosting climate action by providing financial support and ensuring resources align with climate goals. This teamwork can help speed up efforts for mitigation, adaptation, and sustainable development, particularly through support for Nationally Determined Contributions (NDCs) and technology implementation. Global partnerships and agreements also promote low greenhouse gas (GHG) investments and help reduce emissions.

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About NMSHE

The National Mission for Sustaining the Himalayan Ecosystem (NMSHE) is one of the eight missions under India's National Action Plan on Climate Change. The Mission is being coordinated by the Department of Science and Technology, Government of India. The broad objectives of NMSHE include – understanding of the complex processes affecting the Himalayan Ecosystem and evolve suitable management and policy measures for sustaining and safeguarding the Himalayan ecosystem, creating and building capacities in different domains, networking knowledge institutions engaged in research and development of a coherent data base on Himalayan ecosystem, detecting and decoupling natural and anthropogenic induced signals of global environmental changes in mountain ecosystems, studying traditional knowledge systems for community participation in adaptation, mitigation and coping mechanisms inclusive of farming and traditional health care systems and developing regional cooperation with neighbouring countries, generate a strong database through monitoring and analysis, to eventually create a knowledge base for policy interventions.

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About Mizoram State Climate Change Cell

The State Climate Change Cell (SCCC) of Mizoram was created on 25th November, 2014 with the financial support from the Climate Change Programme (CCP) Division (the then Strategic Programme Large Initiatives Coordinated Actions Enabler (SPLICE) and Climate Change Programme (CCP) Division) of Department of Science & Technology, Govt. of India through the National Mission for Sustaining the Himalayan Ecosystem (NMSHE) of National Action Plan on Climate Change (NAPCC). The project Phase-I was completed by the end of FY2019-2020. The project Phase II (Strengthening the State Climate Change Cell under NMSHE (Phase 2) for the state of Mizoram) was then continued under the further support from the CCP division of DST, Govt. of India from FY 2021 to 2022. There are three project staff along with two project investigators currently working under the cell. The Mizoram SCCC has been functioning under the aegis of Mizoram Science, Technology & Innovation Council (MISTIC), Directorate of Science Technology, Govt. of Mizoram. The Cell concentrates in implementation of its own project objectives whilst meeting the requirements of the mission objectives of the NMSHE under the National Action Plan on Climate Change (NAPCC), Government of India. Simultaneously, the Mizoram SCCC has been given the responsibility of a leading role by Government of Mizoram to implement the mission objectives of the Strategic Knowledge Mission (SKM) under the Mizoram State Action Plan on Climate Change (SAPCC).

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