

Climate Information Advisory Services (CIAS)

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EDITORIAL

CLIMATE CHANGE AND THE GROWING NEED FOR BETTER CLIMATE INFORMATION

Climate change is reshaping the nature, scale, and unpredictability of extreme weather events. Rising global temperatures are altering environmental conditions and exposing communities to hazards that increasingly challenge historical experience and conventional approaches to risk management. The devastating Nepal-Tibet disaster of 26 August 2026 offers a stark reminder of these emerging risks. The glacier collapses triggered catastrophic flooding and landslides along the Himalayan River systems, resulting in a devastating loss of 1,400 lives and leaving 6,000 missing. Recent scientific analysis indicates that human-induced warming contributed to the conditions that destabilized the glacier, while other factors also played a role. We extend our deepest sympathy to those who lost their lives, those still missing, and their families and communities.

Such events demonstrate why timely, reliable, and accessible Climate Information Advisory Services (CIAS) are increasingly important. Climate information must move beyond scientific data to become practical knowledge that supports preparedness, planning, and informed decision-making. Achieving this requires stronger collaboration among climate scientists, researchers, policymakers, development practitioners, and communities. The evolving global climate system further reinforces this need. A strong El Niño is developing

in the tropical Pacific and is expected to influence temperature and rainfall patterns across many regions through late 2026 and into early 2027. Its wider impacts remind us that climate risks are interconnected, with events in one region potentially creating consequences far beyond their immediate location. The frequency of lightning is increasing, and the resulting mortality rate is rising at a concerning rate due to a lack of awareness. Through the CIAS newsletter, we remain committed to strengthening the bridge between climate science, information, and action. By combining scientific evidence, innovation, collaboration, and local knowledge, we can help develop climate services that anticipate emerging risks, support informed decisions, and contribute to a more resilient future.

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Readers are invited to send their feedback, views and opinions on the issues and concerns addressed in the newsletter. Please write to the Editor, CIAS Newsletter, at tapas.rc@brac.net

BRAC BRINGS DECISION SUPPORT TOOL TO UNIVERSITIES AND AGRICULTURAL EXPERTS

Md. Obaidullah Al Kabir

Social Inclusion and Community Capacity Building Specialist, Climate and Environmental Innovation Programme, BRAC

How can complex climate data help farmers, teachers, and policymakers make better decisions? BRAC's Climate and Environmental Innovation Programme answered this question through three workshops held in August and September 2026. The events introduced the JO-CREWSnet website and Decision Support Tool (DST) to university academics, BRAC staff, and agricultural experts.

The JO-CREWSnet project is a research collaboration between BRAC and the Massachusetts Institute of Technology (MIT). Now in its fifth year, the project works in the southwest region of Bangladesh. It combines climate projections with social, economic, and infrastructure data to support climate-resilient planning in agriculture, water, and shelter. The DST is an integrated, map-based platform that helps users see climate risks and plan adaptation actions.

Workshop with BRAC Staff

The first workshop was held on 12 August 2026 at BRAC Centre in Dhaka. It was organized for BRAC's own programmes, including the Climate and Environmental Innovation Programme and the Disaster Risk Management Programme.

Dr. Md. Liakath Ali, Director of both programmes, welcomed the participants. He shared that JO-CREWSnet is one of MIT's five Climate Grand Challenges flagship projects. He explained that the project aims to help communities in agriculture, water, and shelter adapt to climate shocks. He also stressed that feedback from users is essential before the project ends.

Mr. Abu Sadat Moniruzzaman Khan, Programme Head, explained why climate projections matter for Bangladesh. He said long-term climate information helps stakeholders plan for disasters and reduce loss and damage.

Ms. Tasnia Bahar Chowdhury, Specialist, Economics, then gave a live demonstration of the website and DST. She showed the Heatwave Model, water security DST, the Soil Salinity Model, and crop suitability projections for Boro rice. She explained how the MIT Regional Climate Model (MRCM) downscales global data to a higher-resolution model for Bangladesh.

Participants explored the website themselves and gave useful feedback. They said the homepage was cluttered and needed a simpler menu. They also asked for a search bar, downloadable maps and data, and clearer explanations of technical terms. They suggested a single map viewer instead of four separate tool pages.

Workshop with Academics

On 8 September 2026, BRAC took the DST to Jashore. The workshop was held at the BRAC Learning Centre (BLC) and invited academics from eight universities, including Jashore University of Science and Technology, Khulna University, Khulna University of Science and Technology, Khulna Agricultural University, Gopalganj Science and Technology University and Patuakhali Science and Technology University.

Mr. Tapas Ranjan Chakraborty, Senior



Figure: Workshop on JO-CREWSnet Website and Decision Support Tool with Academics

Programme Manager, welcomed the participants and introduced the project team, which includes scientists from MIT and BRAC colleagues. He clarified that the website is for research and information, not commercial use.

Ms. Tasnia Bahar Chowdhury then presented the website and DST in detail. She explained the project's three main impact mechanisms: the website, the DST, and the Adaptation Centre. She showed practical initiatives like sunflower seed coating, the Adaptation Fortress for shelter, and a Reverse Osmosis (RO) initiative for drinking water.

She also demonstrated the Heatwave DST, the Soil Salinity DST, and the Water Security DST. She explained how heatwave information could help schools plan their calendars and help farmers plan cultivation.

Md. Obaidullah Al Kabir facilitated the feedback session. In the session, participants were divided into four groups based on their expertise, including agriculture, infrastructure, environment, GIS, and hydrology. They discussed what they liked, what was difficult, and what could be improved.

The academics appreciated the integrated, map-based platform. But they faced problems downloading data and interpreting technical indicators. They asked for more climate scenarios, local and indigenous knowledge, community feedback mechanisms, and simplified multi-hazard

warnings. They also suggested a two-tier interface: a simple version for general users and an advanced version for researchers. A mobile-friendly version was also recommended.

Agricultural Workshop

The third workshop was held on 21 September 2026 at BRAC Centre in Dhaka. This time, the audience was agricultural experts from institutions like BRRI, BARI, BADC, IRRI, the Department of Agricultural Extension, and the Bangladesh Climate Change Trust.

Dr. Md. Liakath Ali opened the workshop. He explained the difference between short-term weather information and long-term climate information. He said JO-CREWSnet focuses on long-term projections for temperature, rainfall, cyclones, salinity, and tidal flooding.

Mr. Tausif Ahmed Qurashi, Senior Programme Manager, presented BRAC's work in climate-vulnerable coastal areas. He shared impressive results: coastal cultivation expanded from 200 bighas to over 8,000 bighas, 4,476 farmers were engaged, and cropping intensity rose from 140% to 220%.

Ms. Tasnia Bahar Chowdhury then demonstrated the hazard models, the MRCM, the Water Security DST, and the Heatwave DST. She explained how dry-bulb and wet-bulb temperatures help measure heat stress.

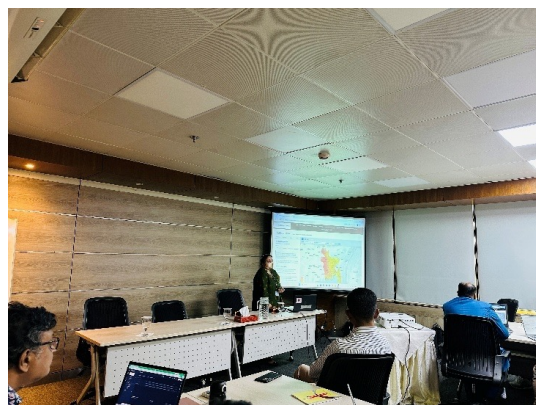


Figure: Workshop on JO-CREWSnet Website and Decision Support Tool with Agricultural Experts

In the open discussion, participants gave strong feedback. They said the DST should move beyond showing risks and explain what actions to take. They recommended crop-specific climate thresholds, climate adjusted crop calendars, and integration of BARI's crop variety data with climate projections.

Looking Ahead

All three workshops showed strong interest in the JO-CREWSnet website and DST. Participants agreed that the platform is a

valuable resource, but it needs to become more user-friendly, more location-specific, and more action-oriented.

The feedback from all workshops will be shared with the MIT team. A Bangladeshi delegation, including government focal persons, will visit MIT to help refine the tools. The long-term goal is to make JO-CREWSnet a practical, forward-looking decision-support tool that helps Bangladesh build a climate-resilient future.

WHEN EVERY HOUR COUNTS: BUILDING A PEOPLE-CENTERED FLASH-FLOOD WARNING SYSTEM IN THE HAOR BASIN

M. Anisul Islam

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In the deeply flooded haor basin of Tahirpur, Sunamganj, the arrival of water can transform an entire landscape within hours. Heavy rainfall on the steep southern slopes of the Meghalaya Plateau rushes downstream through rivers and channels, often overtopping or breaching submersible embankments. When this happens shortly before the Boro (winter) rice harvest, farming families may watch their principal source of food and income disappear beneath the water.

For haor communities, flash floods are not exceptional events; they are a recurring reality. Their consequences, however, become particularly devastating when floodwaters arrive earlier than expected. Farmers usually invest heavily in a single Boro (winter) crop and depend on its harvest for much of the year. A few additional days of warning can therefore determine whether a family saves its crop or can reduce the losses.

Recognizing this challenge, the Center for Natural Resource Studies (CNRS), with support from the Comprehensive Disaster Management Programme (CDMP) under the

Ministry of Food and Disaster Management and UNDP Bangladesh, conducted an extensive study and adopted a pilot of an early warning system for flash floods in Tahirpur upazila of Sunamganj district, which started in 2007 and was completed in December 2008. The study combined scientific analysis, institutional consultation, field observation, and the knowledge of local communities to propose a practical and people-centered warning model.

The urgency of the initiative was evident from the historical record. In 2004, an early flash flood reportedly damaged 90 per cent of the Boro crop in Sunamganj. Household-level information collected for the study also showed that almost every surveyed household was affected that year, with many losing their entire crop. Such losses extend beyond landowners, such as agricultural laborers losing employment, families facing food insecurity, livestock being sold at distress prices because of scarcity of fodder and to meet the recurrent subsistence costs, and households falling deeper into debt.

The study found that flash-flood risk is driven by interconnected natural and

human factors. Intense upstream rainfall generates rapid runoff from the Meghalaya hills, while deforestation and cultivation on hill slopes reduce the soil's ability to retain water. Downstream, sedimentation raises river and haor beds and decreases their water-carrying capacity. Weak or unfinished embankments, inadequate drainage structures, poorly maintained sluice gates and unplanned roads further obstruct the movement of water and increase pressure on crop-protection infrastructure.

CNRS therefore proposed an early warning

approach that would bring together rainfall forecasts from upstream catchments, recent rainfall observations, river-gauge readings of FFWC/BWDB, local rainfall forecasts and assessments of embankment conditions. By analyzing these indicators collectively, the system estimates the likelihood and extent of a flash flood and guides timely protective action. The study developed empirical and conceptual models for this purpose, while emphasizing that they would require two to three years of field testing and refinement before becoming fully operational.

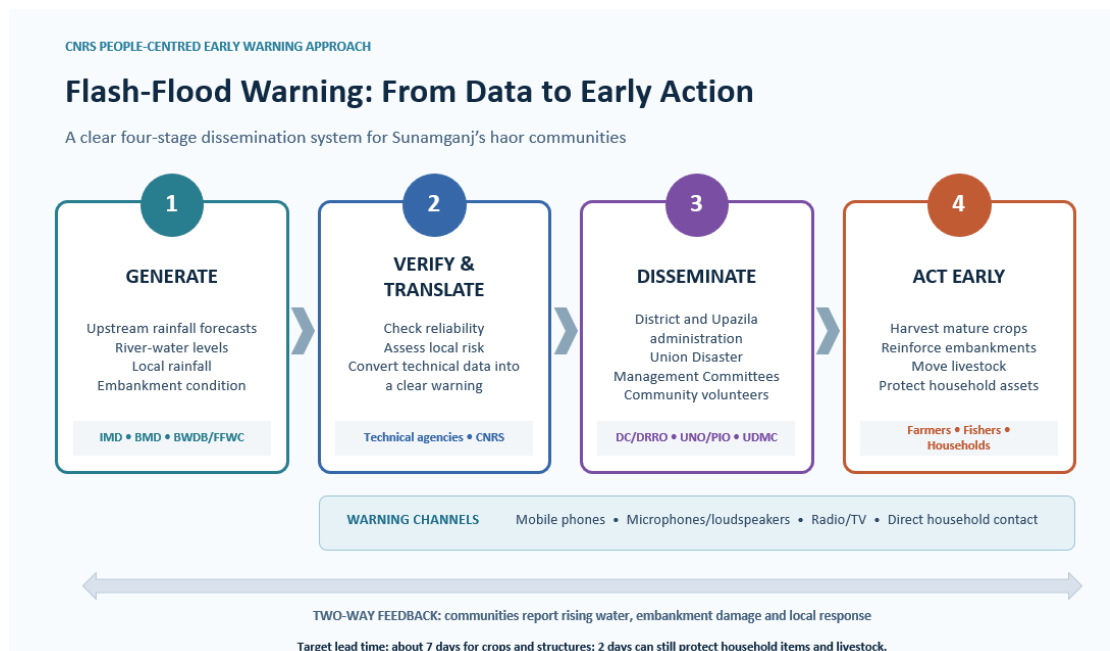


Figure: A four-stage dissemination system for flash flood warning [3]

Scientific information alone, however, cannot save crops or protect households. A warning is useful only when it reaches people in time, is expressed in language they understand and is linked to actions they can take. The report therefore placed communities at the center of the proposed system. Local farmers told the study team that they would need approximately seven days of warning to save at least 70 per cent of their agricultural assets, outside property and homestead structures. A two-day warning could still allow them to move household belongings, livestock and poultry to safer

places. These findings demonstrate that the value of a warning depends not simply on its technical accuracy but also on the amount of time it gives people to act.

Haor communities already possess valuable coping knowledge. Villagers routinely monitor water movement, organize shifts to maintain round-the-clock vigilance, and mobilize volunteers when embankments are threatened. Better-off households often contribute money for emergency repairs, while poorer households provide labor. Microphones and loudspeakers are

sometimes used to call people together and communicate urgent information. A formal early warning system should strengthen these existing practices rather than replace them.

The proposed communication chain connects technical agencies with local government institutions and households. Rainfall and river information would be collected and interpreted by responsible technical organizations, translated into simple and locally meaningful messages, and shared through the upazila administration, Union Disaster Management Committees (UDMCs), NGOs and community volunteer groups. Multiple channels, including mobile communication, local announcements, microphones, loudspeakers, radio and television, would help ensure that warnings reach women, older people, persons with disabilities and remote households.

Community members also stressed that warning systems must be accompanied by practical risk-reduction measures. Their priorities included timely repair of crop-protection embankments, removal of the barriers for drainage, e.g., re-excavation of closures on the river sections and canals, construction and maintenance of culverts and sluice gates, plantation along embankments, and meaningful community participation in planning and monitoring public works.

The CNRS study and piloting delivered a clear message that remains highly relevant. An effective early warning is not merely a forecast, but a complete chain linking risk knowledge, scientific monitoring, clear communication, and community capacity to respond. It also requires cooperation among government agencies, research institutions, local government, NGOs, the media and communities on both sides of the upstream-downstream system.

For the people of Sunamganj, even a few hours can matter and several days can protect a year's livelihood. By connecting science with local knowledge and turning forecasts into timely action, a people-centered early warning system can give haor communities something immensely valuable, which is time to protect their crops, livestock, homes, and future.

Acknowledgement: CNRS gratefully acknowledges the contribution of the study team and is also grateful for the research support and kind permission granted to use part of his monograph by Dr. Surendra Singh, Professor, Department of Geography, and the DST-Sponsored Project, Department of Geography, North-East Hill University, Shillong, India, for using their data in preparing this report.

HEATWAVE PROJECTION FROM MIT TO ADAPTATION FORTRESS

Tasnia Bahar Chowdhury

Specialist, Economics, Climate and Environmental Innovation Programme, BRAC

Massachusetts Institute of Technology (MIT) projected that Bangladesh's heat-stress risk is changing dramatically. In the past, severe heat stress was experienced only about once every 100 years, but future climate conditions, depending on the emissions pathway, are projected to shift

the heatwave frequency to approximately once every 4 to 8 years. This is not just an increase in daytime temperature; it signals a move toward more frequent and persistent dry heat stress, including conditions that can also affect nighttime recovery [\[4\]](#). The seriousness of this shift is reflected in the

2024 heatwave, when prolonged exposure to elevated temperatures combined with water shortages produced wide-ranging harms. Communities faced increased health risks such as heatstroke and dehydration, agricultural losses, and social disruption, such as school closures and intensified drinking water stress [28]. These outcomes demonstrate how heat stress can quickly become a multi-sector emergency involving health systems, livelihoods, and everyday community life. As the climate warms,

projections also indicate that heat will become more widespread and enduring, with a stronger likelihood of “dry heat extremes” occurring across both day and night. Importantly, April and May emerge as transition months where risk peaks, linked to both water scarcity and rising dry-bulb heat extremes. This timing matters for planning heat response measures, including decisions about work hours, school schedules, and emergency shelter readiness

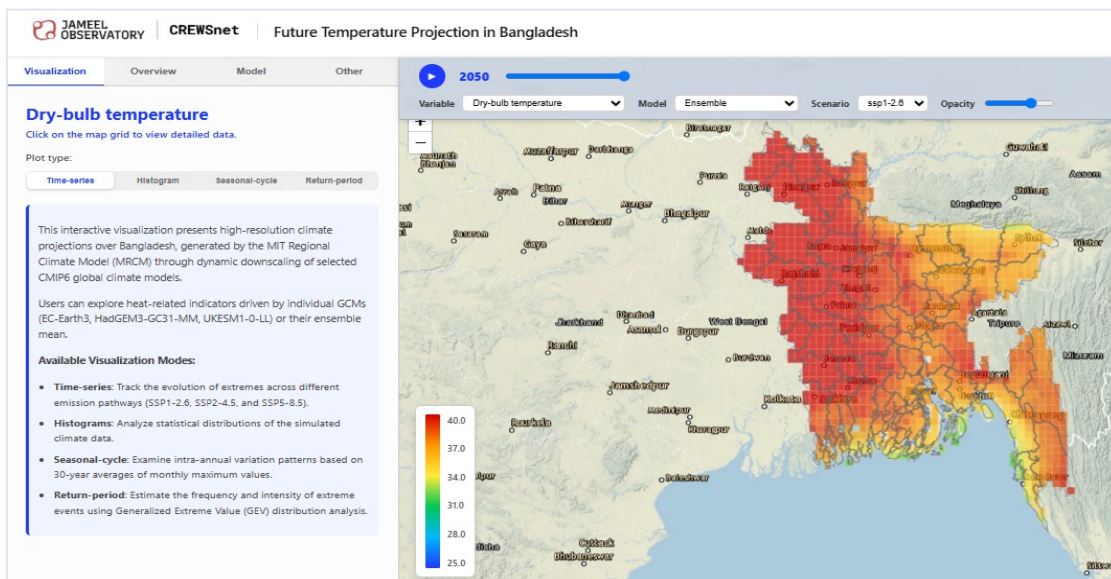


Figure: Decision Support Tool for Heatwave Projection

To support such decisions, MIT translated its modeling work into a high-resolution Decision Support Tool (DST) for Bangladesh. Using the MIT Regional Climate Model (MRCM) at 10 km resolution, the system applies dynamic downscaling of selected CMIP global climate models and includes land-process realism through coupling with the Integrated Biosphere Simulator. The outputs are bias-corrected using Parametric Quantile Mapping to improve reliability. The resulting projections from 2021-2050 are presented through an interactive “Future Temperature Projection” visualization that includes multiple modes, such as multiple Shared Socioeconomic Pathway (SSP) scenarios (e.g., SSP1-2.6, SSP2-4.5, SSP5-8.5), seasonal cycles, histograms, and

return-period estimates using GEV analysis, helping decision-makers understand not only how hot it will get, but how often extreme heat events are likely to occur [18].

These projections connect directly to a key adaptation question: how will dry and humid heat conditions, including the frequency, duration, and severity of heatwaves, change across Bangladesh, and where should planning be prioritized? The modeling is paired with the recognition that heat hazards are increasingly overlapping with existing risks. This makes adaptation not only about temperature management but also about resilient infrastructure that can withstand stress during multiple disaster types, including cyclones.

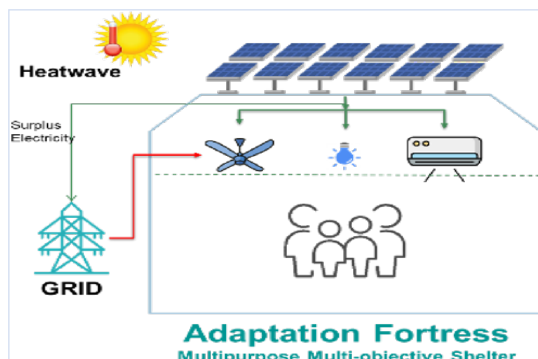


Figure: Adaptation Fortress concept

The Adaptation Fortress (AF) concept responds to this need by proposing multipurpose shelters designed for both heat stress relief and cyclone protection [16]. Historically, Bangladesh did not always require dedicated heat shelters, but recent extremes have shown that specialized cooling and protective spaces can be lifesaving during government-declared heat emergencies. AFs are designed to be more than a temporary refuge: they include solar power with battery backup to maintain energy access, air-conditioned rooms for high-risk individuals, and a design that supports community use when cooling demand is lower.



Figure: 1st Adaptation Fortress

The first AF pilot is being implemented at Baradal Aftab Uddin Collegiate School in Baradal union, Assasuni upazila, Satkhira district, by MIT in collaboration with BRAC under the Jameel Observatory Climate Resilient Early Warning System Network (JO-CREWSnet) project. This location was selected after community surveys, workshops, site visits, and discussions with the school committee. The building

already functions as a school-cum-cyclone shelter and serves local needs because it is centrally located within walking distance to key community institutions such as the market, health clinic, and union parishad office. The retrofit adds heat-focused capacity, air conditioning units in four rooms (above the ground floor), rooftop solar panels, and elevated batteries above flood levels. There are 33 solar panels installed in the AF, and it has the capacity to produce 20,460 kWh of electricity. Since its inauguration on 18 July 2026, the AF solar system has generated 3,061 kWh of electricity for the national grid by 31 July 2026. Of this, the AF consumed 683 kWh, resulting in a surplus of 2,378 kWh supplied to the national grid (Rural Electrification Board (REB) electricity official bill).



Figure: Solar Panels of 1st Adaptation Fortress rooftop

Finally, the AF initiative includes a practical evaluation and scaling plan. Performance will be assessed through community surveys during the heat season, operational feedback from the school committee, monitoring of energy generation and air conditioning usage, and use of hyper-local weather data. With successful piloting and refinement, the model aims to scale across southwest Bangladesh, potentially enabling relief for large numbers of vulnerable residents through a network of purpose-built shelters that turn climate projections into real-world protection.

WHEN MOUNTAIN HAZARDS INTERACT: WHAT NEPAL'S RASUWA DISASTER (2026) CAN TEACH US ABOUT SCIENCE, RISK AND DEVELOPMENT

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Rasuwa Disaster (Nepal 2026): The Prologue

Homo sapiens, one of the many faunal species on planet Earth, has emerged as remarkably capable of confronting environmental challenges. This ability, coupled with advances in science-based risk assessment and disaster-risk reduction, has enabled human societies to live and prosper in places where environmental conditions are extremely unfavorable, from high-altitude and freezing environments to hot and arid regions. Yet even a careful assessment of risk does not always produce adequate warning, particularly when pressures accumulate gradually over a long spell of time or when potentially hazardous processes develop without clear, observable signals until the moment of failure. The recent landslide and flash-flood disaster in Nepal, which occurred on the morning of 26 August 2026 near the Nepal–China border in Rasuwa District, is a striking example. The event was difficult to anticipate and difficult to comprehend because of its scale, rapid onset and cascading impacts, including loss of life, injuries, people reported missing, damage to property and infrastructure and effects on ecosystems and species.

Disasters can leave affected places fundamentally changed. Ecosystems and ecosystem services, productive environments that support food and livelihoods, public services, institutions and patterns of social and economic interaction may all be disrupted for years or even decades. The impacts of the Nepal disaster thus may extend beyond the immediate and highly visible consequences. This

article does not attempt to revisit the rapidly evolving figures on immediate casualties and damage. Instead, it asks a different set of questions – what should happen next? What research and assessment should be undertaken to understand how this disaster occurred? And how can science and technology help Nepal and other mountain regions better anticipate and reduce the risk of a similar event in the future? The impacts can broadly be considered in two categories: first, immediate impacts such as loss of life and property, and second, strategic and long-term losses involving assets and development gains accumulated over many years, even decades after decades. This article focuses primarily on the second category and on the scientific and practical actions that should follow.

The Loss of Assets Built Over Decades

One of the most consequential impacts of a major disaster is the loss or deterioration of development gains accumulated over decades through the investments and efforts of governments, non-governmental organizations, development partners, donors, local communities and other actors. These gains can be viewed as at least five interconnected forms of assets. These are as follows.

- Physical assets: roads, bridges, irrigation systems, power infrastructure, housing, schools and health facilities.
- Productive assets: agricultural land, ecosystems and enterprises that support livelihoods and local economies.
- Human assets: education, skills and

health accumulated through years of investment in people.

- Institutional assets: public agencies, regulatory systems, governance arrangements and scientific organizations.
- Knowledge assets: information and understanding generated through research, monitoring, observation and accumulated experience.

The disaster appears to have severely affected several of these asset categories. In Nepal, the first two categories are severely affected, while the remaining three are strategically affected. While some immediate losses can be addressed through emergency response and reconstruction, strategic assets accumulated through decades of development are much harder to restore, and some losses may never be fully reversible because development does not occur through a single project or investment. It emerges gradually through numerous, multidimensional and interconnected programmes. When those accumulated gains are disrupted, communities and institutions may have to restart their lives with deep gaps in the asset base that previously supported their resilience and wellbeing. The significance therefore extends beyond the physical geography of the disaster. Development partners, governments, donors, researchers and communities have all contributed to building these assets. Their loss represents not only a national setback but also a loss of accumulated development knowledge and investment. In that sense, the event should be viewed as an unusual disaster whose consequences may be both locally profound and globally instructive.

Three Immediate Questions for Defining the Way Forward

What should happen next? A useful way forward is to organize the post-disaster agenda around three sets of questions. The first set concerns response and recovery. These questions are relatively

straightforward: how can lives be protected, essential services restored, affected communities supported, and critical infrastructure repaired? Government agencies, non-governmental organizations, and development partners have already begun work in these areas. The second set concerns post-disaster needs assessment (PDNA) or a joint needs assessment (JNA). How should the scope of such an assessment be defined? Should it capture not only physical damage and immediate economic losses, but also the development assets accumulated over decades? A broader loss-and-damage assessment would help define a more realistic long-term 'build back better' programme. The third set of questions is more forward-looking and, in my view, particularly important. How did the hazard develop? Which interacting physical processes produced the event? Which warning signals, if any, existed before failure? Could those signals have been detected? And what combination of observations, modelling, and early-warning systems could help identify a similar risk in the future? These questions matter not only for Nepal. They are also relevant to mountain communities around the world that face increasingly complex interactions among climate, hydrology, geology, glaciers, land use, and human activity.

Why Understanding the Landslide Process Matters

In hilly and mountainous terrain, landslide susceptibility emerges from the interaction of geological structure, geomorphology, hydrological inputs, and slope mechanics. Rainfall, snowmelt, and glacier melt can alter infiltration, groundwater recharge, saturation, and pore-water pressure, while surface-water flow can erode and remove support from slope toes. These hydrological changes interact with lithology, weathering, fractures, faults, bedding, and foliation to modify the mechanical strength and stress state of slope materials. Climate change can intensify or alter some of these processes by changing precipitation extremes, snow, and glacier dynamics, freeze-thaw regimes, soil

moisture, and, at high elevations, permafrost conditions.

An integrated geological–hydrological–hydrogeological–geotechnical–climatological framework is therefore needed. No single factor, considered in isolation, is sufficient to explain the behavior of a complex mountain slope. It is also important to clarify how water destabilizes slopes. Rainfall, snowmelt, and glacier melt do not necessarily destabilize slopes simply because they add weight. In many rainfall-induced landslides, important mechanisms include increased saturation and pore-water pressure, changes in effective stress, reductions in shear strength, seepage forces, and erosion or removal of support.

Geological Processes and Groundwater Pathways

Rock type is important, but lithology alone does not determine groundwater behavior. Critical geological characteristics include lithology, porosity, permeability or hydraulic conductivity, degree of weathering, fractures and joints, faults, bedding planes, foliation, discontinuity orientation, soil and regolith thickness, sediment grain size and sorting, geological contacts, and valley and slope geometry. In mountainous terrain, groundwater often follows preferential pathways rather than moving uniformly through the geological mass. For example, massive granite may have low primary porosity but transmit groundwater efficiently where it is highly fractured. Limestone can develop secondary permeability through dissolution and karst processes. The thickness and character of sedimentary and weathered materials depend on geological history, erosion, weathering, glacial activity, valley geometry and mass-wasting processes. The contrast between intact bedrock, weathered bedrock, colluvium and soil is especially important because these layers may have very different hydraulic and mechanical properties.

Water can accumulate above a relatively impermeable layer and then move laterally along the interface, creating a potential

failure surface. Rainfall may therefore influence slopes through a chain of linked mechanisms such as infiltration, increased soil moisture, groundwater recharge, rising groundwater levels, increased pore-water pressure, seepage forces and, in some situations, increased saturated mass. Surface-water flow is an additional and distinct mechanism. Rivers and streams can erode the toe or banks of slopes, remove supporting material and increase instability. This mechanism differs from rainfall infiltration and should be explicitly represented in the assessment framework. Three major water pathways can therefore be distinguished as, first, rainfall – infiltration – groundwater recharge – increased pore-water pressure. Second, snow/glacier melt – runoff and infiltration – groundwater recharge – elevated groundwater/pore-water pressure. Third, river/stream flow – bank and toe erosion – loss of lateral support – increased slope instability. Water–rock interaction can also drive dissolution, hydrolysis, oxidation, carbonation, mineral alteration, and ion exchange. These processes can modify mineralogical, hydraulic, and mechanical properties. Limestone dissolution, for example, can enlarge fractures and create conduits or cavities. Chemical weathering can also transform primary minerals into clay-rich materials with different hydraulic and mechanical properties. The magnitude and direction of these effects are highly site-specific. They should therefore be investigated rather than assumed.

Climate Change: A Forcing Factor, Not a Stand-Alone Explanation

Climate change modifies the hydrological and thermal boundary conditions under which geological and geomorphological processes operate. Relevant changes include precipitation intensity and seasonality, snow accumulation and melt timing, glacier mass balance, freeze–thaw cycles, soil moisture, extreme rainfall, and permafrost conditions at high elevations. Climate change should not automatically be presented as the direct cause of an individual landslide. Rather, it can intensify

or alter hydrological and thermal processes that interact with pre-existing geological and geomorphological susceptibility. Temperature is particularly relevant in mountain environments. Freeze–thaw cycles can widen discontinuities as water entering fractures freezes and expands. Warming can also accelerate snow and glacier melt and thaw ice-rich ground, potentially changing the mechanical properties of previously frozen materials. If the objective is not merely to document what happened in this Rasuwa (Nepal, 2026) disaster but to improve future risk assessment and early warning, the post-disaster scientific programme should be designed as an integrated investigation rather than as a collection of disconnected studies. In summary, the major areas of focus should be as follows.

1. Geological and geomorphological characterization

Characterize lithology, geological structure, faults, joints, bedding and foliation, weathering, soil and regolith thickness, sediment characteristics, slope geometry, and drainage networks.

2. Hydrogeological characterization

Characterize rainfall, snow and glacier melt, infiltration, groundwater recharge, hydraulic conductivity, groundwater levels, groundwater-flow pathways, springs, pore-water pressure, and surface-water-groundwater interactions.

3. Slope-stability characterization

Assess slope angle, soil and rock strength, cohesion, friction angle, unit weight, discontinuity orientation, pore pressure, erosion, potential failure surfaces, and factor of safety.

4. Climate and anthropogenic forcing

Incorporate precipitation extremes, temperature, snow and glacier dynamics, land-cover change, deforestation, road construction, slope cutting, drainage modification, urbanization, mining, quarrying, and other relevant land-use changes.

Science and Technology: From Investigation to Early Warning

A major opportunity after a disaster of this nature is to connect laboratory experiments, field observations, remote sensing and modelling into a single learning system. Laboratory simulation, following the proposed workflow, can help examine how interacting processes generate slope responses under controlled conditions. These experiments should then be tested against field observations and monitoring data. Remote sensing can play a vital role by identifying slope deformation, land-cover change, glacier retreat, drainage changes, landslide scars and other geomorphological features. However, remote sensing generally cannot directly measure subsurface pore-water pressure at depth. Field observations and monitoring, together with hydrogeological and geotechnical modelling, are therefore essential for characterizing the subsurface system.

The ultimate goal should be an operational, integrated risk-assessment and early-warning framework. Such a framework would combine observations of environmental change with models of hydrological, hydrogeological and geotechnical processes, allowing emerging conditions to be interpreted as signals of changing risk. The strength of this approach lies not in any single method but in the interaction among them.

Looking Beyond This Disaster

The most important question after a disaster is not only how quickly we can rebuild what was lost but also what we can learn before the next event. The Rasuwa (Nepal) disaster presents a difficult and painful opportunity to examine how complex mountain hazards emerge from the interaction of geological, hydrological, climatic, geomorphological, and human processes. Recovery should not be understood simply as replacing damaged infrastructure. A major disaster can erase or weaken development gains that have accumulated over decades, such as physical and productive assets, human capabilities,

institutions, and the knowledge systems built through years of investment, research, monitoring, and experience. Rebuilding, therefore, needs to restore not only what is physically lost but also the foundations of resilience that development programmes have painstakingly created. This is why the post-disaster assessment matters so much. If the loss of development gains is not adequately recognized, the scale of recovery needs may be underestimated, and opportunities to build back better may be missed. A comprehensive assessment should therefore connect immediate damage and loss with longer-term development impacts and with the scientific understanding needed to reduce future risk.

A comprehensive post-disaster scientific programme should document the event, reconstruct its physical sequence, identify contributing factors, map areas of residual and future risk, and develop monitoring indicators that can support early warning. Such work would add value far beyond the affected area. It could also help protect future development investments by identifying where, when,

and under what conditions accumulated assets become vulnerable to cascading hazards. The larger lesson is that unusual disasters require us to move beyond single-hazard thinking. Mountain systems are dynamic, interconnected, and nonlinear. Understanding these interactions is difficult, but it is precisely where the next generation of disaster-risk science needs to focus, especially in the era of Earth Intelligence (EI) and Artificial Intelligence (AI). If the experience of the Rasuwa disaster (Nepal, 2026) can be transformed into a rigorous programme of investigation, monitoring, modelling, and knowledge sharing, the disaster may yield one of its most important legacies, not only better science and better early warning but also a stronger understanding of how to protect, preserve, and rebuild the development gains on which mountain communities depend. In this sense, the real measure of recovery will not be how quickly we replace what the disaster destroyed. It will be whether we can recover stronger, retain the gains that remain, learn from those that were lost, and reduce the likelihood that future disasters will erase years of development once again.

WHAT SOUTH WEST COASTAL AGRICULTURE TELLS US ABOUT A CHANGING CLIMATE?

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Across Bangladesh's southwest coastal belt, climate change is rarely experienced as a single event. Agriculture in this region of the country operates at the intersection of land, saline waters, tides, and increasingly variable climate. The Bangladesh National Adaptation Plan (NAP) noted that around 1.0566 million hectares of coastal and offshore land are affected by varying degrees of soil salinity [20]. In this perspective, agricultural evolution can serve as a living record of how temperature changes and related conditions have reshaped what is grown.

A farmer may not be able to describe climate change through temperature anomalies or

model projections in terms of temperature or sea level rise, but they are able to recognize how their cultivation windows and practices have changed. Amidst all this for farmers, the changing crop calendar, increasing salinity, prolonged waterlogging, unreliable freshwater, shorter winters, extreme heat, cyclones, and the difficult question that returns every season: what can still be grown successfully here? - have only intensified.

Lessons from farmers' lived experience

Earlier in August 2026, a historical trend assessment, focusing on broad historical

patterns, crop transitions, and reported drivers of change, was undertaken through BRAC's Climate and Environmental Innovation Programme (CEIP) under the JO-CREWSnet, project across the three working locations [15]. This study looked into how farmers have answered that question over more than three decades. Working with experienced farmers in Satbaria in Keshabpur, Baradal in Assasuni, and Munshiganj in Shyamnagar, the assessment reconstructed changes in crops and varieties from the late 1980s to 2026. The discussions looked particularly at Boro Rice, Rabi crops, and, to some extent, homestead crops and explored not only what farmers cultivated but also when varieties changed and why.

When we brought the findings from the three locations together, the pattern was a much more dynamic agricultural system in which farmers continuously adjust their choices in response to changing environmental conditions, technology, seed availability, and markets. One of the strongest findings is that there is no uniform agricultural pathway across the southwest.

Different agricultural realities

In Satbaria, Keshabpur, farmers repeatedly recalled waterlogging, drought, heavy rainfall, and increasing heat as important influences on crop choices. Traditional Boro rice varieties have gradually given way to BRRI and hybrid varieties. At the same time, several Rabi crops that were once common, including lentils, grass pea, chickpea, mung bean, cotton, and sugarcane, have declined considerably. Farmers also associated declining wheat cultivation with shorter winter periods. More recently, maize, in contrast, has entered the local farming system, with farmers reporting its introduction around 2024.

In Baradal, Assasuni, the challenge has been different. Here, farmers described Boro cultivation being historically constrained by salinity, inadequate irrigation and high iron content in irrigation water. At different periods, Boro cultivation became so difficult that it was discontinued or limited to a very

small number of farmers. Yet the agricultural system did not simply contract. Farmers diversified. Improved mustard varieties became increasingly common. Sunflowers re-emerged after disappearing for a period. Maize and watermelon have also entered the cropping system more recently.

This tells us something important: adaptation is not only about finding a better variety of the same crop. Sometimes farmers respond to environmental constraints by changing the composition of the farming system itself. Research in different parts of the coastal belt of Bangladesh published in 2026 stated that crop diversification depends not only on environmental conditions but also on irrigation access, farm resources, markets, and household economic capacity [24].

Further south in Munshiganj, Shyamnagar, salinity and freshwater scarcity are central to farmers' accounts of agricultural change. Cyclone Aila in 2009 emerged repeatedly in discussions as a major turning point because of saline-water inundation and prolonged waterlogging. Farmers recalled gradually moving from older local Boro varieties towards BRRI, BINA, and hybrid varieties. T. Aman rice also experienced substantial varietal change. Meanwhile, watermelon, diversified vegetables, and later maize became increasingly visible within the local agricultural economy.

Another study in southwestern Bangladesh found that soil salinity can peak during the critical reproductive stage of dry-season rice, placing traditional varieties under greater stress than newer saline-tolerant varieties [13].

Farmers are not choosing crops based on climate alone

A useful lesson from these consultations is that farmers do not make agricultural decisions based on climate tolerance alone. A variety may tolerate salinity but still be abandoned if its yield is poor, its grain is not preferred by consumers, it is vulnerable to disease, or it does not generate an adequate return.

Farmers repeatedly referred to a combination of factors: yield, crop duration, salinity tolerance, freshwater availability, pest and disease resistance, seed availability, taste, market demand, and profitability. Research in coastal Bangladesh has also shown that crop diversification is combinedly influenced by salinity, water availability, drainage, mechanization, market connectivity, and household resources [24].

The experience of T. Aman rice in Munshiganj is particularly illustrative. Farmers discussed varieties that were suitable for saline conditions, while those were not necessarily retained because grain quality and market preference also mattered. Similarly, changes in potato varieties were linked not only to production performance but also to taste, market acceptance, and commercial return.

A crop may be technically suitable for a future climate but still fail to become a viable farmer choice if seed is unavailable, irrigation costs are high, or buyers do not value the product. Biophysical suitability and farmer adoption are related, but they are not the same thing. The discussion with the farmers illustrated that while the locations are part of the southwest coastal zone, the agricultural landscape is not uniform. Several long-established crops are persisting but changing internally. T. Aman, Boro, mustard, potato, and chilli have remained part of local farming systems, while their varieties have progressively shifted from local or traditional types towards improved and hybrid options.

Moreover, new crops are entering some farming systems. Maize and watermelon are among the clearest examples. Watermelon, in particular, was largely absent from earlier cropping systems in several locations but has become an important commercial option in parts of Assasuni and Shyamnagar.

Sunflower has shown location-specific prevalence, disappearing and later re-emerging in parts of Baradal, while remaining much less established in the other two locations. Boro similarly shows contrasting

trajectories: relatively strong varietal transition in some locations, but persistent structural constraints in others.

When farmers' memories can complement climate models!

It is important to realize that farmers' collective recall and lived experience do not replace meteorological records, crop trials, or modelling. But it provides something: a personal account of people who are at the frontline of the changing climate and how they actually responded when conditions changed in the past. Conversely, where farmers continue to cultivate a crop despite environmental stress, their experience may point towards varieties, management practices, or market incentives worth investigating.

This is where farmer knowledge and modelling can become mutually reinforcing – the decline of some crops, the introduction of others, and the continuous search for better-performing varieties reflect farmers' attempts to negotiate an increasingly uncertain production environment.

This becomes particularly relevant to the wider work of JO-CREWSnet. The project, under its focus area of agriculture, is bringing together climate and environmental information, research, modelling and locally grounded knowledge to better understand climate risks and support decisions in vulnerable communities. While a model may indicate that a crop or variety is biophysically suitable under particular temperature, rainfall or salinity conditions. The farmers' accounts add another layer: whether that option is practical when freshwater is scarce, seed is difficult to obtain, irrigation is costly, grain quality is less preferred, or the market return is insufficient.

Farmers have long adapted through different observations and experimentation to shocks; the opportunity now lies in how to strengthen their decision-making for their adaptation process.

IOT-ENABLED SMART AQUACULTURE: DIGITAL SOLUTIONS FOR CLIMATE-AFFECTED FISHERIES AND AQUACULTURE

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Fisheries and aquaculture remain an important subsector of Bangladesh's economy and food system, contributing 2.58% to the national GDP and sustaining the livelihoods of roughly 12% of the population, including 1.4 million women. With global rankings such as 1st in hilsa catch and 5th in aquaculture from closed water bodies, this sector achieves a total production of about 51.11 lakh metric tons annually. Beyond domestic food security, the sector is a massive export earner, generating BDT 6,144.91 crore in FY 2024–25 alone [9].

Despite this production, the sector faces numerous challenges from climate change, such as erratic rainfall, salinity intrusion, and extreme weather events. Traditional farming practices heavily depend on time-consuming manual monitoring for water quality. Fish growth is closely correlated with water temperature. Sudden temperature fluctuations can rapidly deplete dissolved oxygen levels or spike toxic ammonia from accumulated feed waste, leading to heavy production losses.

To build a more resilient future for our fish farmers, integration of AI engine-based Internet of Things (IoT) technology into commercial aquaculture could be an effective option to meet the protein demand. This floating digital solution offers a transformative approach to pond management.

What IoT Does?

- The IoT device utilizes sensors to continuously collect real-time water quality data, specifically monitoring pH, dissolved oxygen, ammonia, and salinity levels.
- All gathered data is securely stored in

the cloud, allowing farmers to track conditions remotely via an easy-to-use mobile application.

- When water parameters exceed safety thresholds, the system immediately sends an SMS notification in Bangla to the user's mobile phone, including actionable steps to improve the water quality.
- To further mitigate risk, the system can automatically initiate response actions, such as turning on aerators or water pumps, to maintain optimal aquatic conditions.

By transitioning to sensor-based smart aquaculture, farmers can significantly reduce their feed, operational, and labor costs while making informed decisions based on reliable data rather than intuition. This digital integration not only forecasts adverse climatic conditions and detects early disease outbreaks but also presents a profitable model of commercial farming.



Figure: IoT device in Pond

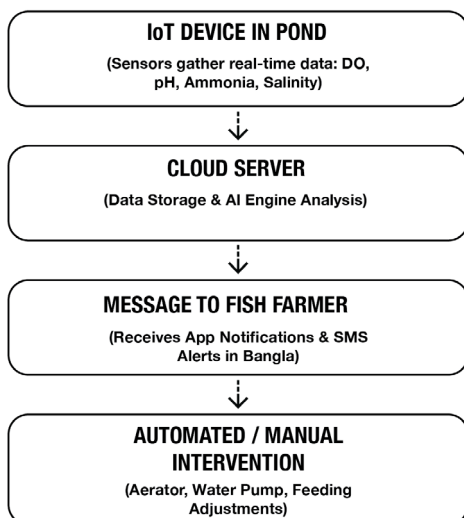


Figure: IoT in Pond: System Diagram

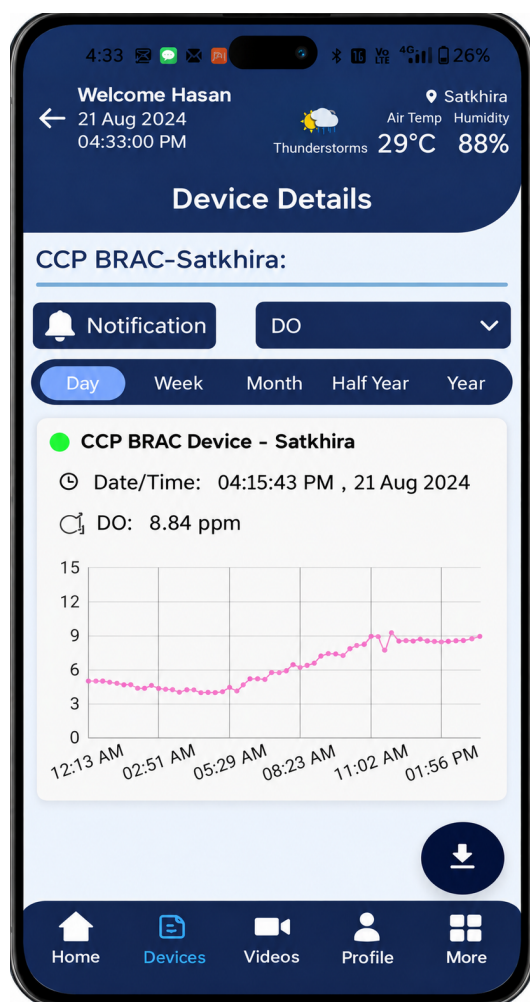


Figure: IoT device control by smartphone

Risk Scenarios & Required Actions

Alert	Action Taken
Excessive heat	Stop / Reduced feeding Increase aeration Water exchange Increase water
Erratic rainfall	Stop / Reduced feeding Increase aeration Water exchange Bottom clean
Disease outbreak	Stop / Reduced feeding Sampling Liming Increase aeration
Increase Ammonia	Stop / Reduced feeding Increase aeration Sampling Bottom clean

IoT in Field

Under the Rain for life project, an IoT device has been installed in a pond in Assasuni upazila, Satkhira district. It watches the pond 24/7, tracks water quality in real-time, and as the reading crosses the preset safety threshold, it flags risk and automatically generates an alert message.

One year earlier, when the integrated IoT sensors continuously monitored the water and detected that the pH level had dropped to 5.5 or lower, the system instantly recognized that a critical safety threshold had been crossed. The cloud server processed this data and immediately dispatched an SMS notification directly to the farmer's mobile phone. Rather than just warning of the drop, the alert included the real-time pH reading alongside a specific, actionable step to apply 1.5kg of lime per decimal, ensuring the farmer could rapidly improve the water quality.

A QUIET DISASTER THAT STRIKES IN MINUTES: LIGHTNING - EXPOSURE AND PREPAREDNESS

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Lightning is an electrical discharge produced inside thunderstorms. It is a normal feature of convective weather across the tropics, but in Bangladesh it has become one of the deadliest hazards of the year. Floods and cyclones develop over days and can be tracked as they approach. A thunderstorm that is already overhead leaves only minutes to reach shelter, and that is what makes lightning so difficult to survive in an open field. In 2016, the Government of Bangladesh added it to the national list of natural disasters, followed by a May in which more than 200 people were killed, 82 of them on a single day. Department of Disaster Management figures indicate roughly 3,835 lightning deaths between 2015 and 2025, an average close to 300 a year, most of them farmers working in open fields.

Lightning forms through the separation of electrical charge inside a deep convective cloud. Strong updrafts carry moisture above the freezing level, where ice crystals and heavier soft hail collide and transfer charge, and when the difference becomes large enough, it is released, either within the cloud or between the cloud and the ground. Conditions during the pre-monsoon are close to ideal for this process, as intense surface heating combines with warm, moist air from the Bay of Bengal while drier air arrives from the northwest, producing the severe local storms known as Nor'westers. According to a 17-year climatology based on observations from NASA's Lightning Imaging Sensor, about 69% of all flashes over Bangladesh occur in the pre-monsoon months of March to May, with most of the remainder during the monsoon [8]. The north and northeast are struck far more often

than the south, and activity increases as the land rises towards the Himalayan foothills. These same weeks are the busiest of the agricultural year. Boro harvesting, which supplies more than half the country's rice, places the greatest number of people in open fields exactly when the hazard peaks. The pattern of casualties reflects this. A national casualty record covering 1990 to the middle of 2016 lists 3,086 lightning deaths and 2,382 injuries, around 93% of them in rural areas [7]. Farming was the activity most often being carried out at the moment of death, followed by deaths that occurred inside dwellings. The heaviest losses fell on Sunamganj, Netrokona, Kishoreganj, Brahmanbaria, Cox's Bazar, and Chapainawabganj, districts which overlap closely with areas where Climate Information Advisory Services (CIAS) already operate.

The link between lightning and a warming climate is less settled than is often assumed. Analysis published in Progress in Disaster Science finds a downward trend in strikes in recent years but no matching decline in deaths [19]. Much of the explanation lies in exposure, as more people work more land with fewer tall trees and fewer solid buildings around them than a generation ago. Projections offer no resolution either, because climate models cannot represent individual thunderstorms, and the leading methods of estimating lightning disagree, one predicting more in a warmer atmosphere and another less, with no agreement even on the direction of change over the tropics [26]. Projections for Bangladesh point to a warmer and more unstable atmosphere, which favors storm formation without indicating how many flashes will result [14].

The hazard is already large, and exposure to it is increasing.

Forecasting capability has improved more than is generally appreciated. The Bangladesh Meteorological Department (BMD) introduced a lightning forecasting system in 2024 and now issues location-specific alerts several hours ahead of a storm. A recent study in the journal *Atmospheric Research* indicates that the most and least active pre-monsoon lightning days can be distinguished a day ahead using low-level moisture, atmospheric instability, and wind structure [25]. Day-ahead guidance is therefore within reach, at a timescale a voice message or weekly advisory can carry.

The consequences of a strike extend beyond the immediate loss of life. Victims are most often working-age adults, so a single death can remove a household's main earner, while livestock losses and interrupted harvesting add further pressure at a critical moment for the crop. Lightning cannot be prevented, but its impacts can be reduced through preparation. No location outdoors is safe during a thunderstorm, and only a substantial building or an enclosed vehicle offers real protection. Sheltering under an isolated tree is dangerous. The national programme to plant palm trees addressed a genuine problem, the loss of tall natural conductors, but it was discontinued in 2022, partly because the trees need decades to reach a useful height. Where thunder follows a flash within 30 seconds, people should move indoors immediately and wait 30 minutes after the last thunder before returning to work. Because many deaths occur inside poorly constructed houses,



Figure: Lightning in Bangladeshi farm-land

contact with plumbing, wiring, and wet walls should be avoided, and livestock should be moved off open ground before a storm arrives.

Advisory services can strengthen this preparation in several ways. Seasonal risk calendars at the upazila level can indicate which weeks require intensified messaging, and daily risk information during March, April, and May can help farmers plan field activities. Mapping the nearest solid structures to working fields is valuable in the haor, where shelter may be a kilometer away. Verifying warnings against observed lightning matters too, since a system that raises the alarm too often loses the trust of the people it serves. Preparedness of this kind depends on collaboration among meteorological services, disaster management agencies, development organizations and community networks. The science underpinning lightning prediction continues to advance, but the greatest gains will come from ensuring that timely information reaches the people standing in open fields and that they know what to do when it arrives.

THE 2% FIBER: CLIMATE RISK IN BANGLADESH'S \$39 BILLION WARDROBE

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In the humid plains of Jashore and the salt-crusted margins of Bangladesh's south, a modest shrub with waxy leaves and cream-colored flowers is attempting something close to absurd: clothe a nation of more than 170 million people, anchor a 40 billion USD export industry, and survive a climate turning against it. Cotton is Bangladesh's forgotten cash crop. It rarely makes headlines here, yet it sits exactly where economic ambition meets ecological reality. Bangladesh exports more knitwear and woven garments than almost any country on earth and grows astonishingly little of the raw fiber its factories consume. That gap is where cotton's story begins and where a changing climate is quietly rewriting the ending.

Ready-made garments earned Bangladesh approximately \$39.35 billion in FY 2024-25, about 81.5% of everything the country sold abroad, and cotton knitwear alone accounted for more than half that value [2]. Yet domestic farms supply only 150,000 to 155,000 bales a year, under two percent of demand [1]. To keep the mills running, Bangladesh has become the world's largest single importer of raw cotton, buying from West Africa, Brazil, India, and the United States, absorbing billions in price volatility and foreign-exchange exposure every marketing year (a 12-month period to track local production). Each bale grown at home is a bale of that exposure removed, which is why the Cotton Development Board, formed in 1972 to rebuild domestic cultivation, aims to grow the crop from around 44,000 hectares toward 75,000 by the end of this year and 100,000 by 2030 [21].

A Crop Held Back by More Than Weather

Agronomists at the Bangladesh Agricultural Research Council consider roughly 2.56 million hectares, mostly under the kharif-2 season (roughly July to October), highly suitable for cotton, and reckon a further quarter-million hectares of underused char land, drought-prone Barind tracts, saline coastal belts, and hill-tract jhum plots could be planted without displacing rice or any other staple. In practice, the cultivated area has sat within a narrow band of 42,000 to 46,000 hectares for years, farmed by around 60,000 households [21]. The constraints are as structural as agronomic: cropping intensity is already above 190%, a five-to-six-month season is competing directly with rice and jute for land, thin ginning capacity, volatile prices, and a policy apparatus long preoccupied with rice self-sufficiency [22]. Even so, Bangladesh yields, around 1,090 kilograms of lint per hectare, already beat India's 483 kilograms and Pakistan's 671 kilograms, though they trail Australia and China [21]. The agronomic capacity exists. What is missing is the ecosystem around it: financing, processing, extension, price stability, and increasingly, a stable climate to grow in.

Heat at the Flowering Window

Cotton is sold as a hardy, drought-tolerant crop, and in many ways it is. But its reproductive biology is delicate, and that fragility collides directly with how Bangladesh's climate is shifting. Heat is the sharpest hazard. Yield falls steeply once temperatures move outside the optimum

range of 20 to 30°C, and heat stress during flowering is now recognized as one of the greatest threats to cotton yield worldwide. Squares and flowers drop once daytime temperatures during flowering pass 30°C, and buds, flowers, and even formed bolls are shed once bud-formation temperatures exceed 33°C [27]. Boll number and boll retention, the two traits that most determine final yield, fall sharply under heat stress: one meta-analysis puts the loss at roughly 110 kilograms of lint per hectare for every degree above the optimum daily maximum, while other work found a single extra degree cuts lint yield by around 10%, largely through smaller bolls and fewer seeds per boll [23] [27]. Combine daytime and night-time heat stress in controlled trials, and boll retention can fall to zero. For a country already logging more frequent, more intense heatwaves, this is not a distant risk. It lands during exactly the weeks when a season's crop is deciding whether it will flower and set bolls at all.

Rain, Salt, and Pests

Rainfall is the second front. Cotton needs far less water than paddy but still needs moisture at critical stages, and its growing season brackets the monsoon, when rainfall has become irregular in timing and intensity. Unseasonal pre-monsoon showers can delay sowing, and heavy rain during flowering can damage the crop directly [22]. Then there is salt. Bangladesh's coastal belt, nearly 29,000 square kilometers, a fifth of the country, holds more than 30% of the nation's agricultural land, and about 53% of that coastal area already carries soil salinity, with affected crops losing 20 to 40% of yield [11]. Cotton is often pitched as a pioneer crop for reclaiming saline soils, and an established plant that can tolerate soil conductivity up to around 11 dS/m without much loss. But it is acutely vulnerable at the seedling stage: a poorly timed saline pulse early in the season can wipe out an entire crop even on land the plant would otherwise handle well. Warmer,

more humid conditions have also brought a rise in jassids and other cotton pests, pushing farmers toward heavier pesticide use that erodes already thin margins [22].

Growing Into the Margins

The paradox is that the land agronomists' picture for cotton's expansion – saline coasts, drought-hit Barind tracts, char land, and hill-tract jhum plots – was largely unsuited to the staple rice economy to begin with and is now exposed to the same climate stresses. The Cotton Development Board has spent years developing salt-tolerant and drought-resistant varieties, promoting rice-cotton intercropping in the Chittagong Hill Tracts, and encouraging farmers on roughly 150,000 hectares of uncultivated Barind land to plant cotton in place of tobacco [21]. International partners are starting to back this work. In 2025, the Board signed a cooperation agreement with the sustainable-sourcing platform CottonConnect, aimed at building a traceable, regenerative, climate-adapted cotton supply chain [5]. Recent academic work goes further, arguing that cotton in Bangladesh should be treated as a sustainability project rather than a purely agronomic one, folding improved varieties, better water management, greater ginning capacity, and stronger farmer price guarantees into a single climate-adaptive strategy [10].

A Fiber Bangladesh Cannot Afford to Waste

Cotton is also a quiet carbon sink. Its fiber is roughly 95% cellulose, which is itself more than 40% carbon by weight, so every kilogram of lint holds close to half a kilogram of biogenic carbon pulled straight from the air during growth. A single acre of lint alone captures more than 3,500 pounds of carbon [6]. Before accounting for regenerative practices such as reduced tillage and cover cropping, cotton's overall greenhouse gas sequestration is estimated at roughly 23%

above the emissions generated in growing it, and unlike synthetic fibers that persist for centuries, cotton fabric returns to the natural carbon cycle within its working life [12]. Every hectare grown on saline coastland or drought-hit Barind soil, instead of a bale imported at foreign-exchange cost, is both a small buffer for an industry that employs millions and a quiet removal of carbon from a warming atmosphere.

Whether that potential is realized is now more a policy choice than an agronomic one. It depends on whether Bangladesh invests fast enough in salt- and heat-tolerant cotton varieties, ginning capacity, weather forecasting reaching farmers directly, and cultivation on the marginal lands where cotton could genuinely do some good instead of competing with staple food crops. Like the flowering window of the plant itself, the country does not have an especially generous clock.

Where Climate Information Advisory Services Fit

Every stress above – heat at flowering, unseasonal rain, salinity, pests – is exactly what BRAC's Climate Information Advisory Services (CIAS) was built to track and get ahead of. CIAS is provided to over 30,000 farmers in the form of weekly upazila-level agrometeorological advisories, monthly

livestock and poultry advisories, and seasonal weather outlooks for a climate zone, disseminated directly through voice SMS, WhatsApp groups, and text across a network of Adaptation Clinics and other programme offices. For a crop as narrowly timed as cotton, that lead time matters as much as the variety in the ground. The same weekly cycle that helped farmers in Shyamnagar protect Boro seedbeds from a January cold spell, while an unwarned neighbor lost nearly a third of his, is the model for what cotton needs at flowering and at the saline seedling stage.

Future projections of heat stress, rainfall variability, and soil salinity provided by the Decision Support Tool (DST) could help the Cotton Development Board site to identify and assess new cultivation away from where salinity is likely to spike at the seedling stage or heat is likely to hit the flowering window, instead of leaving that to trial and error [17]. Extending CIAS's existing advisories, built around paddy, vegetables, livestock, and poultry, to cotton's specific thresholds would not replace the varietal breeding or ginning investment the crop still needs. But it would give farmers the same warning window other CIAS crops already have. Cotton does not have a generous flowering window, and CIAS is one of the more direct ways Bangladesh can help it keep time.

BEYOND THE FORECAST: TURNING WEATHER DATA INTO LIVELIHOOD DECISIONS IN BANGLADESH

Alavi Nafisa

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For a farmer, a weather forecast becomes valuable only when it answers a practical question: Should I sow today? Should I irrigate? Should I apply pesticide, or will the rain wash it away? Is it time to harvest before the weather changes?

This is where climate information becomes

more than a forecast. It becomes an early warning for livelihoods. Across Bangladesh, farming families are making increasingly difficult decisions as rainfall becomes less predictable and floods, drought, cyclones, salinity, and extreme weather disrupt familiar agricultural seasons. Farmers

not only need to know what the weather might be, but they also need to understand what that information means for the crop in their field and what they can do before conditions change. For Save the Children in Bangladesh, this connection between information and action is an important part of strengthening climate resilience. A forecast may indicate that heavy rain is approaching. A climate-smart agricultural advisory takes that information one step further and helps a farmer decide whether to delay pesticide application, adjust irrigation, harvest a mature crop, protect livestock or reconsider the timing of planting. When information arrives early enough and in a form people can use, it can help protect both crops and household income.

The FARRM School

One approach supporting forecast-action connection is the Agromet Forecast Application for Risk and Resource Management, or FARRM School, implemented with technical partner RIMES and closely connected with the government agricultural extension system. The approach has been piloted across 24 unions in six upazilas of Gaibandha, Patuakhali, and Chattogram, bringing climate information closer to farmers living in riverine, floodplain, and coastal areas.

The FARRM School has done more than introduce farmers to weather information. It has also connected them directly with the Department of Agricultural Extension. Before the programme, many farmers had little regular contact with Sub Assistant Agriculture Officers. Over the 24-week learning period, that began to change. Farmers could discuss the crops standing in their fields, the weather conditions they were facing, and the decisions they needed to make, while the officers provided practical advice on planting, harvesting, irrigation, fertilizer use, pest management, and crop

selection. Farmers were also introduced to the Bangladesh Agro Meteorological Information Service (BAMIS), helping them access forecasts and agricultural information themselves. That relationship continued even after the classes ended. Farmers now reach out to the agriculture officers whenever they need advice, creating an ongoing link between climate information, extension services, and day-to-day farming decisions.

For Md. Ruhul Amin, Sub Assistant Agriculture Officer in Fulchari, Gaibandha, the change is visible in farmers' fields. His observation captures an important part of the FARRM School approach.



“The main challenges in this area are floods, followed by drought. During the 24-week training, farmers learned how they can adapt their crop production to these conditions, as well as how to manage fertilizer and control pests. They have learned these practices well and are now applying them in their fields. Previously, farmers in this area did not usually plant rice in rows. Now they are planting rice in rows.” - Md. Ruhul Amin

Climate information becomes more useful when it is combined with practical agricultural knowledge. Farmers are not only hearing that rain, drought, or flood conditions may be coming. They are learning how to adjust the way they cultivate in response. For Md. Nizam Uddin Shikdar of Idrakpur, Lohalia Union, Patuakhali, this has influenced how he plans his farming

throughout the year. For Nizam, the change is not simply having access to more information. It is having greater confidence to decide what to cultivate, when to cultivate it and which practices are appropriate for the conditions ahead. Other farmers have experienced the value of a single timely decision.



“Through the BAMIS app, I now access weather information that helps me plan my cultivation and choose suitable crops for each season. Through the FARRM School, I also learned practical techniques such as seedling production using sack and tray methods, bio fertilizer, and pesticide use, and pest management with pheromone traps. I applied these techniques to cultivate lentils, nuts, chilli, and different vegetables, which helped me achieve better production and earn a good profit. These learnings have made me much more confident in my farming decisions.”

- Md. Nizam Uddin Shikdar

In Chattogram, Md. Ozi Ahamad was preparing to apply pesticide to his rice field when weather information indicated heavy rainfall. Knowing that the rain could wash the pesticide away, he postponed the application and avoided approximately BDT 4,000 in unnecessary pesticide costs. He also began using BAMIS information for timely pest control activities. The wider assessment of the FARRM School shows that these individual stories reflect a broader change. In the final assessment, 79.8% of participating farmers reported that the knowledge gained had significantly

influenced their agricultural decisions. By Kharif II, 99.7% reported applying FARRM School knowledge to protect their crops, and the same proportion said they had shared what they learned with others in their communities.

The MET Club

Farmers are not the only people bringing weather information into households. The Meteorology Club, known as MET Club, is creating another pathway through children and schools. The club helps children understand weather observation, forecasts, uncertainty, early warnings, and preparedness. Its e-learning platform is now integrated into the official website of the Bangladesh Meteorological Department (BMD), connecting the learning approach directly with the country's national meteorological institution. In practice, children learn to follow official forecasts, understand what changing weather conditions may mean, and discuss appropriate actions with their teachers. They then share simple and relevant messages with classmates, parents, and other family members. MET Club was designed to help children become informed users and communicators of weather information, and field experience has already shown children carrying warnings from school into their families and communities. During adverse weather in Chattogram, for example, children were supported to understand BMD forecasts and then inform their peers and families about the risks in their regions. In Gaibandha, Rakibul Hasan Rijju, a MET Club member, shows what this can mean for a farming family. Rakibul's mother is a farmer. When he learned that rain was expected, he told her to bring in the harvested rice before the rainfall arrived. A forecast that reached a child at school therefore became a practical farming decision at home. This may seem like a small action, but it represents an important change in how climate information

can travel. Scientific information does not have to be limited to a technical bulletin or even to the person directly receiving an advisory. It can move through agricultural officers, farmers, schools, and children until it reaches the person who needs to make a decision.

For Save the Children in Bangladesh, this is what meaningful climate information looks like. It connects official forecasts with practical advisories, trusted government services, farmers, children, and families.

It helps people understand not only what weather may be coming, but also what they can do about it. The value of climate information is ultimately not measured by how many forecasts are produced. It is measured by what happens next. When people understand the information, trust it, and act before a potential loss occurs, a forecast becomes something much more powerful. It becomes an early action that can protect crops, income, food security, and family livelihoods.

UPCOMING EVENTS

Adaptation Center Members' Visit to MIT

Jameel Observatory CREWSnet Adaptation Center (AC), a virtual center, is designed to connect JO-CREWSnet principal investigators (PIs) and researchers with senior technical policymakers and planners at key civil-service institutions in Bangladesh. Members of AC are a selected group of Bangladeshi technical experts who are also members of civil society organizations in Bangladesh and have been voluntarily engaging with JO-CREWSnet activities and initiatives and soliciting their advice and input. The upcoming Jameel Observatory CREWSnet Adaptation Center Workshop, to be held at MIT from 28 September to 2 October 2026, will bring together the JO-CREWSnet Theme Teams and Adaptation Center members to review progress, exchange knowledge, and strengthen collaboration across four thematic areas: Shelter, Water Security, Agriculture, and National Adaptation Plan (NAP). The five-day program will begin with an opening dinner and optional MIT/Boston campus tours. The core sessions will combine presentations from the Theme Teams and Adaptation Center members with structured discussions and a visit to MIT's Civil and Environmental Engineering Department's Marelli Lab to better understand the sunflower seed coating

initiatives. The theme-based breakout sessions will then offer opportunities for deeper technical discussions, identification of research and implementation priorities, and development of potential areas for collaboration. The workshop will conclude with thematic wrap-up sessions, a special lecture by Professor Shafiqul Islam of Tufts University on Water Policy of India and China and the Impacts on Bangladesh Water Security, followed by closing remarks.

Climate Data for Young Researchers – A Student Orientation to the JO-CREWSnet Decision Support Tool

Students are the next generation of researchers and policymakers. Giving them early exposure to climate data, modelling, and decision-support systems can strengthen their ability to conduct research, engage in policymaking, and pursue further studies in climate science, disaster management, water resources, agriculture, and related fields.

Therefore, BRAC's Climate and Environmental Innovation Programme is organizing a special workshop for university students titled "Climate Data for Young Researchers: A Student Orientation to the JO-CREWSnet Decision Support Tool". The event will be held at the BRAC Learning Centre (BLC) in Jashore on 11 October 2026.

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CIAS AS OF SEPTEMBER 2026

Current Participant Reach

 **Voice SMS**

17,095

**Participant
Agriculture Farmer**

5,572

**Livestock
Farmers**

3,648

**Poultry
Farmers**

 **Text Document Advisory**

21

**Adaptation
Clinics**

12

MF Offices

5

ICCP Offices

Total Farmer Reach ≈ 30,000

Emergency Warning

Emergency warning alerts during extreme weather events, including flash floods and cyclones.

Dissemination Channels



**Direct-to-Mobile
Voice SMS**



**WhatsApp
Farmer Groups**



**Email
Dissemination**



**Emergency
Warnings**



**Printed Notice
Boards**



Newsletter

What More CIAS Comes with

- Training, orientation, and workshops for farmers and other relevant stakeholders, so advisories are easily understood and used in farm decisions.
- CIAS newsletter to share advisories, updates and good practices with a wider audience
- Climate projection and decision support tool to support planning with longer-term climate outlooks.

Upcoming Plan

Scale Up Voice SMS: Around 22,500 farmers would be included under the projects of the Climate and Environmental Innovation Programme. With this addition, the weekly voice SMS would grow to about 49,000.

CIAS Glance: Develop a dashboard to organize, visualize, and monitor CIAS-related information and survey data to support data management, analysis, and monitoring of advisory reach and feedback. Relevant information will be presented in a user-friendly and interactive format for monitoring, planning and decision-making.

Orientation with Sector Specialists on CIAS: Hold discussions with Sector Specialists (SSs) to review and clarify the key meteorological terms and weather-related indicators used in CIAS advisories to ensure CIAS messages are technically accurate, relevant, and easy for project staff and farmers to understand and apply in different agricultural and livelihood contexts.

CIAS Events: National and coastal regional gathering of CIAS practitioners to understand the diversity and scope of weather and climate information in wider spectrum. Expecting the event in Dhaka and Jashore respectively in December.

El Niño and La Niña Discussion: A consultation on El Niño and La Niña risk to identify preparedness action, which will be held on 17 October 2026 in BRAC Centre.

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