3RD INTERNATIONAL CONFERENCE ON FUTURE CHALLENGES IN SUSTAINABLE URBAN PLANNING & TERRITORIAL MANAGEMENT

# SHORELINE: A NATURE-BASED SOLUTION (NbS) INTEGRATED CLIMATE DSS PLATFORM FOR COASTAL INFRASTRUCTURE IN BANGLADESH

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## INTRODUCTION

In Bangladesh's coastal regions, climate-vulnerable infrastructure is often managed reactively due to limited access to timely and actionable climate data [1]. This gap has hindered the shift toward climate-smart infrastructure planning [2]. To address this, the SHORELINE project developed a digital **Climate Advisory Platform** featuring an integrated **Decision Support System (DSS)** that enables proactive, data-driven infrastructure management [3] .

The platform integrates real-time sub-seasonal to seasonal (S2S) and short-to-medium term (SMTR) forecasts, historical climate data from 1981 to 2024 acquired from BMD, and multiple bias corrected, downscaled future global climate model (GCM) projections from 2025 to 2100 to generate localized advisories. Developed in partnership with **IWFM-BUET**, **LGED**, and supported by **BMD**, the system equips planners with the tools needed to anticipate and respond to climate risks. LGED has formally committed to piloting and adopting the platform.

## GOALS

The SHORELINE project was initiated with the overarching goal of enhancing climate resilience in Bangladesh's coastal regions by transforming climate data into actionable infrastructure guidance. Specifically, it aimed to:

1. **Strengthen Infrastructure Resilience** by providing early warnings and supporting local authorities in protecting critical assets like drainage systems and cyclone shelters.
2. **Advance Data-Driven Planning** using localized climate data to guide decisions and integrate long-term climate risk into infrastructure strategies.

## METHODOLOGICAL FRAMEWORK

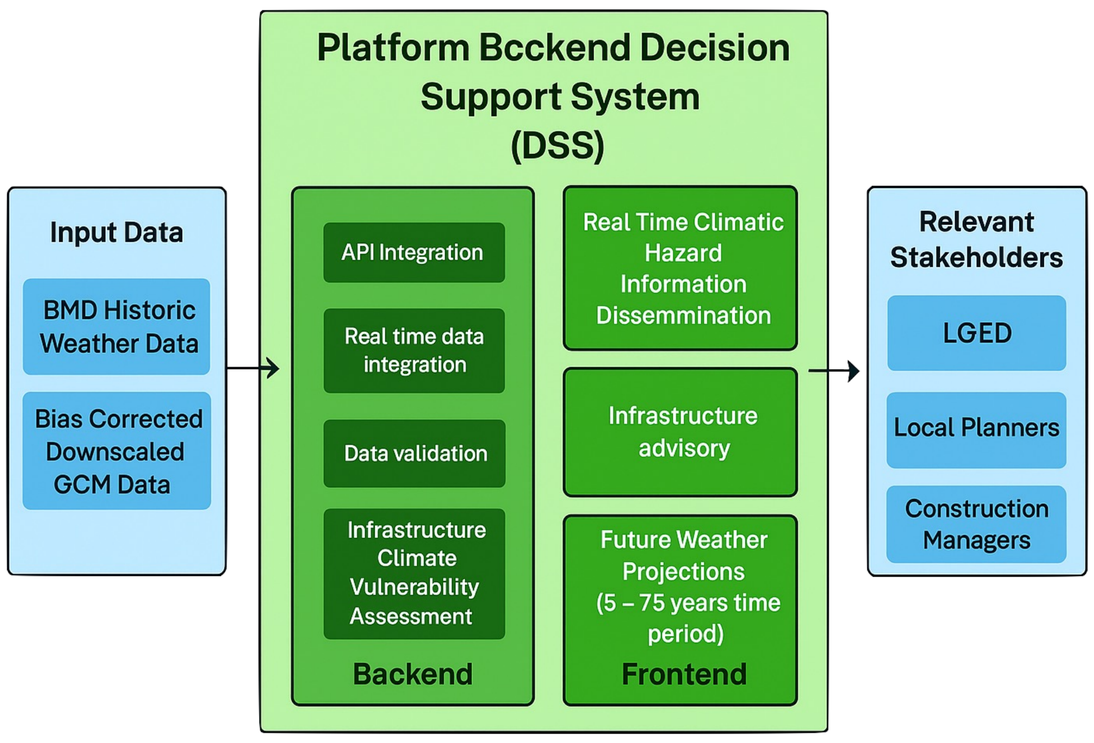
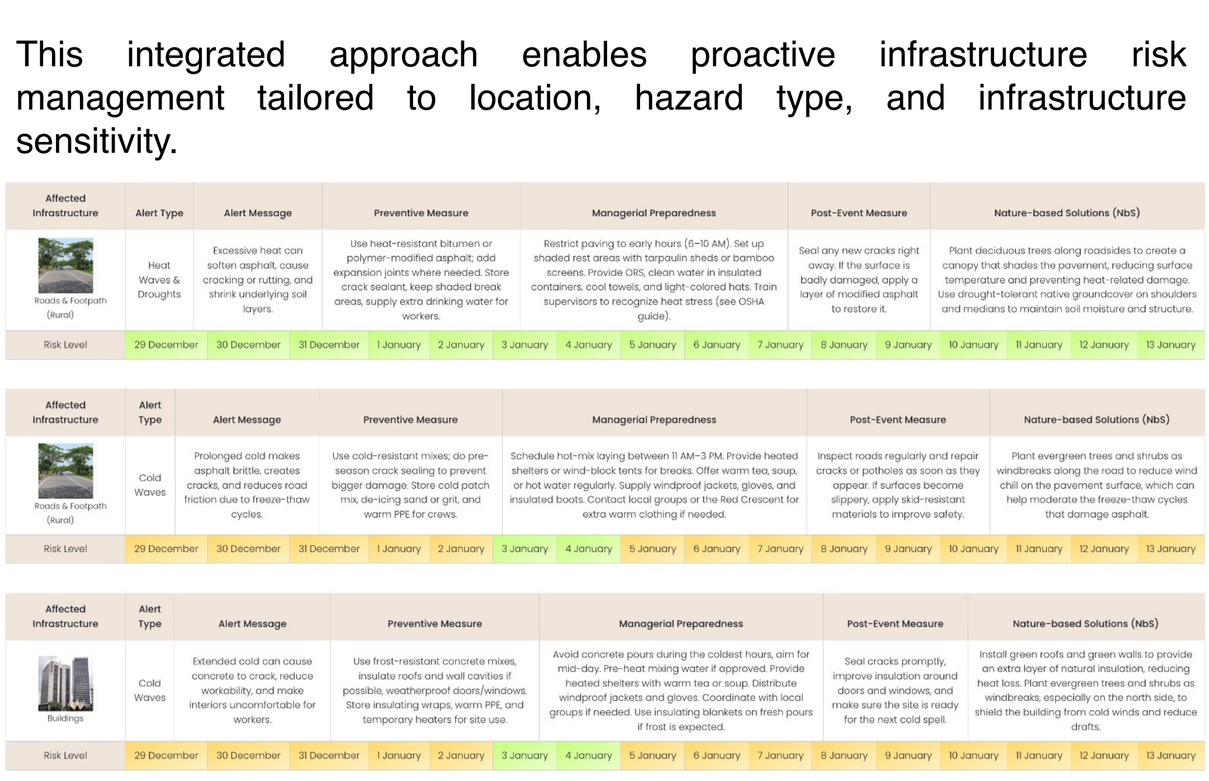



**Figure 1:** The SHORELINE platform's DSS analyses historic and future projected climate data to evaluate infrastructure vulnerability, providing real time hazard information and climate advisory for relevant stakeholders.

## RESULTS AND DISCUSSION

The Infrastructure Advisory Panel (Figure 2) leverages the platform's Decision Support System (DSS) to deliver actionable planning and management guidance by analyzing backend infrastructure vulnerability data alongside future climate projections and short- to medium-term (SMTR) real-time forecasts.

This integrated approach enables proactive infrastructure risk management tailored to location, hazard type, and infrastructure sensitivity.



| Affected Infrastructure | Alert Type | Alert Message | Preventive Measure | Managerial Preparedness | Post-Event Measure | Nature-based Solutions (NbS) |
|---|---|---|---|---|---|---|
| Roads & Footpath (Rural) | Heat Waves & Droughts | Excessive heat can soften asphalt, cause cracking or rutting, and shrink underlying soil layers. | Use heat-resistant bitumen or polymer-modified asphalt; add expansion joints where needed. Store crack sealant, keep shaded break areas, supply extra drinking water for workers. | Restrict paving to early hours (6–10 AM). Set up shaded rest areas with tarpaulin sheds or bamboo screens. Provide ORS, clean water in insulated containers, cool towels, and light-colored hats. Train supervisors to recognize heat stress (see OSHA guide). | Seal any new cracks right away. If the surface is badly damaged, apply a layer of modified asphalt to restore it. | Plant deciduous trees along roadsides to create a canopy that shades the pavement, reducing surface temperature and preventing heat-related damage. Use drought-tolerant native groundcover on shoulders and medians to maintain soil moisture and structure. |

| Risk Level | 29 December | 30 December | 31 December | 1 January | 2 January | 3 January | 4 January | 5 January | 6 January | 7 January | 8 January | 9 January | 10 January | 11 January | 12 January | 13 January |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| Affected Infrastructure | Alert Type | Alert Message | Preventive Measure | Managerial Preparedness | Post-Event Measure | Nature-based Solutions (NbS) |
|---|---|---|---|---|---|---|
| Roads & Footpath (Rural) | Cold Waves | Prolonged cold makes asphalt brittle, creates cracks, and reduces road friction due to freeze-thaw cycles. | Use cold-resistant mixes; do pre-season crack sealing to prevent bigger damage. Store cold patch mix, de-icing sand or grit, and warm PPE for crews. | Schedule hot-mix laying between 11 AM–3 PM. Provide heated shelters or wind-block tents for breaks. Offer warm tea, soup, or hot water regularly. Supply windproof jackets, gloves, and insulated boots. Contact local groups or the Red Crescent for extra warm clothing if needed. | Inspect roads regularly and repair cracks or potholes as soon as they appear. If surfaces become slippery, apply skid-resistant materials to improve safety. | Plant evergreen trees and shrubs as windbreaks along the road to reduce wind chill on the pavement surface, which can help moderate the freeze-thaw cycles that damage asphalt. |

| Risk Level | 29 December | 30 December | 31 December | 1 January | 2 January | 3 January | 4 January | 5 January | 6 January | 7 January | 8 January | 9 January | 10 January | 11 January | 12 January | 13 January |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| Affected Infrastructure | Alert Type | Alert Message | Preventive Measure | Managerial Preparedness | Post-Event Measure | Nature-based Solutions (NbS) |
|---|---|---|---|---|---|---|
| Buildings | Cold Waves | Extended cold can cause concrete to crack, reduce workability, and make interiors uncomfortable for workers. | Use frost-resistant concrete mixes, insulate roofs and wall cavities if possible, weatherproof doors/windows. Store insulating wraps, warm PPE, and temporary heaters for site use. | Avoid concrete pours during the coldest hours, aim for mid-day. Pre-heat mixing water if approved. Provide heated shelters with warm tea or soup. Distribute windproof jackets and gloves. Coordinate with local groups if needed. Use insulating blankets on fresh pours if frost is expected. | Seal cracks promptly, improve insulation around doors and windows, and make sure the site is ready for the next cold spell. | Install green roofs and green walls to provide an extra layer of natural insulation, reducing heat loss. Plant evergreen trees and shrubs as windbreaks, especially on the north side, to shield the building from cold winds and reduce drafts. |

| Risk Level | 29 December | 30 December | 31 December | 1 January | 2 January | 3 January | 4 January | 5 January | 6 January | 7 January | 8 January | 9 January | 10 January | 11 January | 12 January | 13 January |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

**Figure 2:** The Infrastructure Advisory System module of the SHORELINE platform converts climate forecasts into targeted, time-sensitive advisories for specific infrastructure types, aligning forecast data with vulnerability insights to support proactive risk management.

The Infrastructure Planning Management panel (Figure 3) enables users to explore historic and projected climate data (1981–2100) for temperature and rainfall. By selecting a location, time range, and infrastructure type, users receive tailored insights and long-term planning advisories to support climate-resilient investment and design. Key functions of the panel include:

- **Location-Based Trends:** View climate data by district or upazila.
- **Climate Graphs:** Visualize temperature and rainfall (1981–2100).
- **Infrastructure Insights:** Choose infrastructure type to receive relevant projections and recommendations.
- **Custom Timeframes:** Plan over 5 to 75 years.
- **Downloadable Reports:** Export planning briefs.
- **Design Guidance:** Receive risk-based engineering recommendations.

This panel bridges the gap between climate projections and infrastructure planning, helping ensure that investments are future-proofed against evolving environmental threats.

The climate projections for the selected Upazilas are computed using two datasets: historic weather data recorded by the BMD and projections from 13 CMIP6 GCM models. The projected data is validated against the historic records to estimate average maximum and minimum climate values, while extreme scenarios are cross-verified to ensure reliability. This validated dataset is further enhanced through integration with real-time API feeds.

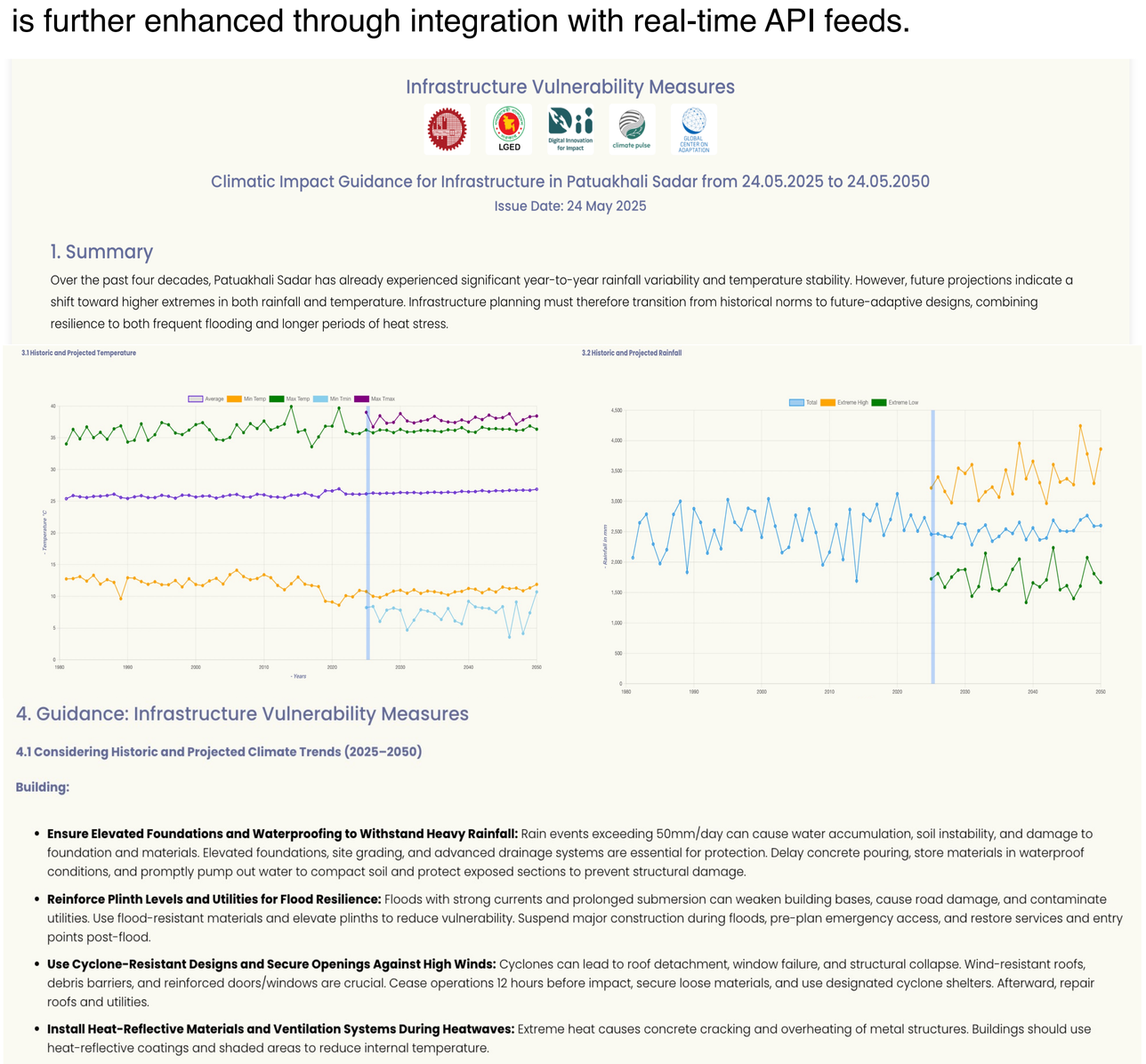



**Figure 3:** The SHORELINE platform's Planning Management Interface combines long-term climate projections with infrastructure vulnerability data to generate location-specific, time-bound guidance.

## CONCLUSION

The SHORELINE project developed a climate-informed DSS to improve infrastructure resilience in coastal Bangladesh. By combining real-time, historical, and projected climate data, the platform provides actionable guidance for planners. With validation from BUET and LGED, it enables proactive, data-driven risk management at the local level.

## ACKNOWLEDGEMENTS

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## REFERENCES

[1] M. Z. Hoque, S. Cui, X. Lilai, I. Islam, G. Ali, and J. Tang, "Resilience of coastal communities to climate change in Bangladesh: Research gaps and future directions," Watershed Ecology and the Environment, vol. 1, pp. 42–56, 2019, doi: 10.1016/j.wsee.2019.10.001.

[2] Md. Z. Hossain and N. Huq, "Institutions Matter for Urban Resilience: The Institutional Challenges in Mainstreaming Climate Smart Disaster Risk Management in Bangladesh," 2013, pp. 169–191. doi: 10.1007/978-3-642-31110-9_11.

[3] A. Parven, I. Pal, and C. Wuthisakkaroon, "Climate Smart Disaster Risk Management for a Resilient Community in Satkhira, Bangladesh," 2020, pp. 477–496. doi: 10.1007/978-981-32-9527-8_26.

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