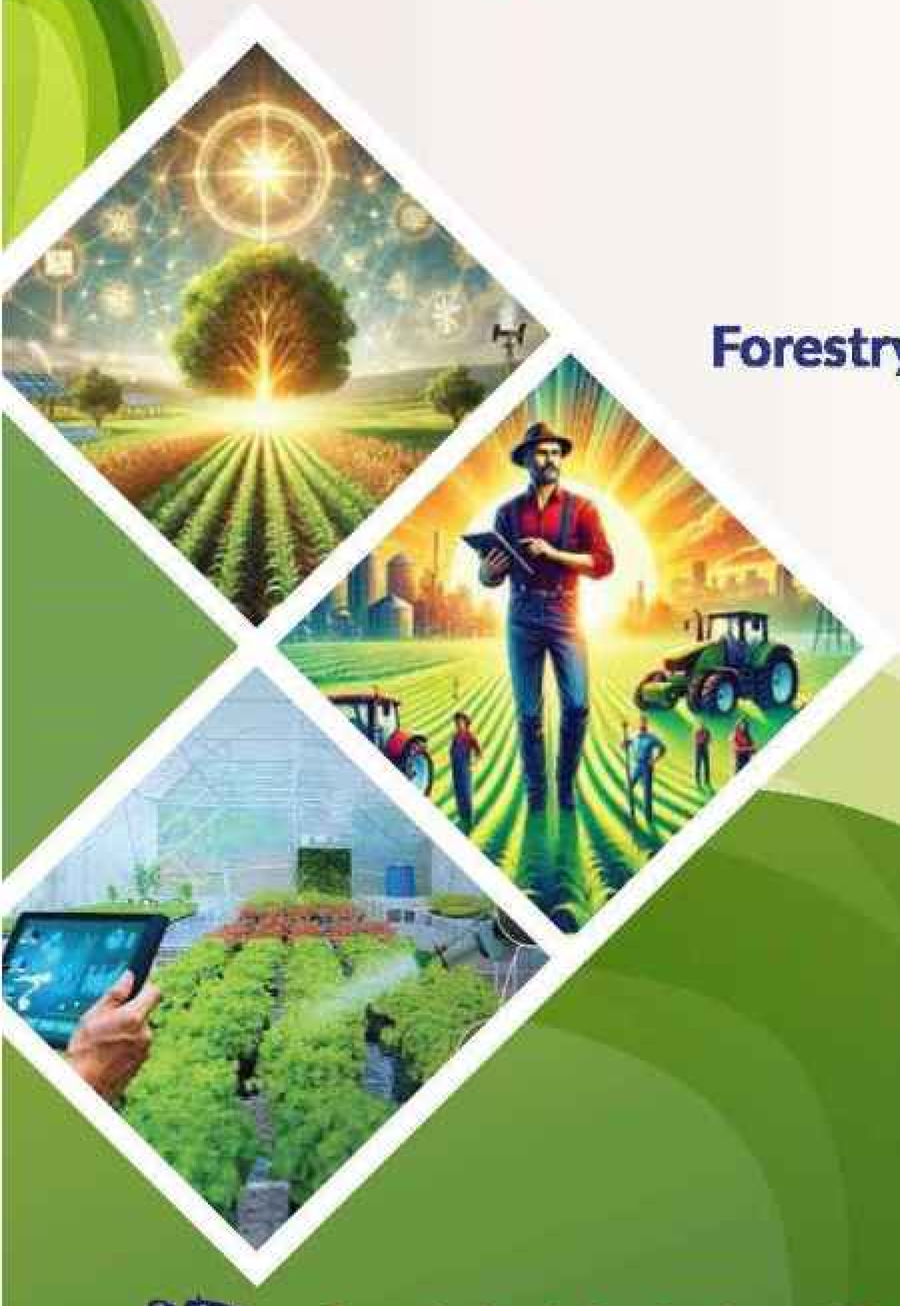
Batch 1 & 2

Training Manual on

Climate Reality Leadership in Agriculture Sector



Organized by

Forestry Unit, NRM Division

Bangladesh Agricultural Research Council
Farmgate, Dhaka-1215, Bangladesh
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Batch 1st and 2nd

Climate Reality Leadership in Agriculture Sector

TRAINING MANUAL 2025

Course Director: Dr. Md. Baktear Hossain, *Member-Director (NRM), BARC*
Course Coordinator: Dr. Md. Saifullah, *MD (A&F) and CSO (Forestry) (Add. Charge), BARC*

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Date: 20-22 January 2025

Forestry Unit
Natural Resources Management Division
Bangladesh Agricultural Research Council
Farmgate, Dhaka-1215, Bangladesh

Published in
January 2025

No/of copies
50 Copies

Publication No. 38

Published by

Forestry Unit
Natural Resources Management Division
Bangladesh Agricultural Research Council (BARC)
Farmgate, Dhaka-1215, Bangladesh

Funded by
Program on Agricultural and Rural Transformation for Nutrition Entrepreneurship and Resilience (PARTNER), BARC Component

Printed at
Mojumdar Computers, Nilkhet, Dhaka

Cover design
Mohammad Nazmul Islam (Graphics Designer)
Agricultural Information Centre, BARC, Dhaka

Citation:
Saifullah, M., Mahboob, M.G. and Jewel, K.N.A. (eds.). 2025. Climate Reality Leadership in Agriculture Sector: Training Manual 2025. Forestry Unit, Natural Resources Management Division, Bangladesh Agricultural Research Council (BARC), Farmgate, Dhaka-1215, Bangladesh

Soft copy download link: http://apps.barc.gov.bd/BARC-Forestry/CRL.pdf

Batch 1

Venue: Conference Room-2, Main Building (3rd Floor), BARC

Training on

Climate Reality Leadership in Agriculture Sector

Date: 20-22 January 2025

Inaugural Venue: Conference Room-2, Main Building (3rd Floor), BARC

Course Director: Dr. Md. Baktear Hossain, Member-Director (NRM), BARC, Dhaka.

Course Coordinator: Dr. Md. Saifullah, Member-Director (A&F) & CSO (Forestry), BARC, Dhaka

Time Events

Time	Events
09: 00	Registrations and Guests take their seats
09: 30	Recitations from the Holly Quran
09: 35	Welcome Addresses by Dr. Md. Saifullah, MD (A&F) & CSO (Forestry), BARC
09: 40	Address by Chief Guest, Dr. Nazmun Nahar Karim, Executive Chairman, BARC
09: 50	Addresses by Chairperson, Dr. Md. Baktear Hossain, Member Director (NRM), BARC
10: 00	Tea Break

Date & Time		Lecture Title	Resource Person
1st Day (20/01/2025)			
10:30-11:30	:	Climate Reality Leadership: A Powerful Tool for Empowering Agricultural Sector	Dr. Md. Safiul Islam Afrad, Professor, Dptt. of Agric. Extn. & Rural Dev., BSMRAU
11:30-12:30	:	The Leader's Guide to Climate Change: Causes and Scientific Evidence	Dr. A.K.M. Saiful Islam, Professor, Dept. of IWFM-BUET
12:30-13:30	:	Climate Change Impact on Water, Agriculture and Food Security	
13:30-14.30	:	**Break for Lunch and Prayer**	•
14:30-15:30	:	Leadership in Identifying Hazard, Risk and Vulnerability in Agricultural Sector	Engr. Malik Fida A Khan Executive Director, CEGIS
15.30-16:30	:	Leadership in Climate Negotiations: Achievements and Shortcomings of COP 29	
16.30	:	**Day Closing with Tea**	•
2nd Day (21/01/2025)			
9:30-10:30	:	Gender Integration in Climate Actions	Dr. Nasiba Aktar, Gender specialist, PCU, PARTNER program (DAE)
10:30-11:00	:	**Tea Break**	•
11:00-12:00	:	Strengthening Climate Leadership in Agriculture: Insights from Bangladesh's NAP Journey	Mr. Mirza Shawkat Ali, Director (CC&IC), DoE
12:00-13:00	:	Transformative Leadership in Nationally Determined Contributions: From Policy to Action in Agriculture	Kbd. Md. Ziaul Haque, Director, DoE
13:00-14:00	:	**Break for Lunch and Prayer**	•
14:00-15:00	:	Uniting Leadership for Climate Solutions: National and Global Discourses	Mr. Md. Shamsuddoha Chief Executive, CPRD
15:00-16:00	:	Leadership in Climate Justice: Driving Change for a Climate-Resilient World	
16:00	:	**Tea Break and Closing**	•
3rd Day (22/01/2025)			
09:45-10:45	:	Leading the Way in Climate Action: Unlocking GCF Financing Modalities	Mr. Mosleuddin, Sr. Prog. Officer (Adaptation Finance), GCA
10:45-11:00	:	**Tea Break**	•
11:00-12:00	:	State of Climate Finance for the Agriculture Sector in Bangladesh	Dr. Ahsan Uddin Ahmed, Ex iTAP Member, GCF
12:00-13:00	:	Climate Risk Management by means of Insurance in Agriculture Sector – An Interface Between Theory and Practice	
13:00-14:00		**Break for Lunch and Prayer**	
14:00-15:00	:	From Policy to Practice: Leadership Strategies in Carbon Trading	Kbd. Md Foezullah Talukder Head, CC Program, CCDB
15:00-16:00	:	Empowering Adaptation Leaders: Insights from the ACASA Initiative	Mr. Md. Hamidur Rahman, Director (Computer & GIS), BARC
16:00-16:30	:	**Tea Break**	•

Certificate Giving Session (Venue: Conference Room-2, Main Building (3rd Floor), BARC):

Chairperson: Dr. Md. Baktear Hossain, Member Director (NRM), BARC

16:30-16:35	:	Address by Course Coordinator: Dr. Md. Saifullah, MD (A&F) & CSO (Forestry), BARC
16:35-16:40	:	Remarks by Two Participants
16:40-16:45	:	Remarks by the Chief Guest Dr. Nazmun Nahar Karim, Executive Chairman, BARC
16:45-16:55	:	Certificate Awarding
16:55-17:00	:	Remarks by Chair and Course Director: Dr. Md. Baktear Hossain, MD (NRM), BARC, Dhaka.
17:00	:	**Closing**

Batch 2

Venue: Auditorium, Main Building (3rd Floor), BARC

Training on
Climate Reality Leadership in Agriculture Sector

Date: 20-22 January 2025

Inaugural Venue: Conference Room-2, Main Building (3rd Floor), BARC

Course Director: Dr. Md. Baktear Hossain, Member-Director (NRM), BARC, Dhaka.
Course Coordinator: Dr. Md. Saifullah, Member-Director (A&F) & CSO (Forestry), BARC, Dhaka

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17:00	:	Closing

Contents

Climate Reality Leadership: A Most Powerful Tools for Empowering Agricultural Sector

Prof. Dr. Md. Safiul Islam Afrad
Treasurer, BSMRAU, Gazipur

Introduction

Climate change poses serious challenges to agricultural productivity, food security, and the livelihoods of farmers globally, with the impacts being most severe in developing countries like Bangladesh. Smallholder farmers, who are responsible for producing the majority of the world's food, are particularly at risk due to their vulnerability to climate variability. Farmers are confronting growing challenges from climate change, such as unpredictable rainfall, rising temperatures, and extreme weather events. These changes have resulted in lower crop yields, more frequent pest outbreaks, and increased food insecurity. Smallholder farmers, who often lack access to modern agricultural techniques, climate data, and financial support, struggle to adapt to these conditions. Without focused interventions, their capacity to grow food and support their families will continue to diminish, worsening poverty and food insecurity in rural communities.

Bangladesh's unique biophysical, economic, and geographical characteristics make it highly vulnerable to extreme weather events. Despite being responsible for less than 0.36% of global greenhouse gas emissions, Bangladesh ranks 152nd out of 188 countries in per capita emissions. The country is ranked 6th on the Global Climate Risk Index (2017) and 160th out of 181 countries in terms of climate vulnerability. It is also one of the least prepared countries to address climate change, ranking 25th in readiness, meaning it struggles to mitigate or adapt to the impacts of climate change.

As one of the largest deltas in the world, Bangladesh has a dense network of tributaries from the Ganges, Brahmaputra, and Meghna (GBM) rivers. Most of the country is situated less than 10 meters above sea level, with 10% of the land lying below 1 meter. About 80% of the country's surface consists of a vast floodplain, while 1.2 million hectares of arable land in the coastal and offshore areas are affected by soil salinity. Sea levels have risen by 4mm per year at Hiron Point and 8mm per year at Cox's Bazar. The Himalayan glaciers have shrunk by 21% in area since the 1980s, losing 174 gigatons of water between 2003 and 2009, which has led to catastrophic flooding in the GBM basin. The IPCC projects a 32 cm rise in sea levels by 2050 and 88 cm by 2100, compared to 2000 levels, putting around 27 million people at risk from sea level rise by 2050 (Murshed *et al.*, 2019).

Climate change is expected to cause significant economic losses for Bangladesh, with an annual GDP loss of 2% by 2050 and 9.4% by 2100. Over the 45 years from 2005 to 2050, cumulative GDP losses are projected to total around US$597.1 billion (at 2005 prices). Rural women, who play vital roles in agriculture, will be disproportionately impacted by climate change.

The agricultural sector stands at the forefront of the fight against climate change. As both a contributor to greenhouse gas emissions and a sector heavily impacted by changing weather patterns, agriculture is uniquely positioned to drive solutions for a sustainable future. In this context, Climate Reality Leadership emerges as one of the most powerful tools for empowering the agricultural sector to confront these challenges.

The Climate Reality Leadership focuses on educating and equipping individuals with the knowledge, skills, and networks needed to create meaningful climate solutions. When applied to agriculture, this leadership model fosters the adoption of innovative, climate-smart practices that enhance productivity while reducing environmental harm.

This approach equips farmers, policymakers, and agricultural stakeholders with the knowledge to recognize the link between climate change and agriculture, adopt sustainable and adaptive farming practices, and advocate for policy reforms and access to green technologies.

By integrating scientific expertise, community participation, and actionable strategies, Climate Reality Leadership transforms agriculture into a resilient, sustainable, and productive sector. This paper examines how climate leadership acts as a catalyst for empowering the agricultural sector, safeguarding food security, driving economic growth, and promoting environmental conservation in the face of a changing climate.

Climate Change and Agricultural Vulnerability

The Intergovernmental Panel on Climate Change (IPCC) highlights that climate change significantly impacts agricultural productivity through temperature variations, shifting rainfall patterns, and a higher incidence of extreme weather events. Smallholder farmers in developing nations are especially vulnerable due to their limited resources and adaptive capacity (IPCC, 2021). Research by Lobell *et al.* (2011) indicates that crop yield losses could rise to as much as 20% by 2050 without the adoption of adaptive measures, underscoring the critical need for climate-smart agricultural practices.

Impacts of Climate Change on Agriculture: The IPCC identifies agriculture as one of the sectors most vulnerable to climate change, with rising temperatures, shifting precipitation patterns, and more frequent extreme weather events driving significant impacts (IPCC, 2021). These changes lead to declining crop yields, soil degradation, and water scarcity. A meta-analysis by Lobell *et al.* (2011) highlights the susceptibility of staple crops like wheat, rice, and maize to heat stress and drought. The study forecasts potential yield reductions of up to 20% in some regions by 2050 if adaptive measures are not implemented.

Regional Disparities in Agricultural Vulnerability: Research by Nelson *et al.* (2010) reveals that developing nations, particularly in Sub-Saharan Africa and South Asia, face significant challenges due to their limited adaptive capacity, reliance on rain-fed agriculture, and socio-economic constraints. Kurukulasuriya and Rosenthal (2013) underscore the stark disparity in adaptive measures between developed and developing regions. While advanced economies are implementing technology-driven solutions, smallholder farmers in less-developed areas remain highly exposed to the impacts of climate change.

Extreme Weather Events and Agricultural Risks: Rosenzweig *et al.* (2014) demonstrate that extreme events such as floods, droughts, and hurricanes have caused substantial agricultural losses worldwide. For instance, the 2019 floods in the Midwestern United States resulted in billions of dollars in damages to crops and infrastructure. Shukla *et al.* (2018) examined the effects of drought in India, highlighting how unpredictable monsoon patterns intensify rural poverty by diminishing agricultural productivity and exacerbating food insecurity.

Soil Degradation and Water Scarcity: Lal (2020) emphasizes that rising temperatures exacerbate soil erosion, nutrient loss, and desertification, posing a severe threat to sustainable agricultural productivity. Whereas, Foley *et al.* (2011) show that shifting precipitation patterns have intensified water scarcity, significantly affecting irrigation-dependent crops such as rice and sugarcane.

Vulnerability of Livestock Farming: Thornton *et al.* (2009) reveal that livestock farming is highly susceptible to climate-related challenges, including heat stress, declining forage quality, and water scarcity. These effects jeopardize both productivity and the livelihoods of pastoralist communities.

Socio-Economic Impacts on Farmers: Morton (2007) highlights that climate change amplifies existing socio-economic disparities in rural areas, with marginalized groups such as smallholder farmers and indigenous communities being the least prepared to manage climate-related challenges. Similarly, Deressa *et al.* (2009) found that key factors like education, access to credit, and secure land tenure play a crucial role in enhancing farmers' capacity to adapt to climate variability.

Mitigation and Adaptation Gaps: Campbell *et al.* (2014) identify limited awareness, weak policies, and insufficient funding as significant obstacles to the adoption of climate-smart agriculture. Similarly, Vermeulen *et al.* (2012) stress the importance of a holistic approach that integrates local knowledge, modern technology, and supportive policy frameworks to strengthen resilience in the agricultural sector.

The study highlights the complex vulnerabilities of agriculture to climate change, emphasizing the urgency of targeted interventions. These include capacity-building programs, investments in climate-resilient technologies, and the development of inclusive policies to bridge gaps in adaptive capacity across regions and communities. Tackling these challenges is essential for safeguarding food security and promoting sustainable livelihoods in the face of a changing climate.

Climate Reality Leadership and Capacity Building

Leadership programs that equip leaders to create a strong climate action impact and empower local stakeholders, such as those implemented by the Food and Agriculture Organization of the United Nations (FAO), have demonstrated success in integrating sustainable practices and increasing farmers' resilience (FAO, 2019). Similarly, the Climate Reality Leadership Initiative, led by former US Vice President Al Gore through the Climate Reality Project, seeks to equip individuals with the knowledge and tools to inspire climate action. The initiative's emphasis on knowledge-sharing, community engagement, and advocacy makes it a transformative approach to addressing climate challenges across sectors, including agriculture. Furthermore, Hargreaves and Fink (2012) emphasize the critical role of leadership in driving systemic change, noting that climate leaders act as catalysts by translating complex climate science into practical solutions for diverse communities.

The Role of Leadership in Agricultural Adaptation: Trained leaders can effectively bridge the gap between scientific knowledge and practical implementation, particularly for smallholder farmers. Morton (2007) demonstrate that farmer-led leadership initiatives have increased the uptake of sustainable practices, such as conservation tillage and agroforestry, by fostering peer learning and trust among community members.

Capacity Building for Climate Resilience: Capacity building is recognized as a fundamental component of climate adaptation. Reports from FAO (2019) indicate that training programs emphasizing resource management, climate-smart technologies, and risk assessment have substantially improved the resilience of vulnerable farming communities. Anderson *et al.* (2017) asserts that leadership initiatives combining local knowledge with scientific expertise are more effective, as they align with the cultural and socio-economic contexts of the communities they aim to serve.

Education and Training as Drivers of Change: Participatory workshops and on-the-ground training programs enhance farmers' awareness of climate risks and adaptive strategies (Meadows *et al.*, 2015). The study emphasizes that interactive platforms, including digital tools and farmer field schools, are crucial for building the capacity of rural communities to effectively address climate change.

Advocacy and Policy Engagement: Advocacy is a key element of effective climate leadership. Leaders trained through initiatives such as the Climate Reality Project have played a significant role in driving policy reforms in agriculture, including the introduction of subsidies for sustainable practices and investments in renewable energy solutions. Jost *et al.* (2015) stress that empowering local leaders to advocate for their communities ensures that policies are inclusive and tailored to the specific challenges faced by smallholder farmers.

Community-Led Solutions Through Leadership: Research by Altieri and Nicholls (2023) demonstrates that community-driven leadership promotes collective action, allowing farmers to share resources and knowledge for mutual benefit. This strategy is especially effective in areas with fragmented landholdings and inadequate infrastructure. Tschakert *et al.* (2016) emphasizes the critical role of grassroots leaders in engaging marginalized groups, including women and youth, to actively participate in climate adaptation efforts.

Challenges in Capacity Building and Leadership Development: While leadership initiatives have shown significant success, Vermeulen et al. (2012) highlight persistent barriers such as inadequate funding, limited institutional support, and restricted access to technology, all of which hinder the scalability of successful models. Additionally, Agarwal (2020) underscores that gender inequities often curtail women's participation in leadership programs, diminishing their potential impact in agriculture-dependent regions.

The literature underscores the transformative potential of Climate Reality Leadership in addressing climate challenges, particularly in agriculture. By prioritizing capacity building through education, advocacy, and community engagement, climate leaders can facilitate the adoption of sustainable practices and drive meaningful policy reforms. However, addressing systemic challenges such as funding limitations and social inequities is essential to fully harness the potential of these initiatives.

Sustainable Agricultural Practices

Agriculture is the backbone of global food security and economic stability, yet it faces unprecedented challenges due to climate change, population growth, and resource depletion. Traditional farming methods, while effective in the past, have often led to soil degradation, water scarcity, and biodiversity loss, undermining the very ecosystems on which agriculture depends. In this context, sustainable agricultural practices have emerged as a transformative solution to ensure food production while safeguarding environmental health and social equity.

Sustainable agriculture refers to farming methods that meet current food and textile needs without compromising the ability of future generations to meet their own needs. These practices aim to balance three critical objectives: economic viability, environmental stewardship, and social responsibility. By integrating innovative technologies, traditional knowledge, and policy support, sustainable agriculture promotes efficient resource use, enhances soil and water quality, reduces greenhouse gas emissions, and strengthens resilience to climate change.

Studies on climate-smart agriculture (CSA) highlights its critical role in improving food security while mitigating greenhouse gas emissions. Practices such as agroforestry, precision farming, and conservation agriculture have been proven to enhance productivity and soil health. Altieri and Nicholls (2020) stress the value of blending traditional knowledge with modern techniques to develop holistic and sustainable farming systems.

Policy Advocacy and Resource Mobilization

In the face of escalating climate challenges and socio-economic inequalities, policy advocacy and resource mobilization have become critical pillars for driving sustainable development in the agricultural sector. Effective policy frameworks, coupled with adequate resource allocation, are crucial for empowering farmers, encouraging the adoption of sustainable practices, and enhancing resilience to climate change impacts.

This perspective emphasizes the need to align policy advocacy with resource mobilization to drive transformative change in agriculture. Together, these strategies ensure that the sector not only adapts to the realities of a changing climate but also continues to serve as a foundation for global food security and sustainable development.

Policy analyses highlight the pivotal role of strong leadership in shaping climate policies. Leaders with expertise in both environmental and agricultural challenges are uniquely positioned to advocate for initiatives such as carbon farming, renewable energy adoption, and equitable resource distribution (Anderson *et al.*, 2020).

Empowering Farmers Through Climate Leadership

Farmer-led initiatives, driven by trained climate leaders, have been documented to improve adoption rates of sustainable practices. Research by Pretty *et al.* (2011) underscores the role of participatory approaches in enhancing farmers' sense of ownership and commitment to environmental stewardship. Moreover, gender-focused studies, such as those by Agarwal (2020), reveal that empowering women through leadership training amplifies the effectiveness of climate-resilient agricultural interventions.

The Role of Leadership in Climate Adaptation: Leadership plays a pivotal role in guiding farmers toward adopting sustainable practices. According to Pretty *et al.* (2018), farmer-led leadership initiatives significantly increase the adoption of climate-smart agriculture by fostering trust and collaboration within communities. Hargreaves and Fink (2012) emphasize that climate leadership empowers farmers to transition from traditional practices to innovative solutions by providing knowledge, motivation, and support systems.

Knowledge Sharing and Capacity Building: Leadership training programs centered on climate resilience equip farmers with the knowledge and skills to implement adaptive strategies (Meadows *et al.*, 2016). Initiatives such as farmer field schools, participatory workshops, and digital platforms have demonstrated their effectiveness in strengthening farmers' capacity to manage climate risks. Altieri and Nicholls (2023) assert that combining traditional knowledge with scientific innovations enhances the impact of leadership initiatives, ensuring that solutions are both locally relevant and culturally appropriate.

Community-Led Solutions and Peer Networks: Community-driven strategies, including cooperatives and farmer networks, facilitate resource sharing and mutual learning, thereby bolstering resilience to climate shocks (Tschakert *et al.*, 2014). Morton *et al.* (2017) found that peer-led initiatives, where experienced farmers mentor their peers, significantly increase the adoption of sustainable practices such as conservation agriculture and agroforestry.

Gender and Youth Inclusion in Climate Leadership: Women leaders often possess a deep understanding of local challenges and contribute innovative approaches to resource management and adaptation strategies (Agarwal, 2020). Similarly, Leach *et al.* (2020) highlight the vital importance of involving youth in leadership programs, noting their receptiveness to new technologies and their capacity to drive sustainable, long-term transformation in agricultural systems.

Advocacy and Policy Influence: Effective farmer leaders frequently serve as advocates, shaping policies that promote sustainable agriculture. Gupta and Bavinck (2019) highlight instances where farmer-led advocacy has secured subsidies for eco-friendly practices, enhanced market access, and improved disaster management policies. Vermeulen et al. (2012) underscore the pivotal role of farmer leaders in bridging the gap between policymakers and local communities, ensuring that policies are both inclusive and tailored to local contexts.

Challenges in Empowering Farmers Through Leadership: Although climate leadership holds great potential for empowering farmers, several barriers persist, including insufficient funding, limited access to education, and pervasive social inequalities. FAO (2019) notes that these challenges are especially acute in low-income regions, where institutional support is often lacking. Additionally, Deressa et al. (2009) highlight structural obstacles such as land tenure insecurity and restricted access to credit, which significantly hinder farmer empowerment and the development of effective leadership.

Success Stories of Climate Leadership: Case studies by the World Bank (2020) showcase successful examples of climate leadership, such as initiatives in Kenya and India, where trained farmer leaders have spearheaded the widespread adoption of drought-resistant crops and efficient irrigation systems. Pretty *et al*. (2011) emphasize the "lead farmer" model in Malawi, where trained individuals serve as local champions for sustainable practices, leading to improved yields and enhanced community resilience.

These studies highlight the transformative potential of empowering farmers through climate leadership. By promoting knowledge-sharing, strengthening advocacy, and fostering inclusivity, leadership initiatives can accelerate the adoption of sustainable agricultural practices. However, overcoming systemic barriers such as resource limitations and social inequalities is crucial for maximizing the impact of these efforts.

Conclusion

The agricultural sector is at a critical juncture, facing the dual challenges of ensuring food security and addressing the adverse impacts of climate change. In this context, Climate Reality Leadership emerges as a powerful tool for equipping the sector to navigate these challenges effectively. By integrating knowledge dissemination, advocacy, and community engagement, this leadership model transforms farmers, policymakers, and stakeholders into active agents of change.

Through Climate Reality Leadership, farmers gain access to vital education on climate-smart practices, resources for sustainable farming, and platforms to amplify their voices in policy discussions. These initiatives not only reduce the environmental footprint of agriculture but also increase its resilience to climate shocks. Additionally, by promoting inclusivity and prioritizing gender and youth involvement, this leadership framework fosters equitable growth and innovation throughout the sector.

While progress has been made, challenges such as funding gaps, policy inefficiencies, and limited resource access continue to hinder large-scale implementation. Addressing these barriers requires ongoing investment in leadership programs, stronger public-private partnerships, and alignment between global and local efforts to support sustainable agricultural transformation.

In conclusion, Climate Reality Leadership serves as a beacon of hope for the agricultural sector, proving that with the right tools, knowledge, and collaboration, it is possible to create a sustainable, resilient, and equitable future for both agriculture and the planet.

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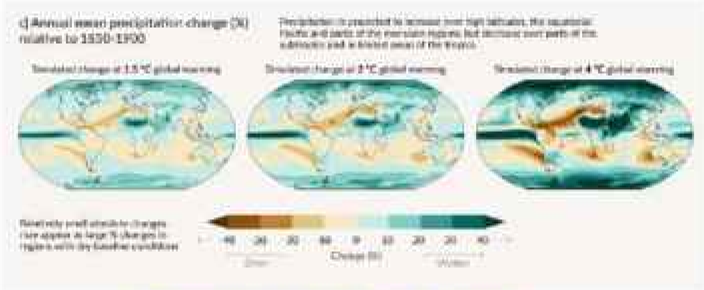
Training Workshop on "Climate Leadership in Agriculture Sector"

Climate change: Causes, and scientific evidence



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Lead Author: IPCC AR6, WGI - Chapter 12, SPM

Contributing Author: IPCC AR6, WGI- Chapter 9, 10, TS

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Lecture outline

- Climate variability and climate change
- Global warming and greenhouse gases
- Evidence of climate change
- Changes in climate extremes
- Projected changes in extremes
- Changes in Climatic Impact Drivers
- Who is responsible?
- Paris Climate Agreements

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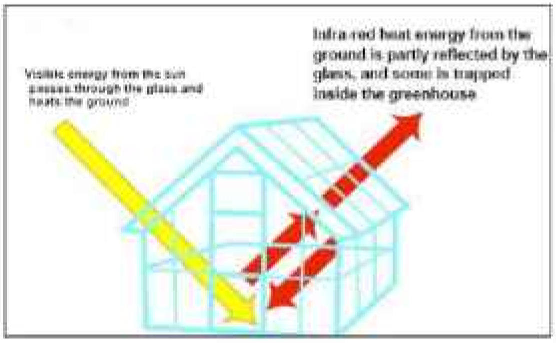
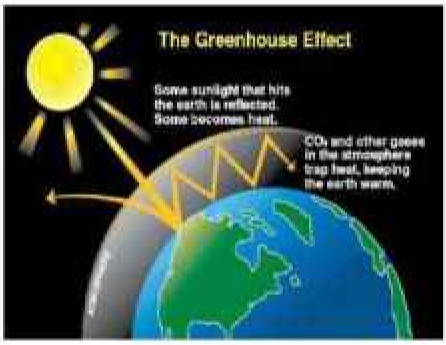
Climate Change, Global Warming and Greenhouse effect

CO2 and some minor radioactively active gases (water vapor, carbon dioxide, methane, nitrous oxide, and ozone) are known as greenhouse gases which acted as a partial blanket for the thermal radiation from the surface which enables it to be substantially warmer than it would otherwise be, analogous to the effect of a greenhouse





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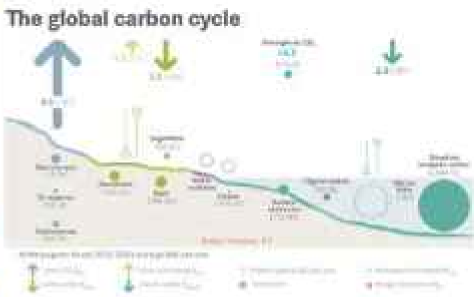
Greenhouse gas effect



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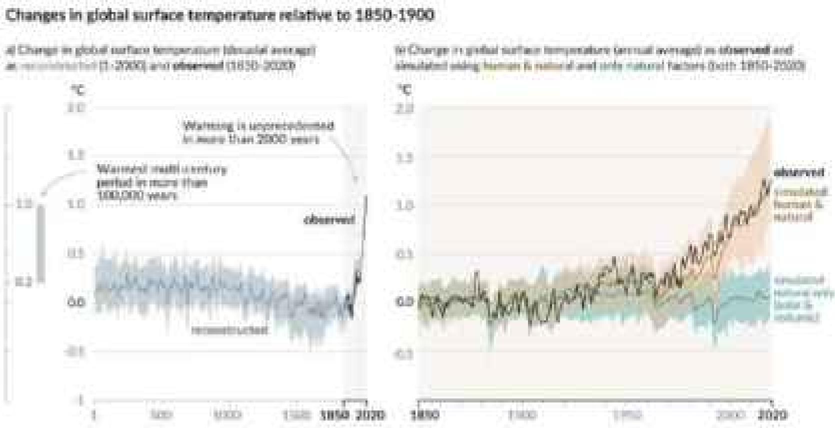
Human influence has warmed the climate at a rate that is unprecedented in at least the last 2000 years

Figure SPM.1



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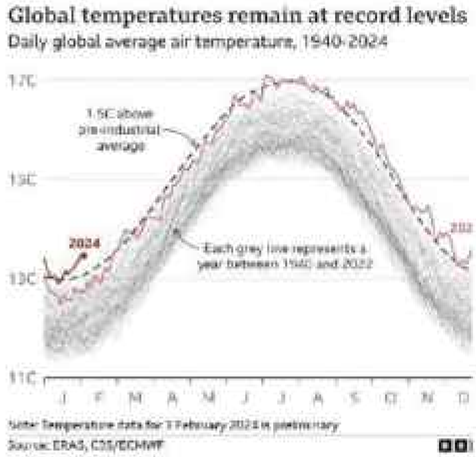
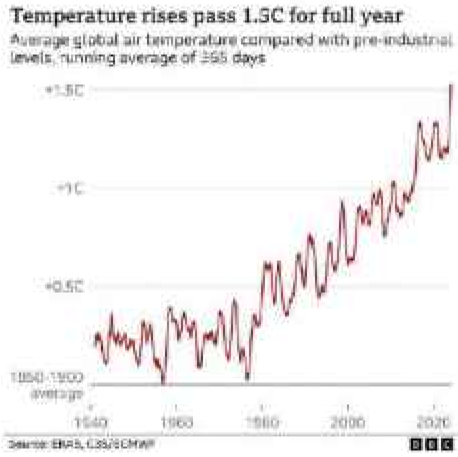
Temperature Records in 2023





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CO_2 concentration	Sea level rise	Arctic sea ice area	Glaciers retreat
			
Highest	**Fastest rates**	**Lowest level**	**Unprecedented**
in at least	in at least	in at least	in at least
2 million years	**3000 years**	**1000 years**	**2000 years**

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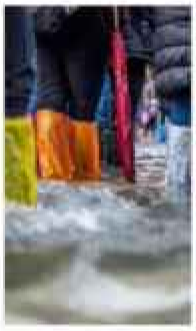
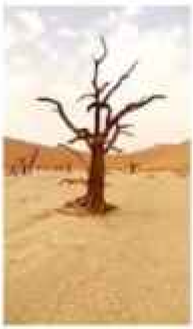
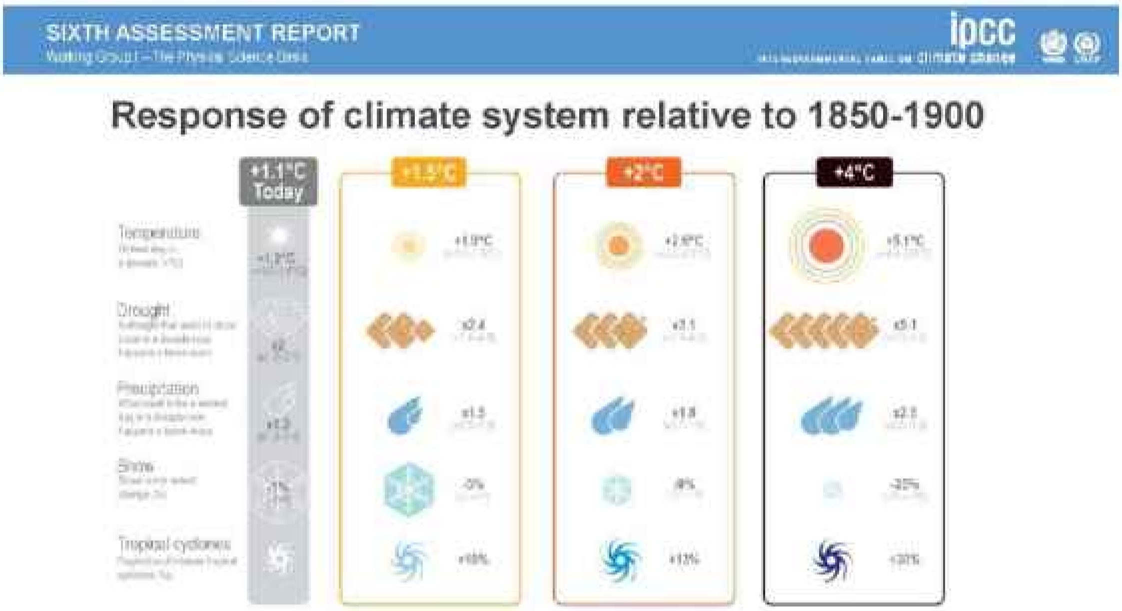
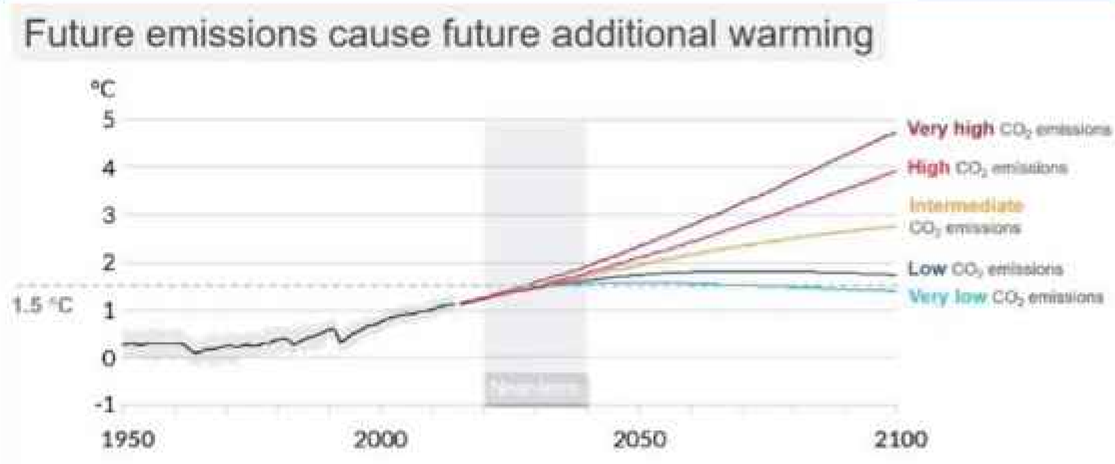
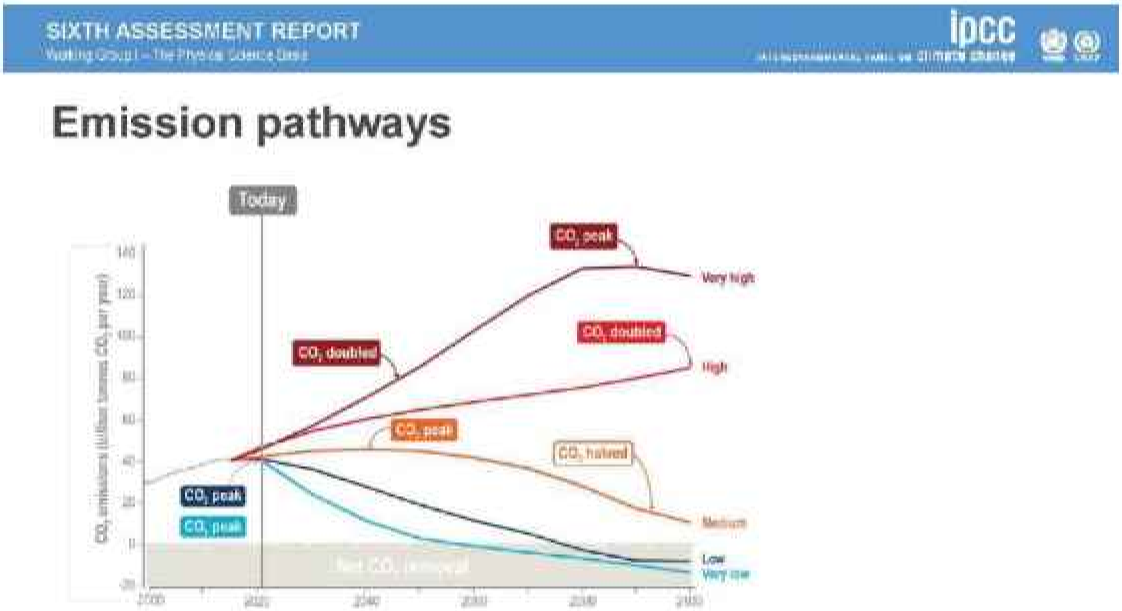
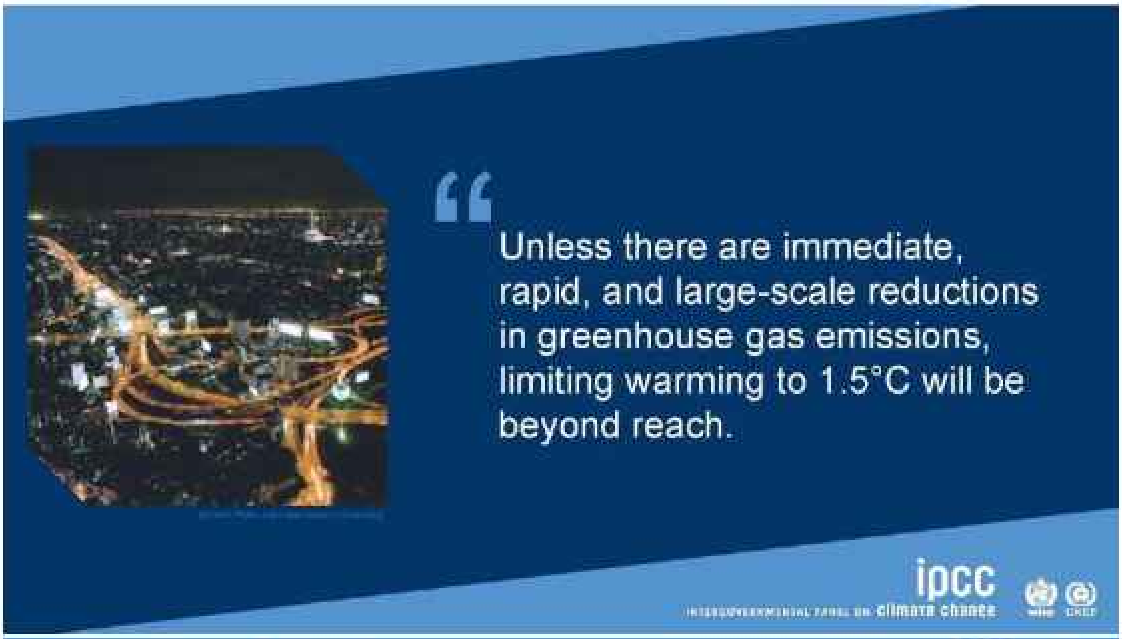
				
Extreme heat	Heavy rainfall	Drought	Fire weather	Ocean
More frequent More intense	More frequent More intense	Increase in some regions	More frequent	Warming Acidifying Losing oxygen

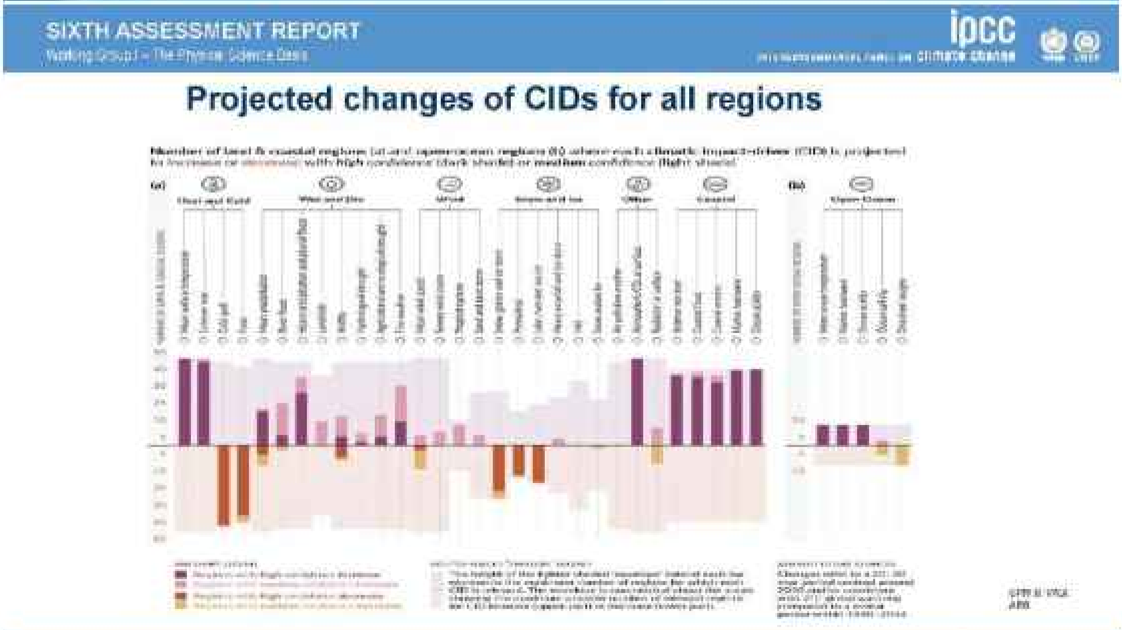


ভবিষ্যতের গ্রিনহাউস গ্যাস নিঃসরণ অতিরিক্ত উষ্ণতা সৃষ্টি করবে। মোট বৈশ্বিক উষ্ণায়ন অতীত এবং ভবিষ্যতের কার্বন-ডাই-অক্সাইড নিঃসরণ উপরই প্রধানত নির্ভর করবে।






Unless there are immediate, rapid, and large-scale reductions in greenhouse gas emissions, limiting warming to 1.5°C will be beyond reach.
ipcc
INTERGOVERNMENTAL PANEL ON climate change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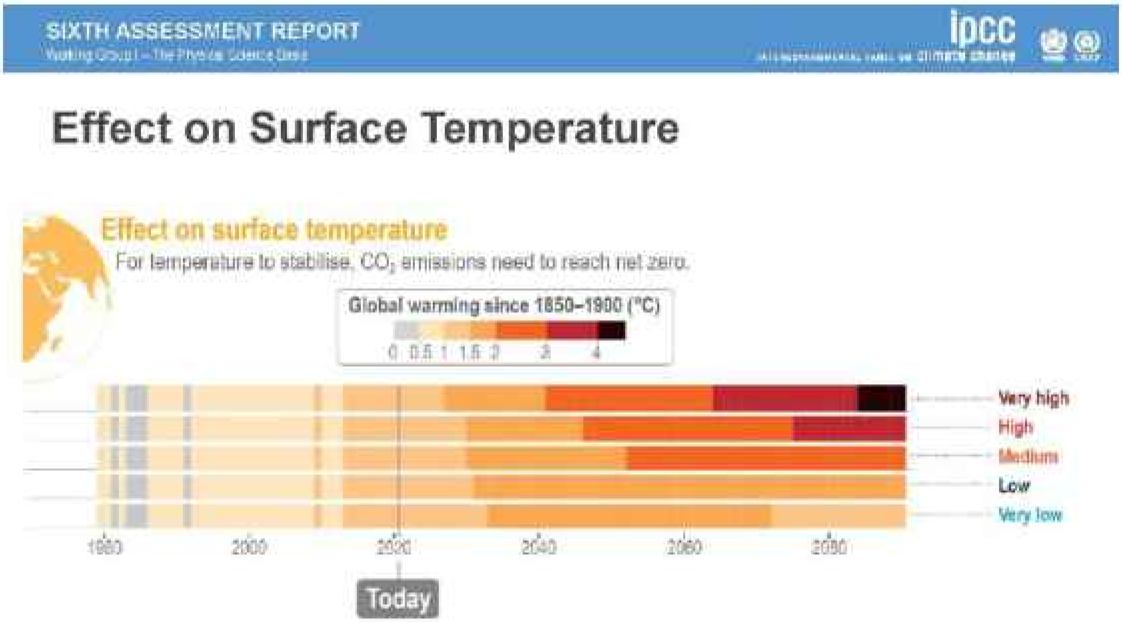
INTERGOVERNMENTAL PANEL ON climate change
Projected changes of CIDs for all regions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INTERGOVERNMENTAL PANEL ON climate change
Effect on Surface Temperature
Effect on surface temperature
For temperature to stabilise, CO_2 emissions need to reach net zero.
Global warming since 1850–1900 (°C)
0 0.5 1 1.5 2 3 4
Very high
High
Medium
Low
Very low
1980
2000
2020
2040
2060
2080
Today

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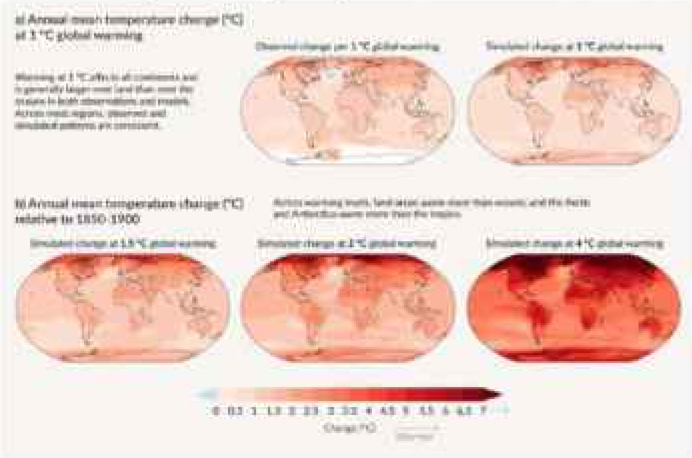
With every increment of global warming, changes get larger in regional mean temperature, precipitation and soil moisture

Figure SPM.5



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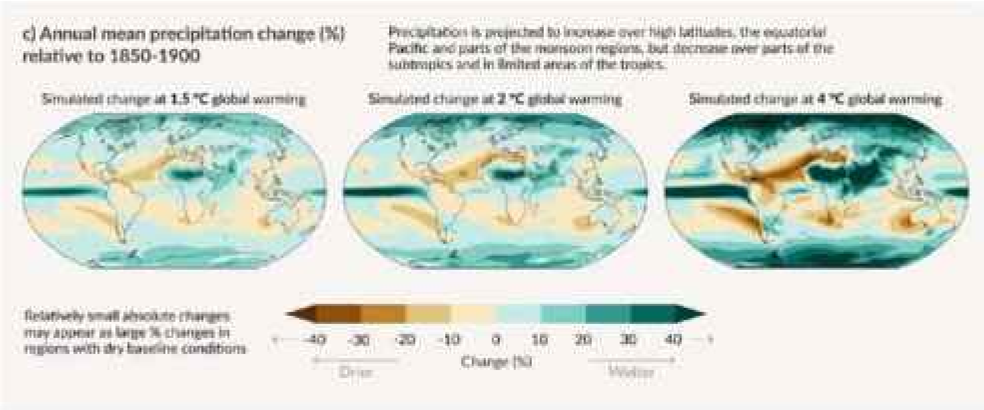

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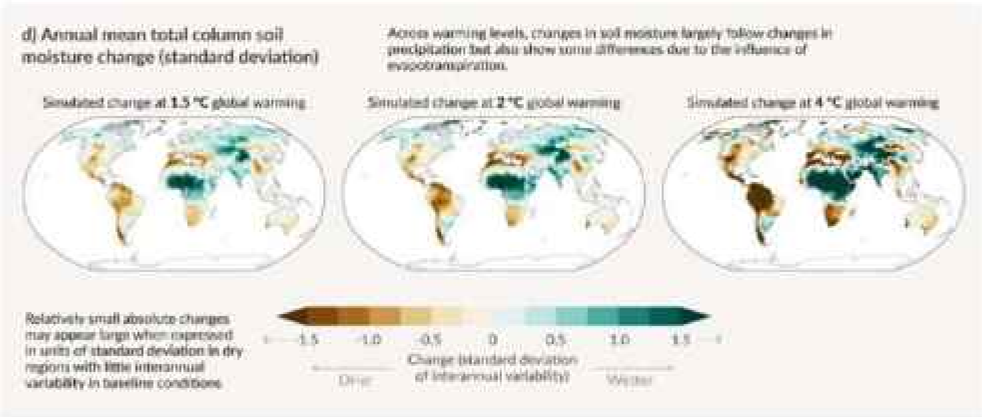

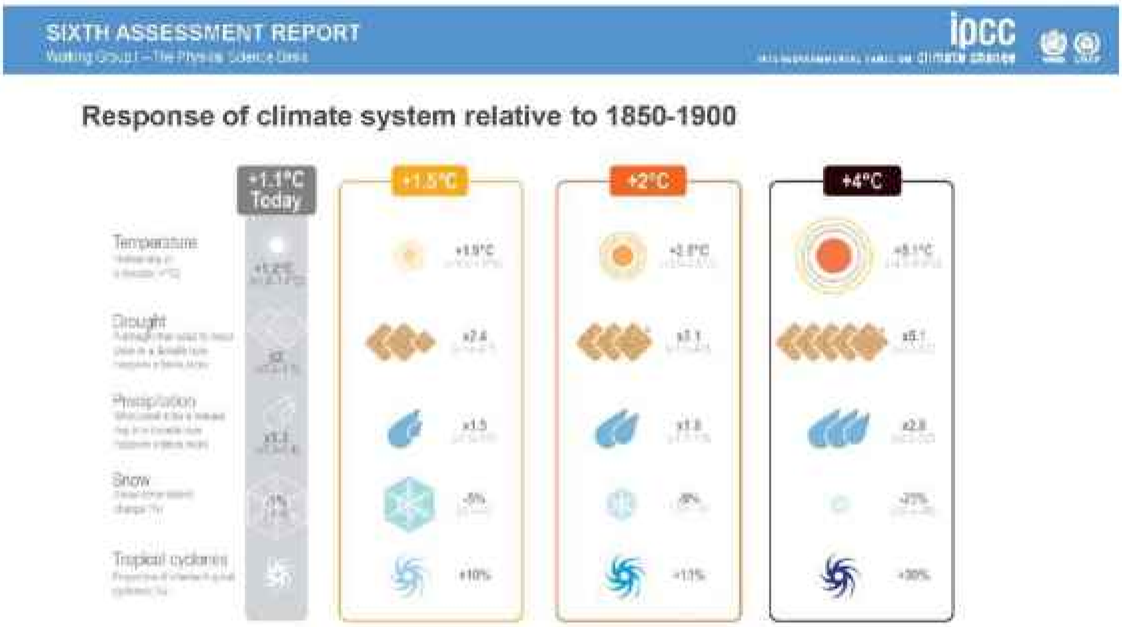
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Response of climate system relative to 1850-1900
+1.1°C Today
+1.5°C
+2°C
+4°C
Temperature
Drought
Precipitation
Snow
Tropical cyclones
+10%
+13%
+30%


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Long-term consequences : Sea level rise
Today, sea level has already increased by 20 cm and will increase an additional 30 cm to 1 m or more by 2100, depending on future emissions.
Sea level reacts very slowly to global warming so, once started, the rise continues for thousands of years.
+1.5°C
+2°C
+4°C
10,000 year commitment
33m


It is indisputable that human activities are causing climate change, making extreme climate events, including heat waves, heavy rainfall, and droughts, more frequent and severe.
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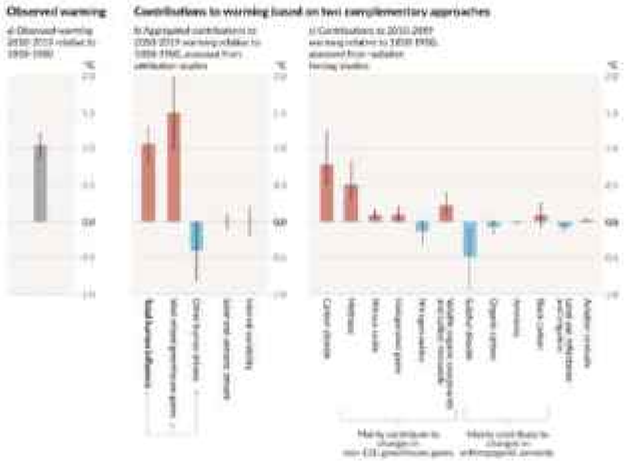
Observed warming is driven by emissions from human activities, with greenhouse gas warming partly masked by aerosol cooling

Figure SPM.2



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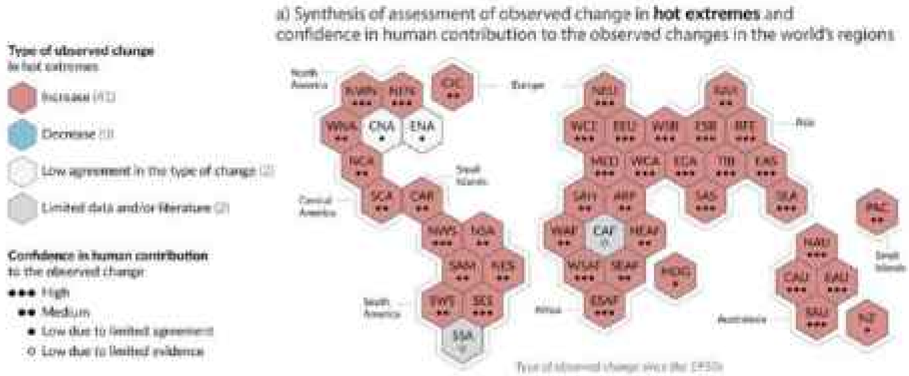
Climate change is already affecting every inhabited region across the globe, with human influence contributing to many observed changes in weather and climate extremes

Figure SPM.3



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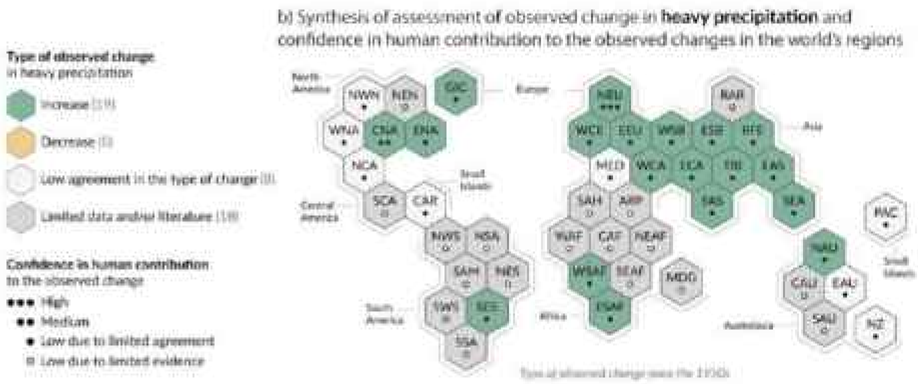

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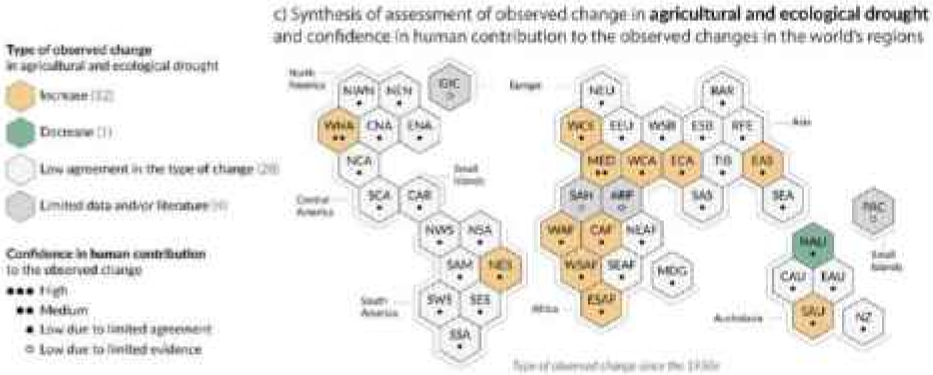

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Climatic impact-drivers

Heat & cold | Rain & drought | Snow & ice | Wind | Coastal & oceanic | Other | Open ocean

A **climatic impact-driver** could go over **thresholds** known to lead to **severe** consequences for people, agriculture, or wildlife

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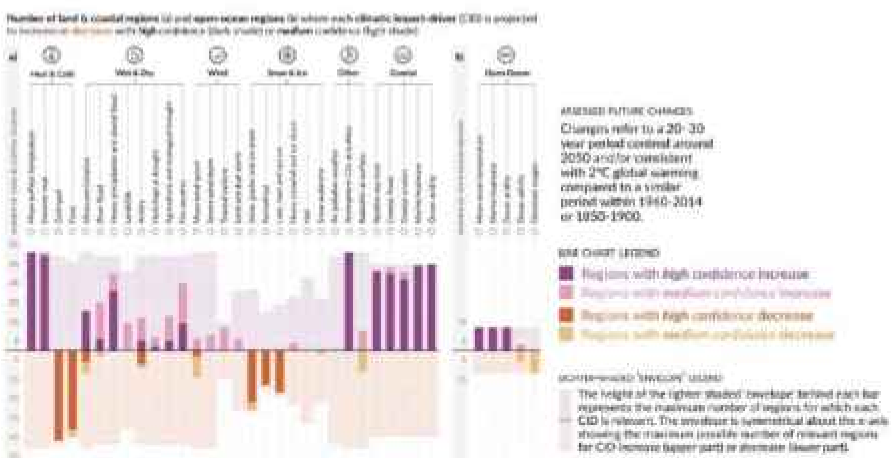
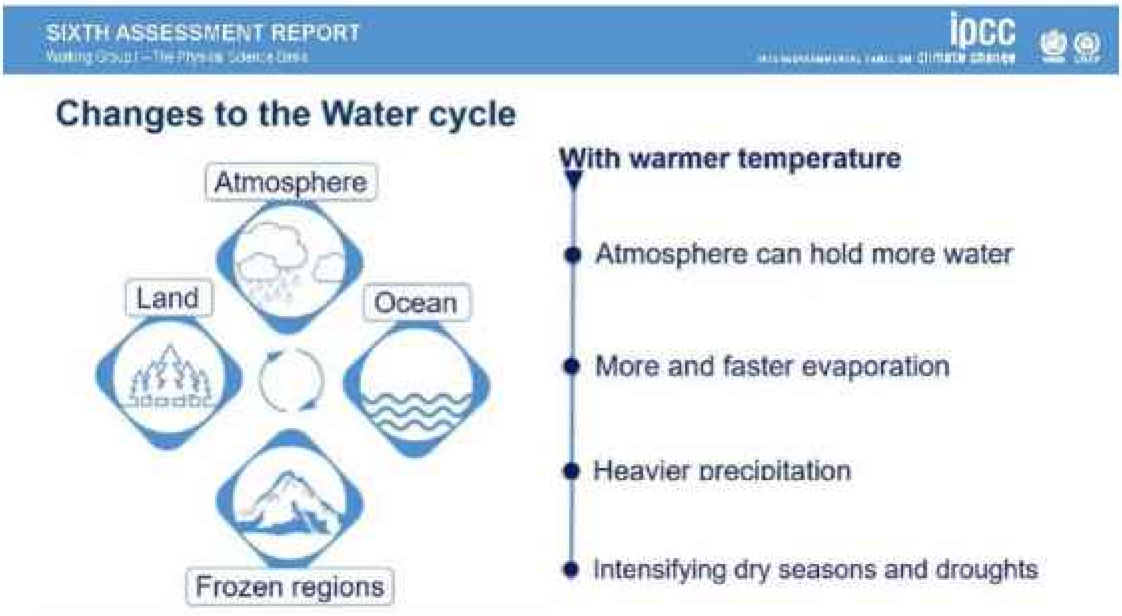
Multiple climatic impact-drivers are projected to change in all regions of the world

Figure SPM.9

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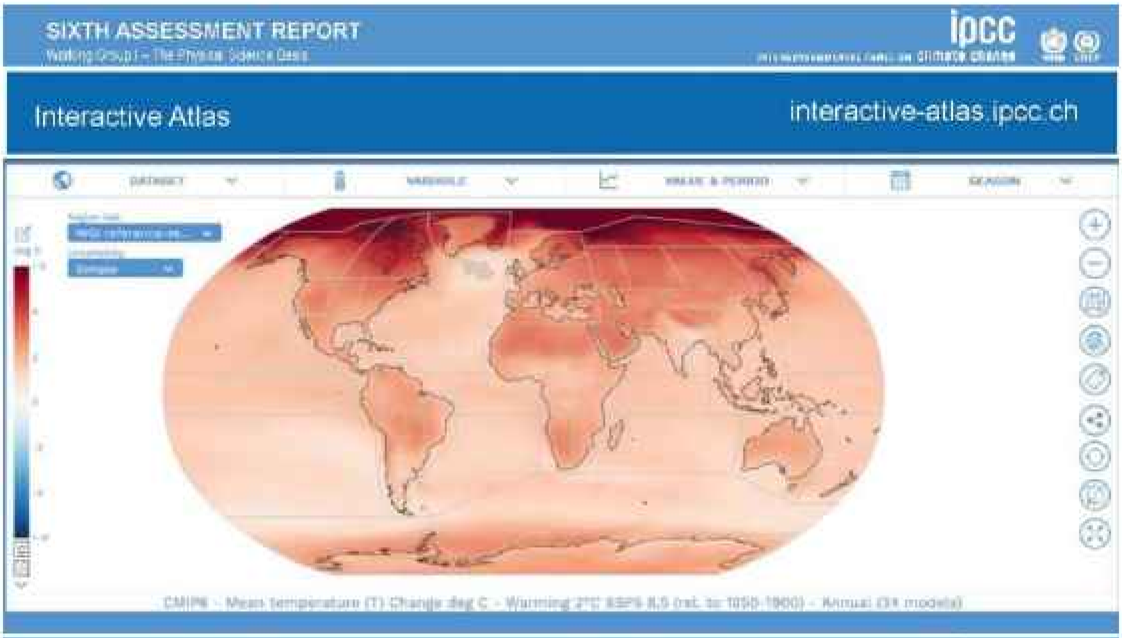
Changes to the Water cycle
Atmosphere
Land
Ocean
Frozen regions
With warmer temperature
Atmosphere can hold more water
More and faster evaporation
Heavier precipitation
Intensifying dry seasons and droughts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Interactive Atlas
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https://interactive-atlas.ipcc.ch/
#IPCCAtlas
OUR POSSIBLE CLIMATE FUTURES
Temperature
Precipitation
OUR POSSIBLE CLIMATE FUTURES
Temperature
Precipitation

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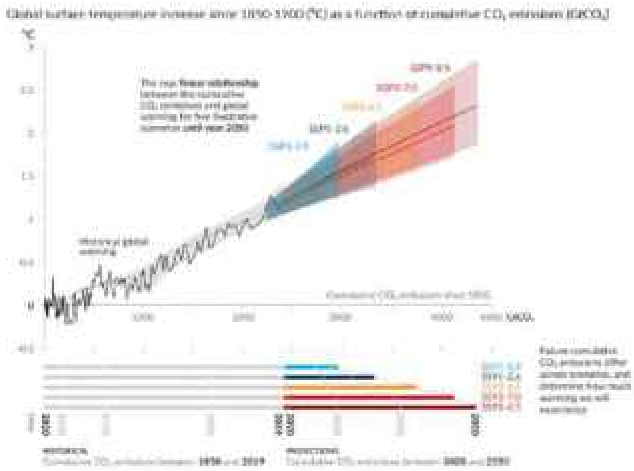
Every tonne of CO_2 emissions adds to global warming

Figure SPM.10



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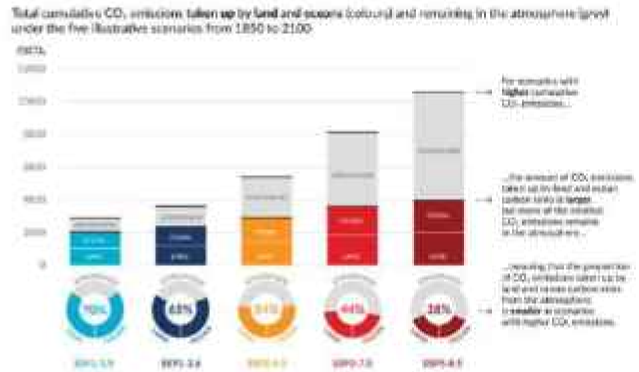
ipcc INTERGOVERNMENTAL PANEL ON climate change

The proportion of CO_2 emissions taken up by land and ocean carbon sinks is smaller in scenarios with higher cumulative CO_2 emissions

Figure SPM.7



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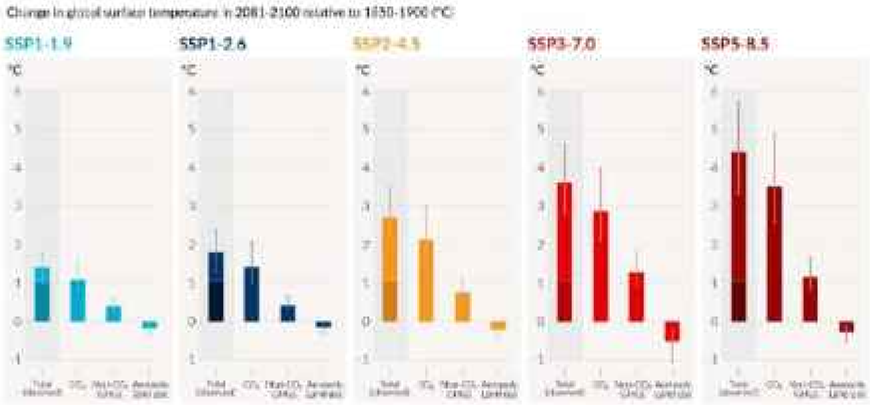
Future emissions cause future additional warming, with total warming dominated by past and future CO_2 emissions

Figure SPM.4



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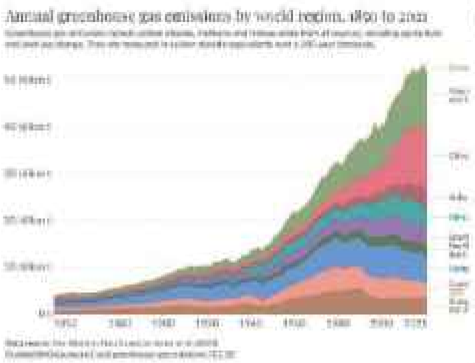
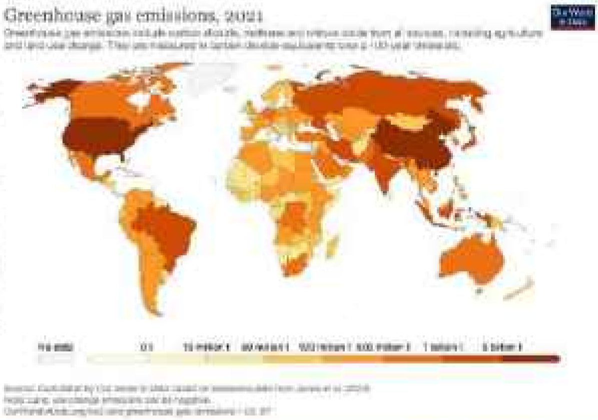
Annual green house gas emissions 2021





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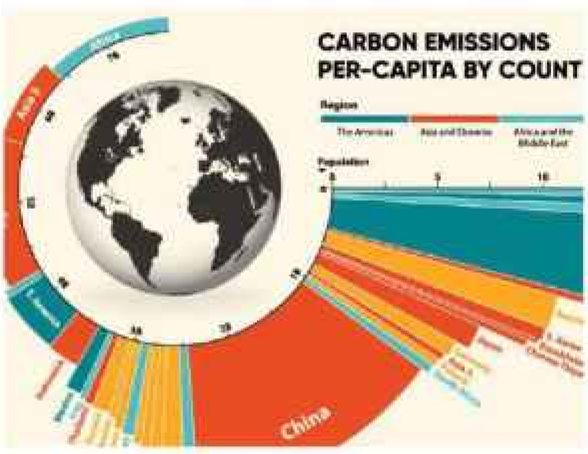
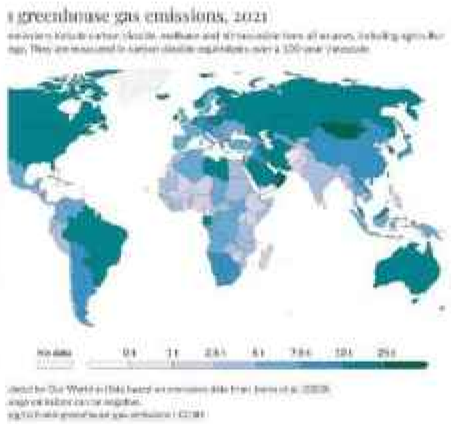
Annual green house gas emissions per capita 2021





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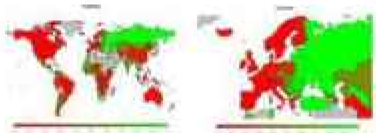
Paris Climate Agreement

- Adopted in 2015, the agreement covers climate change mitigation, adaptation, and finance.
- As of February 2023, 195 members of the United Nations Framework Convention on Climate Change (UNFCCC) are parties to the agreement. Of the three UNFCCC member states which have not ratified the agreement, the only major emitter is Iran. The United States withdrew from the agreement in 2020, but rejoined in 2021.
  - (a) Holding the increase in the **global average temperature to well below 2 °C** above pre-industrial levels and pursuing **efforts** to limit the temperature **increase to 1.5 °C** above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;
  - (b) Increasing the ability to **adapt to the adverse impacts of climate change** and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production;
  - (c) Making finance flows consistent with a **pathway towards low greenhouse gas** emissions and **climate-resilient development.**
- Under the agreement, each country must determine, plan, and regularly report on its contributions. No mechanism forces a country to set specific emissions targets, but each target should go beyond previous targets.

Probability that countries achieve their Paris Agreement Goals according to their nationally determined contributions (NDCs)



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SATURDAY 20 JANUARY 2025, BARC, DHAKA

Training Workshop on "Climate Leadership in Agriculture Sector"

Climate Change Impact on Water, Agriculture and Food Security

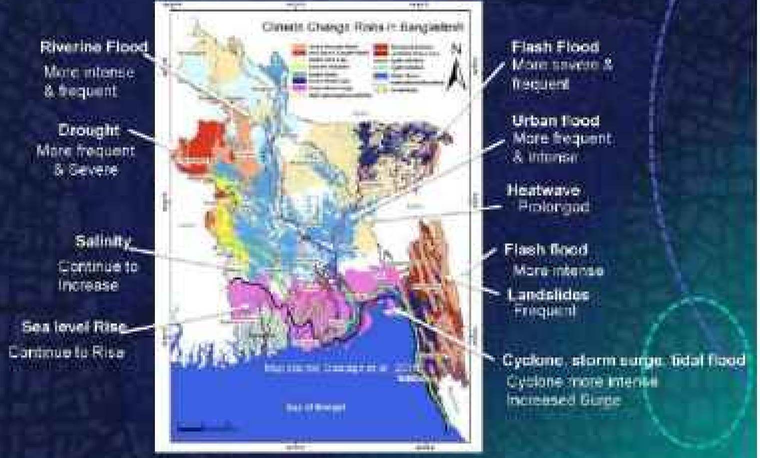
Professor A.K.M. Saiful Islam

Institute of Water and Flood Management (IWFM)
Bangladesh University of Engineering and Technology (BUET)

Lecture outline

- Regional Climate Predictions and Modeling (RCM)
- Multi-model Ensemble Regional Climate Projections for Impact studies using CORDEX simulations
- Future Changes in Temperature and Rainfall Extremes
- Future Changes in Metrological Droughts
- Future Changes Flows in GBM River Systems
- Future Changes in cyclones and storm surges
- Future Changes in Permanent Inundation Due to Sea Level Rise
- Future Changes in Water Salinity
- Future Changes in the Boro and Aman Rice yields
- Future Changes in Coastal Erosion

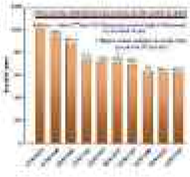
Natural Hazards Expected to Change under Global Warming

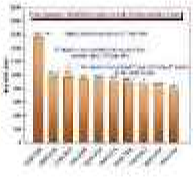


Extreme Events: Floods

Flood in Sylhet in June 2022

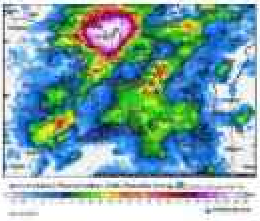
- Between 22%-30% of Bangladesh's territory is inundated yearly 45. In 2022, Bangladesh suffered one of the most devastating floods in its history impacting 7.2 million people. We have seen major floods in 2016, 2017, 2019, 2020, 2022.
- According to IPCC, Precipitation and rivers floods will increase over much of Asia (high to medium confidence).

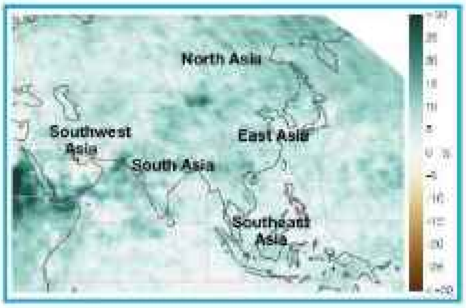




Extreme Events: Urban Floods

- According to IPCC, Projected changes in maximum 1-day precipitation at 2°C global warming under SSP5-8.5 Scenario relative to the 1995-2014 baseline (From Interactive Atlas).





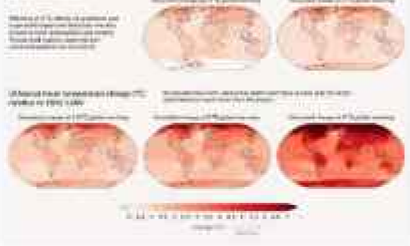
- Highest ever rainfall in 50 years: Rangpur city under knee-deep water on 27 September 2020 of 433mm rainfall is recorded by BMD in 12 hours.

IPCC

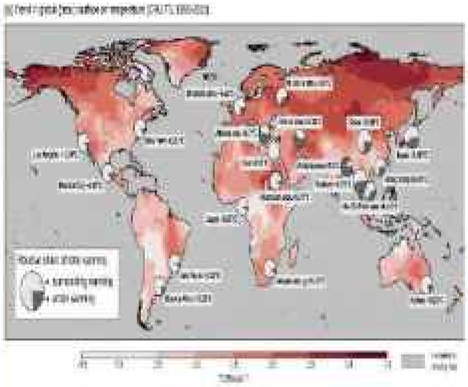
Extreme Events: Heatwave

- The number of days per year where temperature exceeds 35°C would increase by more than 150 days in many tropical areas by end of century for SSP5-8.5 scenario, such as the Amazon basin and South East Asia under SSP5- 8.5, while it is expected to increase by less than 60 days in these areas under SSP1-2.6 (except 19 for the Amazon Basin) (high confidence).
- By the end of the 21st century, dangerous humid heat thresholds, such as the NOAA Heat Index (HI) of 41°C, will be exceeded much more frequently under the SSP5-8.5 scenario than under SSP1-2.6 and will affect many regions (high confidence).
- In many tropical regions, the number of days per year where a HI of 41°C is exceeded would increase by more than 100 days relative to the recent past under SSP5-8.5, while this increase will be limited to less than 50 days under SSP1-2.6 (high confidence).

With every increment of global warming, changes get larger in regional mean temperature, precipitation and soil moisture



Observed trend in global surface air temperature

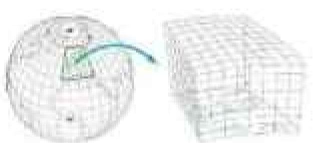


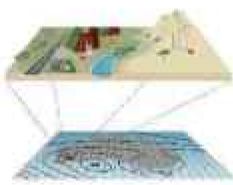
- Despite having a negligible impact on global annual mean surface-air warming (very high confidence), urbanization has exacerbated the effects of global warming in cities (very high confidence).

Cities under global warming

- Urban areas are home to more than fifty percent of the world's population and are the site of most of its built assets and economic activity.
- By 2050, the population in urban areas is expected to increase by 2.5 to 3 billion and comprise two-thirds of the world population.
- For the next three decades, nearly seventy million residents will move to urban areas every year. The majority of these new residents will live in small- to medium-sized cities in the developing world.
- Urban centers and cities are warmer than the surrounding rural areas due to what is known as the *urban heat island effect*.
- This urban heat island effect results from several factors, including reduced ventilation and heat trapping due to the close proximity of tall buildings, heat generated directly from human activities, the heat-absorbing properties of concrete and other urban building materials, and the limited amount of vegetation.
- The difference in observed warming trends between cities and their surroundings can partly be attributed to urbanization.

Regional Climate Modeling (RCM) for Bangladesh over CORDEX: South Asia





- GCM provides output more than 150km resolution which is not enough to capture mesoscale processes.
- RCM daily output with horizontal resolution 50km are available for South Asia CORDEX domain.
- Predictions are considered for extreme emission scenarios, RCP 8.5
- Climate output data have been bias corrected.

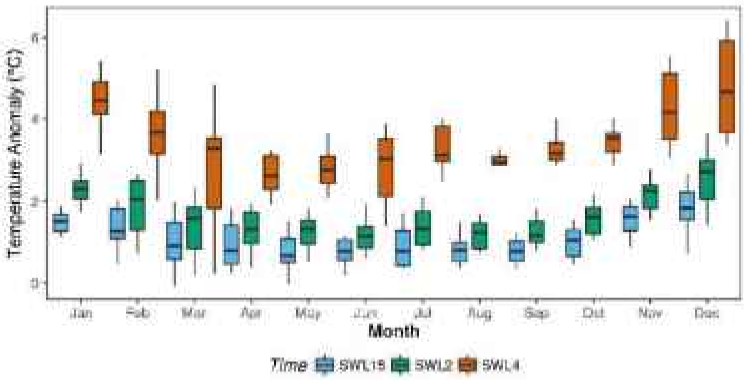
Fahad et al. (2016)

RCM Projections using CIMP5 data

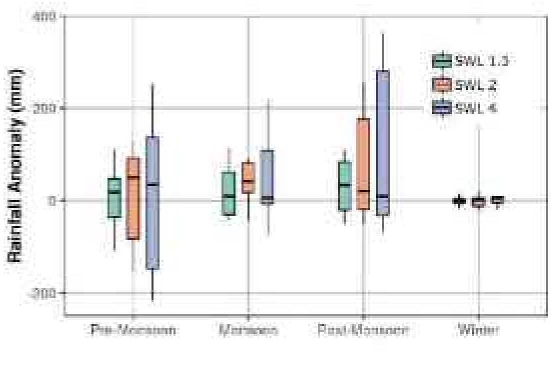
GCM	Ensemble	RCM	RCP8.5 (Year of Crossing)		
			SWL 1.5	SWL 2	SWL 4
ACCESS1-0	r1i1p1	CSIRO-CCAM-1391M	2034	2046	2085
CCSM4	r1i1p1	CSIRO-CCAM-1391M	2018	2031	2079
CNRM-CM5	r1i1p1	SMHI-RCA4	2032	2046	2088
CNRM-CM5	r1i1p1	CSIRO-CCAM-1391M	2032	2046	2088
EC-EARTH	r12i1p1	SMHI-RCA4	2019	2035	2083
CM5A-MR	r1i1p1	SMHI-RCA4	2020	2034	2069
MIROC5	r1i1p1	SMHI-RCA4	2038	2052	-
MPI-ESM-LR	r1i1p1	CSIRO-CCAM-1391M	2021	2040	2083
MPI-ESM-LR	r1i1p1	MPI-CSC-REMO2009	2021	2040	2083
MPI-ESM-LR	r1i1p1	SMHI-RCA4	2021	2040	2083
GFDL-ESM2M	r1i1p1	SMHI-RCA4	2040	2055	-

Specific Warming Levels (SWLs)
It is the mean annual global temperature increase by the end of the century related to preindustrial period (1880). Paris Agreement in 2015 emphasis on reducing GHGs to keep the increase of global mean temperature below 2C and effort should be made to reduce further to 1.5C with respect to pre-industrial period.

Changes of mean monthly temperature over Bangladesh at SWLs



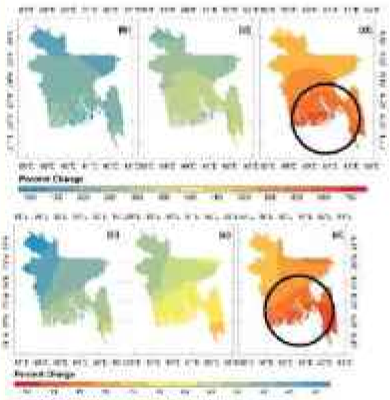
Changes of mean seasonal rainfall over Bangladesh at SWLs

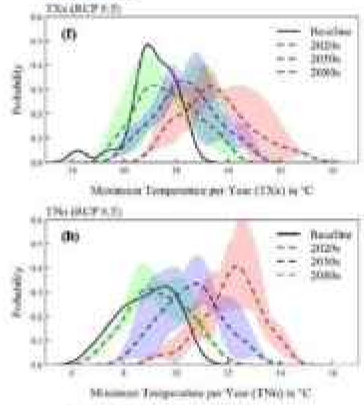


Temperature extremes are increasing – heatwave and health stress will be more intense and frequent

TX90P – Percentage of days when maximum temperature is higher than 90th percentile value.

TXx- maximum of daily maximum temperature





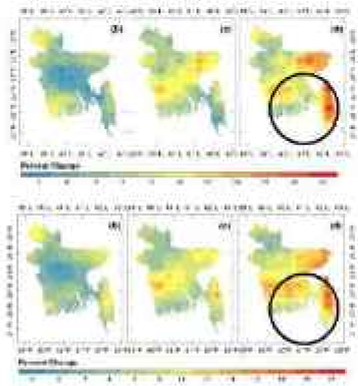
TX10P- Percentage of days when maximum temperature is lower than 10th percentile value

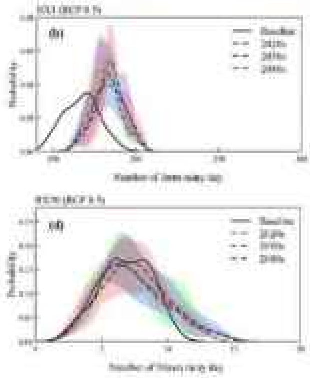
TNn- minimum of daily minimum temperature

Changes of Extreme Rainfall - more flash floods and landslides are expected

Rx1- maximum 1-day rainfall

Rx1- maximum 1-day rainfall



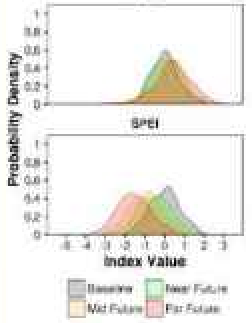


Rx50- number of days when rainfall > 50mm

Rx50- number of days when rainfall > 50mm

Changes of Meteorological Droughts

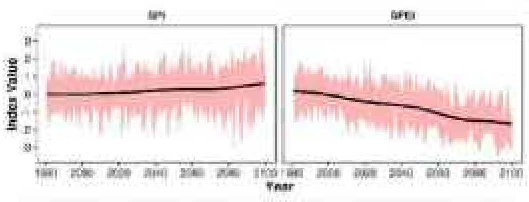
Standard Precipitation Index (SPI) and Standard Precipitation and Evapotranspiration Index (SPEI)



Density distribution of SPI and SPEI values at 3 Month time-scale

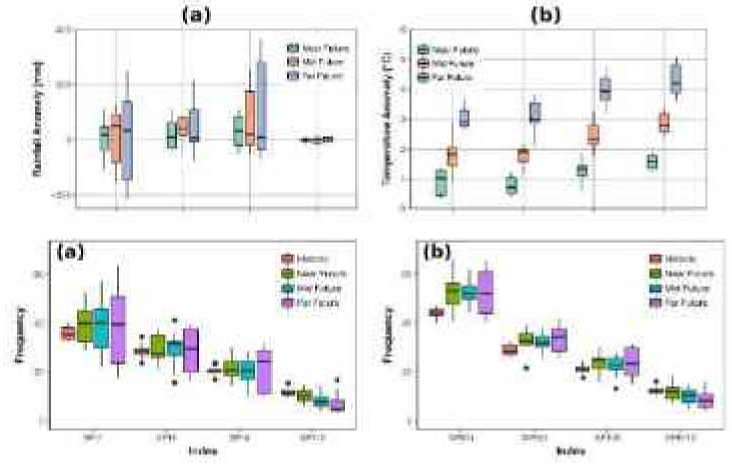
Both SPI and SPEI are calculated relative to a baseline period of 1961 to 2010.

Drought Category	SPI/SPEI Values
No drought	0 ≤ Index
Near normal/Mild drought	-1.0 < Index < 0
Moderate drought	-1.5 < Index ≤ -1.0
Severe drought	-2.0 < Index ≤ -1.5
Extreme drought	Index ≤ -2.0



Ensemble time series of SPI (left panel) and SPEI Thornthwaite (right panel) at 12-month timescale averaged over the country. The red patch is the ensemble spread of the index values.

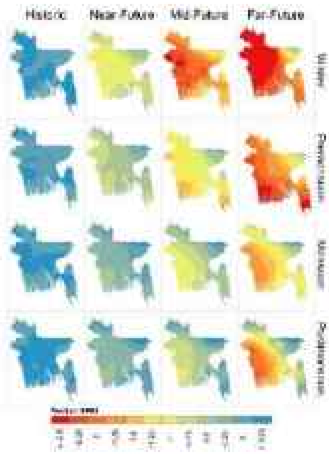
Changes of droughts for different SWL



Projected future median SPEI values over Bangladesh from 11 ensemble of Regional Climate Model (RCM)

Spatial Changes of Meteorological Droughts

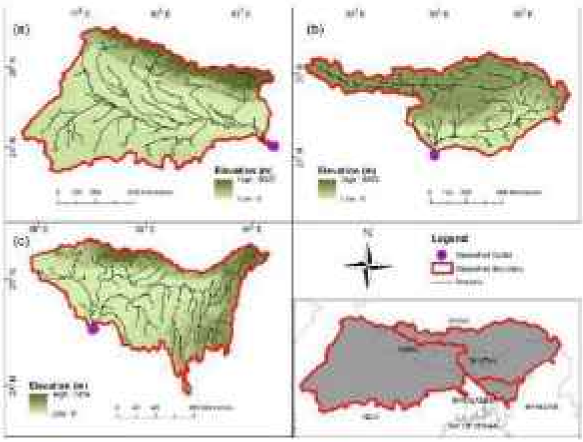
- Inclusion of evapotranspiration in the evaluation of drought is important in the context of global warming.
- The country is expected see more and more deviation from the climatic mean condition.
- At the end of the century, the climate of the country may settle to a condition which may be considered "moderate drought" compared to current climate.
- Long meteorological drought will impact the agriculture and socio-economic condition.



Percentage of area affected with

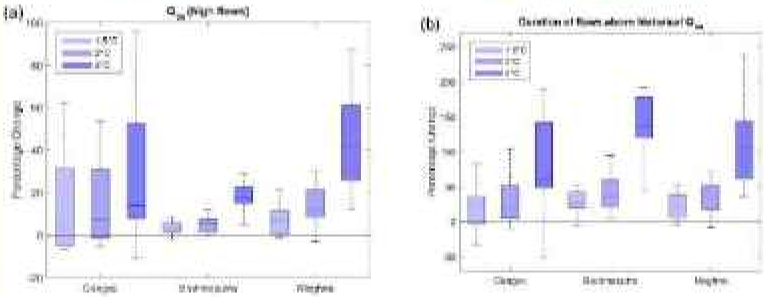
Ganges-Brahmaputra-Megha Basins

The GBM basins are located over India (64%), China (18%), Nepal (9%), Bangladesh (7%) and Bhutan (3%), and the elevation of the basins range from about 0 to above 8000 m above mean sea level (amsl).



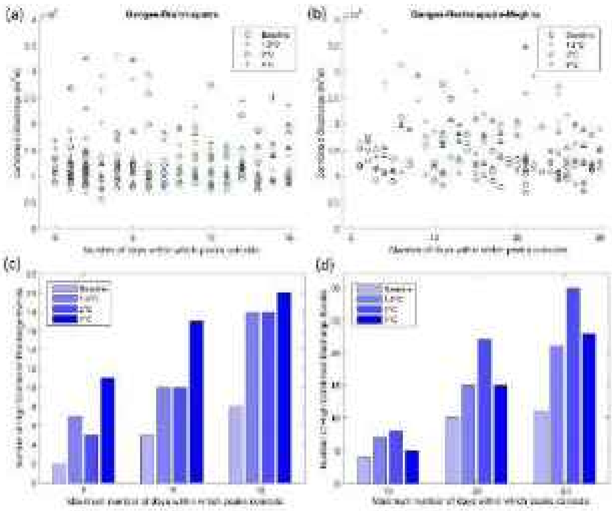
High flows and flood duration will be more increasing in the future

Q90 Flow | Duration of Q90



The ensemble-median values of the changes of Q90 flow at 1.5°C, 2°C, and 4°C are about 3%, 7%, and 14% for the Ganges; 4%, 5%, and 22% for the Brahmaputra; and 9%, 12%, and 42% for the Meghna, respectively

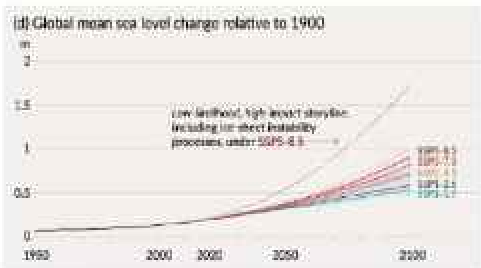
Peak synchronization of GBM Rivers



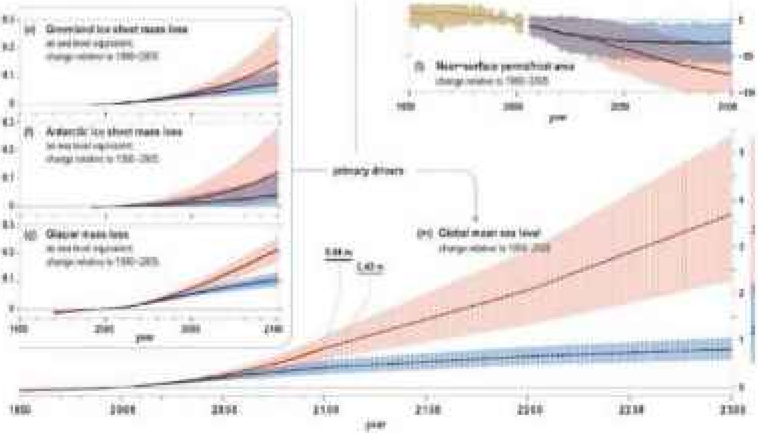
Extreme Events: Sea Level Rise

- Over the 21st century, the majority of coastal locations have a median projected regional sea level rise within ± 20% of the projected GMSL change (*medium confidence*).
- Relative sea level rise is very likely to virtually certain (depending on the region) to continue during the 21st century, contributing to increased coastal flooding in low-lying areas (high confidence) and coastal erosion along most sandy coasts (high confidence).
- Sea level will continue to rise beyond 2100 (high confidence)

It is virtually certain that the Global Mean Sea Level (GMSL) will continue to rise over the 21st century in response to continued warming of the climate system, and GMSL will continue to rise for centuries to millennia due to continuing deep ocean heat uptake and mass loss from ice sheets (high confidence).

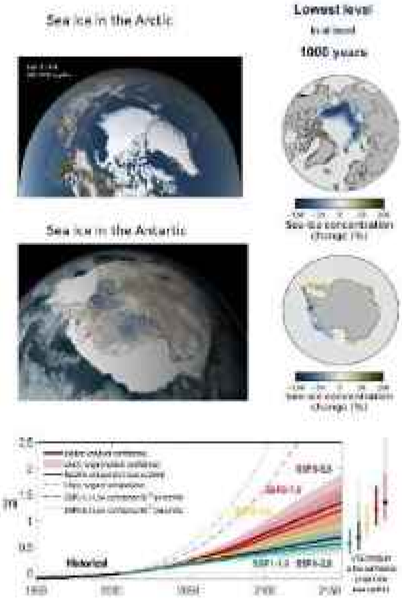


Projected Ice loss and SLR



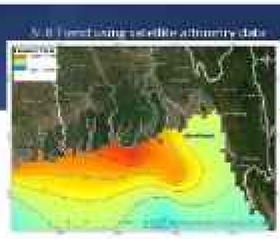
Sea Level Rise

- Bangladesh has been experiencing a rising trend in sea level because of its geographic location and the nature of the delta. Recent estimation of sea-level rise by DoE (2020) indicated the rising trends at different locations of the coastal zone of Bangladesh.
- Between 1901 and 2010 sea level has risen at a rate of 1.7mm/year. From 1993 to 2010, tidal variation indicates a rise of 2.8±0.8mm/year, and it is further validated by satellite altimetry data with a rise of 3.2±0.4mm/year.
- Ocean warming is a global phenomenon due to climate change. The Bay of Bengal is also experiencing increasing sea surface temperature and subsequent changes in pH (Sridevi et al., 2021).



Permanent Inundation due to SLR

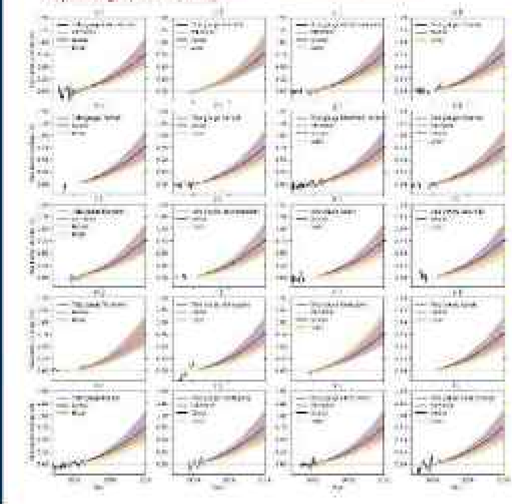
- A recent study of DOE (2022) using coastal model simulations for the four sea level rise scenarios (0.50m SLR, 0.62m SLR and 0.95m SLR) have been analysed for potential inundation in the coastal areas of Bangladesh.
- From the analysis, it can be seen that, sea level rise induced flooding will cover 12.3%, 15.5%, and 18% areas of the coastal zone for SLR scenarios of 0.50m SLR, 0.62m SLR and 0.95m SLR, respectively.
- Figure shows inundation map for 0.95m SLR. But the major part of inundation will be in the districts of Barisal, Jhalokati, Pirojpur, Gopalganj and Patuakhali. These districts are affected from the SLR as they do not have comprehensive flood protection system.
- The areas flooded are mostly inner coastal areas that are not protected by polders. So, the flood protection for these areas should be considered as a priority for the future climate change scenario.



Inundation map for 0.95m SLR

21st century sea level projections for RCP8.5 at tide gauge locations in the Bay of Bengal (ARRCC, 2020)

21st century sea level projections for RCP8.5 at tide gauge locations in the Bay of Bengal (ARRCC, 2020)



2081-2100	RCP2.6	RCP4.5	RCP8.5
Coxs Bazar	0.17-0.52	0.52-1.0	1.4-0.56
Port Blair	0.24-0.65	0.34-0.73	0.49-2.02
Visakhapatnam	0.18-0.6	0.27-0.68	0.38-2.96
Paradip	0.18-0.6	0.29-0.67	0.39-2.04
Teknaf	0.17-0.53	0.29-0.68	0.4-0.05
Gangra	0.16-0.6	0.29-0.65	0.39-2.03
Diamond Harbour	0.14-0.58	0.20-0.64	0.37-2.01
Chennai	0.18-0.62	0.29-0.71	0.43-2.00
Rangpuri	0.19-0.62	0.29-0.66	0.41-2.09
Nagapattinam	0.2-0.63	0.3-0.71	0.42-2.09
Sagar	0.16-0.57	0.30-0.66	0.33-2.09
Khal Tea	0.2-0.22	0.20-0.66	0.34-2.09
Tuticorin	0.28-0.6	0.31-0.71	0.45-2.00
Khepupara	0.18-0.61	0.29-0.67	0.39-2.04
Barisal	0.24-0.66	0.34-0.73	0.46-2.02
Akyab	0.18-0.62	0.29-0.66	0.41-2.05
Haldia	0.14-0.58	0.20-0.64	0.37-2.01
Chittagong	0.17-0.52	0.29-0.66	0.41-2.08
Hiron Point	0.16-0.61	0.20-0.67	0.39-2.04
Moulamein Tee	0.25-0.59	0.29-0.7	0.37-2.02
Char Changa	0.18-0.6	0.20-0.67	0.38-2.04
Ko Taphao Noi	0.25-0.65	0.33-0.73	0.44-2.07

Permanent Inundation due to SLR

- A recent study of DOE (2022) using coastal model simulations for the four sea level rise scenarios (0.50m SLR, 0.62m SLR and 0.95m SLR) have been analysed for potential inundation in the coastal areas of Bangladesh.
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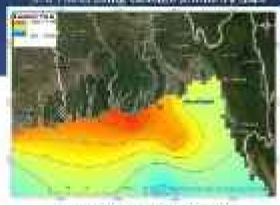
SLR Trend using satellite altimetry data



Inundation map for 0.95m SLR

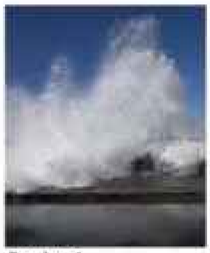
Ocean and ice sheets

Ocean temperature

Increasing

Greenland Ice Sheet

Melting



Sea level

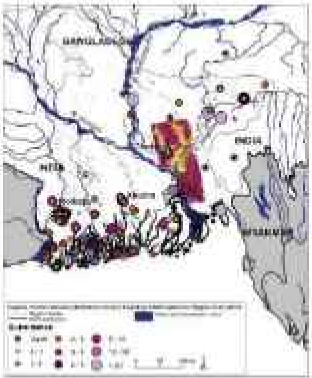
Rising

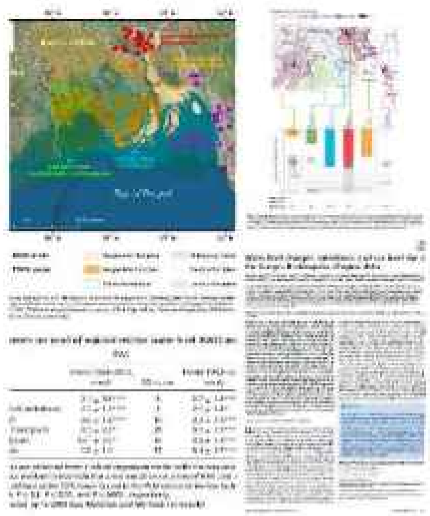
Beyond 2050, sea level projections are increasingly sensitive to emissions

- The *likely* global mean sea level rise is
- by 2100:
  - about 0.6-0.9 m under a high emissions scenario (SSP3-7.0)
  - about 0.3-0.6 m under a low emissions scenario (SSP1-2.6)
- by 2150:
  - about 1.0-1.9 m under a high emissions scenario (SSP3-7.0)
  - about 0.5-1.0 m under a low emissions scenario (SSP1-2.6)

Rates of subsidence recorded from the literature for the GBM delta

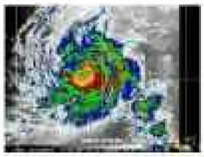
- Subsidence reported in this recent time, has a higher rate (8.8 mm/yr) than measurements over much longer time periods (as little as 1.2 mm/yr).
- However, the standard deviation of the results increases in more recent time, compared with long-term records, indicating a greater variability and spread in results.



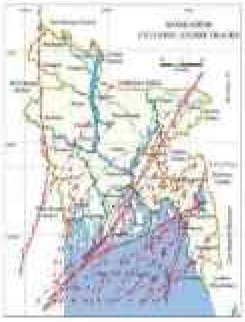


Trends in Water Level and Subsidence

Extreme Events: Cyclone

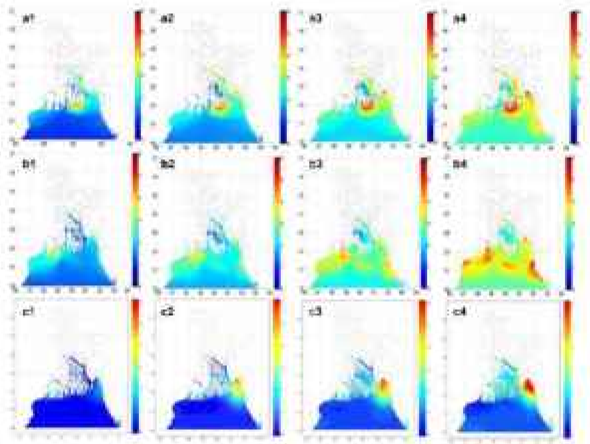


- The Indian Ocean has warmed faster than the global average (*very high confidence*).
- The proportion of intense tropical cyclones (TC), average peak TCs wind speeds, and peak wind speeds of the most intense TCs will increase on the global scale with increasing global warming (*high confidence*).
- Intensification of tropical cyclones and/or extratropical storms in projected in more regions from 2^{0}C GWL and above (*medium confidence*)



Cyclone Dana (2024) Date: 22-24 October 3-min wind: 110 km/hr 1-min wind: 130 km/hr Surge: < 1m **Damage: USD 73.3 million** **Fatalities: 7**	**Cyclone Remal (2024)** Date: 24-28 May 3-min wind: 110 km/hr 1-min wind: 140 km/hr Surge: 3 m **Damage: USD 606 million** **Fatalities: 84**	**Cyclone Midhili (2023)** Date: 14-18 November 3-min wind: 50 km/hr 1-min wind: 95 km/hr Surge: < 1 m **Damage: USD million** **Fatalities: 5**	**Cyclone Hamoon (2023)** Date: 21-25 October 3-min wind: 120 km/hr 1-min wind: 155 km/hr Surge: < 1 m **Damage: USD 250 million** **Fatalities: 5**
Cyclone Mocha (2023) Date: 9-15 May 3-min wind: 270 km/hr 1-min wind: 215 km/hr Surge: 3-3.5 m **Damage: USD 2.24 billion** **Fatalities: 463**	**Cyclone Sitrang (2022)** Date: 22-25 October 3-min wind: 65 km/hr 1-min wind: 85 km/hr Surge: < 1 m **Damage: USD 340 million** **Fatalities: 35**	**Cyclone Jawad (2021)** Date: 02-06 December 3-min wind: 75 km/hr 1-min wind: 65 km/hr Surge: < 1 m **Damage: USD 60.4 million** **Fatalities: 2**	**Cyclone Yaas (2021)** Date: 26 April -05 May 3-min wind: 215 km/hr 1-min wind: 250 km/hr Surge: < 2 m **Damage: USD 63.6 million** **Fatalities: 17**
Cyclone Amphan (2020) Date: 16-21 May 3-min wind: 240 km/hr 1-min wind: 290 km/hr Surge: 3-4 m **Damage: USD 1.5 billion** **Fatalities: 26**	**Cyclone Bulbul (2019)** Date: 5-11 November 3-min wind: 140 km/hr 1-min wind: 195 km/hr Surge: < 2 m **Damage: USD 33 million** **Fatalities: 128**	**Cyclone Fani (2019)** Date: 26 April -05 May 3-min wind: 215 km/hr 1-min wind: 250 km/hr Surge: < 2 m **Damage: USD 63.6 million** **Fatalities: 17**	**Cyclone Mora (2017)** Date: 28-31 May 3-min wind: 110 km/hr 1-min wind: 150 km/hr Surge: < 2 m **Damage: USD 6 million** **Fatalities: 6**
Cyclone Roanu (2016) Date: 16-21 May 3-min wind: 85 km/hr 1-min wind: 110 km/hr Surge: 2 m **Damage: USD 31.8 million** **Fatalities: 30**	**Cyclone Komen (2015)** Date: 26 July -2 August 3-min wind: 75 km/hr 1-min wind: 85 km/hr Surge: 1.2 m **Damage: USD 2 billion** **Fatalities: 132**	**Cyclone Mohasen (2013)** Date: 10-13 May 3-min wind: 85 km/hr 1-min wind: 85 km/hr Surge: < 1 m **Damage: USD 35.8 million** **Fatalities: 107**	**Cyclone Aila (2009)** Date: 17-27 May 3-min wind: 110km/hr 1-min wind: 120km/hr Surge: 3 m **Damage: USD 1 billion** **Fatalities: 190**
Cyclone Bijli (2009) Date: 14-17 April 3-min wind: 75 km/hr 1-min wind: 95 km/hr Surge: 2.1 - 3 m **Damage: USD million** **Fatalities: 7**	**Cyclone Sidr (2007)** Date: 11-15 November 3-min wind: 215 km/hr 1-min wind: 260 km/hr Surge: 5.5 m **Damage: USD 2.31 billion** **Fatalities: 3,447**	**1991 Cyclone (1991)** Date: 24-30 April 3-min wind: 235 km/hr 1-min wind: 260 km/hr Surge: 6.1 m Damage: USD 1.5 billion Fatalities: 138,000	**Bhola Cyclone (1970)** Date: 3-13 November 3-min wind: 185 km/hr 1-min wind: 240 km/hr Surge: 10.6 m **Damage: USD 86.4 million** **Fatalities: 500,000**

Changes of inundation patterns or cyclone Sidr (2007), Aila (2009) and Roanu (2016)



Rahman et al. (2016)

Changes of inundation patterns or cyclone Sidr (2007), Aila (2009) and Roanu (2016)

	Sidr			Aila			Roanu		
	Area	%	p	Area	%	P	Area	%	P
Only cyclone	1484	1.2	1.9	1999	1.5	2.3	676	0.46	0.52
0.5m SLR	3380	2.6	4.1	4226	3.3	5.1	2912	1.97	2.24
1m SLR	5777	4.4	7.0	6216	4.8	7.5	7832	5.31	6.02
1.5m SLR	7588	5.8	9.1	7497	5.8	9.0	12550	8.5	9.65

*Inundation Area in Km², % of area w.r.t. country and Affected population in Million

Shaha et al. (2016)

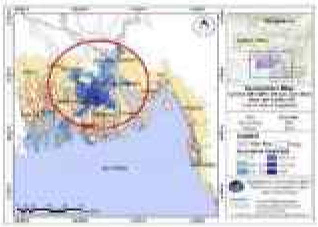
Storm surge Inundation considering sea level rise

For 1991 cyclone under 0.62m SLR and 0.95m SLR Scenario reveals that total 13.05% and 15.37% area will be flooded across the coast. Districts are facing more inundation with the increase of sea level rise are Barishal, Jhalokathi and Pirojpur will be flooded about 65%, 81% and 61% of their total area.

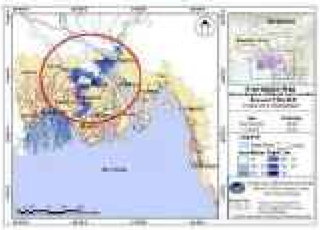
For cyclone Sidr under 0.62m SLR and 0.95m SLR Scenario reveals that total 19.17% and 21.68% area will be flooded across the coast.

For cyclone Amphan under 0.62m SLR and 0.95m SLR Scenario reveals that total 17.5% and 18.1% area will be flooded across the coast.

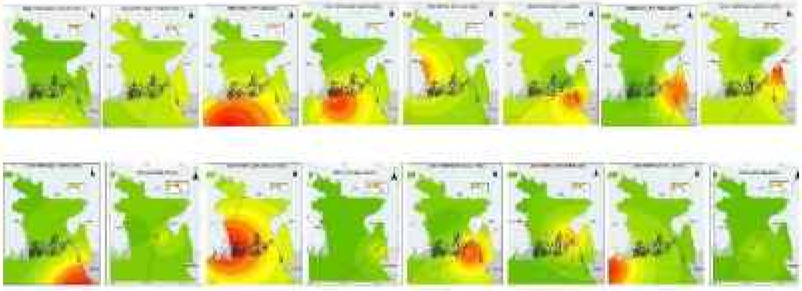
Cyclone Sidr (2007)



Cyclone Amphan (2020)



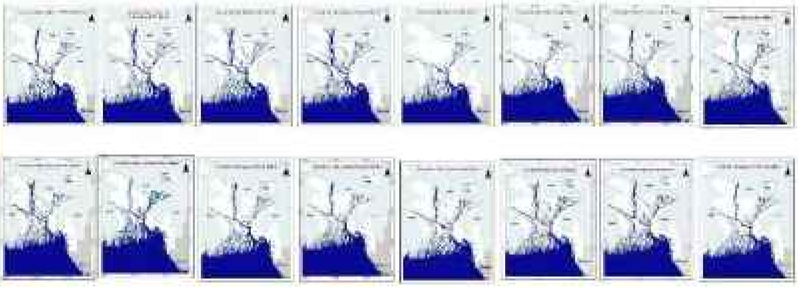
Wind Track for 16 Extreme Events



CHAPTER TWELVE

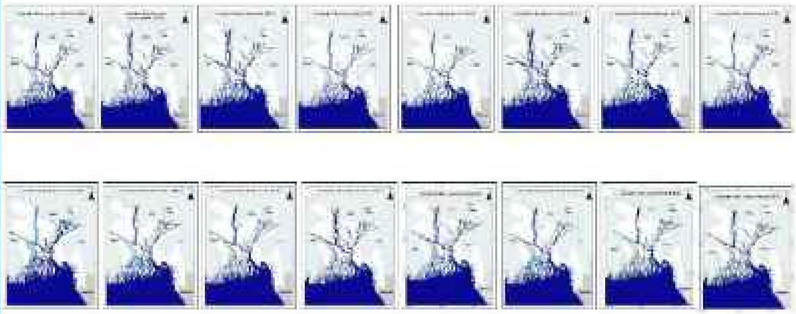
CHAPTER TWELVE

Inundation Map for Base Condition (16 Extreme Events)



CHAPTER TWELVE

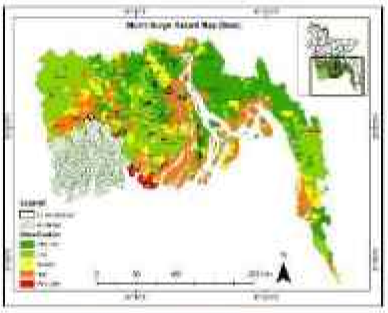
Inundation Map for 0.7m SLR Condition (16 Extreme Events)



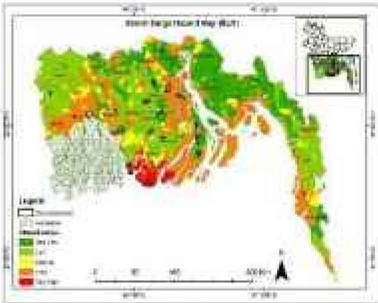
Hazard Ranking for Cyclonic Storms and SLR

Pourashava	Hazard Rank		Maximum Surge Depth (m)		Maximum Inundation Area (sqkm)		Maximum Wind Speed (km/hr)	
	Base	SLR	Base	SLR	Base	SLR	Base	SLR
Kuakata	1	3	8.8	8.9	20	20	200	200
Patharghata	2	1	10.9	11.7	136	160	189	189
Chalna	3	4	12.6	12.9	35	47	99	99
Betagi	4	2	9.7	10.1	24	24	113	113
Mehendiganj	5	5	0.0	0.0	0.0	0.0	65	65
Muladi	6	7	0.0	0.0	0.0	0.0	66	66
Nalchity	7	6	7.6	7.6	95	99	88	88
Banari Para	8	10	10.8	11.5	29	36	76	76
Morrelganj	9	11	10.7	10.8	10	10	111	111
Lalmohan	10	12	9.2	9.8	8	12	89	89
Burhanuddin	11	13	0.0	0.0	0.0	0.0	80	80
Gournadi	12	15	4.9	5.8	27	35	96	96
Bakerganj	13	16	0.0	0.0	0.0	0.0	80	80
Zanjira	14	17	11.8	12.3	111	109	58	58
Paikgachha	15	8	12.6	13.1	31	31	105	105
Kalaroa	16	20	7.5	7.8	135	143	111	111
Bagerhat	17	9	8.7	9.4	31	39	76	76
Noarabad	18	14	12.8	12.9	43	51	73	73
Charfassion	19	21	7.2	7.4	27	27	91	91
Jhalkathi	20	18	10.9	11.7	111	131	81	81
Patuakhali	21	19	0.5	0.8	4	4	65	65
Bhedarganj	22	22	0.0	0.0	0.0	0.0	79	79

Storm Surge Hazard Map (Base line & SLR Conditions)



Storm surge Hazard map
(Baseline conditions)



Storm surge Hazard map
(0.7m SLR conditions)

Crop Modeling using DSSAT (Decision Support System for Agro-technology Transfer)

- Extreme climate change will pose threat on various dimensions and Agriculture is one of them.
- About 75% of our agricultural land is rice and it covers 28% of GDP.

Main window in DSSAT v4.5

Hasan et al. (2016)

Rice Name	Brridhan29
Height	95 cm
Duration of growth	160 days
Grain quality	Medium
Yield (Kg/hectares)	7500
Developed on	1994
Developed by	Bangladesh Rice Research Institute (BRRI)

Crop management data for simulations of BR29 in DSSAT

Parameter	Input Data
Planting Method	Transplant
Transplantation Date	November 21
Planting distribution	Hill
Plant population at seedling	40 plants/ m^2
Plant population at emergence	35 plants/ m^2
Row spacing	20 cm
Planting Depth	5 cm
Transplant age	15-20 days
Fertilizer Application	90 kg/ha applied equally in 3 phases after 15, 35 and 55 days of transplant respectively
Irrigation	1000 mm applied in 15 applications with 7 days interval in 1st month and 10 days interval later
Harvest	May 1

Default values of the genetic coefficients of Boro rice

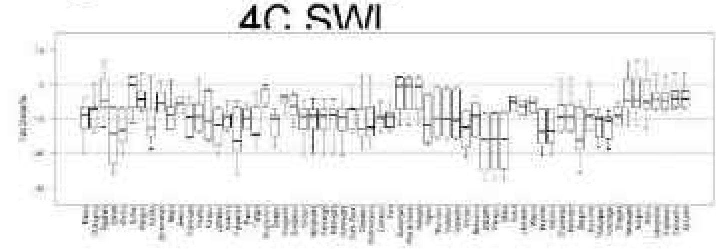
Coefficient ID	Name of coefficient	Default Value
P1	Basic vegetative phase coefficient	650
P20	Critical photoperiod at maximum growth rate	90
P2R	Extent in delay of panicle initiation	400
P5	Time from emergence to maturity	13
G1	Potential spikelet number coefficient)	0.65
G2	Single grain weight in gm in ideal condition	0.25
G3	Tillering coefficient	1.0
G4	Temperature tolerance coefficient	1.0

Values of the genetic coefficients in some important locations (divisions)

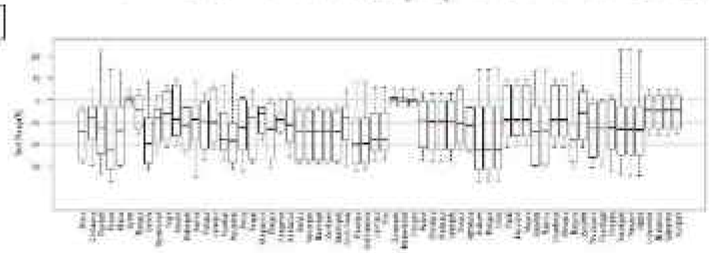
Region	P1	P2R	P5	P20	G1	G2	G3	G4	RMSE (Calibration)	RMSE (Validation)
Dhaka	647	93	415	12.9	67	0.26	1.0	1.0	260	125
Chittagong	645	87	395	12.9	62	0.25	1.0	1.0	312	213
Rajshahi	647	93	415	12.9	67	0.26	1.0	1.0	317	106
Barisal	648	90	400	13	67	0.25	1.0	1.0	192	141
Khulna	648	90	400	13	67	0.25	1.0	1.0	211	139
Sylhet	650	90	400	13	67	0.25	1.0	1.0	169	140

Changes of Boro rice yield at 2C and 4C SWI

2 C

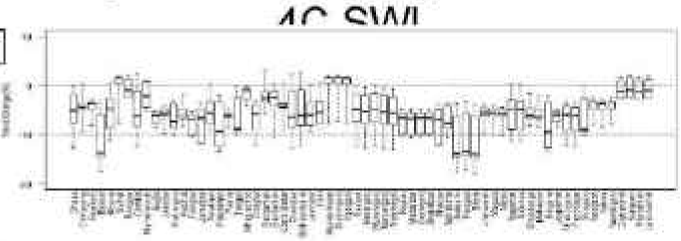


4 C

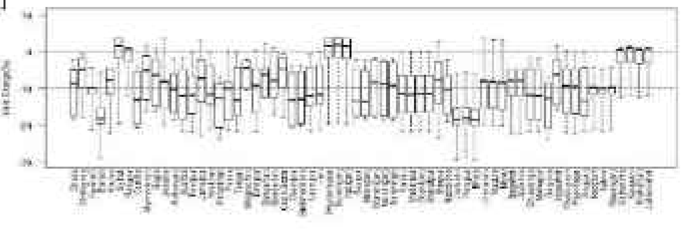


Changes of Aman rice yield at 2C and 4C SWL

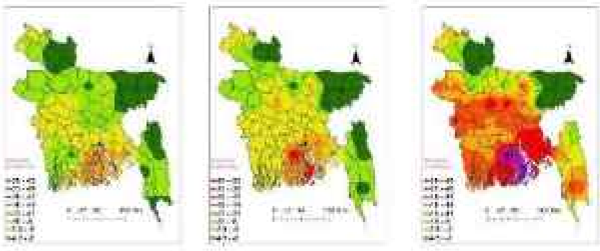
2 C



4 C



Changes of Boro yield at 1.5C, 2C, 4C SWLs

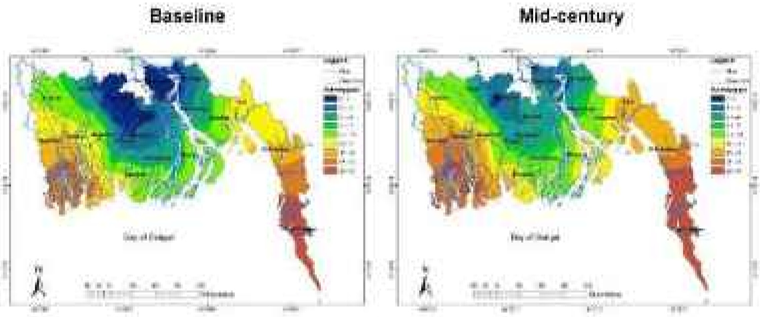


Changes of Aman yield at 1.5C, 2C, 4C SWLs

Change in Salinity

- Water and soil salinity is a common hazards in many parts of the coastal zone. Seventy percent of 2.35 million hectares within the Khulna and Barisal Divisions are affected by different degrees of soil salinity. This reduces the crop area.
- It restricts the cultivation of aus (summer rice), boro (dry season rice), and other rabi (dry season) crops.
- There is a seasonal salinity interface in the estuaries, with the threshold limit for agriculture moving further inward from the coast in May in the southern part of the coastal zone.
- In the southwest region, surface water salinity has been accentuated by the reduction in the dry season upland flows entering the Gorai distributaries. Coastal polders were designed to prevent salt-water intrusion.
- Many polders have lost their function because of both undesired breachings causing crop damage and "desired to breach" facilitating shrimp farming. Land-use conflicts exist in the area. Salinity intrusion inhibits industrialization.

Surface water salinity in Coastal Bangladesh

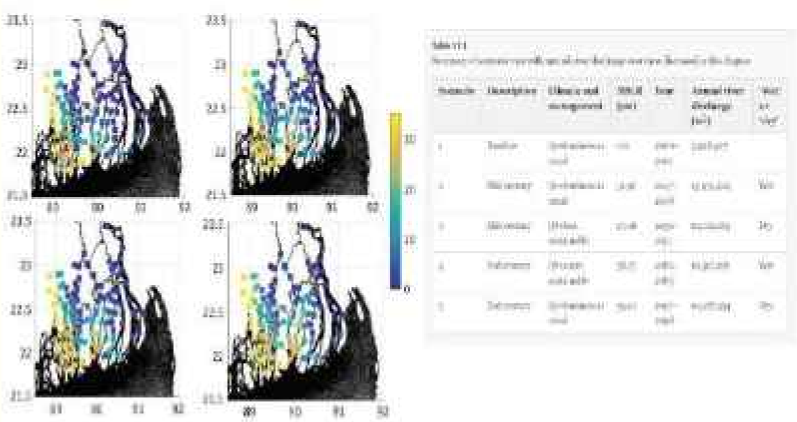


Changes in Salinity (baseline & mid-century)

District	Pourashava	Baseline Salinity (ppt)	Projected mid-century salinity (ppt)
Patuakhali	Patuakhali	2.1 - 4	4.1 - 5
	Kalapara	5.1 - 10	11 - 15
Bagerhat	Bagerhat	5.1 - 10	11 - 15
	Morrelganj	2.1 - 4.0	5.1 - 10
Barisal	Mehendiganj	1.1 - 2	4.1 - 5
	Gaurnadi	1.1 - 2	2.1 - 4
	Muladi	1.1 - 2	2.1 - 4
	Banaripara	0 - 1	2.1 - 4
	Bakerganj	1.1 - 2	2.1 - 4
Khulna	Paikgacha	11 - 15	16 - 20
	Chalna (Dacope)	11 - 15	16 - 20
Satkhira	Kalaroa	11 - 15	16 - 20
Barguna	Patharghata	16 - 20	16 - 20
	Betagi	1.1 - 2	5.1 - 10
Bhola	Charfassion	5.1 - 10	11 - 15
	Borhanuddin	4.1 - 5	5 – 10
	Lalmohan	4.1 - 5	5 – 10
Jhalokathi	Jhalokathi	0 - 1	2.1 - 4
	Nalchity	1.1 - 2	2.1 – 4
Shariatpur	Bhedarganj	0 - 1	1.1 – 2
	Zanjira (Damudya)	0	0 - 1
Pirojpur	Swarupkathi	0-1	1.1-2

Salinity in coastal Bangladesh

Annual maximum salinities for 103 selected points under the four future scenarios

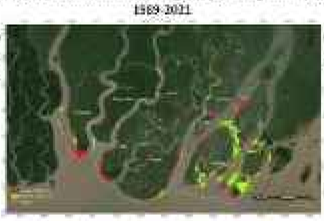


Bricheno et al., 2016

Coastal Erosion

- Land erosion is a common natural phenomenon in the coastal zone. Massive changes have occurred in the coastline over the last two centuries due to land erosion, coupled with land accretion. Boundaries of islands undergo major changes due to land erosion and simultaneous accretion.
- Historical satellite images of Landsat TM and Landsat 8 are analyz… s. It has been found that major accretion is observed in the Rangabali … the Patharghata, Taltali, Kalapara, Galachipa, Amtali and Barguna Sadar.

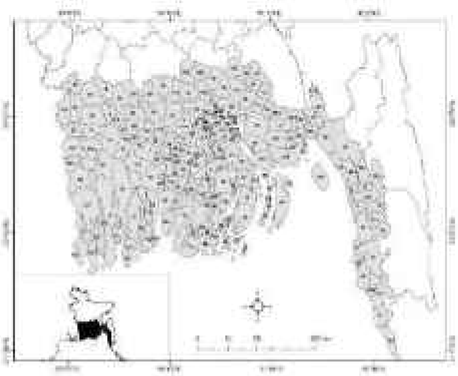
1989-2021



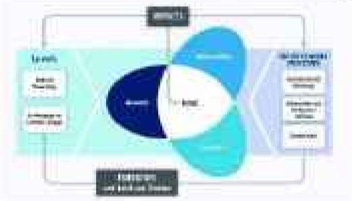
2009-2021 1999-2008 1989-1999 Erosion in Sonar Char

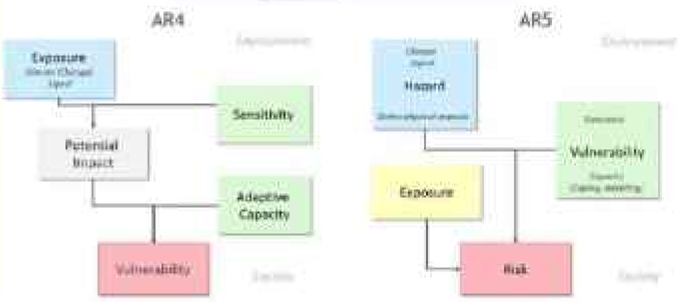
Socioeconomic vulnerability assessment using indicators based multivariate analysis

- Coastal areas of Bangladesh is very much prone to various natural disasters such as cyclone, storm surge, river erosion, flood, salinity intrusion, erratic weather condition, etc.
- 19 coastal districts were selected for the analysis where 140 Upazilas are included



Coastal vulnerability due to climate change following IPCC Framework of assessing vulnerability

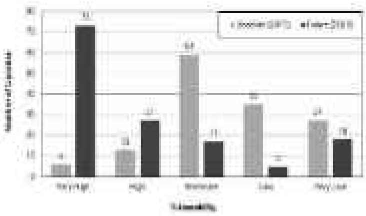


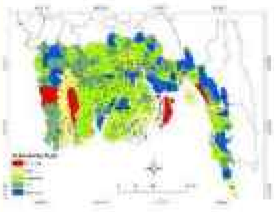


Principle component analysis conducted to determine weight of the indices

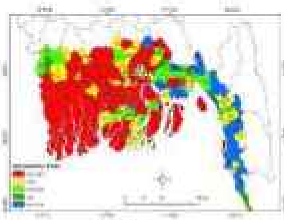
Coastal Vulnerability in preset and in the future (2050)

A total of 140 upazilas (administrative unit) under 19 coastal districts of Bangladesh has been selected as study At present, 6 upazilas come under very high, 13 upazilas under high, 59 upazilas under moderate, 35 upazilas under low and 27 upazilas under very low category of vulnerability





Present (2013)



Future (2050s)

In future, 73 upazilas are mapped as very high, 27 upazilas as high, 17 upazilas as moderate, 5 upazilas as low and 18 upazilas as very low scale of vulnerability

Key Messages

- Extreme Rainfall over Bangladesh will be increased in the future. Chances of flash flood and land slides will be increased.
- Projected changes in mean annual precipitation and temperature over the basins are larger in 4°C than in 1.5°C or 2°C. Changes are greater over Meghna basin than Brahmaputra basin.
- Annual discharges of the Meghna basin change almost linearly with changes in the annual basin-averaged precipitation, while changes in discharges of the Brahmaputra basin are less sensitive to changes in precipitation.
- Mean monthly flows are projected to increase the most in July (for Brahmaputra and Ganges) and in June (for Meghna).
- Floods are likely to increase in both rivers as well as flood durations.
- However, Hydrological droughts are likely to decrease in both rivers along with drought durations.
- SLR rise will also cause permanent inundations in some parts of the coastal areas of Bangladesh.
- Under high emission RCP 8.5 scenarios the mean yield of Boro rice will decrease about 10% during 2030's and about 20% by 2100.

Publications on floods and climate change

- Attributing the 2017 Bangladesh floods from meteorological and hydrological perspectives. Hydrology and Earth System Sciences, 23, 1409-1429, doi 10.5194/hess-23-1409-2019
- Attributing the 2017 Bangladesh floods from meteorological and hydrological perspectives. Hydrology and Earth System Sciences, 23, 1409-1429, doi 10.5194/hess-23-1409-2019
- Determining Flash Flood Danger Level at Gauge Stations of the North East Haor Regions of Bangladesh. Journal of Hydrological Engineering, 24(4), 05019004
- Observed Trends in Climate Extremes over Bangladesh from 1981 to 2010. Climate Research , 77(1), 45-61
- Future floods in Bangladesh under 1.5°C, 2°C and 4°C global warming scenarios. Journal of Hydrological Engineering, 23(12), 04018050
- Challenges for flood risk management in flood prone Sirajganj region of Bangladesh. Journal of Flood Risk Management, e12450
- A global network for operational flood risk reduction. Environmental Science & Policy, 84, 149-158
- Regional changes of precipitation and temperature over Bangladesh using bias corrected multi model ensemble projections considering high emission pathways. International Journal of Climatology, 38(4), 1634-1648, doi: 10.1002/joc.5264.
- Assessing High-End Climate Change Impacts on Floods in Major Rivers of Bangladesh Using Multi-Model Simulations. Global Science and Technology Journal, 6(2), 1-14
- Impact of High End Climate Change on Floods and Low Flows of the Brahmaputra River. Journal of Hydrologic Engineering, 22 (10), doi: 10.1061/%28ASCE%29HE.1943-5584.0001567
- Extreme flows and water availability of the Brahmaputra River under 1.5°C and 2°C global warming scenarios. Climatic Change, pp 1-17, doi: 10.1007/s10584-017-2073-2.
- Hydrological response to climate change of the Brahmaputra basin using CMIP5 General Circulation Model ensemble. Journal of Water and Climate. doi: 10.2166/wcc.2017.076.
- Assessing extreme rainfall trends over the northeast regions of Bangladesh, Theoretical and Applied Climatology, 1-12, doi: 10.1007/s00704-017-2285-4.

Publications on cyclone and storm surges

- Projected changes of inundation of cyclonic storms in the Ganges-Brahmaputra-Meghna delta of Bangladesh due to SLR by 2100, Journal of Earth System Science, 23, 1409-1429.
- Towards improved storm surge models in the northern Bay of Bengal. Continental Shelf Research, 135, pp.58-73. doi:10.1016/j.csr.2017.01.014.
- Mapping of Climate Vulnerability of the Coastal Regions of Bangladesh using Principal Component Analysis. Applied Geography, 102, 47-57.
- Seasonal modulation of M2 tide in the northern Bay of Bengal. Continental Shelf Research, 137:154-162, doi:10.1016/j.csr.2016.12.008.
- Tidal intrusion within a mega delta: An unstructured grid modelling approach. Estuarine, Coastal and Shelf Science, 182(5):12-26, doi:10.1016/j.ecss.2016.09.014.
- Improved bathymetric dataset and tidal model for the northern Bay of Bengal. Marine Geodesy. 39(6), pp. 422-438, doi:10.1080/01490419.2016.1227405.
- Modelling the increased frequency of extreme sea levels in the Ganges-Brahmaputra-Meghna delta due to sea level rise and other effects of climate change. Environ. Sci.: Processes Impacts, 2015 (17) 1311-1322 , doi:10.1039/C4EM00683F.
- Field investigation on the performances of the coastal structures during Cyclone SIDR, Natural Hazards Review, ASCE, Vol. 12, pp. 111-116.031 doi:10.1061/(ASCE)NH.1527-6996.0000

Thank you

A comprehensive
handout on

Leadership in

Identifying Hazard, Risk and Vulnerability in Agricultural Sector

20
25

Prepared By

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What's Inside the Handbook?

This handbook offers an in-depth exploration of Bangladesh's agricultural sector under a changing climate. It starts by highlighting the country's proactive policy frameworks—NAPA, BCCSAP, BDP 2100—that guide national adaptation strategies. The handbook then examines pioneering agricultural achievements, from leading Hilsha production to innovative stress-tolerant crop varieties. Next, it delves into the core risks and vulnerabilities shaping food security, including extreme weather events, rising temperatures, and coastal salinity. Readers will also discover success stories of climate-resilient infrastructure and community-led adaptations. Ultimately, the handbook underscores how Climate-Smart Agriculture (CSA) and the National Adaptation Plan can foster a more secure, sustainable future.

Disclaimer

The information presented in this lecture note is based on current scientific understanding and data available in primary and secondary sources till date. While every effort has been made to ensure accuracy, climate science is continuously evolving, and updates may occur beyond this publication.

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Content Map

1. Preamble

Bangladesh has been proactive and adept in climate change adaptation, as mandated by the Constitution in its 15th amendment, Article 18A, which focuses on the protection and improvement of the environment and biodiversity. The country has reinforced its climate adaptation efforts through several strategic frameworks, including the National Adaptation Programme of Action (NAPA) in 2005, the Bangladesh Climate Change Strategy and Action Plan (BCCSAP) in 2009, the Bangladesh Delta Plan 2100 (BDP 2100) in 2018.

Despite these efforts, Bangladesh ranked 7th among the top ten most affected countries between 2000 and 2019 in terms of the Long-Term Climate Risk Index (CRI), as reported by the Global Climate Risk Index of Germanwatch in 2021. Economic losses due to climate change in Bangladesh over the past 40 years are estimated at USD 12 billion, suppressing the GDP annually by 0.5% to 1.3%, a figure that could rise to 2% by 2050 under extreme climate change scenarios.

Nestled in the verdant landscapes of Bangladesh, agriculture isn't just an economic sector; it's the lifeblood of the nation. Accounting for a substantial 14 percent of the GDP and providing livelihoods for over 40 percent of the population, agriculture is the cornerstone of the country's prosperity. However, beneath the lush greenery lies a tale of resilience tested by the relentless forces of climate change. With every unpredictable monsoon, every sweltering heatwave, and every cyclone that lashes the coast, the vulnerabilities of Bangladesh's agricultural sector are laid bare. The stakes couldn't be higher; the very foundation of food security and economic stability hangs in the balance.

Against this backdrop, the imperative to adapt, innovate, and transform agricultural practices for a climate-resilient future has never been more urgent. Enter Climate-Smart Agriculture (CSA), a paradigm shift in agricultural development that champions sustainability, resilience, and adaptability in the face of a changing climate. Under the guiding light of the National Adaptation Plan (NAP), Bangladesh is poised to embark on a journey of transformation, where traditional farming practices give way to innovative, climate-smart solutions.

2. Pioneering Achievements in Agriculture

Bangladesh's agricultural landscape is not just a testament to its productivity; it's a saga of ingenuity and perseverance in the face of formidable challenges. From the fertile plains of the Ganges Delta to the bustling markets of Dhaka, the nation's agricultural achievements stand as a beacon of hope amidst the tumultuous waters of climate change. Leading globally in Hilsha production, Bangladesh has mastered the art of harnessing its aquatic resources. The country is also a global leader in jute production, ranking second worldwide, and similarly holds the second position in jackfruit production. These feats showcase Bangladesh's diverse agricultural expertise and its ability to excel in both aquatic and fiber production sectors. Moreover, Bangladesh ranks third in rice production globally. The vast rice fields across the country not only serve as the backbone of its agricultural economy but also as a symbol of its resilience. These achievements highlight not only Bangladesh's agricultural prowess but also its unwavering commitment to sustainability and resilience amidst climate uncertainties.

Figure 1: Achievements of Bangladesh in Agriculture

3. Climate Risk and Vulnerabilities in Bangladesh

3.1 Evidences of Climate Change in Bangladesh

Bangladesh, located in the delta of the Ganges-Brahmaputra-Meghna rivers and with a low-lying coastal geography, faces numerous challenges exacerbated by climate change. Key evidences of climate change impacting Bangladesh include:

- **Average Temperature Rise:** Bangladesh has experienced an average temperature increase of 0.56°C per century. This gradual rise in temperature contributes to shifts in weather patterns and climatic conditions across the country.
- **Increased Rainfall:** The country has observed an increase in average annual rainfall by 8.4 mm per year. This trend indicates changes in precipitation patterns, influencing agricultural practices, water management, and flood risks.
- **Frequency of Mega Floods:** In recent decades, Bangladesh has witnessed five mega floods, compared to only one similar event in the previous 30 years. These catastrophic floods cause widespread devastation, displacing communities and disrupting livelihoods.
- **Early Flash Floods:** There has been a noticeable increase in early flash floods, occurring before the typical monsoon season. These sudden floods pose immediate risks to communities, agriculture, and infrastructure.
- **Extreme Hot Days:** Over the past 60 years, Bangladesh has experienced 7-10 more extreme hot day events than in previous decades. These heatwaves impact public health, agriculture, and urban heat islands.
- **Sea Level Rise and Salinity Intrusion:** Bangladesh faces rising sea levels, leading to increased salinity in coastal areas. This phenomenon threatens freshwater resources, agriculture, and ecosystems dependent on balanced salinity levels.
- **Ocean Temperature Increase:** Ocean temperatures off the coast of Bangladesh have risen by 0.2-0.3°C over the last 40 years. Warmer oceans contribute to stronger cyclones and affect marine biodiversity and fisheries.
- **Super Cyclones:** The frequency of super cyclones (Category 3 or higher) has increased by approximately 6% compared to the past 30 years. These powerful storms cause extensive damage to coastal communities and infrastructure.
- **Drought Severity:** North-western Bangladesh has experienced increasing severity of droughts. These drought events impact agricultural productivity, water availability, and food security in the region.

These climate change impacts underscore the vulnerability of Bangladesh to environmental changes and highlight the urgent need for adaptive measures and resilience-building strategies.

3.2 Departure of Avg. Annual Temperature during 1991-2019 relative to Climate Normal

In recent decades, Bangladesh has witnessed a significant departure from the average annual temperature relative to the climate normal period of 1961-1990. This departure serves as a crucial indicator of climate change impacts in the region:

- **Temperature Trend:** The average annual temperature in Bangladesh has been increasing at a rate of approximately 0.015°C per year. This steady rise indicates a warming trend that surpasses historical norms, affecting various aspects of life and the environment.
- **Seasonal Variations:** Notably, there has been an observed increase in minimum temperatures during key seasons:
    - **Winter:** Minimum temperatures have risen by 0.45°C, influencing cold-related issues, agricultural practices, and energy consumption patterns.

- **Monsoon:** Minimum temperatures have increased by 0.52°C, impacting crop growth cycles, disease dynamics, and water availability.

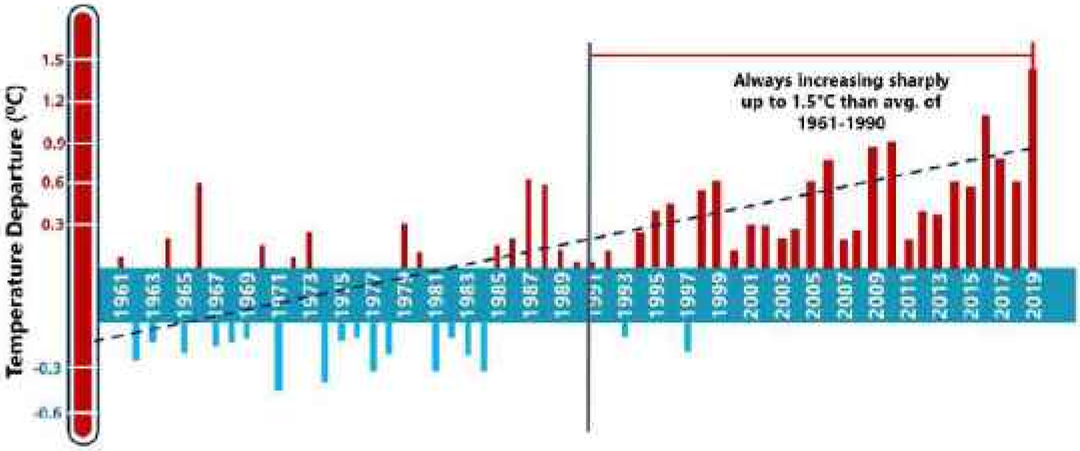

Figure 2: Departure of Avg. Annual Temperature during 1991-2019 relative to Climate Normal

These temperature shifts are critical for understanding the broader implications of climate change on Bangladesh's ecosystems, agriculture, water resources, and public health. They underscore the need for adaptive measures and resilience-building strategies to mitigate the adverse effects of warming temperatures.

3.3 Seasonal Variation of Floods in Haor, April 2015-2022

Haor in Bangladesh has unique hydro-ecological characteristics covering 8,590 sq. km, which constitutes 44% of the designated haor region in the North East. The haor region includes a mosaic of wetlands comprising rivers, canals, large areas of seasonally flooded cultivated plains, and beels. Fifty percent of haors (170 out of 373) belong to deeply flooded areas.floods caused by severe rainfall in the mountainous areas of India during the pre-monsoon period often lead to severe damages to paddy crops in Haor regions, particularly in April and May. These floods inundate agricultural lands and homes, displacing populations and disrupting livelihoods dependent on agriculture and fishing.

The Center for Environmental and Geographic Information Services (CEGIS) utilizes European Space Agency (ESA) Sentinel-1 Synthetic Aperture Radar (SAR) imagery with a resolution of 10 meters to conduct detailed flood extent analyses. This technology enables precise mapping and monitoring of flood-affected areas, facilitating timely disaster response and management.

Flood-affected Statistics:

- **2015:** Floods affected approximately 865 sq. km (4%) of Haor areas.
- **2017:** A devastating flood event inundated 6,685 sq. km (33%) of Haor Area
- **2022:** Floods impacted 2,120 sq. km (11%) of Haor Area

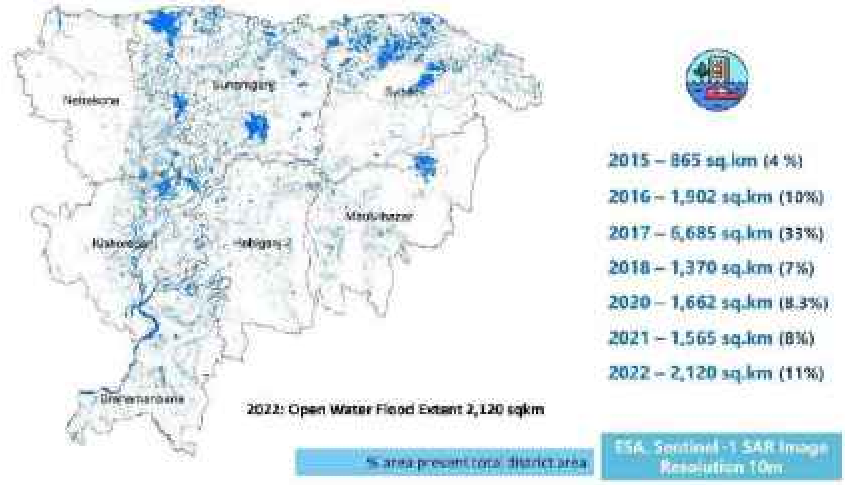

Figure 3: Seasonal Variation of Floods in Haor, April 2015-2022

3.4 Distribution of Cyclone Induced Storm Surge

Historical data analyzed by CEGIS indicates a pattern of cyclone occurrence in Bangladesh over the past 60 years, with significant clusters in specific months. Cyclones have been observed most frequently in May (35 events), June (38 events), October (52 events), and November (42 events). These seasonal peaks are influenced by meteorological conditions in the Bay of Bengal (BoB). In May and June, the pre-monsoon period sees warm sea surface temperatures and favorable wind patterns conducive to cyclone formation. October and November, marking the post-monsoon phase, witness cyclonic disturbances as monsoon winds withdraw, creating conditions for storm development amidst transitioning weather patterns.

The Saffir-Simpson Hurricane Wind Scale, used to classify cyclones based on sustained wind speeds and potential damage, categorizes storms from Category 1 (minimal damage) to Category 5 (catastrophic damage with wind speeds exceeding 157 mph). In recent decades, there has been an observed increase in Category 4 and Category 5 cyclones affecting the Bay of Bengal coast. These storms bring devastating winds and storm surges, posing significant risks to coastal communities, infrastructure, and ecosystems. The intensification of cyclones is linked to rising sea surface temperatures, a consequence of climate change, which enhances cyclonic activity in the region.

Understanding the seasonal distribution and intensity of cyclones is crucial for enhancing disaster preparedness, early warning systems, and resilience-building efforts in vulnerable coastal areas of Bangladesh. Efforts to mitigate the impacts of cyclones include improved forecasting, infrastructure resilience, and community preparedness to reduce the socio-economic and environmental impacts of these extreme weather events.

3.5 Observed Trend of Sea Level Rise

Recent studies conducted by the Center for Environmental and Geographic Information Services (CEGIS) for the Department of Environment (DoE) in 2019 reveal that sea levels along the coastal areas of

Bangladesh are rising at a rate of 3 to 6 mm per year. This analysis is based on data from water level gauge stations managed by the Bangladesh Water Development Board (BWDB) and the Bangladesh Inland Water Transport Authority (BIWTA). The observed trend underscores the ongoing impact of climate change on coastal regions, affecting communities and ecosystems dependent on stable sea levels for their livelihoods and safety. Detail report is of this study has been published by DoE.

Link for Detail Study by CEGIS: https://www.thedailystar.net/environment/climate-change/news/sea-level-rise-bangladesh-faster-global-average-3613116

3.6 Projection of Sea Level Rise

According to the Intergovernmental Panel on Climate Change (IPCC) AR6 report, the global mean sea level rose by 0.20 meters (range of 0.15 to 0.25 meters) between 1901 and 2018. The rate of sea level rise has accelerated significantly in recent decades: from 1.3 mm per year between 1901 and 1971, to 1.9 mm per year between 1971 and 2006, and further to 3.7 mm per year between 2006 and 2018. Projections indicate that relative to the period 1995–2014, global mean sea levels are likely to rise by 0.28–0.55 meters by 2100 under the lower emission scenario (SSP1-1.9), and by 0.63–1.01 meters under the higher emission scenario (SSP5-8.5).

SSP5-8.5 represents one of the pathways used in climate modeling to project future greenhouse gas emissions and socioeconomic development scenarios. It is characterized by high greenhouse gas emissions and limited climate change mitigation efforts, reflecting a future where global emissions continue to rise unabated. Under SSP5-8.5, which represents a high emissions trajectory, sea level projections for Hiron Point in the Bay of Bengal indicate:

- **By 2050:** A projected increase of 0.25 meters (range of 0.05 to 0.5 meters).
- **By 2080:** A projected increase of 0.65 meters (range of 0.1 to 0.9 meters).
- **By 2100:** A projected increase of 0.90 meters (range of 0.15 to 1.2 meters).

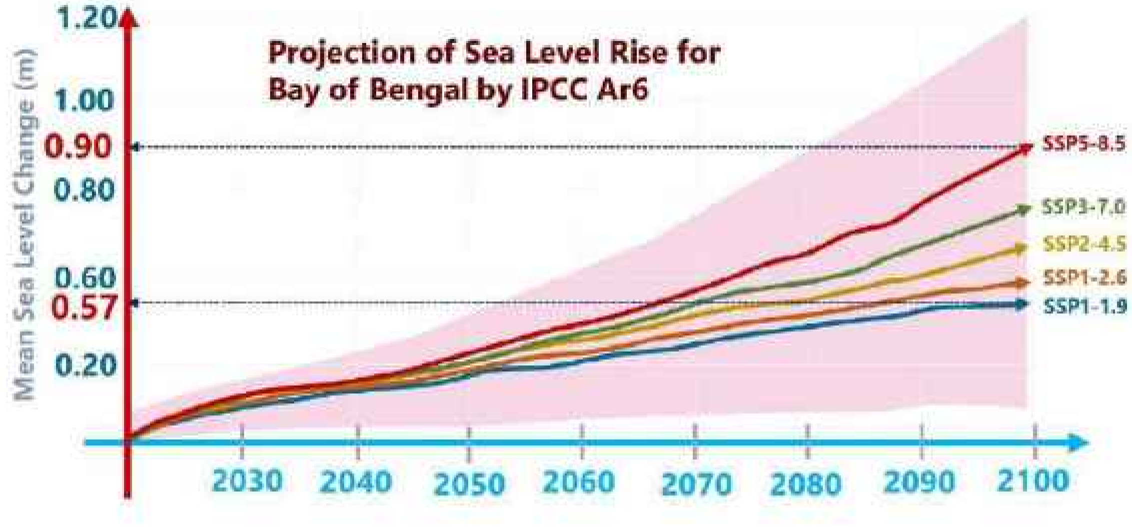

Figure 4: Projection of SLR for Bay of Bengal (Hiron Point) by IPCC Ar6

3.7 Risk & Vulnerabilities in Agriculture and Food Security

A major part of Bangladesh's food production system is at significant risk due to climate signals and hazards. Rising temperatures and uncertain rainfall patterns can cause phenological changes in plants, leading to lower yields. Higher temperatures beyond critical thresholds can have various detrimental effects on crops, including:

- **Spikelet sterility in rice:** Rice plants may fail to produce viable grains if exposed to high temperatures during flowering.
- **Reversal of vernalization in wheat:** Wheat requires a period of cold to germinate; high temperatures can disrupt this process.
- **Reduced tuber formation in potatoes:** High temperatures can hinder the development of potato tubers.
- **Loss of pollen viability in maize:** Maize pollen may become non-viable at elevated temperatures, reducing successful fertilization.

If temperatures exceed critical limits even for short periods during flowering, crop yields can be severely affected. Increased temperatures can also accelerate phenological development, reducing the grain-filling period and thus lowering yield.

Rising temperatures also intensify infestations of pests and diseases. For instance, recent research indicates that leaf folder infestations in rice fields could increase by 80-136 percent in different regions of Bangladesh by 2050. This threat is more pronounced in the northwest, north-central, and northeast regions and is likely to affect other major crops and vegetables as well, causing substantial production losses.

Coastal regions face significant risks due to sea-level rise and cyclonic storm surges. Coastal flooding could lead to rice crop production losses of 7.4 percent and 10.1 percent with sea-level rises of 0.62 meters and 0.92 meters, respectively, under the RCP8.5 scenario.

Fisheries and Aquaculture

Fisheries play a vital role in Bangladesh's economy, contributing 3.52 percent of GDP (26.37 percent of agricultural GDP), 1.39 percent of export earnings, and more than 60 percent of the animal protein supply in people's diets. Fishing provides direct or indirect employment to 12 percent of the total population. Over 50 percent of fish production comes from aquaculture, which is highly sensitive to climatic signals and hazards.

Research suggests that pond water quality degrades when temperatures exceed 25°C. Temperatures above 22°C reduce feed intake by fish, while temperatures above 32°C can cause slow growth and mortality. Extreme temperatures and erratic rainfall directly impact fish physiology, growth, reproductive systems, feeding behavior, production, and migration in inland and marine waters. The sensitivity of certain species to high temperatures and other climatic conditions poses significant concerns.

Recent studies indicate a potential decrease in the marine fish catch due to climate change impacts.

Summary of Key Risks for Crops

The potential impacts on crop production due to various climate signals and hazards are summarized below:

- **Excessive rainfall**: Crop damage, waterlogging, loss of cultivable lands, and altered cropping patterns.
- **Extreme heat**: Reduced crop yields, increased pest infestations, and altered flowering patterns.
- **Cold spells**: Crop damage and phenological changes.
- **Frequent river floods**: Crop damage, loss of fisheries and livestock production, and loss of livelihoods.
- **Early or frequent flash floods**: Crop damage during the dry season, harvesting and storage problems, altered cropping patterns, seasonal migration, and shifting occupations.
- **Severe droughts/water scarcity**: Irrigation water crises, reduced yields, food crises, and increased pests and diseases.
- **Frequent lightning**: Deaths of farmers.
- **Increased salinity**: Crop damage among traditional varieties, lower yields, unsuitable irrigation water, altered cropping patterns, limited agricultural production, loss of livelihoods, and internal displacement.
- **Frequent cyclones/tornadoes and storm surges**: Crop damage, loss of livelihoods, human deaths, and food and medicine crises.
- **Sea-level rise**: Reduced availability of cultivable lands, lower crop yields, and hampered food security.

3.6 Risk & Vulnerabilities of Bangladesh (National Level)

According to data from the Bangladesh Bureau of Statistics (BBS) in 2016 and 2022, climate change-induced disasters have inflicted substantial economic and social impacts on Bangladesh. From 2009 to 2014 alone, household damages amounted to approximately USD 2.30 billion, equivalent to 1.3% of the annual GDP. This trend continued with an average annual GDP loss of 1.3% due to climate-related disasters between 2016 and 2021.

Projections from the World Bank in 2021 highlight escalating risks in Bangladesh's coastal zones. By 2025, approximately 7 million people are expected to be at risk, a number projected to increase to 13 million by 2050. These populations face heightened vulnerabilities to sea level rise, storm surges, and other climate-related hazards, exacerbating displacement and economic strain.

Furthermore, internal climate migration is anticipated to rise significantly in Bangladesh. By the 2050s, an estimated 19.9 million people within the country may be displaced due to climate impacts, representing a substantial portion of South Asia's total climate migrants. This demographic shift poses profound challenges for urban planning, infrastructure development, and social cohesion.

The Ministry of Environment, Forest and Climate Change (MoEFCC) highlighted that a projected average temperature rise of 2°C by mid-century could lead to severe economic repercussions. Bangladesh could experience annual GDP losses of around 2% by 2050 and up to 9% by 2100 if significant climate action is not undertaken. Such losses threaten national goals related to water and food security, poverty reduction, and sustainable development, jeopardizing decades of progress in improving livelihoods and reducing poverty rates.

4. Past Initiatives and Success Stories

Over the years, Bangladesh has implemented several pioneering initiatives to combat the impacts of climate change and bolster agricultural resilience. Among these efforts are the introduction of **12 stress-tolerant crop varieties**, strategically selected to withstand adverse conditions such as drought, floods, and salinity. These varieties have not only enhanced food security but also stabilized agricultural yields across diverse ecological zones.

Additionally, the distribution of **19,428 metric tons of stress-tolerant seeds** has been pivotal in mitigating climate variability's effects on crop production. By promoting the adoption of resilient seeds, Bangladesh has fortified its agricultural sector against the uncertainties of changing climatic patterns, ensuring sustainable farming practices.

In the realm of infrastructure development, **Bangladesh has constructed 8,592 climate-resilient houses.** These structures serve as robust shelters during extreme weather events, safeguarding vulnerable communities and minimizing displacement and loss.

Innovative agricultural practices have also been embraced, exemplified by the creation of **12,900 floating vegetable beds.** These beds adapt flexibly to fluctuating water levels, particularly beneficial in flood-prone regions, where they enhance food security and livelihoods by maintaining productivity even during inundations.

Figure 4: Floating Agriculture in Pirojpur (Source: The New Humanitarian)

Furthermore, **the establishment of 550 Mujib Killa,** raised lands designed to withstand flooding, has proven crucial in maintaining agricultural productivity in flood-prone areas. These elevated lands provide a secure refuge during floods, preserving crops and ensuring continuity in agricultural activities.

Collectively, these initiatives underscore Bangladesh's proactive stance in climate change adaptation, showcasing its commitment to sustainable development and resilience-building across various sectors. They serve as successful models of innovation and adaptation, contributing significantly to enhancing food security, livelihood sustainability, and environmental resilience in the country.

5. Impact of Climate Change on Agriculture and Food Security

5.1 Impact of Temperature

Temperature extremes significantly affect crop growth and yield in Bangladesh. Each crop has an optimal temperature range for vegetative and reproductive stages, and deviations from this range can lead to reduced productivity. For instance, a 4°C increase in temperature, anticipated due to climate change, is projected to cause a substantial reduction in crop yields: a 28% decrease in rice and a 68% decrease in wheat output. High temperatures above 25°C can hinder potato growth, with growth ceasing entirely above 29°C. Similarly, maize production is significantly affected if temperatures exceed 35°C during the flowering stage.

5.2 Impact of Rainfall

Rainfall variability poses challenges to crop production in Bangladesh. Insufficient rainfall leads to drought conditions, while excessive rainfall causes floods and subsequent drainage problems that result in waterlogging. Heavy rainfall during the active growth period can lead to taller plants that are prone to lodging and decay in standing water. Water deficit during the vegetative stage reduces plant height, tiller number, and leaf area, although recovery is possible if water is available before flowering. However, water deficit during flowering and grain filling stages can lead to a 50% and 21% average reduction in crop yield, respectively.

5.3 Impact of Sea Level Rise and Cyclones

Sea level rise and cyclones significantly exacerbate vulnerabilities in coastal agricultural areas of Bangladesh. As sea levels continue to rise, coastal crop areas and their production potential are increasingly threatened, rendering existing farming practices unsustainable in many regions. Studies conducted by CEGIS for the Department of Environment in 2020 underscored these risks, estimating potential damage to pre-monsoon (Aman) crops at 5.8%, 7.2%, and 9.1% under sea level rise scenarios of 50 cm, 62 cm, and 95 cm, respectively. Particularly vulnerable districts such as Barisal, Patuakhali, Jhalokathi, and Pirojpur face significant agricultural losses.

The study also analyzed crop damage if a 1991-like cyclone occurs. It was found that sea level rise-induced flooding due to a 1991-like cyclone would cause Aman crop production losses of 5.9%, 8.1%, 7.4%, and 10% for 50 cm, 62 cm, and 95 cm sea level rise scenarios, respectively. The estimated crop damage value ranges from BDT 4,077 million to BDT 6,650 million, considering the same cropping area, yield rates, and crop prices for the four scenarios.

Furthermore, the study assessed the impact of a cyclone similar to Sidr. Sea level rise-induced flooding due to a Sidr-like cyclone would result in Aman crop production losses of 5.9%, 8.2%, 7.4%, and 10.1% for 50 cm, 62 cm, and 95 cm sea level rise scenarios, respectively. The crop damage value is estimated to be between BDT 4,315 million and BDT 7,406 million, considering the same cropping area, yield rates, and crop prices for the four scenarios.

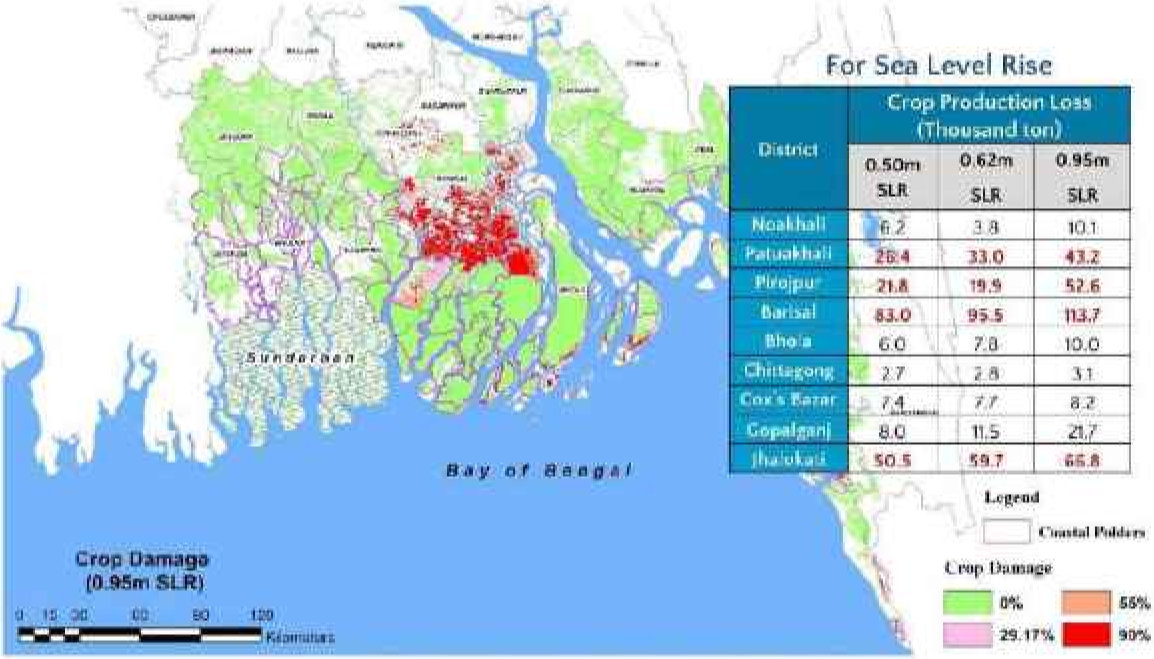

Figure 5: Crop Production Loss Due to Sea Level Rise (CEGIS Study)

5.3 Impact of Drought

Drought is a recurring issue in Bangladesh, particularly in the northwestern (NW) region, including districts such as Rajshahi, Naogaon, Nawabganj, Dinajpur, Joypurhat, Bogra, and Thakurgaon. These areas often experience severe and very severe drought conditions, significantly affecting crop production. The table below provides a classification of drought severity and its corresponding impact on crop yield:

Drought Class (Kharif)	Area (million ha)	Percent of Yield Reduction
Very Severe	0.34	> 45%
Severe	0.74	35 – 45%
Moderate	3.17	20 – 35%
Slight	2.9	< 20%
No Drought	0.68	-

In the context of the NW region:

- **Rajshahi, Naogaon, Nawabganj, and Dinajpur:** These districts frequently face very severe drought conditions, leading to more than a 45% reduction in crop yields.
- **Joypurhat, Bogra, and Thakurgaon:** These districts often encounter severe droughts, resulting in a 35–45% reduction in crop yields.

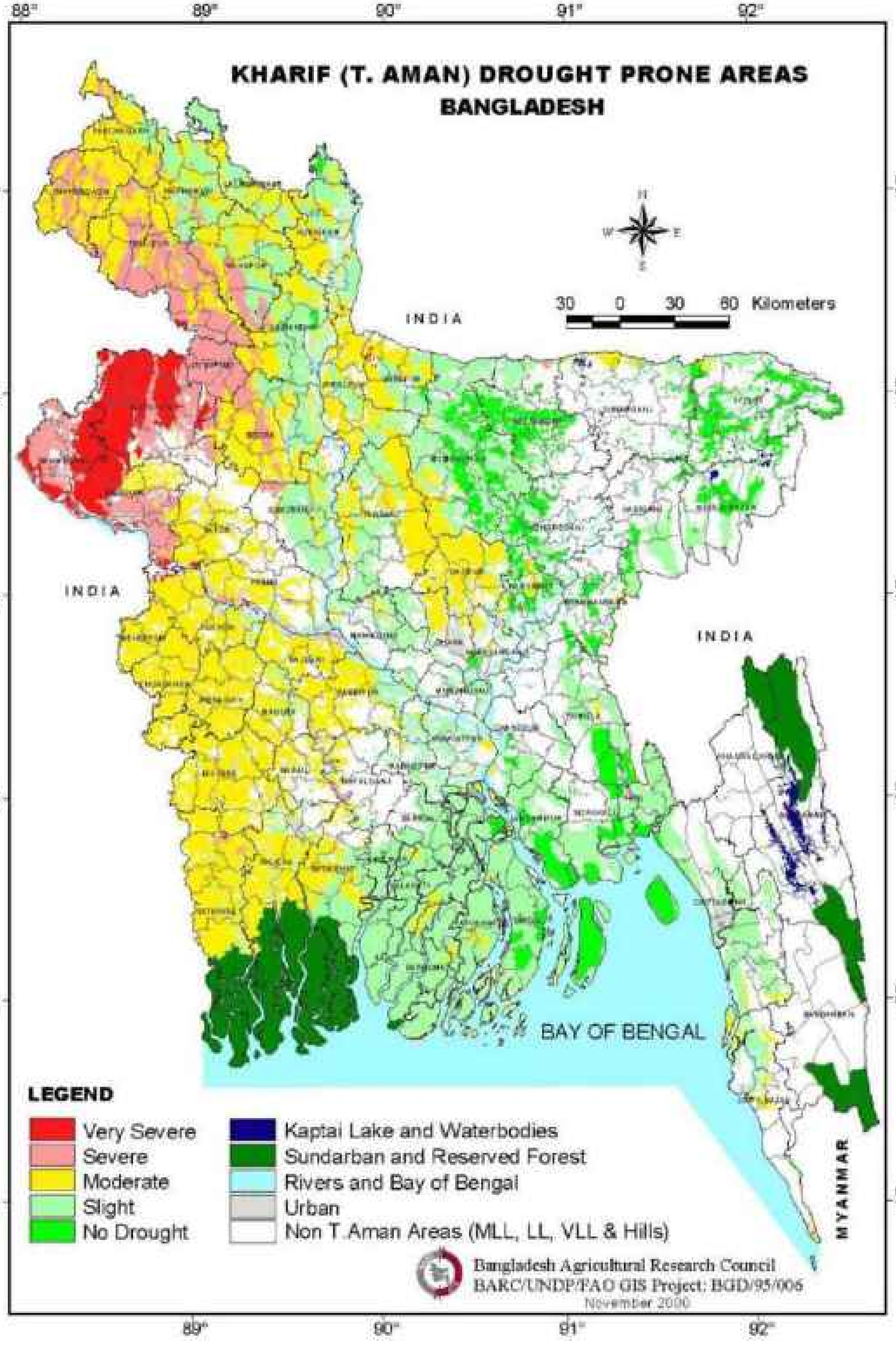

Figure 6: Kharif Drought Prone Areas in Bangladesh

5.4 Impact of Monsoon and Flash Floods

Monsoon floods and flash floods are common occurrences in Bangladesh, significantly impacting agricultural production. The increased frequency and intensity of these floods under climate change scenarios present severe challenges to crop yields and food security.

Higher discharge and low drainage capacity, combined with increased backwater effects, are expected to escalate the frequency and severity of such devastating floods. Both the Boro and Aman crops are particularly vulnerable to these conditions.

- **Boro Crop Vulnerability:** The Boro crop, grown during the dry season, is increasingly at risk from early flash floods. Flash floods occurring in the pre-monsoon period can submerge fields before the harvest, leading to significant crop losses. In recent years, the Haor areas have witnessed regular losses of Boro rice due to early flash floods.
- **Aman Crop Vulnerability:** The Aman crop, planted during the monsoon season, is highly susceptible to prolonged and severe monsoon floods. Major floods in Bangladesh, such as those in 1988, 1998, 2002, and 2008, have caused substantial reductions in agricultural production. For instance, the 1988 flood led to a 45 percent reduction in agricultural production. Similarly, the 1998 floods delayed Aman plantation, resulting in significant losses in potential Aman production.

The cumulative effect of these floods is not only the immediate loss of crops but also long-term impacts on soil health, cropping patterns, and farmers' livelihoods. Prolonged floods delay planting, disrupt the growth cycle of crops, and increase the risk of diseases and pest infestations.

11. Spotlight on Preparedness: Why Identifying Hazards, Risks, and Vulnerabilities in Bangladesh's Agricultural Sector Matters

Agriculture in Bangladesh is more than just an economic pillar—it is the backbone of food security and rural livelihoods, contributing 14 percent of GDP and employing over 40 percent of the population. Yet, as extreme weather events intensify and sea levels inch higher each year, the country's agricultural sector teeters on the frontline of climate change. **Identifying hazards, risks, and vulnerabilities** within this sector has therefore become a critical first step in safeguarding national prosperity and social stability.

By systematically mapping out climate threats—such as drought-prone areas in the northwest, flood-vulnerable Haor regions, and cyclone-exposed coastal zones—policymakers and practitioners can better channel resources and design targeted interventions. This process goes beyond mere data collection; it lays the foundation for adaptive policies like the National Adaptation Plan (NAP) and Climate-Smart Agriculture (CSA). Pinpointing where and how rising temperatures, erratic rainfall, or storm surges will impact farmers allows for strategic investments in stress-tolerant seeds, climate-resilient infrastructure, and improved water management systems.

Moreover, these assessments highlight **who** is most at risk—be it smallholder farmers reliant on rain-fed irrigation, fisheries-dependent coastal communities, or marginalized groups lacking financial safety nets. Tailoring support to these vulnerable populations not only sustains local food production but also bolsters community resilience against the next inevitable climate shock. Coupled with indigenous knowledge and scientific research, risk analyses can catalyze innovative solutions like floating vegetable beds, hydroponic farming, or improved post-harvest facilities that keep pace with shifting environmental realities.

In essence, the careful identification of hazards, risks, and vulnerabilities in Bangladesh's agricultural sector lays the groundwork for **forward-thinking leadership and inclusive development**. It ensures that

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Glossary of Key terms

Adaptation in the context of climate change refers to the process of making adjustments to societal, economic, and environmental practices in response to changing climatic conditions. It involves actions such as enhancing infrastructure resilience, implementing new farming techniques, or developing early warning systems to better cope with and thrive in altered weather patterns and environmental conditions.

Adaptive Capacity is the ability of a system (e.g., a community, sector, or society) to adjust to climate change—including climate variability and extremes—to moderate potential damages, take advantage of opportunities, or cope with the consequences.

Climate-Smart Agriculture (CSA) is an integrative approach to address interlinked challenges of food security and climate change by sustainably increasing agricultural productivity and resilience while reducing or removing greenhouse gas emissions.

Disaster is a serious disruption of the functioning of a community or a society due to hazardous events interacting with conditions of vulnerability, leading to widespread human, material, economic, or environmental losses.

Exposure relates to the extent to which a system, community, or asset is exposed to potential climate-related risks and hazards. For instance, urban areas located in low-lying coastal zones are highly exposed to the risks of sea-level rise, storm surges, and increased frequency of extreme weather events like hurricanes or heavy rainfall.

Hazards is a potentially damaging physical event, phenomenon, or human activity that can cause loss of life, injury, property damage, social and economic disruption, or environmental degradation (e.g., floods, droughts, cyclones).

Mitigation involves taking proactive measures to reduce or prevent the adverse impacts of climate change. This includes efforts to minimize greenhouse gas emissions through the adoption of renewable energy sources, energy efficiency improvements, afforestation to sequester carbon dioxide, and technological innovations aimed at reducing carbon footprints across various sectors.

Nature-Based Solutions (NbS) means actions to protect, sustainably manage, and restore natural or modified ecosystems to address societal challenges (e.g., climate change, food security), thereby providing both human well-being and biodiversity benefits.

Resilience refers to the capacity of individuals, communities, ecosystems, and economies to withstand and recover from climate-related disruptions, shocks, or stresses. It involves building adaptive capacities, fostering social cohesion, enhancing ecosystem services, and implementing policies and strategies that promote sustainable development and climate resilience.

Risk is the potential for a hazard event to lead to adverse consequences, typically assessed as a function of the hazard itself, the exposure of assets or communities, and their vulnerability.

Scenario in the context of climate change is a plausible description of how future conditions may unfold, based on a coherent and internally consistent set of assumptions about key environmental, social, and economic factors and their relationships. For example, the Intergovernmental Panel on Climate Change (IPCC) uses different scenarios, such as Representative Concentration Pathways (RCPs), to explore various possible futures based on different levels of greenhouse gas emissions and socioeconomic development trajectories. These scenarios help policymakers and researchers understand the range of potential outcomes and inform decisions on adaptation and mitigation strategies.

Sensitivity in the context of climate change refers to the degree to which a natural or human system responds to changes in its environment. For example, coastal regions are highly sensitive to rising sea levels and increased storm intensity, which can lead to erosion, flooding, and infrastructure damage.

Vulnerability describes the susceptibility of a system or community to harm, damage, or adverse effects resulting from climate change impacts. Factors contributing to vulnerability include socioeconomic conditions, inadequate infrastructure, limited access to resources, and geographical location. Vulnerable communities often face disproportionate risks and challenges in adapting to and mitigating climate change impacts.

Climate Reality Leadership in Agriculture Sector

Handout on

Leadership in Climate Negotiations:

Achievements and Shortcomings of COP 29

Prepared By

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Table of Contents

Navigating This Handout: A Roadmap

This handout is designed to offer a comprehensive look at the achievements and challenges emerging from **COP29**, the 2024 UN climate conference held in Baku, Azerbaijan. By breaking down the key components of the conference—from its theme and focus areas to the leadership lessons learned—the handout aims to provide a clear understanding of why COP29 matters and how its outcomes shape future climate negotiations. Here's how you can make the most of each section:

1. **Introduction (Section 1.1)**
   - **What is COP29?**
     Explore the broader context of the United Nations Framework Convention on Climate Change (UNFCCC) and understand why COP29 was a pivotal moment. This section sets the stage by describing the importance of climate finance, the tensions around fossil fuel dependence, and the evolving role of vulnerable nations like Bangladesh.
2. **Theme of COP29 (Section 1.2)**
   - Discover the overarching motto—**"Investing in a Livable Planet for All"**—and how it underscores global efforts toward equitable, sustainable development. Gain insights into the slogan, **"In Solidarity for a Green World,"** and learn why solidarity was a key message throughout the conference.
3. **Key Focus of COP29 (Section 2)**
   - Delve into the conference's central emphasis on **climate finance** and understand how trillions of dollars are needed to meaningfully reduce emissions, strengthen resilience, and support developing countries at greatest risk from climate impacts.
4. **Priority Areas of COP29 (Section 3)**
   - Get an overview of the five main priority areas—ranging from **phasing out fossil fuels** to **promoting sustainable practices**—that shaped negotiations, guided policy proposals, and framed discussions around transitioning to low-carbon economies.
5. **Leadership and Negotiation Achievements (Section 4)**
   - Learn about the most significant milestones achieved during COP29, such as the **full operationalization of the Loss and Damage Fund**, finalizing **Article 6** (carbon markets) of the Paris Agreement, and broadening **transparency** in climate reporting. This section highlights how strong leadership—both from governments and civil society—can drive substantive progress.
6. **Shortcomings and Ongoing Challenges (Section 5)**
   - Understand the critical gaps and controversies that lingered after COP29. Key issues include **insufficient climate finance**, limited commitments to **fossil fuel phase-out,** and **geopolitical uncertainties** that threaten to undermine long-term climate pledges.
7. **Spotlight on Bangladesh: Gains and Challenges (Section 6)**
   - Examine how Bangladesh, a highly climate-vulnerable nation, navigated the COP29 landscape. This section uncovers the country's **gains**, such as the operationalization of the Loss and Damage Fund, and **challenges**, including inadequate funding and marginalization in negotiations.
8. **Broader Leadership Takeaways (Section 7)**
   - Explore key insights on how leadership and diplomacy are evolving in the climate arena. This section explains why **vulnerable nations**, **civil society activists**, and **major emitters** each play a vital role in steering global climate policy, and how divisions between rich and poor countries continue to shape the negotiations.
9. **Future Outlook (Section 8)**
   - Look ahead to **COP30 in Brazil** and beyond, where unresolved issues around finance, adaptation, and fossil fuel reduction will be revisited. This section discusses the significance of forthcoming climate summits and the potential for a truly **just transition** to cleaner economies.

1. Introduction

1.1 What is COP29??

Climate change stands as one of the most urgent challenges of our time, demanding coordinated global action. Against this backdrop, the annual Conferences of the Parties (COP) under the United Nations Framework Convention on Climate Change (UNFCCC) serve as a pivotal arena for international climate negotiations. Each year, nearly 200 countries convene to assess progress, set targets, and forge solutions to mitigate and adapt to an evolving climate crisis.

COP29, held from November 11–22, 2024, in Baku Stadium, Azerbaijan, represented a defining moment in this ongoing global effort. Hosted by a nation whose economy is heavily reliant on oil and gas exports, COP29 highlighted the complexities of balancing economic interests with the urgent need for climate action. Under the overarching theme, **"Investing in a Livable Planet for All,"** and the slogan, **"In Solidarity for a Green World,"** delegates grappled with the tension between ambitious goals for emissions reductions and the realities of economic development—particularly in developing countries most vulnerable to climate impacts.

Azerbaijan's presidency placed **climate finance** at the center of COP29, recognizing that financial resources play a critical role in helping nations transition to low-carbon economies, safeguard ecosystems, and build resilience against climate-induced disasters. Alongside these priorities, negotiations touched on the phase-out of fossil fuels, operationalizing carbon markets under Article 6 of the Paris Agreement, and enhancing transparency in climate reporting. Notably, countries also continued to develop mechanisms like the **Loss and Damage Fund**, aimed at supporting communities already facing irreversible climate impacts.

Yet, beneath these milestones lie major questions about the **leadership** required to advance—and sustain—global climate commitments. Are financial pledges from wealthier nations sufficient to address the scale of the crisis? How can countries dependent on fossil fuel exports reconcile economic realities with the urgent need for emission cuts? How can vulnerable nations—such as Bangladesh—leverage global platforms effectively to secure climate justice?

This lecture note examines the **achievements** of COP29, including new finance commitments and progress on the Loss and Damage Fund, while also addressing the **shortcomings** revealed in negotiations. It explores how leadership—whether in the form of governmental policies, civil society activism, or private-sector investments—shapes the outcomes of high-stakes climate diplomacy. Finally, it highlights the lessons learned from COP29 as the international community looks ahead to COP30 and beyond, recognizing that successful climate action depends on forging a more equitable, transparent, and ambitious path forward for all.

1.2 Theme of COP29

The overarching theme of COP29 was **"Investing in a Livable Planet for All."** This theme encapsulates the conference's focus on sustainable investment strategies that ensure environmental resilience and equitable benefits for all nations and communities. The slogan **"In Solidarity for a Green World"** highlighted the collective responsibility and collaborative spirit necessary to address the global climate crisis effectively.

2. Key Focus of COP29

The **key focus of COP29 centered primarily on climate finance**, recognizing that trillions of dollars are essential for countries to significantly reduce greenhouse gas emissions and safeguard lives and livelihoods against the escalating impacts of climate change. The emphasis on finance aimed to facilitate the transition to low-carbon economies and support climate-resilient infrastructure, particularly in developing nations that are most vulnerable to climate impacts.

3. Priority Areas of COP29

COP29 identified several **priority areas** to enhance ambition and enable actionable climate solutions:

- **Climate Finance**: Achieving a new agreement to **triple finance to developing countries** by 2035, increasing from the previous goal of USD 100 billion annually to USD 300 billion annually.
- **Phasing Out Fossil Fuels:** Accelerating the phase-out of fossil fuels with the goal of achieving **net zero emissions by 2050** or sooner.
- **Building Climate-Resilient Societies:** Empowering groups that steward nature to enhance societal resilience against climate impacts.
- **Promoting Sustainable Practices:** Encouraging sustainable practices across various sectors to mitigate environmental degradation.
- **Transitioning to Low-Carbon Economies:** Implementing policies and initiatives that facilitate the shift towards low-carbon economic models.

4. Leadership and Negotiation Achievement

COP29 showcased notable progress driven by both collective and individual leadership from key negotiators, international organizations, and civil society. These achievements not only reflected the conference's overarching focus on climate finance and resilience but also underscored the evolving nature of global climate governance. Major milestones include:

4.1 Operationalization of the Loss and Damage Fund

- **Full Activation of the Fund**: Having been initially proposed at COP27, this fund was fully activated at COP29, marking a breakthrough in providing dedicated support to the most climate-vulnerable countries, including small island states, least developed countries, and African nations.
- **Leadership and Governance**:
  - **Executive Director**: Ibrahima Cheikh Diong's appointment signals strong administrative leadership.
  - **Key Agreements**: The Fund's Board signed a Trustee Agreement and Secretariat Hosting Agreement with the World Bank, as well as a Host Country Agreement with the Republic of the Philippines.
- **Significance of Pledges**: Over $730 million was pledged, with the Fund set to begin financing projects in 2025—representing a major step in shifting from promises to tangible action.

3.2 Full Operationalization of Article 6 of the Paris Agreement

- **Unlocking International Carbon Markets**: COP29 ended a decade-long stalemate by finalizing rules for high-integrity carbon markets. This enables countries and corporations to collaborate on reducing emissions through transparent trading of carbon credits.
- **Financial and Environmental Impact**:
  - **Cost Savings**: Implementation is projected to cut the cost of achieving Nationally Determined Contributions (NDCs) by up to $250 billion per year.
  - **Human Rights and Transparency**: Guidelines ensure projects respect indigenous rights, incorporate rigorous verification, and allow for periodic rule updates.
- **Negotiating Breakthrough**: Resolving Article 6 disagreements required substantial diplomatic leadership, reflecting a spirit of compromise and "learning by doing."

3.3 Agreement to Triple Public Climate Finance to Developing Countries

- **Ambitious New Finance Target**: COP29 negotiators reached consensus on tripling public finance from $100 billion to $300 billion annually by 2035, while aiming for a combined $1.3 trillion in yearly climate investments from both public and private sources.
- **Rationale and Impact**:
  - **Protecting Vulnerable Nations**: Enhanced finance is crucial for adaptation and for small and developing nations facing disproportionate climate risks.
  - **Supporting Stronger NDCs**: This pledge underpins more robust national climate plans, pushing countries to revise and enhance their targets in 2025 and beyond.
- **Challenges Ahead**: Although the pledge is historic, many developing countries deemed it insufficient given the escalating scale of the climate crisis.

3.4 Advancements in Transparent Climate Reporting

- **Biennial Transparency Reports (BTRs)**: Thirteen Parties submitted their first BTRs, setting a precedent for enhanced accountability.
- **Conclusion of Transparency Negotiations**: All items under the Enhanced Transparency Framework (ETF) were resolved, equipping nations with robust tools to monitor, verify, and report their climate actions.
- **Leadership in Accountability**: By finalizing these frameworks, leaders reinforced the principle that transparent, evidence-based reporting underpins effective climate policy.

3.5 Progress on Adaptation

- **Focus on Least Developed Countries (LDCs)**: A dedicated support program was established to accelerate National Adaptation Plan (NAP) implementation, reflecting strong advocacy from LDC negotiators.
- **Baku Adaptation Road Map**: Launched to guide progress on the Global Goal on Adaptation, this roadmap provides indicators and timelines leading up to COP30.
- **High-Level Dialogue on NAPs**: Ministers from LDCs and Small Island Developing States united to discuss financing solutions for meeting the 2025 NAP submission deadline.

3.6 Other Notable Achievements

- **Gender and Climate Change**: The Enhanced Lima Work Programme on Gender and Climate Change was extended for a further 10 years, with plans to adopt a new Gender Action Plan at COP30.
- **Civil Society Participation and Youth Involvement**: Over 55,000 attendees highlighted growing public engagement, including dedicated spaces for youth-driven dialogues.
- **Support for Indigenous Peoples**: Adoption of the Baku Workplan renewed the Facilitative Working Group's mandate, reinforcing Indigenous leadership in climate solutions.

5. Shortcoming and Ongoing Challenges

While COP29 achieved several milestones—from fully operationalizing the Loss and Damage Fund to finalizing Article 6 rules—these advancements also illuminated deeper systemic challenges within global climate governance. Despite pledges to enhance financial support and streamline climate action, the following shortcomings remain significant hurdles:

5.1 Insufficient and Contested Climate Finance

- **Critique of New Targets**: Although richer nations committed to tripling public climate finance to $300 billion annually by 2035, many developing countries deemed the figure inadequate given the escalating climate crisis.
- **Private Sector Reliance**: A large share of the $1.3 trillion annual target is expected to come from private investment, raising concerns about equitable access to funds and the risk of profit-driven solutions overshadowing public-interest projects.
- **Equity Concerns**: Countries like Bangladesh voiced dissatisfaction that wealthier nations have not met earlier finance promises, compounding skepticism about these new, more ambitious targets.

5.2 Limited Progress on Fossil Fuel Phase-Out

- **Lack of a Clear Global Timeline**: Although there was momentum to accelerate the phase-out of fossil fuels, the conference did not explicitly commit to a binding phase-out schedule for coal, oil, and gas.
- **Host Country Debates**: Azerbaijan's economic reliance on oil and gas, along with questions surrounding its governance, sparked debate over the suitability of the host nation and whether it could champion a swift transition away from fossil energy.

5.3 Persistent Divisions Between Developed and Developing Nations

- **Negotiation Tensions**: The heightened expectations around finance and technology transfers revealed ongoing fractures between richer nations and those most vulnerable to climate impacts, as evidenced by disagreements over how much funding should come from public sources versus private investment.
- **Marginalization of Vulnerable Voices**: Despite Bangladesh's vocal advocacy, it and other climate-vulnerable nations noted a sense of sidelining in key negotiations, underscoring broader imbalances in decision-making power.

5.4 Implementation Gaps and Delayed Decisions

- **Article 6 Challenges**: Although the rulebook for international carbon markets was finalized, some observers worry that loopholes could allow for "greenwashing" without leading to genuine emission reductions, especially if market mechanisms are not carefully monitored.
- **Fossil Fuel Reduction Timeline Postponed**: Critical discussions on a binding timeline for phasing out fossil fuels and scaling up renewables were deferred to COP30, prolonging uncertainty and slowing immediate policy action.

5.5 Heightened Activism and Civil Society Pressure

- **Increased Confrontation**: Environmental NGOs, youth activists, and frontline communities intensified their demands for swift and far-reaching reforms, reflecting growing frustration with the pace of negotiations.
- **Future Diplomatic Strains**: The surge in civil society engagement may strain future COPs if official processes do not more effectively integrate activist perspectives and address calls for justice and equity.

5.6 Geopolitical Uncertainties

- **Shifts in Major Economies**: Anticipated political changes in the United States fueled concerns about the durability of financial commitments, while China's growing role in climate finance added another layer of complexity.
- **Long-Term Agreements in Question**: Countries worry that shifting geopolitical priorities could undermine the stability of funding pledges, further complicating both adaptation and mitigation strategies.

6. Spotlights on Bangladesh: Gains and Challenges

Bangladesh emerged as a prominent advocate for climate-vulnerable nations at COP29, highlighting both the country's acute vulnerabilities to climate impacts and its proactive efforts to foster global resilience. Despite facing formidable challenges in securing equitable financing and stronger emission commitments, Bangladesh leveraged the Baku conference to underscore the urgent needs of nations on the frontline of the climate crisis.

6.1 Gains

1. **Operationalization of the Loss and Damage Fund**
   - Bangladesh welcomed the Fund's full activation—originally agreed upon at COP27—as a critical mechanism to provide financial assistance to countries most affected by climate change.
   - The country presented its **Loss and Damage Framework**—developed by the Department of Environment (DoE) with intellectual support from CEGIS—which lays out strategies for assessing climate-induced losses and accessing international climate finance.
   - Key leaders and activists, including Syeda Rizwana Hasan and Malik Fida A Khan, emphasized this framework's importance in strengthening Bangladesh's capacity to address recurring disasters like floods and cyclones.

2. **Support for Tripled Climate Finance**
    - The agreement to raise annual public finance from $100 billion to $300 billion by 2035 offers Bangladesh a potential increase in resources to bolster adaptation and mitigation efforts.
    - This expanded pool, albeit still debated as insufficient, can aid the country's transition to renewable energy, as well as enhance coastal protection and disaster-preparedness measures.

6.2 Challenges

1. **Insufficient Funding and Equity Concerns**
    - Despite the newly established Loss and Damage Fund, its initial $20 billion pool is far below the estimated $1.3 trillion required annually.
    - Over-reliance on private-sector contributions raises further concerns about equitable access to much-needed climate financing.

2. **Climate Finance Commitment Still Inadequate**
    - Scale vs. Reality: The USD 300 billion/year target by 2035 does not sufficiently address Bangladesh's immediate and long-term needs. The reliance on private-sector contributions further raises equity concerns, as these funds may come with strings attached or favor profit-oriented projects.

3. **Uncertainty Around Grant-Based and Concessional Finance**
    - Lack of Binding Commitments: Although COP29 called for more public grants and concessional loans, definitive pledges and enforcement mechanisms remain weak. This uncertainty hampers Bangladesh's ability to plan and implement large-scale adaptation or mitigation projects.

4. **Marginalization in Negotiations**
    - Bangladesh, despite its leadership in climate resilience, felt sidelined in core negotiations. Such marginalization mirrors the broader inequities that persist within international climate diplomacy.

5. **Inadequate Commitments from High-Emitting Nations**
    - The country criticized wealthy nations for not offering more robust public grants, leaving adaptation efforts heavily dependent on loans and private investments.
    - The absence of a binding global timeline to phase out fossil fuels intensifies Bangladesh's vulnerability to rising sea levels and other climate threats.

6. **Delayed Mitigation Decisions**
    - Key discussions on fossil fuel reductions were postponed until COP30, posing risks to Bangladesh's efforts to move toward cleaner energy and reduce its reliance on imported fuels.

7. **Just Transition Imperative**

    - Equitable Shift: Bangladesh needs a just transition strategy that ensures economic and social protections for communities affected by climate impacts and the shift away from fossil fuels. This includes job retraining, community consultation, and fair access to technological innovations.

8. **Gender Equality in Climate Action**

    - Mixed Progress: While the extension of the Lima Gender Action Plan is a positive step, integrating gender-responsive policies into adaptation and mitigation projects requires greater financial and institutional support—still lacking at the global level.

9. **Concerns Over Carbon Markets**

    - Risk of Unequal Benefits: Although carbon credits may open new funding avenues, Bangladesh worries that wealthier nations could dominate these markets. Robust oversight and fair credit pricing are essential to ensure Bangladesh can truly benefit from carbon trading mechanisms.

6.3 Outlook

Despite these setbacks, Bangladesh remains committed to championing stronger and more equitable climate action. As it prepares to host **COP31 in 2026**, the nation intends to leverage its platform to:

- Advocate for **binding emission reduction** timelines from major polluters.
- Push for **increased public grants** and concessional loans to meet its adaptation and mitigation needs.
- Strengthen **regional and South-South cooperation**, especially in areas like disaster risk reduction, renewable energy, and coastal resilience.
- Elevate the roles of **youth, Indigenous communities,** and **women** in shaping climate policies, aligning with broader gender and justice agendas.

7. Boarder Leadership Takeaways

1. Shifts in Global Climate Leadership

- **Emergence of Vulnerable Nations' Voices**: Countries like Bangladesh and other frontline states demonstrated growing influence by placing loss and damage, just transition, and equitable finance firmly on the negotiation table. This underscores a shift in leadership dynamics, where low- and middle-income countries are increasingly shaping the agenda.
- **Role of China and Other Major Emitters**: China's heightened transparency in climate finance signals a potential pivot in how major emitters engage with the global community. Meanwhile, wealthier nations face scrutiny for pledging large sums without fully delivering on previous commitments.

2. Finance as a Pivotal Lever

- **Public vs. Private Funding**: The agreement to triple climate finance to $300 billion annually by 2035 offers a measure of progress, yet the reliance on private capital raises questions about equitable access and long-term sustainability.
- **Calls for True Solidarity**: Persistent criticisms about insufficient public funding highlight the need for genuine, grant-based support rather than debt-driven solutions—especially in nations already bearing disproportionate climate burdens.

3. Managing Political and Economic Trade-Offs

- **Fossil Fuel Phase-Out Debates**: Azerbaijan's role as COP29 host highlighted the tension between economic reliance on fossil fuels and global decarbonization goals. Balancing these interests demands innovative policy frameworks and leadership that can navigate socio-economic realities while driving climate ambition.
- **Geopolitical Uncertainties**: Anticipated political changes in major economies—such as the United States—underscore that climate action can be fragile when it depends on shifting political tides, necessitating stronger international safeguards.

4. Inclusive Participation and Youth Activism

- **Civil Society's Growing Influence**: With over 55,000 attendees, COP29 witnessed unprecedented civil society engagement. Youth activists, Indigenous Peoples, and grassroots organizations insistently called for faster and more inclusive climate action.
- **Potential for Tension or Transformation**: While heightened activism can strain diplomatic processes, it also accelerates accountability and injects fresh perspectives, potentially propelling negotiations toward more robust outcomes.

5. Next Steps for Equitable Climate Governance

- **Toward COP30 and Beyond**: Ongoing divisions—particularly in finance, fossil fuel phase-outs, and transparency—demand continued leadership and dialogue. COP30 in Brazil will serve as a litmus test for whether global actors can transform lofty commitments into actionable strategies.
- **Building Long-Term Momentum**: Strengthening global leadership hinges on bridging trust gaps, securing stable financing, and embracing inclusive decision-making. Nations that demonstrate transparency, fairness, and responsiveness to civil society are likely to emerge as credible leaders in the unfolding climate era.

In essence, **COP29** underscored that leadership is not merely about making pledges—it requires sustained action, genuine collaboration, and a deep commitment to equity. Addressing these broader challenges will determine how effectively the international community can forge a climate-resilient future for all.

8. Future Outlook

Looking beyond COP29, the international community faces an urgent mandate: to translate pledges into tangible, equitable progress. Several key developments and milestones loom on the horizon:

1. **COP30 in Brazil (2025)**
   - **Focus on Implementation**: Building on partial agreements around climate finance and fossil fuel reduction, COP30 is expected to yield more concrete pathways for phasing out coal, oil, and gas.
   - **Refining Climate Finance Mechanisms**: Negotiators and stakeholders will likely revisit issues of public vs. private funding, seeking more robust structures to ensure equitable disbursement of promised resources.
   - **Revised NDC Submissions**: Countries will be under pressure to strengthen their Nationally Determined Contributions, especially given global calls for accelerated decarbonization and enhanced adaptation measures.
2. **Toward a Just Transition**
   - **Economic and Social Dimensions**: Future negotiations must address the social implications of fossil fuel phase-outs, including job retraining, community redevelopment, and support for local economies.
   - **Technological Collaboration**: From renewable energy to climate-resilient infrastructure, technology-sharing frameworks could bridge the gap between developed and developing nations.
3. **Geopolitical and Economic Factors**
   - **Changing Political Climates**: Shifts in major economies—such as the U.S., EU, and China—will significantly shape the global climate agenda, influencing financial commitments and market-based mechanisms.
   - **Evolving Role of Non-State Actors**: Civil society groups, private sector alliances, and subnational governments will continue to press for bolder policies, potentially redefining the scope of official negotiations.

9. Conclusion

COP29 in Baku offered a complex landscape of ambition, partial successes, and persistent inequities. On one hand, the **full operationalization of the Loss and Damage Fund** and **tripling of climate finance commitments** to $300 billion annually by 2035 signaled progress in acknowledging the needs of frontline nations. Similarly, **finalizing Article 6** and expanding **transparency frameworks** have laid a structural foundation for more accountable climate action.

Yet, significant gaps remain. **Criticisms of inadequate funding, lack of binding fossil fuel phase-out timelines, and the overreliance on private capital** underscore deep-rooted challenges in achieving a fair, effective global climate regime. Nations like Bangladesh exemplify both the promise and pitfalls of international climate diplomacy, championing stronger resilience measures yet grappling with insufficient and uneven support.

These realities point to a clear imperative: global leaders, negotiators, and civil society must sustain pressure to fulfill and surpass existing commitments. Efforts at **COP30 in Brazil** and beyond will need to integrate meaningful finance mechanisms, prioritize just transitions, and ensure that all voices—particularly those most vulnerable—are heard and respected. Only through **inclusive, transparent, and ambitious cooperation** can the world mobilize at the speed and scale necessary to confront the escalating climate crisis.

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Gender Integration in Climate Action

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Purpose

This handout complements the presentation "Gender Integration in Climate Action" by summarizing key concepts, challenges, opportunities, and strategies for gender-responsive climate initiatives.

Objectives of Gender Integration in Climate Action

- **Understand Gendered Impacts:** Recognize how gender roles, societal structures, and intersecting factors create different experiences and vulnerabilities for men, women, and marginalized groups in the context of climate change.
- **Explore Barriers and Opportunities:** Identify systemic obstacles that limit gender equality in climate action and explore opportunities for inclusive approaches to drive transformative change.
- **Implement Actionable Steps:** Learn practical strategies for embedding gender-responsive measures into climate policies, programs, and initiatives.

Why Gender Matters in Climate Action

- **Differentiated Impacts:**
  - Women often shoulder primary responsibilities for managing household resources (e.g., water, food, energy), making them more vulnerable to climate shocks.
  - Men frequently work in sectors like agriculture and fisheries, heavily impacted by climate variability.
- **Inclusivity Enhances Solutions:**
  - Climate projects are more effective and sustainable when integrating diverse perspectives, including those of women and marginalized groups.
  - Women's participation in decision-making fosters innovation and equitable solutions.
- **Resilience and Equity:**
  - Gender integration empowers communities, ensuring all members contribute to and benefit from climate action.

Key Dimensions of Gender-Climate Nexus

1. **Biological Factors:**
   - Age, disability, and health conditions (e.g., pregnancy) increase risks.
   - Example: Pregnant women face mobility challenges during disasters.
2. **Territorial/Physical Factors:**
   - Rural populations often lack infrastructure and resources, increasing vulnerability.
   - Example: Lack of quick emergency response systems in rural areas.

3. **Economic Factors:**
    - Poverty limits access to recovery resources, exposing low-income families to higher risks.
    - Example: Women's livelihoods are disproportionately affected due to limited access to credit and technology.
4. **Social and Political Factors:**
    - Cultural norms and discrimination limit women's mobility, access to services, and decision-making roles.
    - Example: Women may lack access to shelters during disasters due to cultural restrictions.

Challenges in Gender Integration

- **Barriers to Equality:**
    - **Underrepresentation:** Women are significantly underrepresented in climate policy forums, excluding their perspectives.
    - **Cultural Norms:** Deep-rooted patriarchal systems limit women's public participation.
    - **Resource Gaps:** Women lack access to financial resources, technology, and training, perpetuating inequalities.
- **Gender-Differentiated Vulnerabilities:**
    - Women and marginalized groups face heightened risks due to restricted access to resources and services.
    - Example: Salinity-induced water scarcity disproportionately impacts women in coastal areas.

Opportunities for Transformative Change

- **Leadership and Innovation:**
    - Women-led initiatives, such as renewable energy projects, demonstrate innovative solutions.
- **Synergy with Sustainability Goals:**
    - Aligning gender equality with climate action enhances environmental and social outcomes, advancing Sustainable Development Goals (SDGs).
- **Success Stories:**
    - Women's cooperatives in regions like Africa and Asia have led reforestation and water conservation efforts, improving biodiversity and community resilience.

Strategies for Gender-Responsive Climate Action

1. **Conduct Gender Analyses:**
    - Examine impacts of climate policies on different genders to address disparities effectively.
2. **Promote Inclusive Leadership:**
    - Advocate for women's participation in decision-making processes at all levels.
3. **Build Capacity and Awareness:**
    - Develop training programs to empower women with technical skills relevant to climate resilience.

4. **Allocate Resources Equitably:**
    - Prioritize funding for gender-focused initiatives and ensure equal access to financial and technological resources.
5. **Integrate Gender in Climate Adaptation:**
    - Use frameworks like the National Adaptation Plan (NAP) to align gender-responsive goals with national climate strategies.
    - The NAP process incorporates gender-responsive planning at every stage, ensuring that adaptation measures address the specific vulnerabilities and strengths of different genders. It emphasizes meaningful participation of women and marginalized groups, integrates gender-focused criteria in adaptation options, and includes gender-sensitive monitoring and evaluation frameworks. NAP also aligns with national policies such as Bangladesh's Climate Change Strategy and Action Plan (BCCSAP) to support long-term resilience and equity.

<u>Interactive Activity: Gender and Climate Analysis</u>

1. **Objective:** Engage participants in analyzing gender disparities within climate initiatives.
2. **Steps:**
    - **Step 1:** Select a dimension of human well-being (e.g., food production, water availability, health, natural disasters, or displacement).
    - **Step 2:** Analyze gender impacts in groups, considering roles, responsibilities, and social status.
    - **Step 3:** Answer key questions on gendered differences, their causes, and examples.
    - **Step 4:** Present findings and discuss common themes.

Summary and Key Takeaways

- Climate change affects genders differently; addressing these differences is critical for effective action.
- Gender-sensitive policies enhance inclusivity and sustainability of climate initiatives.
- Overcoming systemic barriers fosters participation at all levels, leading to transformative outcomes.

<u>Supporting Resource:</u>

- **Checklist for Gender-Responsive Climate Action:**
    - Conduct gender analyses in project planning.
    - Ensure equal representation in decision-making.
    - Establish clear gender-specific objectives and measure progress.

Case Study Examples:

1. **Women-Led Solar Initiatives:**
    - Women's cooperatives install solar panels, enhancing energy access and reducing emissions.
2. **Community-Based Water Management:**
    - Women-led rainwater harvesting initiatives increase water availability and community resilience.

1. ***Supporting resources with layout:***

01: Gender in general

https://youtu.be/yJ51tcNxV_o

Box 01		
Type	**Description**	**Icon**
Youth Men	A young person who identifies as male, typically under the age of 18.	
Youth Women	A young person who identifies as female, typically under the age of 18.	
Men	An adult who identifies as male.	
Women	An adult who identifies as female.	
Cisgender	A person whose gender identity matches the sex they were assigned at birth.	
Transgender	A person whose gender identity differs from the sex they were assigned at birth.	
Non-Binary	A person who does not identify exclusively as male or female.	
Genderqueer	A person who identifies outside traditional gender categories.	
Agender	A person who identifies as having no gender or being gender-neutral.	⊘
Genderfluid	A person whose gender identity shifts over time.	
Two-Spirit	A term used by some Indigenous peoples to describe a person with both masculine and feminine spirit	

02: Climate change and gender

Box 02 Sustainable Development Goals – SDG 13: "Taking Urgent Action to Combat Climate Change—SDGs and the Paris Agreement"

The following suggested targets and indicators are associated with the 13th SDG:

- Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries
- Integrate climate change measures into national policies, strategies and planning
- Improve education, awareness raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning
- Implement the commitment undertaken by developed country parties to the UNFCCC to a goal of mobilizing jointly US$100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the Green Climate Fund through its capitalization as soon as possible
- Promote mechanisms for raising capacities for effective climate change-related planning and management, in LDCs, including focusing on women, youth, local and marginalized communities

Sources: UN 2015a

Box 03 Climate Risk and Reasons for Concern (RFCs)

Key risks inform what is described in Art 2 of the UNFCCC Convention as "dangerous anthropogenic interference with the climate system." They enunciate the potentially severe adverse impacts for humans and ecological systems of climate change hazards. The IPCC organizes many of the risks of climate change into the following five reasons for concern (RFCs).

RFC 1. Risks to unique and threatened systems
RFC 2. Risks of extreme weather events
RFC 3. Distribution of impacts and vulnerabilities
RFC 4. Aggregate impacts
RFC 5. Risks of large-scale singularities

RFCs show probabilities of impacts and happenings at various degrees of warming and are expressed as reasons for concern associated the particular RFC. They vary substantially depending on the development pathways chosen (e.g., business as usual vs. switch to renewable energy). The following are risks reported in the 5th IPCC Assessment Report associated with the relevant RFC described above:

Risk of death, injury, ill-health or disrupted livelihoods in low-lying coastal zones and small island developing states and other small islands, due to storm surges, coastal flooding, and sea level rise. [RFCs 1-5]

- Risk of severe ill-health and disrupted livelihoods for large urban populations due to inland flooding in some regions. [RFCs 2 and 3]
- Systemic risks due to extreme weather events leading to breakdown of infrastructure networks and critical services such as electricity, water supply, and health and emergency services. [RFCs 2-4]
- Risk of mortality and morbidity during periods of extreme heat, particularly for vulnerable urban populations and those working outdoors in urban or rural areas. [RFCs 2 and 3]
- Risk of food insecurity and the breakdown of food systems linked to warming, drought, flooding and precipitation variability and extremes, particularly for poorer populations in urban and rural settings. [RFCs 2-4]
- Risk of loss of rural livelihoods and income due to insufficient access to drinking and irrigation water and reduced agricultural productivity, particularly for farmers and pastoralists with minimal capital in semi-arid regions. [RFCs 2 and 3]
- Risk of loss of marine and coastal ecosystems, biodiversity, and the ecosystem goods, functions, and services they provide for coastal livelihoods, especially for fishing communities in the tropics and the Arctic. [RFCs 1, 2 and 4]
- Risk of loss of terrestrial and inland water ecosystems, biodiversity, and the ecosystem goods, functions, and services they provide for livelihoods. [RFCs 1, 3 and 4]

Sources: Oppenheimer et al. 2014

Summary questions

- How does climate change impact human development? Give some examples of RFCs (reasons for concern) associated with climate variability and change.
- Explain how climate change impacts affect different segments of society differently.
- What key developments and achievements have taken place since 2015 that affect climate change? How might they be relevant for the betterment of livelihoods of the poor, especially women?

Box 03: Definitions of vulnerability and its components

Vulnerability: The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

Exposure: The presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social or cultural assets in places and settings that could be adversely affected.

Sensitivity: The degree to which a system is affected, either adversely or beneficially, by climate-related stimuli. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to a rise in the sea level).

Adaptive capacity: The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities or to respond to consequences.

Sources: IPCC 2014c; IPCC 2001

Box 04 Climate change and the gender gap

• Eighty percent of people displaced by climate change are women.

• Globally, women earn 24 percent less than men and hold only 25 percent of administrative and managerial positions in the business world; 32 percent of businesses have no women in senior management positions. Women still hold only 22 percent of seats in single or lower houses of national parliament.

• Nine in 10 countries have laws impeding women's economic opportunities, such as those which bar women from factory jobs, working at night or getting a job without permission from their husbands.

• A study using data from 219 countries from 1970 to 2009 found that, for every one additional year of education for women of reproductive age, child mortality decreased by 9.5 percent.

• Over four million people a year die prematurely due to illness caused by indoor air pollution, primarily from smoke produced while cooking with solid fuels.

• More than 70 percent of people who died in the 2004 Asian tsunami were women. Similarly, Hurricane Katrina, which hit New Orleans (USA) in 2005, predominantly affected poor African-Americans, especially women.

• Women do not have easy and adequate access to funds to cover weather-related losses or adaptation technologies. They also face discrimination in accessing land, financial services, social capital and technology.

• If all countries were to match the progress toward gender parity of the country in their region with the most rapid improvement on gender inequality, as much as US$12 trillion could be added to annual global GDP growth in 2025.

Sources: UNDP (2015); FAO (2011); UNFPA and WEDO (2009); World Bank Group (2015); Gakidou et al. (2010); MGI (2015); UNDP (2015a); WHO (2016)

Box 05 Gender-differentiated impacts of climate change

Climate Change Effects	Potential Risks	Examples	Potential Effect on Women
Direct			
Increased ocean temperature	Rising incidence of coral bleaching due to thermal stress	Loss of coral reefs can damage the tourism industry, where women comprise 46% of the workforce.	Women may face job losses and reduced income in tourism-related sectors.
Increased drought and water shortage	South-East Asia could experience water shortages due to droughts, severe rainfall, and salt-water intrusion into freshwater.	Women and girls in developing countries are primary water collectors and managers.	Decreased water availability may increase women's workload, threaten family livelihoods, reduce school enrollment for girls, and limit income-generating opportunities.
Increased extreme weather events	Greater intensity and number of cyclones, hurricanes, floods, and heat waves	Natural disasters kill more women than men on average or at an earlier age than men.	Women are disproportionately affected by natural disasters, leading to higher mortality rates and greater vulnerability.
Indirect			
Increased epidemics	Climate variability contributes to malaria epidemics in East Africa and cholera outbreaks in Bangladesh.	Women have less access to medical services and face increased caregiving responsibilities.	Female-headed households and those affected by HIV may struggle to adapt, reducing resilience to climate change impacts.
Loss of species	By 2050, climate change could result in a species extinction rate of 18% to 35%.	Women often rely on crop diversity to accommodate climate variations. Permanent temperature changes will reduce agro-biodiversity and traditional medicine options.	This may affect food security and limit health remedies, disproportionately impacting women who rely on these resources.
Decreased crop production	Temperature increases may threaten agricultural productivity, stressing crops and reducing yields.	Low-income rural populations, particularly women, who depend on traditional agriculture or marginal lands, are most affected.	Women farmers, often poorer and more dependent on agriculture, face devastating impacts on their livelihoods due to reduced crop yields.

Sources: UNDP 2010b

Video presentation - Sisters of the Planet - Sahena (Bangladesh)
https://www.google.com/search?q=Video+presentation+-+Sisters+of+the+Planet+
+Sahena+(Bangladesh)&oq=Video+presentation+-+Sisters+of+the+Planet+
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ome&ie=UTF-8#

Making the climate effort gender-responsive

Box 6 Gender terms

Gender analysis

This refers to careful and critical examination of how differences in gender roles, activities, needs, opportunities and rights/entitlements affect men, women, girls and boys in certain situations or contexts. A key element of gender analysis is the examination of women's and men's access to and control of resources—especially economic, political and knowledge resources and access to and control of time. Other important analysis factors that should be considered along with gender include age, poverty levels, ethnicity, race and culture.

Gender mainstreaming

This is the process of assessing the implications for men and women of any planned action, including legislation, policies or programmes, in all areas and at all levels. It is a way to ensure that women's and men's concerns and experiences are an integral dimension of all development efforts. The goal of gender mainstreaming is gender equality. Gender mainstreaming is a 'whole of-government' responsibility.

Gender responsiveness

This refers to outcomes that reflect an understanding of gender roles and inequalities and which make an effort to encourage equal participation and equal and fair distribution of benefits. Gender responsiveness is accomplished through gender analysis and gender inclusiveness.

Gender roles

Gender determines what is expected, allowed and valued in a woman or a man in a given context. In most societies, there are differences and inequalities between women and men in the responsibilities they are expected to take up, the activities that are considered normal or acceptable, their access to and control over resources, and their participation in decision-making.

Sources: UNDP 2015c

Box 7 Gender Mainstreaming Checklist for Climate Change

Ensure that women participate equally and actively alongside men and are enabled to take up leadership positions throughout the programme management cycle.

Questions to ask in a gender analysis

- Which men and which women hold the power in this community?
- What activities are performed by women and men? How will climate change affect the abilities of women and men to fulfil their differing responsibilities?
- Who owns and controls resources? What are the levels of access to and control over resources of women and men?
- Who makes the decisions? Who sets the agenda?
- Who gains and who loses from processes of development?

Gender-related differences to be understood

- Differences in the lives of poor women and men in the target community
- Different roles, skills, capacities and aspirations of women and men
- Different levels of access to and control over key productive, information and technology resources
- Different levels of vulnerability, resilience and autonomy of men and women when confronted with different threats
- Different local knowledge possessed by women and men concerning natural resources and agricultural production. This may include climate change-relevant information on risk, adaptation and mitigation.
- Division of labour among women and men
- Different levels of participation and leadership enjoyed by women and men
- Barriers that unequal gender relations present to women's development in this particular community

Note: For more information on how to conduct gender analysis, see UNDP 2016b

GROUP EXERCISE:

Instructions for the Group Exercise:

Step 1: Select a Dimension of Human Well-Being

Choose one area that is heavily influenced by climate change. Examples include:

- Food production
- Water availability
- Natural disasters
- Health
- Population displacement

Step 2: Group Discussion and Analysis

1. **Divide into 5 Groups:** Each group will focus on one selected dimension.
2. **Analyze Gender Impacts:** Discuss and list how the selected issue affects men and women differently, considering their roles, responsibilities, and social status. Use the following prompts:
    - What are the specific challenges faced by women?
    - What are the specific challenges faced by men?
    - How do existing gender roles and inequalities influence these impacts?

Step 3: Answer the Key Questions

As a group, answer these questions:

1. **Are women and men affected in the same manner by this issue?**

Provide examples of similarities or differences in how the issue impacts men and women.

2. **Why are these impacts different or similar?**

Discuss the underlying causes, such as social, cultural, or economic factors, that lead to these differences or similarities.

Step 4: **Group Reporting:**

- **Presentation:** Each group will present their findings to the larger group.
- **Discussion:** Facilitate a discussion to identify common themes and insights across all dimensions.

Example Analysis Template for Groups:

Dimension	Impact on Men	Impact on Women	Key Differences/Similarities
Food Production	Loss of income as primary earners in farming	Increased workload in food preparation, limited access to land and resources	Women may face greater food insecurity due to lower resource control.
Water Availability	Difficulty in irrigation for crops	Increased burden of water collection, reduced hygiene options	Women spend more time and energy managing water needs.
Natural Disasters	Physical injuries during manual labor	Higher mortality rates, loss of caretaking resources	Women often have less mobility and fewer survival resources.

Strengthening Climate Leadership in Agriculture: Insights from Bangladesh's NAP Journey

Introduction

Bangladesh is globally recognized as one of the most vulnerable countries to climate change. Its unique geography, situated at the confluence of several major rivers and home to extensive low-lying areas, makes it particularly susceptible to climate-induced challenges. These include rising sea levels, erratic weather patterns, increased frequency of cyclones, and saline intrusion. Agriculture, a cornerstone of Bangladesh's economy and livelihood for millions, is one of the sectors most affected. This essay delves into the nation's journey with its National Adaptation Plan (NAP) and highlights key lessons for strengthening climate leadership in agriculture.

The Role of Agriculture in Bangladesh's Economy

Agriculture contributes approximately 13% to Bangladesh's GDP and employs over 40% of its workforce. It ensures food security for a population of more than 170 million people. Despite its critical importance, the sector faces numerous challenges, including shrinking arable land due to urbanization, water scarcity, and vulnerability to climate change.

The recurring impacts of floods, droughts, and cyclones have significantly disrupted agricultural productivity, leading to economic losses and food insecurity. Thus, enhancing resilience and adaptive capacity in agriculture is not just a developmental imperative but also a key to ensuring long-term sustainability.

The National Adaptation Plan: An Overview

Bangladesh has been proactive in addressing climate change through various national and international initiatives. The NAP, developed under the guidelines of the United Nations Framework Convention on Climate Change (UNFCCC), represents a strategic effort to enhance adaptive capacity across vulnerable sectors, including agriculture. The plan emphasizes integrating climate change considerations into national and sectoral development planning.

Key Objectives of the NAP:

1. **Risk Assessment and Mapping:** Identifying climate vulnerabilities and risks at national and local levels.
2. **Capacity Building:** Strengthening institutional and community capacities to adapt to climate challenges.
3. **Integration of Climate Policies:** Ensuring alignment between climate policies and agricultural development strategies.
4. **Resource Mobilization:** Securing financial and technical resources to implement adaptation measures.

Insights from Bangladesh's NAP Journey

1. Participatory Planning and Implementation

One of the hallmarks of Bangladesh's NAP process is its emphasis on participatory planning. Stakeholders from various levels—government agencies, local communities, NGOs, and the private sector—have been actively involved. This inclusive approach ensures that adaptation strategies are context-specific and responsive to the needs of the most vulnerable populations, particularly smallholder farmers.

2. Integration with Development Policies

Bangladesh has demonstrated success in integrating climate adaptation into broader development policies. Programs like the Bangladesh Delta Plan 2100 and the Climate Change Strategy and Action Plan (BCCSAP) align with NAP priorities. This integration ensures that climate adaptation is not treated as a standalone issue but as a core component of national development.

3. Promotion of Climate-Smart Agriculture (CSA)

The NAP has emphasized the adoption of climate-smart agriculture practices. These include:

- **Crop Diversification:** Encouraging the cultivation of saline-resistant and drought-tolerant crop varieties.
- **Water Management:** Promoting efficient irrigation systems and rainwater harvesting.
- **Agroforestry:** Integrating trees into farming systems to enhance carbon sequestration and biodiversity.
- **Technology Transfer:** Facilitating access to modern tools and technologies for climate-resilient farming.

4. Community-Based Adaptation (CBA)

A key lesson from Bangladesh's NAP journey is the effectiveness of community-based adaptation. By leveraging local knowledge and involving communities in decision-making, the NAP fosters ownership and ensures the sustainability of adaptation initiatives. Examples include the construction of raised seedbeds and community-managed flood shelters.

5. Capacity Building and Education

Capacity-building programs for farmers, extension workers, and policymakers have been central to the NAP's success. Training initiatives on sustainable farming practices and the use of climate information services have empowered stakeholders to make informed decisions.

6. Gender-Responsive Approaches

Recognizing the disproportionate impact of climate change on women, Bangladesh's NAP incorporates gender-responsive strategies. Women's involvement in agricultural decision-making processes and access to resources is prioritized to ensure equitable adaptation benefits.

7. Innovative Financing Mechanisms

Bangladesh has explored diverse financing options to support NAP implementation, including international climate funds (e.g., the Green Climate Fund) and public-private partnerships. Innovative mechanisms, such as crop insurance schemes, have also been introduced to protect farmers from climate-induced losses.

Challenges in Implementing the NAP

Despite its achievements, Bangladesh faces several challenges in implementing its NAP:

1. **Resource Constraints:** Limited financial and technical resources hinder the widespread implementation of adaptation measures.
2. **Institutional Gaps:** Coordination among various government agencies and stakeholders remains a challenge.
3. **Data Limitations:** Inadequate access to reliable climate data hampers effective planning and decision-making.
4. **Social Inequities:** Marginalized groups, including women and indigenous communities, often face barriers to accessing adaptation resources.

5. **Monitoring and Evaluation:** The absence of robust monitoring frameworks makes it difficult to assess the impact of adaptation initiatives.

Recommendations for Strengthening Climate Leadership in Agriculture

Based on insights from Bangladesh's NAP journey, the following recommendations can strengthen climate leadership in agriculture:

1. **Enhancing Policy Coherence:** Foster stronger alignment between national climate policies and sectoral strategies to ensure a unified approach to adaptation.
2. **Scaling Up CSA Practices:** Promote widespread adoption of climate-smart agriculture through targeted investments, capacity building, and technology dissemination.
3. **Strengthening Institutional Capacities:** Build institutional frameworks that facilitate better coordination, accountability, and resource mobilization.
4. **Investing in Research and Innovation:** Prioritize research on climate-resilient crops, weather forecasting systems, and sustainable farming technologies.
5. **Promoting Inclusive Adaptation:** Ensure that adaptation initiatives address the needs of marginalized groups and incorporate gender-responsive approaches.
6. **Leveraging International Cooperation:** Strengthen partnerships with international organizations and donors to secure financial and technical support.
7. **Developing Robust Monitoring Systems:** Establish comprehensive monitoring and evaluation frameworks to track progress and identify areas for improvement.

Conclusion

Bangladesh's journey with its National Adaptation Plan offers valuable lessons for strengthening climate leadership in agriculture. By embracing participatory planning, integrating climate adaptation into development policies, and promoting innovative practices like climate-smart agriculture, the nation has made significant strides in building resilience. However, addressing challenges such as resource constraints and institutional gaps remains critical.

As climate change continues to pose existential threats, the need for robust and inclusive climate leadership in agriculture becomes increasingly urgent. Bangladesh's experience underscores the importance of collaboration, innovation, and commitment in navigating this complex challenge and serves as an inspiration for other vulnerable nations.

Transformative Leadership in Nationally Determined Contributions: From Policy to Action in Agriculture

By Md Ziaul Haque
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Introduction

Article 2 of the **Paris Agreement** presents the purpose of the Agreement by putting forward following statements: This Agreement, in enhancing the implementation of the Convention, including its objective, aims to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty, including by:

(a) Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;

(b) Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production; and

(c) Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development.

Nationally determined contributions (NDCs) are at the heart of the Paris Agreement and the achievement of its long-term goals. NDCs embody efforts by each country to reduce national emissions and adapt to the impacts of climate change. The Paris Agreement (Articles 4.2 and 4.9) requires each Party or country **shall** prepare and communicate successive NDCs every five years that it intends to achieve. Parties **shall** pursue domestic mitigation measures, with the aim of achieving the objectives of such contributions.

Together, these climate actions determine whether the world achieves the long-term goals of the Paris Agreement and to reach global peaking of greenhouse gas (GHG) emissions as soon as possible and to undertake rapid reductions thereafter in accordance with best available science, so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of GHGs in the second half of this century. It is understood that the peaking of emissions will take longer for developing country Parties, and that emission reductions are undertaken on the basis of equity, and in the context of sustainable development and efforts to eradicate poverty, which are critical development priorities for many developing countries (Paris Agreement: Articles 2 and 4.1).

In order to enhance the ambition over time the Paris Agreement provide that successive NDCs will represent a progression compared to the previous NDC and reflect its highest possible ambition. After 1st NDCs in 2015, Parties are requested to submit the next round of NDCs (new NDCs or updated NDCs) by 2020 and every five years thereafter (e.g. by 2020, 2025, 2030), regardless of their respective implementation time frames. Moreover, Parties may at any time adjust their existing NDCs with a view to enhancing its level of ambition (Article 4.11).

NDCs will contain necessary information on both mitigation and adaptation actions to climate change, as well as information related to support provided or received in terms of finance, technology and capacity-building. However, communicating information on mitigation contributions through NDCs by all countries is a mandatory obligation in accordance Article 4.2 and Article 13.7 of the Paris Agreement, where information on adaptation activities is voluntary.

NDC 3.0 (to be submitted in 2025)

IPCC 6th Assessment Report, which was endorsed by the outcome of 1st Global Stocktake (as per Article 14 of the Paris Agreement) at COP28 in 2023 reveals that limiting global warming to 1.5°C with no or limited overshoot requires deep, rapid and sustained reductions in global greenhouse gas emissions of 43 per cent by 2030 and 60 per cent by 2035 relative to the 2019 level and reaching net zero carbon dioxide emissions by 2050. The first global stocktake recognized that the Paris Agreement has driven near-universal progress on climate action, however despite overall progress, the world is not on track to meet the long-term temperature goal of the Agreement. The outcome of the global stocktake (GST) will inform the preparation of subsequent NDCs, in order to allow for increased ambition and climate action to achieve the purpose of the Paris Agreement and its long-term goals. NDCs to be submitted in 2025, also known as NDC 3.0, are to be informed by the outcome of the first global stocktake. NDC 3.0 need to be progressive and more ambitious than current NDCs and may be the last opportunity to put the world on track with a global emission trajectory in line with the Paris Agreement's 1.5°C goal.

Bangladesh Response

Bangladesh, a signatory to the Paris Agreement and a strong supporter, is attempting to uphold the commitments made through its nationally determined contributions. Bangladesh submitted its Intended Nationally Determined Contributions (INDC) or NDC 1.0 to UNFCCC in September 2015 for three sectors such as power, industry, and transport. By 2030, Bangladesh's INDC called for an unconditional reduction in GHG emissions of 12 million tons (5%) from the Business as Usual (BAU) scenario and a conditional reduction of additional 24 million tons (10%) with assistance from the international community, considering 2011 as the base year.

Bangladesh updated the NDC (NDC 2.0) in 2021, including new sectors and gas as part of the global initiative and adhering to the IPCC Guidelines. The updated NDC or NDC 2.0 covers Energy, Industrial Processes and Product Use (IPPU), Agriculture, Forestry, and Other Land Use (AFOLU), and the Waste sectors. In NDC 2.0, Bangladesh put forward quantified emissions reduction commitments of 6.73%, i.e., 27.56 MtCo2e reductions below the business-as-usual scenario by 2030 unconditionally, and an additional 15.12%, i.e., 61.91 MtCO2e reductions by 2030 conditionally, only if there is external financial and technical support. Following table 1 shows the **GHG emission reduction scenario presented in NDC 2.0:**

UNFCCC Sector	Sub-sector	GHG Emission Scenario		GHG Reduction by Mitigation (2030)							
		BAU 2030		Unconditional			Conditional			Combined	
		MtCO 2e	In %	MtCO2e	Reduction MtCO 2e	In %	MtCO2e	Reduction MtC O2e	In %	Reduction MtC O2e	In %
Energy	Power	95.14	23.24	87.13	8.01	29.06	51.4	35.73	57.72	43.74	48.9
	Transport	36.28	8.86	32.89	3.39	12.30	26.56	6.33	10.23	9.72	10.86
	Industry (energy)	101.99	24.91	95.33	6.66	24.17	94.31	1.02	1.65	7.68	8.58
	Other energy sub sectors:										
	Households	House holds	30.41	7.43	28.78	1.63	5.91	24.77	4.01	6.46	5.64
	Commercial	3.35	0.82	2.94	0.41	1.49	2.51	0.43	0.69	0.84	0.94
	Agriculture	10.16	2.48	9.37	0.79	2.87	10.13	0.03	0.05	0.82	0.92
	Brick Kilns	23.98	5.86	20.7	3.28	11.90	12.82	7.88	12.73	11.16	12.47
	Fugitive	8.31	2.03	8.31			4.03	4.28	6.91	4.28	4.78
	F Gases	2.92	0.71	0.78	2.14	7.76	0.03	0.75	1.21	2.89	3.23
Total Energy		312.54	76.34	286.23	26.31	95.46	226.56	59.71	96.46	85.98	96.1
IPPU	Cement and Fertilizer	10.97	2.68	10.97	10.97						

AFOLU	Agriculture and Livestock	54.64	13.35	54	0.64	2.32	53.6	0.4	0.65	1.04	1.16
	Forestry	0.37	0.09	0.37			0.37				
Total AFOLU		55.01	13.44	54.37	0.64	2.32	53.97	0.4	0.65	1.68	1.16
Waste	MSW and wastewater	30.89	7.55	30.28	0.61	2.21	28.44	1.84	2.97	2.45	2.74
Total Emission		**409.41**		**381.85**			**319.94**				
Total Reduction					**27.56**	**6.73**		**61.9**	**15.12**	**89.47**	**21.85**
Note: INDC (2015) or NDC 1.0 proposed 12 MtCO2e *(5%) reduction in unconditional and a further 24* MtCO2e *(10%) reduction in conditional scenario*											
Note: NDC update (2021) or NDC 2.0 proposed 27.56 MtCO2e *(6.73%) reduction in unconditional and an additional 61.91* MtCO2e *(15.12%) reduction in conditional scenario.*											

Total GHG Emissions of Bangladesh

Table 2: Sector-wise National GHG emissions from 2013 to 2019

Sector (Gg CO_2eq)	2013	2014	2015	2016	2017	2018	2019
Energy	86.31	90.85	96.68	105.00	105.00	112.00	115.00
IPPU	2.91	3.07	2.84	3.12	3.22	3.10	4.30
Agriculture, Forestry and Other Land use	66.39	67.51	69.22	70.34	69.80	71.83	72.63
Waste	17.08	17.55	18.60	19.15	19.77	20.40	21.04
Total GHG emission (million tons)	**173**	**179**	**187**	**198**	**198**	**207**	**213**

Table 3: Total GHG emissions of All Sectors for 2019

Inventory Year: 2019		Emissions (Gg)	
Greenhouse gas source and sink categories	CO_2 Emissions (Gg)	CH_4 Emission	N_2O Emission
Total National Emissions and Removals			
1 - Energy	105865	326.73	4.16
1.A - Fuel Combustion Activities_Energy Industries	105865	119.31	4.16
1.A1- Electricity Generation	46679	1.03	0.15
1.A2- Manufacturing Industries and Construction	26765	1.700	0.26
1.A.3 Transport	15895	114.00	3.69
1.A.4- Other Sectors	16526	2.50	0.05
1.B.2 Fugitive Emissions from Natural Gas	0.02	207.42	0.00
2 - Industrial Processes and Product Use	4298		
2.A - Mineral Industry	480		
2.A.1 Cement production	422		
2.A.3 Glass Production	58		
2.B - Chemical Industry	2026		
2.B.1 - Ammonia Production	2026		
2.C- Metal Industry	33		
2.C.1 Iron and Steel Production			
2.D - Non Energy Products from Fuels and Solvent Use	94		
2D.1 Lubricant use	94		
2.F - Product Uses as Substitutes for Ozone Depleting Substances	1665		
2.F.1 - Refrigeration and Air Conditioning	1665		
3 - GHG Emissions Agriculture, Livestock & Forest and other Land -Use Sector	12640	1819	48.76
CH4 emission from rice field		609.6	
Indirect Nitrous Oxide (N2O) from N based fertilizer			6.60
Direct Nitrous Oxide (N2O) emissions from Fertilizer Application			20.58
Direct Carbon Dioxide emissions from urea fertilizer	1870		
Total Enteric CH4 Emissions		1111	
Total Manure CH4 Emissions		98.4	
Total Direct N2O Emissions from Manure System			14.38
Total Indirect N2O Emissions - Volatilization			5.65
Total indirect N2O Emissions - Leaching/Runoff			1.55
3.B - Land use change and Forestry	10770		
4 - Waste		788	6.34
4.A: Solid Waste Disposal		164	
B- Methane emission from domestic waste water		540	
C- Nitrous Oxide Emission from Domestic wastewater			6.34
D- Methane emission from industrial waste water		81.83	
Memo Items (5)			
International Bunkers	474.90	0.01	0.01
A- International Aviation (International Bunkers)	398.54	0.00	0.01
B- International water-borne navigation (International bunkers)	76.36	0.007	0.00
Information Items			
CO2 from Biomass burning for Energy purpose	76000		
Total CO2e emission from all sources	213241	Gigagrams	
Total CO2e emission from all sources	213	Million Tons	

Mitigation in Agriculture

A. Mitigation Scenario of Energy Use in Agriculture

As a part of the mitigation strategy, a target has been set to power 10% of irrigation pumps using solar energy instead of diesel pumps by the year 2041. This mitigation action has been incorporated into the LEAP Modelling framework. However, it is noteworthy that the mitigation scenario only takes into account the use of diesel pumps and no other mode of agricultural vehicles have been considered. Therefore, the extent of the potential impact of this mitigation measure on overall greenhouse gas emissions in the agricultural sector of Bangladesh needs to be further assessed.

Figure shows the comparison BAU and the mitigation scenario in terms of gigagram CO_2 equivalent emissions for the year 2019, 2025, 2030, 2035, and 2041. In the mitigation scenario, the emissions are projected to be 8,207 gigagram CO_2 equivalent in 2041 which is 9% less than the BAU scenario.

	2019	2025	2030	2035	2041
Business As Usual	7,251	7,698	8,091	8,505	9,030
Mitigation Scenario	7,251	7,506	7,723	7,941	8,207

Figure 1: Energy use in agriculture, BAU vs mitigation scenario

Mitigating GHG emissions from the energy use in the agriculture requires implementing effective mitigation action. One possible solution is upgrading irrigation pumps and fishing boats with energy-efficient technologies. This may involve incorporating more efficient engines, improved fuel injection systems, or electric motors. Additionally, the adoption of sustainable farming practices such as crop rotation, mulching, and cover cropping can reduce the need for irrigation and lower emissions from agricultural vehicles. By implementing these strategies, it is possible to mitigate GHG emissions from the agriculture sector in a cost-effective and sustainable manner.

B. Mitigation Scenarios in Agriculture and Livestock

The group of experts, stakeholders, consultants, and research team have examined various mitigation measures that could potentially reduce the projected greenhouse gas emissions in the business-as-usual scenario.

- Improved nutrient management: Improving the timing, placement, and application rates of N-based fertilizers, as well as utilizing precision agriculture methods, can lead to the efficient use of these fertilizers.
- Adoption of best management practices: Implementing best management practices for rice cultivation, such as alternate wetting and drying and aerobic rice cultivation, can significantly reduce emissions from rice fields.
- Use of low-emission feeds: Livestock feed additives can be used to reduce enteric fermentation emissions. For example, using ionophores or tannins in livestock diets has been shown to reduce methane emissions.
- Implementation of manure management practices: Capturing and using methane from manure can be an effective way to reduce emissions from manure management.

Additionally, practices such as composting and anaerobic digestion can reduce emissions from manure.

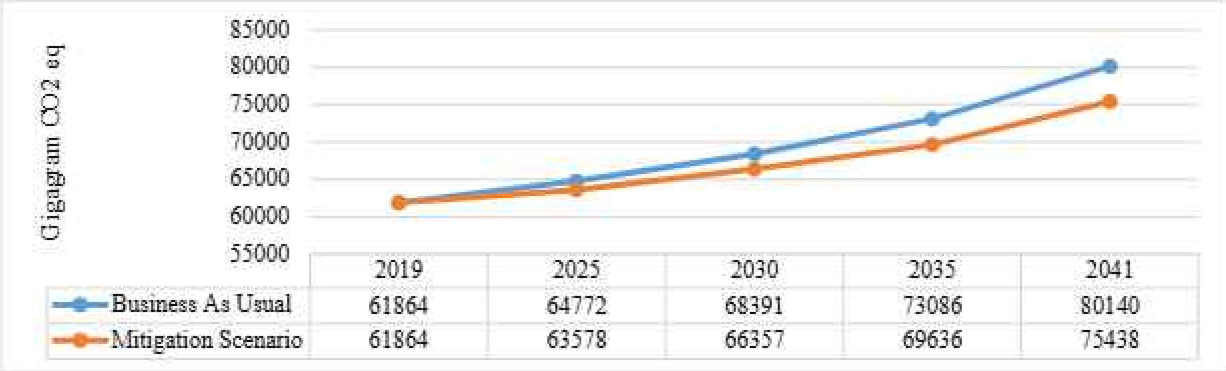

Figure 2: Emission from agriculture sector, BAU vs mitigation scenario

The implementation of the mentioned mitigation measure in the agriculture sector can lead to a reduction of approximately 6% in greenhouse gas emissions compared to the business-as-usual scenario. Figure 2 illustrates the comparison between the BAU and mitigation scenarios, indicating a potential reduction of 4702 gigagrams of CO_2 equivalent emissions in 2041.

Mitigation Action

The government of Bangladesh, in collaboration with national and international organizations, has initiated several major projects in the field of agriculture with the objective of climate change adaptation, production efficiency, and low carbon emissions. One such project titled "Integrated Manure Management and Climate Smart Livestock Production System" was submitted to the Ministry of Fisheries and Livestock in 2021. The proposed projects below are expected to contribute significantly to the development of the sector and to the reduction of carbon emissions from agriculture land.

- Developing and Defining Climate Smart Agriculture Practices portfolios in South Asia
- Design and development of fertilizer deep placement mechanism for existing rice transplanter
- Modeling climate change impact on agriculture and developing mitigation and adaptation strategies for sustaining agricultural production in Bangladesh
- Monsoon Asia climate solution by paddy water management
- Climate Change Adaptation of Khulna Agricultural Region through Climate-Smart Technologies
- Environment Friendly Safe Crop Production Through Good Agricultural Practices (GAP) for Food Security Program

To reduce emissions in the agriculture sector, the following mitigation actions can be taken:

- Implementing improved dietary manipulation practices for ruminant animals
- Introducing regenerative agriculture and integrated agriculture practices.
- Optimizing irrigation water use to reduce methane emissions from rice cultivation, and introducing sprinkler and drip irrigation techniques where possible.
- Practicing minimum tillage to reduce soil exposure and increase soil moisture retention, thereby reducing emissions of CO_2 and methane.
- Upscaling the use of Alternate Wetting and Drying techniques.
- Producing bio-gas and organic manure to reduce land degradation and emissions.
- Increasing livestock productivity through breed development.

Implementing integrated manure management practices to reuse manure as bio-fertilizer, compost, and biogas plant feedstock.

Uniting Leadership for Climate Solutions: National and Global Discourses

Climate change stands as one of the most pressing challenges of our time, demanding immediate and coordinated action from leaders at all levels. The scale of the crisis transcends borders, impacting nations differently but unavoidably, and calls for both national initiatives and global solidarity. Effective leadership in addressing climate change involves fostering collaboration, driving innovation, and embracing equity in the pursuit of sustainable solutions.

1. National Leadership: The Foundation of Climate Action

At the national level, leadership plays a crucial role in crafting and implementing policies tailored to the unique needs of a country. Governments must set ambitious targets for reducing greenhouse gas emissions, transitioning to renewable energy, and protecting natural ecosystems. These efforts are often spearheaded by policymakers who integrate scientific evidence into actionable plans, such as carbon pricing mechanisms, incentives for clean energy adoption, and regulations to curb industrial emissions.

For instance, nations like Denmark and New Zealand have demonstrated effective leadership by committing to net-zero carbon goals and investing heavily in wind energy and sustainable agriculture, respectively. Such national strategies not only reduce domestic emissions but also serve as blueprints for others, showcasing that economic growth and environmental stewardship can coexist.

Moreover, leadership at this level must engage with diverse stakeholders, including businesses, local governments, and civil society. By fostering public-private partnerships, governments can accelerate the development of green technologies and infrastructure. Local leaders, too, play a pivotal role in implementing national policies on a regional scale, ensuring that solutions address community-specific challenges.

2. Global Leadership: The Necessity of Unity

While national initiatives lay the groundwork, global leadership is indispensable for tackling a problem that knows no boundaries. International cooperation is essential for addressing transnational issues like deforestation, ocean acidification, and rising global temperatures. Forums such as the United Nations Framework Convention on Climate Change (UNFCCC) and the annual Conference of the Parties (COP) serve as critical platforms for fostering dialogue and securing commitments among nations.

Agreements like the Paris Accord illustrate the potential of global collaboration, with countries pledging to limit global temperature rise to well below 2°C. However, these commitments must be backed by action and accountability mechanisms to ensure their effectiveness. Leaders must also recognize the disproportionate impact of climate change on vulnerable populations in developing nations. Financial and technical support for these countries—through mechanisms like the Green Climate Fund—is a moral imperative and a practical necessity for equitable climate action.

Non-state actors also play a vital role in global climate leadership. Corporations, non-governmental organizations (NGOs), and international coalitions can drive change by setting industry standards, funding innovative research, and amplifying grassroots initiatives. The combined efforts of these entities amplify the impact of governmental actions, creating a unified front against climate change.

3. Challenges and Opportunities in Leadership

Despite significant progress, challenges persist in uniting leadership for climate solutions. Political and economic interests often create barriers to consensus, with some nations prioritizing short-term gains over long-term sustainability. Additionally, the uneven distribution of resources and responsibilities complicates collaborative efforts, particularly between developed and developing countries.

However, these challenges present opportunities for innovation and leadership. Technology, for example, offers transformative potential in reducing emissions and adapting to climate impacts. Leaders who prioritize investment in clean energy, sustainable urban planning, and climate-resilient agriculture not only mitigate risks but also unlock economic opportunities.

Moreover, fostering a culture of inclusivity in decision-making processes strengthens climate leadership. By amplifying the voices of indigenous communities, youth activists, and marginalized groups, leaders can ensure that solutions are equitable and culturally sensitive. This inclusivity not only enhances the legitimacy of climate policies but also enriches them with diverse perspectives and knowledge systems.

4. Conclusion

Uniting leadership for climate solutions requires a delicate balance of national and global efforts. National leaders must take bold actions to reduce emissions and build resilience, while global cooperation ensures that these actions are harmonized and mutually reinforcing. The complexities of climate change demand that leaders embrace collaboration, innovation, and equity, recognizing that the stakes are nothing less than the survival of humanity and the planet. By rising to this challenge together, leaders at all levels can pave the way for a sustainable and prosperous future.

Leadership in Climate Justice: Driving Change for a Climate-Resilient World

In the face of an escalating climate crisis, the role of leadership in climate justice has never been more critical. Climate justice emphasizes the fair and equitable distribution of the burdens and benefits of climate change and its solutions. It seeks to address the disproportionate impact of climate change on marginalized communities and advocates for systemic changes to ensure a climate-resilient future. Leadership in this context requires vision, inclusivity, and transformative action. This essay explores the multifaceted role of leadership in driving change for a climate-resilient world, addressing the moral imperatives, systemic challenges, and innovative pathways essential for progress.

The Ethical Imperative of Climate Justice

At the heart of climate justice lies an ethical imperative: the need to address the injustices perpetuated by climate change. Vulnerable populations, including low-income communities, indigenous peoples, and small island nations, bear the brunt of climate impacts despite contributing the least to global greenhouse gas emissions. Leadership in climate justice must confront this disparity by championing policies and initiatives that prioritize these groups.

Moral leadership demands accountability from high-emission countries and industries. Leaders must advocate for historical emitters to take responsibility for their contributions to the crisis through mitigation efforts and financial support for adaptation in vulnerable regions. For instance, the principle of "common but differentiated responsibilities" underscores the ethical obligation of wealthier nations to lead global climate efforts while supporting less developed countries.

Systemic Challenges to Climate Justice

Achieving climate justice requires overcoming systemic challenges embedded in global economic, political, and social structures. These challenges include:

1. **Economic Inequality**: Wealth disparities exacerbate the ability of nations and communities to adapt to climate change. Leadership must address the structural inequalities that hinder equitable access to resources and technologies.
2. **Political Will**: The lack of political commitment to ambitious climate action remains a significant barrier. Effective leadership must navigate complex political landscapes to build consensus and drive meaningful policies.
3. **Institutional Barriers**: Existing institutions often lack the capacity or willingness to prioritize climate justice. Leaders must reform these institutions to integrate justice considerations into decision-making processes.
4. **Cultural and Social Norms**: Resistance to change, whether due to entrenched beliefs or misinformation, poses a challenge to advancing climate justice. Leadership must foster awareness and cultural shifts to support transformative action.

Leadership Styles for Climate Justice

Effective leadership in climate justice is not monolithic; it requires diverse approaches tailored to specific contexts. Key leadership styles include:

1. **Visionary Leadership**: Visionary leaders articulate a compelling vision for a sustainable and equitable future. They inspire collective action by framing climate justice as a shared moral and existential goal.
2. **Collaborative Leadership**: Climate justice demands collaboration across sectors, borders, and communities. Leaders who prioritize inclusivity and partnership can build coalitions that amplify impact.

3. **Grassroots Leadership**: Local leaders and community organizers play a critical role in advocating for climate justice from the ground up. Their lived experiences and insights are invaluable for designing effective and context-sensitive solutions.
4. **Transformational Leadership**: Transformational leaders drive systemic change by challenging the status quo and fostering innovation. They empower others to take bold actions and embrace new paradigms.

Innovative Pathways to Climate Justice

Innovation is essential for achieving climate justice. Leaders must champion creative solutions that address both mitigation and adaptation while centering equity. Key pathways include:

1. **Policy Innovation**: Comprehensive policies that integrate climate justice principles are crucial. Examples include carbon pricing mechanisms with revenue redistribution, just transition plans for workers in fossil fuel industries, and inclusive urban planning.
2. **Technological Solutions**: Advancements in renewable energy, sustainable agriculture, and climate-resilient infrastructure can bridge gaps in climate adaptation and mitigation. Leaders must ensure equitable access to these technologies.
3. **Financial Mechanisms**: Climate finance plays a pivotal role in supporting vulnerable communities. Innovative approaches such as green bonds, climate adaptation funds, and debt-for-nature swaps can mobilize resources effectively.
4. **Education and Capacity Building**: Empowering individuals and communities through education and skills development fosters resilience and enables meaningful participation in climate action.

Case Studies: Leadership in Action

Examining real-world examples of leadership in climate justice highlights the potential for transformative impact:

1. **Greta Thunberg and Youth Movements**: Greta Thunberg's leadership has galvanized a global youth movement demanding urgent climate action. By amplifying marginalized voices, these movements underscore the intersection of climate justice and intergenerational equity.
2. **Jacinda Ardern's Leadership in New Zealand**: As Prime Minister, Jacinda Ardern emphasized climate justice through policies aimed at reducing emissions, promoting renewable energy, and addressing social inequities.
3. **Indigenous Leadership**: Indigenous communities worldwide have demonstrated exemplary leadership in environmental stewardship. Their traditional knowledge and advocacy efforts have been instrumental in protecting ecosystems and advancing climate justice.
4. **The Paris Agreement**: The leadership displayed during the negotiation of the Paris Agreement exemplifies global cooperation. The agreement's emphasis on equity and support for developing nations reflects the principles of climate justice.

The Role of Multilateral and Local Institutions

Leadership in climate justice extends beyond individuals to include institutions at all levels. Multilateral organizations, such as the United Nations Framework Convention on Climate Change (UNFCCC), play a crucial role in setting global standards and facilitating cooperation. Simultaneously, local governments and grassroots organizations are pivotal in implementing climate justice initiatives on the ground.

For instance, the Green Climate Fund (GCF) exemplifies institutional leadership by mobilizing resources for climate adaptation and mitigation in developing countries. Similarly, cities like

Copenhagen and Medellín have demonstrated leadership through innovative local policies that prioritize equity and sustainability.

The Future of Climate Justice Leadership

The path to a climate-resilient world requires continuous evolution in leadership approaches. Emerging trends and priorities include:

1. **Intersectional Approaches**: Recognizing the interconnectedness of social, economic, and environmental issues is critical. Leadership must address the intersections of climate justice with gender equity, racial justice, and economic inclusion.
2. **Youth and Intergenerational Leadership**: Engaging younger generations as leaders and decision-makers ensures a long-term commitment to climate justice.
3. **Private Sector Engagement**: Businesses have a significant role in driving climate action. Corporate leaders must align their strategies with climate justice principles, embracing sustainable practices and ethical supply chains.
4. **Resilience and Adaptation**: As climate impacts intensify, leaders must prioritize building resilience in vulnerable communities while maintaining a focus on equity.

Conclusion

Leadership in climate justice is a moral and practical imperative for creating a climate-resilient world. By addressing systemic challenges, embracing diverse leadership styles, and championing innovative solutions, leaders can drive transformative change. The journey towards climate justice requires collective effort, sustained commitment, and the courage to envision and realize a more equitable and sustainable future. As the climate crisis unfolds, the need for principled and visionary leadership has never been more urgent. Together, we can forge a path towards a just and resilient world for all.

Leading the Way in Climate Action: Unlocking GCF Financing Modalities

Introduction

Climate change represents one of the most pressing challenges of the 21st century. Rising temperatures, extreme weather events, and changing ecosystems threaten the livelihoods of billions of people, particularly in vulnerable regions. Addressing this global crisis requires substantial financial resources and innovative approaches to mobilize and deploy them effectively. The Green Climate Fund (GCF), established under the United Nations Framework Convention on Climate Change (UNFCCC), plays a pivotal role in channeling financial support to developing countries for climate mitigation and adaptation projects. This essay explores how unlocking GCF financing modalities can accelerate climate action and foster sustainable development worldwide.

The Role of the Green Climate Fund

The GCF was established in 2010 as a financial mechanism to support developing countries in their efforts to address climate change. Its primary goals include limiting global temperature rise by reducing greenhouse gas (GHG) emissions and enhancing resilience to climate impacts. The GCF operates as a partnership between developed and developing nations, ensuring that financial resources are allocated equitably and strategically to meet global climate targets.

The GCF's unique financing modalities, including grants, concessional loans, equity investments, and guarantees, provide flexibility in funding diverse projects. By leveraging public and private sector finance, the GCF aims to catalyze significant investment in low-carbon and climate-resilient development.

GCF Financing Modalities: An Overview

The GCF offers a range of financing modalities designed to address the varying needs of recipient countries and projects. These modalities include:

1. **Grants** Grants are non-repayable funds provided to support projects with limited or no revenue-generating potential, such as community-based adaptation initiatives. They are particularly critical for Least Developed Countries (LDCs) and Small Island Developing States (SIDS), which often lack the capacity to finance climate projects independently.
2. **Concessional Loans** Concessional loans are offered at below-market interest rates with extended repayment periods. These loans enable countries to invest in transformative infrastructure projects, such as renewable energy plants or resilient urban systems, while maintaining manageable debt levels.
3. **Equity Investments** Equity investments allow the GCF to take ownership stakes in private sector projects, sharing risks and rewards. This modality is particularly useful for scaling up innovative technologies and mobilizing private capital for climate action.
4. **Guarantees** Guarantees provide financial security to private investors by mitigating risks associated with climate projects. This mechanism helps attract private sector participation in high-risk areas, such as renewable energy development in fragile markets.

Challenges in Accessing GCF Financing

Despite its potential, many countries face challenges in accessing GCF financing. These challenges include:

1. **Complex Accreditation Process** To access GCF funds, organizations must be accredited, demonstrating their ability to manage climate finance effectively. This process can be lengthy and resource-intensive, particularly for entities in developing countries.

2. **Capacity Constraints** Many developing nations lack the technical expertise and institutional capacity to design, implement, and manage climate projects that meet GCF requirements. This gap hinders their ability to tap into available funds.
3. **Co-Financing Requirements** GCF often requires co-financing from recipient countries or private sector partners. This stipulation can be a significant barrier for countries with limited fiscal space or underdeveloped private sectors.
4. **Complex Proposal Development** Preparing a successful funding proposal requires detailed feasibility studies, risk assessments, and alignment with GCF investment criteria. This complexity can discourage potential applicants.

Strategies to Unlock GCF Financing Modalities

To overcome these challenges and maximize the impact of GCF resources, several strategies can be implemented:

1. **Streamlining Accreditation Processes** Simplifying and accelerating the accreditation process can enable more entities to access GCF financing. Capacity-building programs and tailored support for national institutions can also enhance readiness.
2. **Enhancing Capacity Building** Investing in capacity-building initiatives can empower developing countries to design and implement high-quality projects. Training programs, technical assistance, and knowledge-sharing platforms are essential components of this strategy.
3. **Promoting Public-Private Partnerships (PPPs)** PPPs can mobilize additional resources and expertise for climate projects. By leveraging GCF guarantees and equity investments, governments can attract private sector participation and scale up climate solutions.
4. **Improving Proposal Development Support** Providing targeted support for proposal development can help applicants navigate the complexities of GCF requirements. Regional hubs and technical advisory services can play a crucial role in this regard.
5. **Fostering Inclusive Approaches** Ensuring that GCF projects prioritize gender equality, social inclusion, and stakeholder engagement can enhance their sustainability and effectiveness. Inclusive approaches also align with the GCF's mandate to promote equitable development.

Case Studies of Successful GCF Projects

Several GCF-funded projects demonstrate the transformative potential of its financing modalities:

1. **Enhancing Climate Resilience in Mozambique** A GCF-funded project in Mozambique focuses on building resilience to cyclones and floods. By integrating grants and concessional loans, the initiative supports the construction of resilient infrastructure and the implementation of early warning systems.
2. **Scaling Solar Power in India** In India, the GCF has supported the deployment of large-scale solar power plants through equity investments and guarantees. This initiative has not only reduced GHG emissions but also enhanced energy access in rural areas.
3. **Sustainable Agriculture in Ethiopia** A grant-funded project in Ethiopia aims to promote climate-resilient agricultural practices among smallholder farmers. By improving soil health and water management, the project enhances food security and livelihoods.

The Role of Innovation in Unlocking GCF Potential

Innovation is critical to unlocking the full potential of GCF financing modalities. This includes:

1. **Digital Solutions** Leveraging digital technologies, such as blockchain and artificial intelligence, can enhance transparency, efficiency, and accountability in climate finance management.
2. **Green Bonds** Developing green bond markets can provide an additional mechanism for mobilizing private sector finance while aligning with GCF objectives.
3. **Blended Finance Models** Blended finance combines public and private resources to address funding gaps and de-risk investments in high-impact climate projects.

Conclusion

Unlocking GCF financing modalities is essential to accelerate global climate action and achieve sustainable development goals. By addressing access barriers, building institutional capacities, and fostering innovation, the GCF can catalyze transformative change in both mitigation and adaptation efforts. As the world continues to grapple with the climate crisis, the GCF's role in mobilizing and deploying financial resources will remain indispensable. Through collaborative efforts and strategic investments, the global community can lead the way toward a sustainable and resilient future.

State of Climate Finance for the Agriculture Sector in Bangladesh

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Extended Abstract

The United Nations Framework Convention on Climate Change (UNFCCC) called for a global effort to address climate change, in terms of both mitigation and adaptation, under its principle involving "Common But Differentiated Responsibility, and Respective Capabilities (CBDRRC)". The principle asked for each country's efforts under a common framework, however such roles are expected to be differentiated based on the country's respective capabilities. Since poor people's livelihoods across the developing countries have been largely dependent on agriculture-based productive systems, early analyses indicated that the sector-specific vulnerabilities could be overwhelming and early actions have been warranted to address such vulnerabilities. Research communities unanimously warned about extremely high vulnerabilities of Bangladesh's agriculture-sector to climate change and suggested various adaptive measures.

The first emission inventory of the country also suggested that the sector emits significantly, primarily through the provisioning of irrigation, intermittent irrigation practices, and animal husbandry. Although the mitigation potentials in such sub-sectoral activities are relatively low compared to other economic activities, if Bangladesh is duly supported, she may achieve her sector-specific mitigation targets laid out in the latest Nationally Determined Contribution (NDC).

Responding to climate change requires mobilization of finance, irrespective of locality. The agriculture sector in Bangladesh involves the overwhelmingly largest share of national population. Since the economy is struggling to graduate to a Low Middle-Income Country (LMIC) from a Least Developed Country (LDC), building resilience to climate change in agriculture sector faces multi-faceted challenges. It is understood that resilience-building in the agriculture-sector is difficult to achieve without the mobilization of finance from international sources.

An analysis of the architecture of climate finance in Bangladesh identifies three (3) broad sources: (a) national financing, (b) bilateral financing, and (c) regional, global and multi-national financing. As expected, the national financing window is perhaps the smallest.

National sources and financing for agriculture sector: National sources consist of (i) Bangladesh Climate Change Trust Fund (BCCTF), and (ii) sectoral spending through (development) projects. A third window came into existence in 2009 in the form of Bangladesh Climate Change Resilience Fund (BCCRF) and fizzled out quickly, which involved international dedicated climate financing for Bangladesh. BCCTF window is rather small, annually replenishable, one third of the annual allocation is never utilized by design, and there is no special arrangement for agricultural sub-sectors. In reality, non-government organizations (NGO) collectively spend much more in agriculture sector alone than the total annual allocation under BCCTF. NGO-led programmes generally focus on awareness raising, extension of risk averting techniques, small-scale water and ecosystem management, off-farm income generating activities that are alternative to production-based livelihoods, and establishing value chains for agricultural products.

Although NGO-led efforts are wide-spread, across all major vulnerability hot-spots in the country, their impacts are far too limited. Such efforts are generally thinly spread, still waiting to be up-scaled and/or mainstreamed by the relevant national agencies. There are project-

specific efforts considered by the concerned national agencies, however the impacts of such climate financing are severely constrained due to lack of inter-agency inter-sectoral cooperation and coordination.

Bilateral development support: Bangladesh has been fortunate to receive bilateral supports from her development partners since independence. Despite the fact that such programme-based supports are predominantly sector-specific and hardly encompassing multi-sectoral complexities, there have been efforts to mainstream climate change concerns in provisioning such supports for agriculture sector. Perhaps it is because of lack of good governance, a significant proportion of such support is also channelled through NGO-led programmes. Experts evaluate the impacts of the latter efforts as being trapped in low-input low-output modalities, which precipitate into inadequate impact with respect to adaptation needs of farming communities. The micro-scale interventions, even those are proved to be useful/beneficial, are not adequately up-scaled and/or mainstreamed due to poor uptake by concerned authorities.

Multi-national, regional and global financing windows: Climate financing in agriculture-sector in Bangladesh has so far received the highest attention from such channels. Most of the allied bodies under the United Nations such as FAO, IFAD, CIMMYT, etc have been involved in providing project-scale supports, often blended with bilateral as well as philanthropic supports. In addition to meeting resilience-building needs among vulnerable farming communities, these supports generally target institutional capacity building and removing systemic institutional and policy barriers to widen the scope of agricultural adaptation. IFAD in particular works closely with relevant national agencies to build infrastructure that play critical roles in facilitating agricultural product marketing and/or in provisioning protection of vulnerable farming communities. CGIAR and the likes generally offer small-scale research support, while IRRI hosts Bangladeshi breeders/researchers to develop hazard-resilient crop varieties.

International/Regional Financing Institutions (IFI) engages with the Government of Bangladesh (GOB) and offer loans, perhaps with an associated small Technical Assistance (TA) component as grant. The agriculture sector has drawn loan financing from such windows. Public organizations under GOB are the primary recipients and finance-utilizing authorities for such finance. Although adaptation has been the priority in developing countries, there is a general tendency of making financing available predominantly in mitigation through these IFI channels.

In the overall global climate financing architecture total disbursement is perhaps dominated by (a) the Global Environmental Facility (GEF), and (b) the Green Climate Fund (GCF). Under GEF, two of the three financing windows are dedicated for advancing adaptation, which are led by the Adaptation Fund (AF) and the Special Climate Change Fund (SCCF). The LDC Fund (LDCF) predominantly finances environmental projects. However, the scope of such financing windows is generally limited. For accessing GEF finance, there is a fixed allocation per country per finding cycle, which is why there exists no competition to draw resources from such international sources. Financing for agriculture using such windows is therefore dependent on country's own priorities. Such financing is found to be effective in piloting resilience-building activities under the leadership of one or more relevant national service delivering agencies involving agriculture.

By far GCF constitutes the largest international fund. It was established under the UNFCCC in 2008 and it has started financing projects since 2015. In each cycle of about four (4) years, GCF finances projects worth of US$11 to 13 billion – both in adaptation and mitigation. Agriculture and food security is one of the key sectors where GCF has particular interests, while it also encourages cross-sectoral projects. Generally, there is no limit (i.e, cap) of any funding proposal, which offers flexibility in seeking finance. GCF finance may be drawn as both loan and grant, depending on the contexts of vulnerability and the needs of the recipient country. The processes of seeking GCF financing is competitive and complex, where stringent criteria are set focusing on project justification, analyses of evidence-based requirements, and ability of the stand-alone project to initiate a paradigm shift and contribution towards sustainable development.

So far, Bangladesh has received financing commitment from GCF in seven (7) country-specific projects – a large majority of the adaptation financing will eventually be utilized for building resilience of poor vulnerable communities, including farming communities. There are two (2) other multi-country projects which are being approved by the GCF, and Bangladesh will be somewhat benefitted from such projects. In spite of the fact that Bangladesh' agriculture sector deserves increased attention for adaptation financing, over 50% of the GCF commitment came for advancing mitigation agenda – that too for non-agricultural sector. The concerned authorities must facilitate in setting national priorities before committing to hasty identification of projects for drawing international climate financing. The cost of nonaction in agriculture might turn into helplessness for millions of people who are the direct beneficiaries of agriculture sub-sectors and it might put excessive pressure on the social protection expenditure of the country.

Scope of climate finance for the agriculture sector in Bangladesh

Generic types[1] of responses	Potential mechanism		Comments
	Adaptation	Mitigation	
Developing agriculture-specific early warning system including advisories & dissemination	√√		In infancy, needs institutional support
Extension of resilient crop varieties for greater food security	√√		In various development stages, used by NGOs
Extension of agronomic adaptive techniques	√√		Widely practiced by NGOs
Maintaining the protection of croplands from climate-induced hazards	√√		Need much improved co-management
Maintaining irrigation to address drought	√√	√√	Mitigation potential not being tapped
Extension of improved animal husbandry	√√	√√	Needs better understanding
Development of climate-resilient dairy	√√	√√	Needs better understanding
Development of climate-resilient aquaculture	√√		In design stage

[1] This is not an exhaustive list. A few long-term responses are deliberately left out.

Climate Risk Management by means of Insurance in Agriculture Sector – An Interface Between Theory and Practice

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Extended Abstract

Agriculture sector plays an important role in shaping up national economy, food security, and livelihoods of a significant proportion of the population. However, the sector is heavily dependent on natural resources, which are being significantly affected by climate change and associated issues. The climate change-related risks associated with the agriculture sector needs to be managed in order to reduce vulnerability of the country.

Climate risk management at global scale may be best approached by mitigation: the sooner and deeper mitigation may be addressed, the climate forcing due to the presence of greenhouse gases can be counteracted with ease. Unfortunately, current understanding and trends of fossil fuel burning clearly suggest that the mother earth is destined to face in excess of 3 degrees warming with respect to pre-industrial levels by 2100. Therefore, global communities need to embrace adaptive measures to address residual adverse impacts of such net warming.

According to IPCC, adaptation is a response to reduce or avoid harm(s) caused by climate stimulii. Global scientific communities have analyzed adaptation, which may be delivered by way of three approaches: (i) reducing "exposure" of a system to climate vulnerability, (ii) reducing "sensitivity" of a system to a hazard, and (iii) enhancing "capacities" within the system so that the capacities may be utilized for reducing vulnerability. The last approach may be slow and may be delivered incrementally.

Adaptation, in generic terms, may be (a) pro-actively designed (i.e, ex-ante), or (b) reactive to a climate stimulii (i.e, ex-post). If a system is well analyzed and understood by the application of cause-and-effect relationships, pro-active design may yield best adaptive results. One may cite examples of (a) the development of an Early Warning System (EWS) that help people's adaptation by considering preparatory measures, especially to reduce impact burden; (b) reduce exposure, such as strengthening drainage by desilting choked rivers/canals to facilitate drainage and reducing the extent of floods; (c) reduce sensitivity, such as building and/or raising crest heights of protective infrastructures that provide safeguards; and (d) enhance adaptive capacities early, such as building a boat so that communication during flood may be maintained. [There may be many other locally applicable examples.]

Taking reactive measures in the aftermath of a hazardous event allows the risks to be taken. Firstly, it allows the climate-induced hazard to occur. One may identify such an approach in saying: live with flood in the floodplains, without having any flood-protecting infrastructure. However, the approach undermines sufferings. Sometimes exposure to a hazardous event can be overwhelming and it may turn into a disaster (i.e, inflicting upon management failures), where people's sufferings and human tragedies cannot be completely eliminated.

In the case of allowing climate-induced hazard to occur, following human sufferings, the humanitarian approach may be applied and affected population/system is generally provided with utmost care and assistance so that they may bounce back to normalcy. However, the cost of sufferings due to the absence of proactive measures cannot always be recuperated in the process of bouncing back. The humanitarian service providers may become complacent due to their kind heartedness, however that ideally cannot compensate for the unaccounted cost of sufferings.

Primarily the economic aspect of bouncing back is the centrepiece in the provisioning of ex-post risk management through insurance. Insurance generally makes up, even if not fully, for someone's hazard-induced losses. The insurance mechanism relies on 'risk pooling', where the collective premium amount from relatively less vulnerable subjects (individual/household/farm/production system) are distributed among subjects who have already suffered through high impacts of the same hazard. Suffering here, above an agreed upon threshold, is a prerequisite that enables the impacted subject to claim for 'post-suffering compensation', generally in economic/financial terms. The process is run generally by a business, where both profit and transaction costs are borne collectively by the insured subject.

The following table briefly analyses a few prevailing conceptions involving insurance business:

Conceptions involving insurance	Common understanding
Perils to be covered	True, however only after the sufferings of the impacted subjects
Involvement of public or private sector	Does neither reduce or escalate sufferings of the impacted subjects
Specific to particular crop/ production and seasonality	Tailored for a particular product/season, however the threshold aspect cannot be discounted
Designed/tailored for individual (hh)/(farm)	Does neither reduce or escalate sufferings of the impacted subjects
Designed/tailored for hazard-specific areas	Does neither reduce or escalate sufferings of the impacted subjects
Voluntary participation	Based on people's choice (people weigh premium burden upfront against potential payback, if impacted above the threshold)
Compulsory participation	Non-democratic approach which is not based on people's choice

Underlying preconditions

No business would develop/offer an insurance product if projections regarding both transaction costs and profit are not guaranteed. In a given vulnerability context, if the total projected premium pool is estimated to cover both the potential pay out amount and the transaction cost, and yet surplus is generated, only then a viable insurance product is offered. The anticipated size of the premium pool is the key in determining an insurance product.

In order for the creation of a big enough premium pool, either the number of subjects subscribing to the product (N) has to be adequate, or otherwise, per subject premium (x/p) should be sufficient to create the desired premium pool. The more/bigger the N, the smaller can be the per subject premium.

In case of a smaller N, the x/p has to be big, which in turn becomes less attractive to the potential subscribers. It dampens the probability of attaining a bigger premium pool.

Index-based crop insurance in Bangladesh

Damage to standing crops due to flood, drought and cyclonic storm surges is common in Bangladesh. Theoretically insurance may be provided for standing crop(s) per unit land for a given hazard-specific seasonality. The severity of hazard-impacts is defined by the application of a few indices, especially the one dealing with a known threshold. For example, aman crop is often severely damaged in the floodplains. Exposure of an aman crop field to a water level which is exceeding by, say, 50 centimeters above the danger level of the nearest flood-severity identification point for seven consecutive days can be defined as the agreed upon threshold for claiming for a payback.

Under such an agreed hazard definition, if the flood exposure time is only six days, then the potential claimant cannot claim any compensation – although his production system suffers nonetheless. Alternatively, if the inundation period is more than the agreed definition of hazard, however the water level is only 49 centimeters above local danger level, still the claim will not stand. In both the circumstances, the crop production system will suffer in any case. This constitutes the biggest uncertainty in crop insurance.

The other major practical difficulty stem from validating the extent of the hazard. In the above example case, if the insurance-business led validation process takes time following the recession of flood water, the claimants keep on suffering until they are paid back. Any delay in the process cause further harm to the claimants. In case, there is market fluctuations in commodity prices (which is often the case for the price of rice, where the market takes into account lesser supply due to crop loss against a constant demand for rice) or an occurrence of post-hazard inflation, the actual payout amount does not ensure an economic 'bounce-back' for the household of the claimants. The insurance product is never designed to avoid delays in pay outs, and accommodating the market signals in the pay out amounts.

National to global linkage in the business

Sometimes, a wide spread climate-induced hazard takes a shape of a disaster where many people suffer, including the insured subjects. If a majority of the insured subjects suffer, the total projected pay out amount may indicate a loss for the business. In the first instance, it further delays the pay out process. Secondly, in anticipation of a loss, the business might apply the bankruptcy clause and that in turn push the entire pay out process into complete uncertainty. While the sufferings of the insured subject continue and the legal process involving the government continues without immediate solutions.

In a bid to avoid such complicacy, the business generally bring the business under a global insurance process (i.e, reinsurance). They pay a premium to the international reinsurer and their business does not require to apply for bankruptcy. However, the validation required for the reinsured business takes further time for investigation, which cause further delays for pay out for the initial insurance business. In this process, the post-hazard recovery process becomes painfully slow.

There is another dimension to this reinsurance business. First of all, the poor Bangladeshi farmers with minimum contribution to the atmospheric build up of GHGs generally suffer through the crop loss and remain food insecure. However, their cash has to be mobilized upfront as insurance premium. The national insurance business amasses the premium pool, and pay for the global reinsurance premium to the international reinsurance business. In this process, instead of provisioning new and additional finance to compensate the members of poor impacted farming communities, rather money is siphoned out from the farmers' pocket to the international reinsurance business, through the help of the national insurance business. The process is certainly not based on the agreed principles of the UNFCCC Process.

Introducing ACASA: A Platform for Climate Adaptation in South Asian Agriculture

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Towards Building Advanced Intelligent System for Agriculture

Navigating the ACASA Platform

The functionalities of the Atlas can be best utilized in the following order:

1. Start by visualizing the data layers in detail in the **Explore Data** tab.
2. The **Adaptation at a glance** tab is then used to look at multiple data layers at once.
3. The **Data Access** tab gives information about the data and their download links.
4. The **Use Cases** tab discusses several possible uses of the ACASA Atlas.
5. Additionally, visit the **Resources** and **About Us** tab to know more about us, ACASA team, data briefs, newsletter updates, expert opinions, and media coverage.

Quick Links
Navigation Menu

Towards Building Advanced Intelligent System for Agriculture

Home Page: Your Gateway to ACASA

Navigation Menu

Navigate through sections like Analytics, Access, Use Cases, Resources, About, and Feedback.

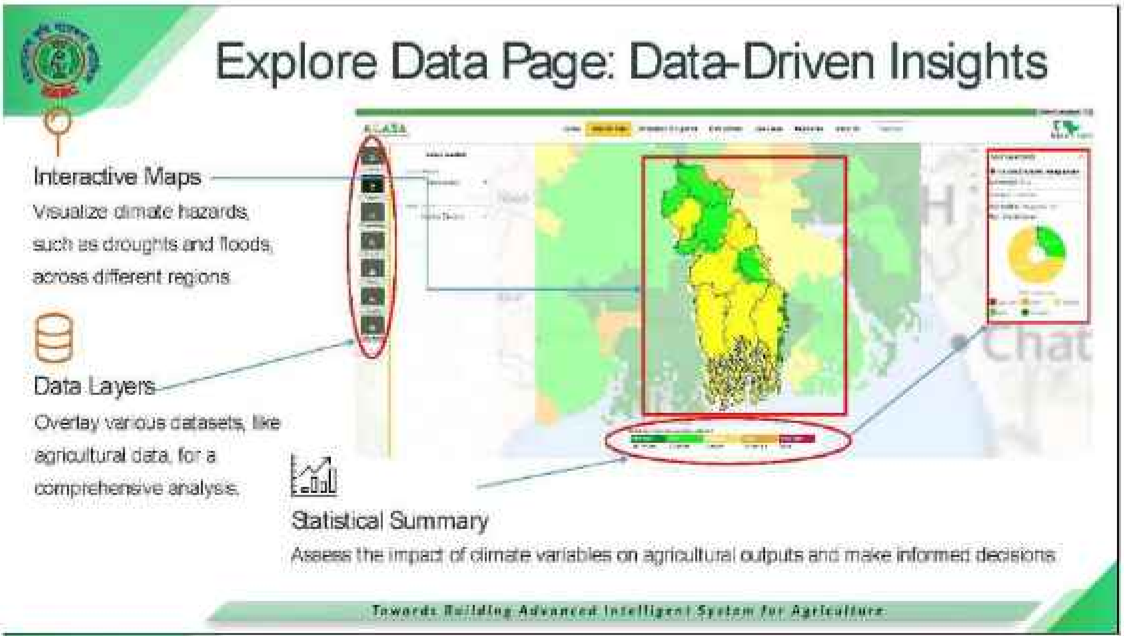
Introduction Section

Learn about ACASA's mission to support climate adaptation in South Asian agriculture.

Quick Links

Access featured tools and other important information.

Towards Building Advanced Intelligent System for Agriculture


Explore Data Page: Data-Driven Insights
Interactive Maps
Visualize climate hazards, such as droughts and floods, across different regions.
Data Layers
Overlay various datasets, like agricultural data, for a comprehensive analysis.
Statistical Summary
Assess the impact of climate variables on agricultural outputs and make informed decisions.
ACASA
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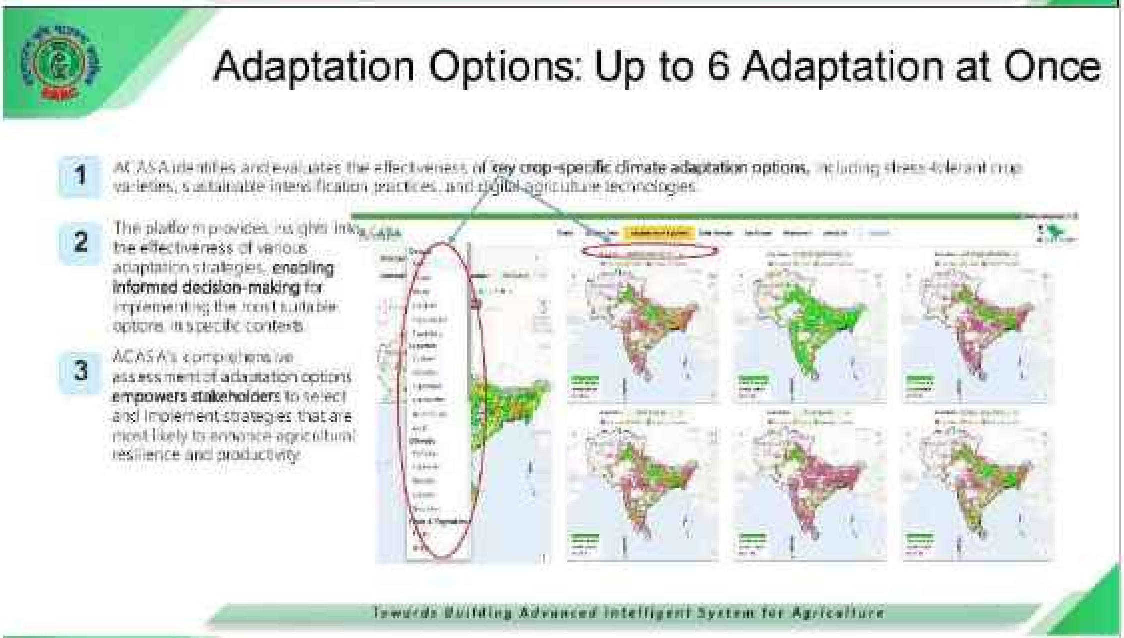
Adaptation Options: Up to 6 Adaptation at Once
1
ACASA identifies and evaluates the effectiveness of key crop-specific climate adaptation options, including stress-tolerant crop varieties, sustainable intensification practices, and digital agriculture technologies.
2
The platform provides insights into the effectiveness of various adaptation strategies, enabling informed decision-making for implementing the most suitable options in specific contexts.
3
ACASA's comprehensive assessment of adaptation options empowers stakeholders to select and implement strategies that are most likely to enhance agricultural resilience and productivity.
ACASA
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Data Access: Data at Your Fingertips
Data Repository
Explore a vast collection of downloadable datasets related to climate and agriculture in South Asia.
Methods
Easily find specific data by keywords or categories to streamline your research.
Data Sources
Learn how to effectively access and utilize the available data for your climate adaptation initiatives.
ACASA
Data Access
Data Catalogue
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Use Cases Page: Stakeholder Decision Support and Real-World Applicatio

1. **Case Study**
   Discover documented instances where ACASA's tools and data have been used effectively in real-world projects.
2. **Detailed Narratives**
   Learn about the challenges faced, solutions implemented, and outcomes achieved in each case study.
3. **A Decision-support tool**
   The platform serves as a decision-support tool for **governments, insurance providers, agri-food industries, donors, and adaptation-focused entities**, enabling informed investments in agricultural adaptation and resilience.

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Resources Page: Supporting Your Efforts

Posts and News
ACASA provides access to a wealth of resources, including publications, media content, and galleries, supporting knowledge dissemination and capacity building in climate adaptation.

Data Drive
The platform serves as a central hub for knowledge sharing, facilitating the exchange of information and best practices related to climate adaptation in South Asian agriculture.

Newsletter-Strides
ACASA empowers stakeholders with the resources they need to make informed decisions, implement effective adaptation strategies, and build a more resilient agricultural system.

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About Page: Understanding ACASA

1. **Mission Statement**
   Learn about ACASA's goals and objectives in supporting climate resilience in South Asian agriculture.
2. **Partner Organizations**
   Discover the collaborating institutions and stakeholders who contribute to ACASA's success.
3. **Contact Information**
   Find details on how to reach the ACASA team for inquiries, collaboration, or feedback.

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Feedback Page: Your Input Matters

Feedback

Feedback Form

1. Submit your comments, suggestions, or report any issues you encounter while using the ACASA platform.

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Thank You

Empowering Climate Adaptation in South Asia

ACASA is a valuable resource for stakeholders working to enhance agricultural resilience in South Asia. By providing comprehensive data, tools, and resources, ACASA empowers decision-makers to implement effective adaptation strategies, ensuring a more sustainable and prosperous future for South Asian agriculture.

For a hands-on experience and to view these features directly, visit: [illegible]

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From Policy to Practices: Leadership Strategies in Carbon Trading

The global fight against climate change has become one of the most pressing issues of our time, necessitating innovative solutions to reduce greenhouse gas emissions. Carbon trading, a market-based approach to controlling pollution by providing economic incentives for reducing emissions, has emerged as a key strategy. While the policies surrounding carbon trading provide a foundational framework, effective implementation depends heavily on leadership strategies that bridge the gap between policy and practice. This essay explores the leadership strategies required for successful carbon trading, examining their roles in fostering compliance, promoting innovation, and ensuring equity in environmental governance.

Understanding Carbon Trading: The Policy Framework

Carbon trading, also known as emissions trading, is a system where countries, organizations, or industries are allocated a certain amount of carbon emissions—often referred to as carbon credits or allowances. Those that emit less than their allowance can sell the surplus to others who exceed their limits. The two primary types of carbon trading systems are:

1. Cap-and-Trade Systems: Governments or regulatory bodies set a cap on total emissions and distribute or auction allowances. Organizations can trade allowances to meet their specific needs.
2. Offset Mechanisms: These allow entities to earn credits by investing in projects that reduce emissions, such as renewable energy or reforestation.

Although these mechanisms are governed by policies like the Kyoto Protocol and the Paris Agreement, translating these policies into actionable practices requires strong leadership at various levels.

Leadership Strategies in Carbon Trading

1. Visionary Leadership: Setting a Clear Direction

Leadership in carbon trading begins with a clear and compelling vision. Visionary leaders articulate the importance of sustainable practices and the role of carbon trading in mitigating climate change. They inspire stakeholders by framing carbon trading not just as a compliance mechanism but as an opportunity for innovation and long-term profitability.

For example, Patagonia's leadership has demonstrated how aligning business strategies with environmental goals can drive both sustainability and market success. By investing in renewable energy and offset projects, they have become pioneers in eco-friendly business practices.

2. Collaborative Leadership: Building Partnerships

Carbon trading operates within a complex web of stakeholders, including governments, businesses, NGOs, and communities. Collaborative leadership is essential for fostering partnerships across these sectors. Effective leaders engage in dialogue, build trust, and create synergies that enable smoother implementation of carbon trading policies.

For instance, the World Bank's Partnership for Market Readiness (PMR) exemplifies collaborative leadership by providing funding and technical assistance to countries developing carbon pricing mechanisms. Such initiatives demonstrate the power of collective action in scaling up carbon trading practices.

3. Strategic Leadership: Aligning Business Goals with Policy Objectives

Strategic leaders align organizational goals with carbon trading policies, ensuring compliance while maximizing economic benefits. This involves integrating carbon trading into broader business strategies, such as adopting energy-efficient technologies or diversifying into low-carbon products and services.

An excellent example of strategic leadership is seen in multinational corporations like Microsoft. The company achieved carbon neutrality by combining internal reductions with investments in carbon offset projects, demonstrating how strategic alignment can drive environmental and financial performance.

4. Ethical Leadership: Ensuring Equity and Justice

One of the criticisms of carbon trading is the potential for inequity, particularly in developing countries where offset projects may disrupt local communities. Ethical leadership focuses on addressing these challenges by ensuring that carbon trading practices respect human rights, promote fair distribution of benefits, and avoid exploitative practices.

Leaders in this domain must advocate for social safeguards and community engagement in offset projects. For example, the Gold Standard certification for carbon offsets ensures that projects deliver measurable environmental and social benefits, reflecting the importance of ethical considerations in carbon trading.

5. Adaptive Leadership: Navigating Uncertainty

The dynamic nature of carbon markets, influenced by political, economic, and environmental factors, demands adaptive leadership. Leaders must be flexible, proactive, and responsive to changes, such as evolving regulatory frameworks or market fluctuations.

The European Union's Emissions Trading System (EU ETS), one of the world's largest carbon markets, exemplifies adaptive leadership. The system has undergone several reforms to address issues like oversupply of allowances, demonstrating how adaptability can enhance the effectiveness of carbon trading.

Challenges in Leadership for Carbon Trading

Despite the importance of effective leadership, several challenges hinder the successful implementation of carbon trading strategies:

1. Regulatory Uncertainty: Frequent changes in policies can create uncertainty, discouraging long-term investments in carbon trading.
2. Market Volatility: Fluctuations in carbon prices can undermine the financial viability of carbon trading.
3. Lack of Transparency: Concerns about the transparency and credibility of carbon offsets can erode trust in the system.
4. Equity Concerns: The unequal distribution of benefits and burdens, particularly in vulnerable communities, remains a critical issue.

Overcoming Challenges Through Leadership

To address these challenges, leaders must adopt innovative and inclusive approaches:

Strengthening Regulatory Frameworks: Leaders can advocate for stable and predictable policies, ensuring that businesses have the confidence to invest in carbon trading.

Enhancing Market Transparency: By supporting independent verification and robust reporting standards, leaders can build trust in carbon trading systems.

Promoting Capacity Building: Training and education programs can empower stakeholders to participate effectively in carbon markets.

Fostering Inclusivity: Leaders should prioritize the inclusion of marginalized communities in decision-making processes, ensuring that carbon trading delivers equitable benefits.

The Role of Technology in Leadership Strategies

Technology plays a crucial role in enhancing leadership strategies for carbon trading. Digital tools like blockchain can improve transparency and traceability in carbon markets, while artificial intelligence can optimize emissions reduction strategies. Leaders who leverage these technologies can drive more efficient and accountable carbon trading practices.

For example, IBM and Energy Blockchain Labs have developed a blockchain-based platform for carbon asset trading in China, showcasing how technology can address issues like fraud and inefficiency in carbon markets.

Future Directions in Leadership for Carbon Trading

As the global focus on climate action intensifies, leadership in carbon trading must evolve to address emerging challenges and opportunities. Key future directions include:

1. Scaling Up Global Cooperation: Leaders must strengthen international collaboration to create harmonized carbon markets that transcend national boundaries.

2. Driving Innovation: Investment in research and development can unlock new technologies and approaches for reducing emissions.

3. Advancing Climate Justice: Leaders must ensure that carbon trading contributes to broader goals of social and environmental justice, particularly in vulnerable regions.

4. Integrating Nature-Based Solutions: Expanding investments in reforestation, wetland restoration, and other nature-based solutions can enhance the effectiveness of carbon trading.

Conclusion

From policy to practice, effective leadership is the cornerstone of successful carbon trading. Visionary, collaborative, strategic, ethical, and adaptive leadership strategies are essential for translating the theoretical benefits of carbon trading into tangible outcomes. While challenges persist, leaders who embrace innovation, inclusivity, and resilience can drive meaningful progress in the fight against climate change. By bridging the gap between policy frameworks and real-world practices, they can ensure that carbon trading becomes a powerful tool for achieving a sustainable and equitable future.

Training Manual on Climate Reality Leadership in Agriculture Sector (Batch 1&2)

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