Towards a Safer and Resilient Nagaland: What we do, why we do, and how we learn

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INTRODUCTION

Towards Safer and Resilient Nagaland: What do we do? why we do? And how we learn?

*By **Dr. Johnny Ruangmei,** Joint Chief Executive Officer, Nagaland State Disaster Management Authority (NSDMA), Nagaland, India**; and Mihir R. Bhatt,** All India Disaster Mitigation Institute (AIDMI), India*

Natural disasters are an existential threat to Nagaland. Nagaland needs an effective and comprehensive strategy to build disaster resilience and climate risk management. Nagaland is prone to multiple hazards and vulnerable to climate variability and its negative manifestations, with increasing complexities due to climate change, which has induced various disasters.

The Nagaland State Disaster Management Authority (NSDMA), under the Home Department, Government of Nagaland, is committed to protecting lives, livelihoods, and the environment by fostering a culture of preparedness, reducing disaster risks, and ensuring effective response and recovery. At the Nagaland State Disaster Management Authority (NSDMA), building resilience is a journey. Every effort made by the NSDMA is aimed at building a resilient infrastructure and a resilient economy.

The vision of the NSDMA, Home Department, Government of Nagaland, is to make Nagaland disaster-ready, climate-resilient, and future-ready, with resilient infrastructure and a **resilient economy.**

An overview of recent achievements and innovative initiatives highlights disaster management in Nagaland—covering policy, institutional innovation, preparedness, and recognition.

Key Achievements and Initiatives

Nagaland is the first State in India to adopt a Disaster Risk Transfer Parametric Insurance Solution (DRTPS). An MoU was signed in August 2024 between the Nagaland State Disaster Management Authority (NSDMA) and SBI General Insurance. This initiative aims to protect critical infrastructure and mitigate economic losses resulting from extreme weather events.

Nagaland State Disaster Management Information System (NSDMIS) & Decentralised Relief Payout System (DRPS) were launched in December 2022. These tools are designed to streamline operations, including tracking disasters, weather patterns, relief funding, and disbursement. The DRPS utilises blockchain technology to facilitate more timely relief payments, particularly in remote areas. These systems align Nagaland with global frameworks (Sendai / Hyogo) for disaster reduction and risk management.

The Nagaland Centre for Disaster Management and Atmospheric Research (NACDAR) studies, manages, and mitigates natural disasters, with a focus on atmospheric and environmental factors.

Vision

- To become a leading centre for disaster management and atmospheric research, contributing to sustainable development, climate resilience, and effective disaster risk reduction in Nagaland and the Northeast region.

Mission

- Conduct advanced research on atmospheric sciences, climate change, and disaster management.
- Provide actionable insights and data to local governments, communities, and stakeholders to enhance disaster resilience.
- Develop early warning systems for various types of natural hazards.
- Foster collaboration with national and international research institutions and universities to enhance the capacity for disaster risk reduction

DISASTER is no longer 'IF' but 'WHEN' (Dr. Johnny Ruangmei). Individuals, Governments, Businesses and Decision-Makers CANNOT BE a stranger to Disaster. Prevent/avoid the accumulation of future risk by every stakeholder. Community experience and niche in science are strategies to be safer.

Uncertainty should not be a reason for inaction" Investments must be made to reduce vulnerability and exposure to hazard. Redefined interventions to strengthen policy, institutions, and capacity, as well as effective disaster risk management, are cardinal to facilitating climate change adaptation and contributing to broader resilience in Nagaland. ■

URBAN RESILIENCE

Joint Training on Urban and Local Resilience in Kohima

*By **Mihir R. Bhatt,** All India Disaster Mitigation Institute (AIDMI), India*

From **July 28–31, 2025**, Kohima, Nagaland hosted a **Joint Training on Urban and Local Resilience**, convened by the Nagaland State Disaster Management Authority (NSDMA) with support from partners. The training brought together municipal leaders, state agencies, community representatives, academics, and private sector experts. Its aim was to help Indian cities and towns move from reactive crisis response to **risk-informed, climate-smart resilience building**.

Joint Training on Urban and Local Resilience held from July 28-31, 2025, in Kohima, Nagaland, India.

Tools for Action

At the core of the training was the **UNDRR Disaster Resilience Scorecard for Cities** and its **Climate Resilience Addendum**. These tools break resilience into ten measurable "Essentials," spanning governance, finance, infrastructure, health, ecosystems, and recovery. Cities can use them to assess disaster readiness, integrate climate projections into zoning, plan across departments, track progress, and design projects that attract finance.

As one NSDMA official remarked, *"The Scorecard makes resilience real. It turns abstract concepts into practical steps that cities like Kohima can actually implement."*

Indian Experiences

The **All India Disaster Mitigation Institute (AIDMI)** shared lessons from applying the Scorecard in five cities:

- **Ahmedabad** – coordination for its Heat Action Plan.
- **Guwahati** – integration of flood and heat risks into zoning.
- **Nagapattinam** – mangroves and green infrastructure for coastal protection.
- **Bhubaneswar** – strengthened early warning systems.
- **Surat** – SME-focused recovery planning.

"These examples show that resilience is not a one-size-fits-all exercise," noted an AIDMI facilitator. *"Each city has its own risks and opportunities, but the Scorecard gives them a common language and pathway."*

Building Consensus and Next Steps

Participants worked in groups to **prioritise and sequence actions** through risk scoring, cost–benefit analysis, vulnerability mapping, and community co-design. They also explored how to assign responsibilities, set indicators, and link actions with funding streams.

One participant from Kohima Municipal Council shared: *"This process helps us see beyond today's emergencies. It gives us a roadmap to prepare for tomorrow's risks."*

Closing discussions emphasised **five priorities for India's urban future**: mainstreaming risk into plans, strengthening governance, mandating resilience in investments, engaging women and youth, and using digital/AI tools.

Kohima's Contribution

By hosting this training, Kohima highlighted the importance of **Northeast Indian cities** in shaping national resilience. The event reinforced that urban resilience is both **technical and social**: it demands inclusive participation, evidence-based planning, and strong ownership.

As one community representative summarised: *"Resilience is not only about infrastructure; it is about people, trust, and working together."*

The lessons from Kohima now offer a roadmap for Indian cities to turn plans into practice and move steadily toward safer, adaptive, and climate-smart futures. ■

Building Community Awareness and Resilience Through Education and Training

*By **Sanjaya Bhatia**, Head of Office Incheon, UN Office for Disaster Risk Reduction (UNDRR), Republic of Korea*

Disaster risk reduction is critical for safeguarding lives, infrastructure, and economic stability. However, one of the most persistent barriers to effective DRR implementation is the lack of training among city and other government officials. Without proper education and access to practical tools and methodologies, governments remain vulnerable to disasters, unable to adopt best practices or make informed, risk-aware decisions. This article explores how education and training can be powerful tools for building community awareness and enhancing resilience.

A key hypothesis underpinning recent research is that enhancing resilience requires a renewed and strategic focus on training government personnel. The absence of such training has left governments underprepared, exposing both citizens and local economies to increased risk. Moreover, a critical gap exists in both research and practice regarding training as a driver for resilience.

In response to this gap, a comprehensive training program was rolled out in 2023-24 by UNDRR involving 308 city officials. Participants completed pre- and post-training surveys assessing their knowledge of DRR principles, tools, planning methodologies, and best practices. Each survey included six questions rated on a 1–5 scale, with 1 indicating strong disagreement and 5 indicating strong agreement.

The findings were significant. Before training, participants displayed moderate awareness of DRR principles (average score: 3.65), but showed lower understanding of tools, methodologies, and real-world examples (average: 3.09). Post-training scores, however, increased dramatically across all categories—ranging from 4.42 to 4.57. This represented an average knowledge gain of over 25%, with some areas—like planning methodologies and tools—improving by more than 45%.

This notable improvement highlights how well-structured, practical training can close key knowledge gaps. For instance, the understanding of DRR tools increased by 45%, suggesting that many officials were previously unaware of the resources available to them. Similarly, familiarity with planning processes improved by

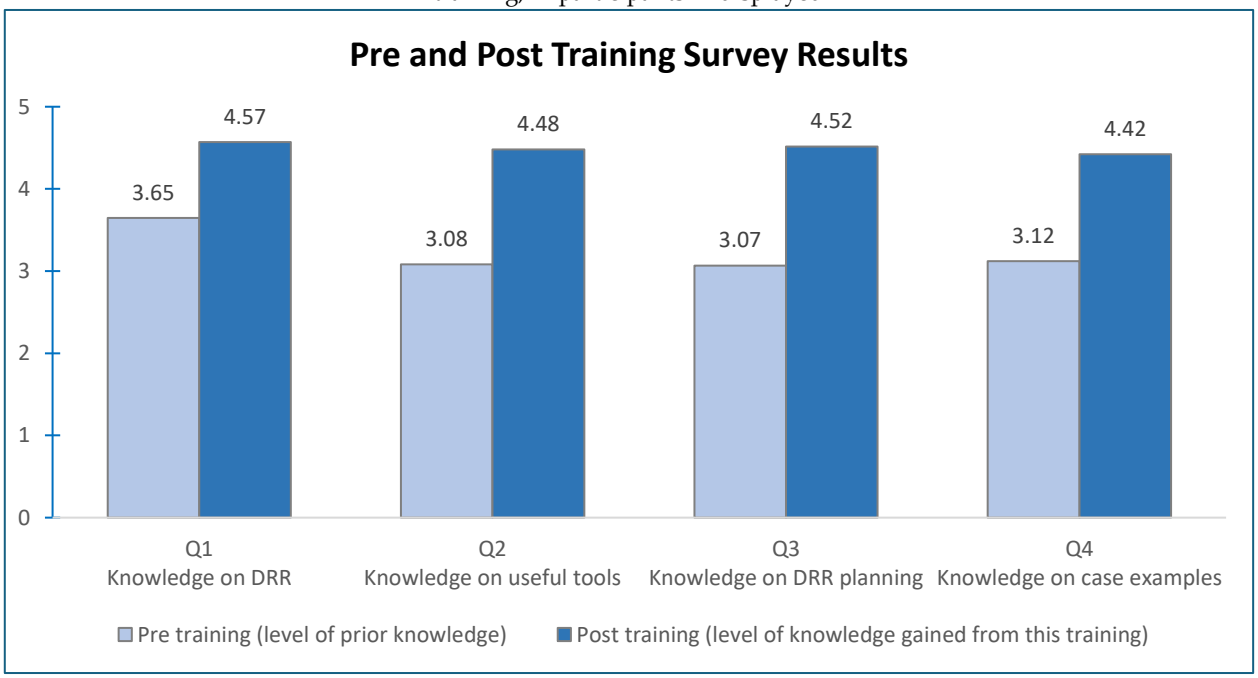

Figure: Pre- and Post-Training Survey Results. (Level of prior knowledge and level of knowledge gained from the training)

47%, underscoring the need for actionable guidance over abstract theory.

Learning from case studies was another area with a large gain (42%), underscoring the value of exposure to real-world successes and failures. These shared experiences reduce the need for governments to "reinvent the wheel" and encourage cross-learning between governments.

Crucially, increased knowledge correlates with better risk-informed decision-making, a cornerstone of sustainable development. Participants overwhelmingly indicated that practical, application-oriented training was more beneficial than theoretical content. This preference signals a need to reframe how DRR education is delivered, emphasising usability, local context, and strategic planning.

The results strongly support the initial hypothesis: training is not just helpful but essential. It builds individual capacity and institutional resilience, making communities safer and better prepared. Training was co-delivered in Nagaland for urban leaders and practitioners in July 2025, in collaboration with the State Disaster Management Authority and others, with similar results. The outcomes of this workshop are awaited, but initial results are encouraging.

In conclusion, lack of training remains a significant barrier to disaster risk reduction, but it can be overcome. A strategic, systematic approach to training officials can build resilient communities capable of anticipating, mitigating, and responding to disaster risks. Investing in education and knowledge transfer is not just a support function; it is central to building safer, smarter communities. ■

RESILIENCE THROUGH PARTNERSHIPS

A Public–Private Partnership That Made School Safety Everyone's Business

*By **Kevisato Sanyu**, Founder, NagaEd, Nagaland, India*

Nagaland's School Safety Policy (SSP) Compliance Course offers a clear lesson for disaster risk governance: when the state sets the mandate and a capable private partner delivers with discipline, policy moves from paper to practice. Conceived as a Public–Private Partnership (PPP) between the Nagaland State Disaster Management Authority (NSDMA), the Department of School Education (DoSE), and NagaEd, the course launched on 1 December 2023, Statehood Day, signalling ownership at the highest levels and immediate system legitimacy. By June 2024, nearly a fifth of all teachers in the state were registered, surpassing Phase 1 targets by almost 200% and proving that a digital compliance model can overcome geography, time, and budget constraints while strengthening trust in public systems.

The governance design was the engine of success. NSDMA set policy direction and convened inter-departmental coordination; DoSE drove adoption across the school system, integrating data flows and issuing official notifications; and NagaEd delivered the digital courseware, learning management system, and responsive support. The partnership, formalised on 9 June 2023, moved from agreement to execution with a milestone-based plan: course modules signed off by 24 November; 46 EBRC master trainers prepared on 28 November; a mandatory compliance circular; and a coordinated media rollout. Hosting and linking the course through official channels ensured open access and reinforced legitimacy.

Crucially, the PPP treated technology as an enabler of compliance and culture, not an end in itself. The system emphasised measurable adoption at the teacher level, shifting school safety from static guidelines to trackable action. From day one, the partners pursued national relevance, designing a quality course that states can adapt and license—placing replication and accountability at the centre.

Inclusion was not an afterthought; it was foundational. National guidelines are unequivocal: school safety applies to every school and must be woven into daily routines. In Nagaland, where roughly 65% of children attend private schools, the PPP operationalised this principle by onboarding private institutions alongside government schools. DoSE and NSDMA enabled equitable tracking by sharing private-school teacher and UDISE data; EBRCs mobilised government schools while the All Nagaland Private School

School Safety Award, presented at the State Level Teacher's Day Celebration to schools with the highest number of certified teachers.

Shri Dr. Johnny Ruangmei presents completion certificate to local teacher.

Association (ANPSA) reached private schools. By Phase 1 close, registrations included 24% of government teachers and 13% of private-school teachers, evidence of programmatic, not token, inclusion.

Implementation matched the ambition. Following launch, a certification workflow and monthly reporting provided a simple, transparent compliance pathway. User feedback underscores design quality and classroom fit: 73% said the self-paced format did not disrupt teaching; 90% found videos engaging; 95% considered learning checks important, and 68% found them easy to attempt. Relevance was near-unanimous: 98% agreed the SSP course is needed in Nagaland, and 96% affirmed that objectives were clear.

A sustained outreach strategy amplified uptake and confidence. During Phase 1, the campaign delivered 16.76 lakh ad impressions and reached 3.64 lakh users across digital and traditional media, correlating with the surge in registrations from May to June. Together, delivery discipline and transparent communication strengthened public confidence in both the education and disaster management systems.

Four takeaways stand out for national replication: a shared vision with target-driven milestones; inclusion by design to avoid coverage gaps; operational clarity that respects classroom realities; and a child-safety focus that builds practical readiness, mock drills, first aid/CPR, and evacuation planning, at the school level. In sum, the NSDMA–DoSE–NagaEd PPP is a replicable playbook: align mission, digitise for scale, include every school, and measure what matters. The case for nationwide scaling is compelling because making school safety everyone's business is precisely how we keep every child safe. ■

RESILIENT NAGALAND

NDMA and Nagaland Government Projects on Disaster Resilience

*By **Manish Patel**, AIDMI, India*

Nagaland's journey toward disaster resilience reflects a strong partnership between national vision and state-level leadership. The collaboration between the National Disaster Management Authority (NDMA) and the Government of Nagaland has helped translate disaster risk reduction (DRR) principles into concrete action on the ground, shaped by the state's unique geography, climate risks, and socio-cultural context.

Nagaland is exposed to multiple hazards, including landslides, floods, forest fires, earthquakes, and emerging climate risks such as extreme rainfall variability and heat stress. Recognising that disasters are no longer episodic but systemic, NDMA-supported initiatives in Nagaland emphasise preparedness, prevention, and resilience rather than response alone. These efforts align with the Sendai Framework and India's national disaster management priorities, while remaining rooted in local realities.

A central pillar of this work is the leadership of the Nagaland State Disaster Management Authority (NSDMA), under the Home Department, Government of Nagaland. With technical guidance from NDMA, the state has strengthened disaster management plans, standard operating procedures, and institutional coordination across departments. Investments in disaster management information systems, early warning dissemination, and decentralised relief mechanisms have improved both preparedness and response, particularly in remote and difficult terrain.

Capacity building is another major focus. Joint trainings, simulation exercises, and exposure to national tools—such as risk assessments and resilience scorecards—have enhanced the ability of state, district, and urban local bodies to anticipate and manage risk. Importantly, NDMA and the Nagaland Government have promoted partnerships with academic institutions, civil society, and the private sector to expand the reach and effectiveness of resilience initiatives.

These projects are guided by a clear rationale: safeguarding lives, livelihoods, infrastructure, and development gains. Disaster resilience in Nagaland is not viewed as a standalone sector but as an integral part of governance and development. By combining national expertise with state ownership and local knowledge, NDMA and the Nagaland Government are laying the foundation for a safer, climate-resilient, and future-ready Nagaland. ■

LOCAL PARTNERSHIPS FOR RESILIENCE

Strengthening Disaster Resilience in Nagaland: Global Perspectives and Local Partnerships

*By **Andreas Bollmann**, Partner, Faber Consulting AG, Switzerland*

Nagaland, a state known for its cultural heritage and ecological diversity, faces growing risks from climate change. Increasingly erratic rainfall, floods, landslides, and droughts threaten hard-won development gains. These hazards are magnified by fragile ecosystems, unplanned urbanisation, and limited coping capacities. Strengthening disaster resilience, therefore, requires global expertise combined with strong local partnerships.

Insurance has long helped societies absorb shocks by transferring financial risk, enabling recovery and growth. Today, climate and disaster risk financing can complement disaster risk reduction (DRR) and climate change adaptation (CCA). But insurance alone is not enough - it must be integrated into a broader resilience strategy.

In Nagaland, the Nagaland State Disaster Management Authority (NSDMA) has taken a leading role in developing integrated solutions. Recognising that State and National Disaster Response Funds are often under-resourced, the NSDMA partnered with Faber Consulting,

Indian insurers, and global reinsurers in 2020 to pilot India's first sub-sovereign parametric disaster risk insurance product. Initially based on satellite data, the product has since been refined to rely more on local weather station data, ensuring more accurate coverage. Furthermore, the new product has enabled Nagaland to secure robust and reliable insurance support on a multi-year basis, leading to improved budget certainty. Supported by the *InsuResilience* Solutions Fund (ISF), the initiative also benefits from grant funding and implementation support.

A pioneering feature is the use of blockchain technology to power a Decentralised Relief Pay-out System (DRPS) linked to Nagaland's Disaster Management Information System (NSDMIS). This ensures faster, more transparent compensation for affected populations - critical during monsoon rains, flash floods, and landslides that frequently disrupt lives, livelihoods, and infrastructure.

The project aims to strengthen Nagaland's disaster response by providing reliable financial resources and accelerating relief pay-outs. The next step is for the NSDMA to embed such insurance mechanisms within a comprehensive risk management framework. This will enable decision-makers to allocate resources between proactive investments, such as resilient infrastructure, improved land-use planning and ecosystem protection, and financial tools, such as insurance, for managing residual risk.

This envisaged integrated approach recognises that resilience cannot be achieved through a single tool. Insurance provides a safety net, but it also works best when paired with investments in risk reduction and adaptation. By combining financial protection with measures that reduce vulnerability, Nagaland can better safeguard development gains and protect its most at-risk communities.

The Nagaland experience offers a valuable lesson with global relevance: partnerships that connect international expertise with local realities can drive meaningful resilience. Through its collaboration with experienced partners, NSDMA is building a forward-looking disaster risk management system. This model demonstrates how innovation, finance, and strong local leadership can create pathways toward safer, more resilient communities in the face of climate change. ■

नागालैंड में आपदा प्रबंधन में नेतृत्व: सुरक्षित और सक्षम भविष्य की ओर

*By **Rohan Trivedi**, AIDMI, India*

नागालैंड आज भारत में आपदा प्रबंधन और जलवायु अनुकूलन के क्षेत्र में एक महत्वपूर्ण उदाहरण के रूप में उभर रहा है। भौगोलिक दृष्टि से पर्वतीय और जलवायु परिवर्तन के प्रभावों के प्रति संवेदनशील यह राज्य भूस्खलन, बाढ़, वनाग्नि और अत्यधिक वर्षा जैसे जोखिमों से लगातार जूझता रहा है। ऐसे में राज्य सरकार और राष्ट्रीय संस्थानों के नेतृत्व ने आपदा जोखिम न्यूनीकरण को केवल प्रतिक्रिया तक सीमित न रखते हुए, उसे शासन और विकास की मुख्यधारा से जोड़ा है।

नागालैंड राज्य आपदा प्रबंधन प्राधिकरण (NSDMA), गृह विभाग, नागालैंड सरकार के नेतृत्व में संस्थागत सुदृढ़ीकरण, जोखिम-आधारित योजना और विज्ञान-आधारित निर्णय प्रक्रिया को प्राथमिकता दी गई है। राष्ट्रीय आपदा प्रबंधन प्राधिकरण (NDMA) के तकनीकी मार्गदर्शन से राज्य में आपदा प्रबंधन योजनाओं, मानक संचालन प्रक्रियाओं और अंतर-विभागीय समन्वय को मजबूत किया गया है। सूचना प्रणाली, प्रारंभिक चेतावनी तंत्र और विकेंद्रीकृत राहत व्यवस्था ने दूरस्थ क्षेत्रों तक समय पर सहायता पहुँचाने में महत्वपूर्ण भूमिका निभाई है।

नागालैंड ने आपदा जोखिम हस्तांतरण, बीमा आधारित सुरक्षा, और डेटा-आधारित पूर्वानुमान जैसे नवाचारी उपायों को अपनाकर वित्तीय और संस्थागत लचीलापन बढ़ाया है। साथ ही, प्रशिक्षण, अभ्यास और ज्ञान साझेदारी के माध्यम से स्थानीय निकायों और समुदायों की क्षमता में निरंतर वृद्धि की गई है।

यह पहलें एक स्पष्ट उद्देश्य से प्रेरित हैं—जीवन, आजीविका और विकास को सुरक्षित रखना। नागालैंड का अनुभव दर्शाता है कि जब नेतृत्व, प्रणाली और विज्ञान एक साथ कार्य करते हैं, तब आपदा प्रबंधन केवल संकट प्रतिक्रिया नहीं रहता, बल्कि एक सुरक्षित, जलवायु-संवेदनशील और भविष्य के लिए तैयार राज्य की नींव बनता है। ■

RESILIENCE PLANNING

Mainstreaming Disaster Risk Reduction in State Policy and Governance Frameworks: Making Disaster Risk Reduction Everyone's Business in Nagaland

*By **Anoop Khinchi,** Nagaland Civil Secretariat, NSDMA, Nagaland, India*

Disaster risk reduction primarily involves the development and implementation of policies and strategies to mitigate vulnerabilities and reduce disaster risk for society. This process ensures that disaster risk management is not treated in isolation, but is embedded in the core of governance, decision-making, and development processes at all levels. The Hyogo Framework for Action, which aims to reduce losses by building community resilience, and the Sendai Framework for Disaster Risk Reduction advocate a multilateral approach.

Disaster and development are related. The development to be sustainable should have policies invariably ingrained with disaster risk reduction. It's also imperative that Climate change adaptation be an essential part of it, and academic rhetoric should give way to practical implementation.

The planning process should involve all stakeholders in cross-sectoral coordination. Departments such as Urban& Rural Development, Agriculture, Social Welfare, DUDA, and Health &Family Welfare should collaborate, replacing the current fragmented approach of the Government. The planning process should be risk-informed, and all departments should incorporate a component in their schemes and interventions to cater to vulnerability. The Agriculture Department should provide timely inputs to help farmers better adjust to climatic uncertainties. Similarly, a good road network could be a lifeline in hours of evacuation. Forest fires can be prevented through coordinated community action. The recent floods in Dimapur and the surrounding areas resulted in loss of life and property. Even the airport runway was inundated with water. All these circumstances need concerted efforts. There should be a proactive approach of prevention, preparedness, mitigation and relief. We need to make Nagaland truly disaster-resilient.

Climate Change Adaptation is a need of the hour. Now it's not a distant thing, but its effects are felt across all walks of life. Climate change is impacting water-borne and vector-borne diseases, such as dengue and JE. Unpredictable rains, floods, and an extended rainy season are all attracting focused attention. Nagaland, being a mountain terrain, is more sensitive to climate change. Agriculture, water resource management, Human Health, and settlements require state-specific adaptation strategies. The One Health program of the Government of India needs to be implemented in spirit. Antimicrobial resistance is emerging as a significant issue, necessitating swift action. Mainstreaming DRR aligns with Sustainable Development Goals (SDGs) by reducing the adverse impacts of disasters on economic, social, and environmental progress.

Who are vulnerable? This is the most important question to be answered. Societal vulnerability, which is widely distributed, needs to be meticulously analysed and identified, addressing the needs of the poor, as well as gender and age differences. There should be emphasis on societal capacity building, empowering them to respond promptly to disasters. The poor should be trained to protect themselves. They should be guided to take care of their settlements and relocated to safe places if needed. The government housing schemes may have provisions to make vulnerable houses disaster-proof.

There should be suitable provisions in the budget to undertake DRR measures. It makes sense to invest some money in safeguarding your life and investments, thereby making development sustainable.

The local government, Urban and rural, should be empowered and capacitated at the grassroots level for risk reduction and building resilience. We need robust early warning systems and actionable information to make communities resilient and save people and economic losses. The most vulnerable should be covered through an insurance-based financial security measure, as Nagaland initiated the DRTPS scheme, one of its kind innovations in the country. More of Retrofitting hospitals should be in place for seamless medical care in times of emergency. A sturdy and reliable communication network for coordination and command control in times of crisis is indispensable.

A proper drainage system and building codes to be enforced, as there is ample evidence that when Building codes are enforced, lives are saved. So if we fail to plan, we are endangering our precious lives and resources at peril. Choice is ours, as inaction can be detrimental. ■

Application of Data Computation with Special Focus on Precision Weather Prediction

*By **Dr. Johnny Ruangmei**, Joint Chief Executive Officer, Nagaland State Disaster Management Authority (NSDMA), Home Department, Govt. of Nagaland, Nagaland, India*

Abstract

This journal article is written to explore the development of scalable, adaptive computing frameworks for weather forecasting. This journal article proposes a computational framework that leverages deep learning, real-time stream processing, and hybrid AI models to enable intelligent decision-making in weather forecasting. For weather forecasting, it presents transformer-based models optimised for short-term nowcasting using satellite and radar data, blended with physical priors to preserve model robustness and realism.

In the era of data-driven science, environmental stability represents as one of the most pressing global concerns. Precision high-resolution weather forecasting is critical for disaster preparedness, agriculture, aviation, and climate resilience. The domain of precision weather prediction demands real-time, high-accuracy computational systems to translate data into actionable insights.

Objectives of this journal article.

This journal article aims to propose for a unified computational framework for precision scientific computing that:

1. Processes real-time weather data using low-latency, high-throughput neural models.
2. Achieves state-of-the-art accuracy in short-term precision weather nowcasting.

This journal article may spark new thinking and insight in the development of a computational framework for precision weather data forecasting and prediction, utilising advanced deep learning and spatiotemporal modelling techniques to enable high-resolution, real-time atmospheric insights.

Precision weather forecasting using advanced deep learning and spatiotemporal modelling—especially with inputs like cloud thickness—is a cutting-edge field with multiple components. This model is an integrated model with networks of sensors, ground weather data, satellite data, and advanced computing capability.

- The interpolation of multiple data and the convergence of surface and spatial data are the key ingredients of data for its accuracy.
- For the precision weather forecasting (climate modelling, extreme event prediction), the Hybrid Quantum-Classical NWP is used.
- The goal of the experiment is to improve the resolution of rainfall prediction. The method used for this experiment is to replace classical parameterisations (e.g., cloud microphysics) with Quantum Neural Networks (QNNs) and to train on ERA5 reanalysis data (ECMWF). This is a basic data code which can be deployed. Precision weather forecasting aims to deliver highly accurate, localised, and timely predictions by leveraging advanced computational techniques. Unlike traditional regional or global weather models, precision forecasting emphasises accurate, granular insights—often down to the neighbourhood or street level—facilitating actionable outcomes for agriculture, aviation, disaster management, and urban planning.

Conclusion: Future Directions

This journal article points its works to demonstrate higher and accurate computing capability for the development of a computational framework for precision weather data forecasting and prediction, utilizing advanced deep learning and spatiotemporal modelling techniques to enable high-resolution, real-time atmospheric insights. ■

Precision weather prediction combines satellite, radar, and ground observations with deep learning and hybrid AI models to generate high-resolution, real-time forecasts. Such data-driven computation improves rainfall nowcasting and extreme weather detection, enabling faster early warning, better disaster preparedness, and informed decision-making for agriculture, aviation, and climate resilience in vulnerable regions.

WAY AHEAD

From Systems to Societal Resilience

*By **Dr. Johnny Ruangmei,** Joint Chief Executive Officer, Nagaland State Disaster Management Authority (NSDMA), Nagaland, India**; and Mihir R. Bhatt,** All India Disaster Mitigation Institute (AIDMI), India*

Nagaland has shown that disaster resilience is not built through isolated interventions but through systems, science, and sustained leadership. The state's experience highlights a critical shift—from managing disasters to managing risk. The way ahead now lies in deepening integration and widening ownership across sectors, institutions, and communities.

First, disaster and climate risks must be embedded into development planning and public finance. Every investment—whether in roads, schools, hospitals, housing, or digital systems—should undergo risk screening. Risk-informed budgeting ensures that resilience is not treated as an additional cost but as a foundation for sustainable development. As demonstrated in Nagaland, aligning infrastructure and policy with evolving climate risks can significantly reduce long-term losses while safeguarding development gains.

Second, early warning systems must translate into early action. Advances in precision weather prediction and platforms such as the Nagaland State Disaster Management Information System (NSDMIS) have strengthened data availability and forecasting capacity. Yet, the true value of these systems lies in their ability to trigger timely, local responses. Information must flow seamlessly to district administrations, village councils, and urban local bodies, enabling rapid decisions that protect lives, livelihoods, and critical infrastructure.

> *"Resilience in Nagaland will not be built by reacting to disasters, but by anticipating risk, embedding science in governance, and ensuring that every investment today reduces tomorrow's vulnerability."*

Third, financial resilience must expand beyond post-disaster relief. Nagaland's leadership in disaster risk transfer and parametric insurance offers a strong national model. The next phase should link these financial instruments with risk reduction incentives—encouraging safer construction, ecosystem-based approaches, and climate-resilient livelihoods. By integrating finance with prevention, resilience becomes both economically viable and socially inclusive.

Fourth, resilience must remain community-centred. Youth groups, women's organisations, schools, and local entrepreneurs are not passive recipients but active agents of change. Building resilience requires continuous engagement, local knowledge, and trust. Capacity building must move beyond one-time training programmes to sustained learning platforms, peer networks, and locally driven solutions that strengthen everyday preparedness.

Fifth, governance systems must become more coordinated and accountable. Cross-sectoral collaboration—linking departments such as urban development, health, agriculture, and environment—is essential to address interconnected risks. Institutional mechanisms should enable data sharing, joint planning, and shared responsibility, ensuring that resilience is embedded across all levels of government.

Finally, knowledge must travel. Nagaland's experience—captured through research, partnerships, and publications—offers valuable lessons for other hill and climate-vulnerable regions. By linking practice with evidence and policy, Nagaland is contributing to a broader national and global dialogue on disaster risk reduction. Leadership, when combined with science, inclusion, and innovation, becomes transformative.

When data, finance, and community leadership work together, disaster management moves from relief to risk reduction—and that is where true resilience begins.

The future of Nagaland lies in connecting governance, technology, finance, and community trust into a single, coherent system. Such a system—anticipatory, adaptive, and accountable—can ensure that resilience is not only achieved but sustained. ■

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