CDRI
Coalition for Disaster Resilient Infrastructure

CDRI FELLOWSHIP PROGRAMME

Cohort 2021-22

PROJECT ABSTRACTS

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COALITION FOR DISASTER RESILIENT INFRASTRUCTURE

The Coalition for Disaster Resilient Infrastructure (CDRI) is a global multi-stakeholder partnership of national governments, UN agencies, programmes, multilateral development banks financing mechanisms, private sector, academic and knowledge institutions. CDRI is committed to working with various stakeholders to promote the resilience of infrastructure globally.

CDRI FELLOWSHIP PROGRAMME

The CDRI Fellowship Programme was launched in September 2020 with the objective of investing in research and innovation to build back and build forward better as the world navigates through global transitions. The Fellowship Programme is a seed grant, providing financial support, capacity development and peer learning opportunities for individuals designing solutions for real-world problems related to the resilience of infrastructure.

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INTRODUCTION

The Coalition for Disaster Resilient Infrastructure (CDRI) is committed to promoting the disaster resilience of existing and new infrastructure in the face of growing climate risks. The Coalition invests in cutting-edge research and innovation through its knowledge initiatives to identify pathways for resilient infrastructure.

The CDRI Fellowship Programme is one such initiative, launched in September 2020, a 12-month seed grant, providing financial support, peer learning and capacity development opportunities for individuals designing actionable solutions for real-world problems related to infrastructure resilience.

The first Cohort of CDRI Fellows was onboarded in June 2021 with 21 teams from nine countries engaged in a variety of research projects covering diverse hazard conditions. The teams have completed their Fellowship, demonstrating considerable progress in their research projects, despite challenges including the Covid pandemic and geopolitical flux.

Solutions that have emerged from this Cohort include strengthening road resilience using landslide susceptibility models, incorporating resilience in ports, using AI and machine learning to strengthen communications, monitoring river migration at sites of critical bridge infrastructure and developing future wetlands inventory for disaster risk reduction in the Himalayan region.

This publication is a compilation of project abstracts of Cohort 2021-22 of the CDRI Fellowship Programme.

The Future Ground: Urban Planning for Infrastructure Resilience (Case: Mumbai)

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The world is witnessing the most significant cumulative urban expansion in history - against the backdrop of climate change and disasters. This anticipated growth requires extensive construction and renewal of reliable infrastructure systems that form the backbone of resilient urban development. These infrastructure systems will be exposed to a range of hazards - particularly hydrometeorological hazards, that are changing with a fair degree of uncertainty. Infrastructure decisions not made mindfully to adapt and respond to these uncertainties can lock in risks and face higher vulnerabilities than they were designed for. However, transitioning to resilient urbanization requires systematic changes in all major infrastructure systems, including energy, industry, land, and ecosystems. Hence, risk-informed urban planning becomes pivotal in adopting a long-term view to inform infrastructure resilience.

This research initiates steps to develop a risk-informed urban planning framework using the Mumbai Metropolitan Region case. A qualitative research process has been undertaken to scan the existing knowledge landscape around risk-informed urban planning and infrastructure resilience; establish the requirements and constraints planners face in translating climate and disaster variables into urban plans and infrastructure policies; and take the first steps towards the development of a risk-informed urban planning framework.

The framework is expected to be utilized for a more extended research project to develop future land-use scenarios for Mumbai under climate change. The aim is to make the findings of this study applicable to a broader set of tropical cities faced with similar risks and development issues.

Regional Road Network Resilience using Landslide Susceptibility Model

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Lack of a reliable landslide susceptibility map in India's Western Ghats has led to poor quantification of risk associated with rainfall-induced landslides to the road networks, as these macro-level susceptibility maps fail to consider the geotechnical characteristics of overlying soil.

The study introduces a framework to improve susceptibility mapping by performing probabilistic slope stability analysis, using different simulation techniques. In addition, optimization techniques are also incorporated, to estimate the location of probe points in an optimal manner.

Highlights of the research include:

- An updated landslide inventory of Kerala focusing on the Western Ghats region
- A novel and robust methodology with which geotechnical properties can be incorporated into macro level susceptibility mapping in a reliable and feasible manner
- An improved landslide susceptibility model for the study region, factoring in the geotechnical properties of the slopes

These provide quantitative expertise on future slope failures, which could be used by the concerned authorities in land-use administration and planning. The model would improve road recovery to enhance resilience, and prioritize roads in the network based on impact, restoration time, mitigation plans and evacuation strategies, thus improving the resilience and recovery of road networks.

GIS-Based Landslide Susceptibility Mapping Using AHP - A Case Study from Bamyan, Afghanistan

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Landslides are one of the critical phenomena that frequently lead to loss of human life and property, as well as causing severe damage to natural resources and infrastructures. Bamyan province is a landslide-prone zone given its mountainous topography, climate conditions, seismic potential and geology. Every year, landslides in Bamyan result in significant economic and social losses (deaths, injuries, and property destruction).

This paper presents a landslide susceptibility analysis in Bamyan, Afghanistan using AHP (Analytic Hierarchy Process) method. To gauge landslide susceptibility, determination of factors affecting the occurrence of landslides in this province were identified through ground observations and comparison of previous research. Twelve factors were identified including lithology, distance to drainage, slope, distance to fault, rainfall, land cover, distance to village, drainage density, elevation, aspect, distance to road and land surface temperature.

According to the relation between the above factors and landslide distribution, the weight value and rating value of each factor were calculated using AHP. Finally, the susceptibility maps of the study area provided using Arc GIS software through weighted overlay method. The final map shows that very high risk, high risk, moderate risk and low risk zones respectively cover 2.88, 58.34, 29.52 and 9.26 percent of the Bamyan areas. Lithology, drainage and slope were identified as key factors determining the occurrence of landslides.

The landslide susceptibility maps presented in this research constitute an important tool for decision maker, planners, and engineers. They can make rapid and well-grounded decisions to minimize and avoid the damage and losses caused by existing and future landslides, or avoid the highly susceptible zones, by suitable preventive measures and mitigation procedures.

Framework for Landslide-Prone Critical Infrastructure Zoning

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Landslides cause human losses, economic losses, and infrastructure disruptions. Lack of precise landslide susceptibility assessment makes it difficult to identify existing critical infrastructures that are more vulnerable to landslides resulting in poor mitigation and preparedness. Landslide susceptibility assessment effectively predicts the likelihood of landslides in a given region and requires a spatially consistent landslide inventory. Terrain attributes and extreme rainfall control the landslide susceptibility. Variation of extreme rainfall in magnitude and intensity further renders landslide susceptibility a dynamic phenomenon.

The project manually mapped over 100,000 landslides in Nepal, moving on to map landslide susceptibility from 2015 to 2020 on a multi-temporal basis. A machine learning model with terrain attributes and 21 different extreme rainfall indices was trained for this purpose. The landslide susceptibility is overlaid on a critical infrastructure spatial index map (representing the intensity of the presence of critical infrastructure based on open street maps) to identify critical infrastructures prone to landslides in Nepal. Different scenarios maps are generated to help prioritize landslide-prone critical infrastructure areas and river corridors on a national scale. The final map delineates areas where climate-resilient slope infrastructure policy needs to be enforced at the granular level. The research outcomes are shared using a web GIS application.

The framework developed as part of the research is scalable to other countries and regions and can be helpful in developing national level infrastructure financing strategies.

Integrating Machine Learning in Disaster Resilience through Rule-Based Verification of Aerial Imagery

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Flood risk management focuses on predicting floods, managing land systems and creating maps for disaster-prone areas. There is a lack of a smart and intelligent system that manages responses in flood-like situations, given the absence of an automated land-based recognition method which can pinpoint the critical areas in need of help when telecommunication systems dysfunction. Timely detection of a flood is crucial to initiate relief services by identifying available routes within the limited timeframe.

The proposed approach targets the shortcomings of the Global Positioning System (GPS) such as variance in location coordinates and delayed information processing by using an unmanned aerial vehicle (UAV)-based imaging framework. This project focuses on using state-of-the-art technology to facilitate disaster response, aiming to build resilience to disasters by using a combination of machine learning and image processing-based methods. It aims to enable detection of flood-affected areas from input aerial imagery in the post-disaster phase.

Infrastructure components such as bridges in these areas can be detected for damage assessment, focusing on detection of cracks from input images. This model can assist in detection of entire road network from aerial imagery for disaster response evacuation planning.

Inventory of High-Altitude Wetlands for Disaster Risk Reduction in Transboundary Himalayan Region

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The transboundary Himalayan region of South Asia consists of internationally recognized Ramsar wetlands valuable for maintaining ecosystem services, biodiversity, and environmental flows crucial for mountain development. Nevertheless, due to wetlands' sensitivity to climate change, the Himalayan ecosystems are rapidly changing in the low-altitude (<3000 m) as well as high-altitude (>3000 m) regions. Thus, a study on the inventory of Himalayan wetlands and their dynamics is of great importance to take needed actions for sustaining ecosystem functions in the transboundary Himalayan region.

In this research, a maximum entropy (MaxEnt) algorithm has been used to model the existing geographic distribution of Himalayan wetlands using specific point location data, understand spatiotemporal changes in wetlands, and map out the probability of new wetland formation considering climate change impact on Himalayan glacier melting. The spatial data of topographic characteristics, soil information, land use/cover, and climate change were used as inputs to the model. Existing wetland locations in the territory of India were used as the training and testing data samples for the inventory modelling.

The research findings show the formation of new wetlands in the Himalayas region due to temperature rise that cause glacier melting and form wetlands in depressed areas. The wetland formation will continue in the future as temperature rise is likely to happen. The probability of wetland inventory is higher in the eastern and western parts of the Himalayas and high-altitude region. This study provides a valuable insight into role of wetlands in managing mountain disasters like floods and landslides.

Integrating Plans and Strengthening Communications Through Artificial Intelligence and Machine Learning

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As disasters have increased in frequency and magnitude throughout the world in recent years, there is an ever growing need to integrate hazard mitigation and risk reduction principles into plans and policies at the local level and into the wide array of local community planning initiatives. While many planning documents may exist within a jurisdictional planning framework, contradictions or gaps between various documents have been observed regarding hazard mitigation and other emergency management functions. Hazard mitigation is often forgotten about during other community planning initiatives, resulting in a lack of integration of hazard mitigation and risk reduction principles into other important planning initiatives.

This research project aims to address these issues by employing Artificial Intelligence (AI) and Machine Learning (ML) for the automated integrated planning of hazard mitigation principles. An automated AI application has been built that utilizes the concept of ML to reduce the current challenges associated with manually performing plan integration, and to provide an automated platform for communities to integrate hazard mitigation principles into other community planning initiatives and documents.

Ultimately, this project strengthens the resilience of policy and governance infrastructure by providing a central online location to view potential gaps in planning initiatives for intergovernmental coordination, and for identifying recommendations to fill gaps and challenges. The end product is a new automated AI application that will help align existing plans, goals, visions, policies, actions, and help increase hazard mitigation and coordination and communications during hazard events.

Disaster Resilience Building Construction Practices in Bhutan - A Research Compliance and Recommendation for National Adaptation

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Located in a seminally active Himalayan region with adverse geographical and geological conditions, Bhutan is vulnerable to various hazards. Landslide is one of the most common hazards intensified due to developmental activities and rainfall claiming lives, property and loss of infrastructure. Despite high risk of landslides, major urban development and expansion are taking a toll on the hilly regions of Bhutan.

Due to its steep mountains and snow cover, Bhutan's total usable land available for settlement is only 1 percent of the total land and 60 percent for forest and environment conservation policies as per the constitutional requirements. Regulations are in place for buildings to have adequate safety against earthquakes but there are no provisions for safety against landslides. The research project aims to address this gap and provide adaptation and mitigation measures towards disaster resilient building construction practices on hilly slopes of Bhutan.

A study was carried out to better understand the factors causing landslides along the urban slopes of Bhutan. Slope profile and subsurface data were acquired through geotechnical investigation, laboratory tests and surveying. The field data was used to perform slope stability analysis and results were interpreted to recommend the appropriate setback and excavation limits. Hydrological data was also acquired for selected areas, to determine the design discharge and suggest appropriate drain types based on slopes.

Findings on mitigation and adaptation measures for sustainable hilly construction practices have been shared and discussed with local stakeholders towards awareness on landslide risk reduction practices. This is also envisaged to help in framing policies and guidelines.

Innovative Structural Protection System for Resilient Community Against Multiple Hazards

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This project aims to develop a new innovative structural protection system to ascertain resilience of hospital building against the multiple hazards. Two natural and one accidental/ manmade hazards are considered in the present study: earthquakes, windstorms, and fire. Improvement in structural performance under these hazards for new and existing structures is aimed for by designing them with seismic isolation system.

Unbonded fibre-reinforced elastomeric isolator (UFREI) is a valuable substitute to the conventional elastomeric isolators for seismic base isolation purpose. The use of fibre-reinforced polymer (FRP) sheets in place of steel reduces the cost of the isolation system considerably, thus making it affordable to a variety of low-cost construction projects. Moreover, the unbonded nature of the isolator makes it more flexible as its horizontal displacement increases. If the polymeric fibres are replaced by natural fibres, the isolator also qualifies sustainability requirement.

The dynamic behaviour of the UFREIs is well researched on, however the change in its behaviour due to variation in the isolator properties are yet to be comprehended fully. This project studies the effects of changes in the geometric or material properties of the UFREI on their dynamic behaviour. A three-dimensional (3D) numerical model is developed and validated with results reported in the standard literature and subsequently, finite element analysis of the UFREI is carried out. It is concluded that the effective stiffness and damping of the UFREI are highly sensitive to the aspect ratio of the isolator.

A detailed numerical study has revealed that the proposed normalized THM could successfully predict the force-deformation behaviour of a variety of UFREIs. Thereupon, a simple design procedure is established which can yield both (a) the geometric isolator properties, and (b) the desired force-deformation characteristics of the UFREI, under site-specific conditions. It provides a useful tool to the designer for estimating the performance of the designed isolator without the need of conducting expensive experimental or time-consuming finite element analyses required before practical implementation.

Risk-Informed School Evaluation Tool (RISE)

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Schools are critical infrastructure, accommodating a highly vulnerable group, namely children, and should be located in safer areas. The Asia Pacific Report of 2019 suggests that investments in the educational sector can empower students and is a crucial entry point for breaking the link between poverty and disasters in the long term. The Asian continent has experienced multiple hazards and cascading risk patterns associated with climate change in the last decades, with statistics suggesting around 200 million affected children every year. Conventional school selection in Asian countries such as India is driven by factors such as academic programmes, curriculum, and staff quality, with less thrust on safety and disaster risk management issues. Lessons from past calamities such as the Gujarat earthquake of 2001 and the 2011 East Japan earthquake and tsunami underscore the need to give equal weightage to risk-informed school selection along with school curricula to safeguard the life of school students and prevent disruption in school education.

Indian cities have grown exponentially, and the growth has resulted in poor choice-making. The country has witnessed many school-related accidents that have taken the lives of hundreds of innocent children. The National School Safety Policy (2016) points out a disconnect between education programmes and disaster response and preparedness, which raises concern. These issues must be addressed, and the incidents be regulated for livability. Presently, there are no available indices to understand the school infrastructure's vulnerability and address the innate academic quality, which affects the decision-making and policy planning.

This study aims to address the present gap, to understand the composite risk patterns and promote sustainable models. The study's methodology involves a theoretical literature review of significant case studies on the themes of parental school selection and school disaster resilience. The indicators derived from both themes have been systematically finalized using the Delphi survey method and fed into a matrix to devise the Risk Informed School Evaluation (RISE) tool.

The goal of the study is to promote interventions in the conventional school selection process, to check the level of awareness and preparedness towards disaster risk management of schools and adding to the promotion of sustainability and resiliency through the application of the derived tool.

Reducing Disaster Fatalities by Amateur Radio Club Station within District Emergency Operation Centres

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Communication failures in disasters cause avoidable mortality, morbidity, and infrastructure losses. To mitigate this vulnerability, Indian district Emergency Operation Centres (EOCs) should establish fail-proof frugal amateur radio stations. Policy and regulation changes are required in India to establish amateur radio stations at district EOCs.

The aim of this transdisciplinary action research is to minimise Indian disaster mortality, morbidity, and tangible infrastructure losses by installing amateur radio or ham club stations (HCS) within district EOCs. Amateur radio is a technical hobby for which the government gives a license permitting communication among licensees on specified VHF, UHF and HF frequency bands. During many disasters, when all other modes of communication fail, frugal amateur radio works because it does not depend on other support system.

This project recommends the Wireless Planning and Coordination Wing of Ministry of Communication, Government of India for policy change to allow Indians to possess amateur radio transceiver (a radio capable of both transmission and reception) with the caveat of transmission only by an amateur radio licensee, as in the US. Currently, ham operators go to disaster sites with their equipment and restore emergency communication. In the process, critical time is lost, when every second makes the difference between lives and deaths.

Therefore, it is recommended that governments install HCS within DEOCs. In this scenario, the ham operator can go to the disaster-affected DEOC and restore amateur radio emergency communication, reducing disaster-induced mortality and infrastructure losses.

Multi-Hazard Risk Indexing of Coastal Critical Infrastructure: A Case Study of Thailand

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The coastal provinces of Thailand are prone to various hazards that include floods, cyclones, tsunamis, and coastal erosion. These hazards pose a serious threat to the existing infrastructures including critical infrastructure in the coastal areas mostly, along the Chonburi and Rayong provinces of Thailand. The Eastern Economic Corridor (EEC) is a special investment zone situated in the coastal area of Chonburi, Rayong and Chachoengsao provinces. The EEC has several major infrastructures and is poised to attract multiple infrastructure development projects.

To safeguard the existing infrastructure and infrastructure being developed in the near future from these hazards, it becomes critical to perform risk management exercises in the EEC area. The project aims to study impacts of multiple hazards and cascading effects on key coastal critical infrastructures of Thailand. It intends to define risk and sensitivity of the existing critical infrastructures in the eastern and western coast of Thailand considering systemic risk.

This study is a unique step to perform risk assessment of critical infrastructures, with a focus on transport, health and education sectors, from natural hazards of floods, cyclones and coastal erosion. The methodology employs the identification of key critical infrastructures and indicators of hazard, exposure, sensitivity and capacity. Further, secondary data is gathered from national and global data sources to analyze hazards, exposure, sensitivity and finally risk of critical infrastructures in the EEC.

The results reveal that districts with the very high-risk level are Si Racha (Chonburi) and Ban Chang (Rayong). Muang Chonburi (Chonburi) and Muang Rayong (Rayong) are high-risk levels. Klaeng (Rayong) is at moderate level of risk, while Ko Sichang (Chonburi) and Sattahip (Chonburi) are considered low risk. Laem Port and U-Tapao Airport are located in very high-risk zones. Similar to Map Taphut Port which is situated in Muang Rayong, has a high level of risk.

Armed with this knowledge, a wiser allocation and prioritization of resources should be facilitated between the districts of Chonburi and Rayong. Additionally, baseline research for the development of databases is highly recommended for future studies. Access to more databases will ensure a more accurate and more comprehensive risk assessment for the future.

Flood Resilient Floating Community Housing

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The rise in global temperature is a result of global warming. Due to this rise in temperature, the glaciers and ice sheets are melting, adding to the volume of the sea and resulting in the expansion of the water surface. There has been a massive shift of land water to oceans due to more usage and less recharge of groundwater leading to the unavailability of fresh water. An additional factor is the rampant concretization of cities. All these factors are responsible for the alarming rise in sea levels affecting many cities today and in coming years.

Floating architecture is the future of the problems of sea level rise and is currently the solution for flood-prone areas. It's implemented as a form of amphibious platform. The retrofitting can be done after careful investigation of the existing structure while for the new structure amphibious option ability can be integrated with the built structures. These structures are now needed to be integrated with the government disaster resilient structures. One such structure can be created in each village of flood-prone areas where this structure can act as a healthcare, education, community centre or even gram panchayat centre for the villagers during the dry season while as a disaster resilient shelter during the disasters. The idea of creating a multifunctional space will make it more relevant to implement and cost-effective. The innovation and technology have to be integrated to create it self-sustainable and self-reliant. The energy-neutral systems can be possible for these floating houses which are beneficial for natural disasters like floods and climate change resulting in sea level rise.

Further research will be done on the implementation of a prototype of the floating community centre. Such floating communities can be self-sustainable and disaster resilient.

Incorporating Infrastructure Resilience in India's Port-led Development Model

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In the increasingly interconnected and interdependent contemporary world, trade forms a significant component of every major economy; for India, trade accounts for over one-third of the total economy. Around 95 percent of India's merchandise trade, by volume, travels through the sea in cargo ships. India has 12 major ports and over 200 non-major ports that facilitate this trade which is expected to continue to grow in the future. In 2021, the Ministry of Ports, Shipping and Waterways of the Government of India unveiled the "Maritime India Vision 2030" which outlines a growth model focussed on building world-class greenfield ports, creating 'smart ports', modernising existing ports, promoting port-led industrialisation and public-private partnerships. While this ambitious vision and the development projects identified under it are critical in facilitating India's transition from a "Brown Economy" to a "Blue Economy", they are being and will continue to be seriously impeded by the ever-growing impacts of anthropogenic climate change.

In this context, this study aims to assess the threats posed by climate change in the form of more intense and frequent extreme weather events and sea-level rise to India's port infrastructure and operations. A climate-change-risk assessment framework and methodology were created which utilise a combination of available climatic data, field-based research, and expert-interviews with port officials to generate "climate-risk profiles" of Indian ports. The framework was tested and implemented through case studies of two of India's major ports, namely, the Mumbai Port Authority (on the west coast) and the Paradip Port Authority (on the east coast). Findings from the two ports were compared to bring out the differences and commonalities in the challenges facing individual ports.

The study highlights the urgent need for devising comprehensive and dynamic climate-change adaptation strategies for individual ports and a concerted policy framework at the national level to ensure long-term security and sustainability of India's maritime trade sector.

Intertwined Nature's Adaptation to Climate Change Using Green & Blue Infrastructure in Lambayeque, Peru

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Economic development has led to massive population movement to urban environments, causing a myriad of challenges such as climate variability, occupation of hazardous areas, heat island effect, alteration of hydrological regime increasing vulnerability in case of climate change and natural disasters.

In the case of Peru, El Niño affects the country resulting in heavy rains, floods caused by higher levels of river streams, landslides, extreme temperature, diseases such as cholera and finally, large losses of endemic fauna and flora. The Lambayeque region was one of the most ravaged during Coastal El Niño 2017, where impacts of the disaster were exacerbated by lack of planning and overuse of hard engineering infrastructure.

This project presents the design of green and blue resilient infrastructure in Chongoyape, Lambayeque, Peru. The final product is the intertwining of design processes, which results from the active reading of the place. The methodology used in the project comprises Research Through Design, resulting in spatial explorations in the form of mapping and transformative models. The aim of this project is to answer the research question: How can green and blue infrastructure be designed in Chongoyape for the town to be climate adaptive?

An important part of the methodology focuses on the exploration of site specificity as a design tool to achieve sustainability in socio-ecological systems, which claims the capacities of resilience and adaptation as its essential components.

The emergence of proposing this project in Chongoyape, arises from the need to mitigate the social, infrastructural and economic damages caused by El Niño-related events. Nature-based solutions are presented as a solution to respond to this challenge. Furthermore, the validation of the project is realized through phasing of the project and participatory actions.

Disaster Resilience of Bridges Exposed to Climate Change and Growing Traffic Load

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The concept of resilience-based performance evaluation, which integrates vulnerability, loss, and recovery measures, is rapidly gaining global importance in bridge engineering research and practice. In this context, the current research developed an analytical framework to assess disaster reliance of reinforced concrete bridges located in chlorine-laden and dense traffic environments. Floods and earthquakes are identified to be two primary natural disasters that have triggered a majority of bridge failures in the past.

Within the research scope, bridges on surface and over waterways assessed. Gradual degradation of these bridges modelled by taking the combined effect of corrosion degradation and traffic-induced fatigue, commonly known as corrosion-fatigue degradation, over life cycles of these bridges. Modelling material deterioration due to corrosion-fatigue involved the simulation of truck traffic on bridge girders using stochastic samples of trucks obtained from weigh-in-motion measurements and the estimation of fatigue stresses at critical locations of bridge girders.

For performance simulation of these bridges under natural disasters, finite element (FE) models of these bridges are developed. These FE models are updated according to the time-variant deterioration of composing materials owing to corrosion-fatigue degradation of bridge girders and corrosion of piers. Nonlinear time history analyses are performed to assess bridge performance under the stated natural disasters. From the obtained results, time-variant disaster risk and resilience are estimated for different life-cycle years of the bridges.

Results showed a declining trend in disaster resilience of the bridges as time progressed. Overall, the research demonstrates the confronting role of bridge degradation for developing disaster resilient bridge infrastructures.

Thermal Stress Testing of Residential Building Using Reference Weather Data

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Weather plays a unique and significant role as it is one of the main inputs and directly affects the thermal loads, and thus, energy performance of buildings. The origin of this proposal is based on the fact that while performing building energy simulations, only weather file is used as an input data to represent the outside weather conditions. Moreover, India uses only typical or average year to quantify building thermal performances developed by ISHRAE for 62 locations using data from the Indian Meteorological Department (IMD), the US National Center for Environmental Data (NCEI, formerly NCDC), and satellite-derived solar radiation data developed by NREL.

The diversity in climate types of India suggests that there is no single strategy to eliminate thermal stresses, reduce energy demand and maximize comfort under extreme climatic conditions. In fact, there is no single standardized definition for thermal stresses in building thermal conditions. Thus, giving rise to the need of identification and quantification of 'thermal stress' due to the extreme climate.

In this study, extreme weather files inclusive of heatwaves are generated. The gap between the typical and extreme thermal loads derived for a residential building type would help define the thermal stress for different climate types. The categorization of thermal stresses identified using cluster analysis would further help building engineers to optimize the building materials selection and its U-value. The two major outcomes from this study are extreme weather files and categorization of thermal stresses.

Managing Landslides and Road Construction in Chure Hill Region, Nepal

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Landslides in hilly areas of Nepal is a natural process,exacerbated by anthropogenic activities. This study attempts to investigate the problem, causes, and consequences of frequent landslides in Nepal's rural areas, where bulldozer-built motorable roads are massively created without sufficient planning and fundamental rural road requirements. Though infrastructure development is a necessary requirement in rural areas, where motorable roads are prioritized, the targeted populace is not reaping the expected advantages. These roads are not only causing landslides and threatening agricultural fields, they are also hurting ecological services.

In such a context, building more roads without considering their resilience is exceedingly questionable. Managing landslides in the delicate Chure hill region, where landslides are common, requires a distinct approach. Understanding resilience (in the local context), Chure Hills' vulnerability and local people's development priorities are critical at this point.

This study investigates all these factors and attempt to provide practical solutions to the country's pressing problems. One of the adaptation methods could be resilient planning by local stakeholders to prevent landslides, in which local indigenous knowledge is combined with current scientific understanding. Furthermore, national, provincial and municipal governments must collaborate on ground-level solutions, which may include suitable policies for landslide management.

Another issue that must be thoroughly carried out as stipulated in IEE/EIA and DPR is effective monitoring of ongoing construction operations. Though finance appears to be a primary limitation for managing landslides at the local level, it is also a management issue, and the quality of operations suffers as a result.

"InfraRivChange" – A Web-based Application to Monitor River Migration at Sites of Critical Bridge Infrastructure in the Philippines

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Shifting rivers represent a geomorphic hazard at sites of critical bridge infrastructure, particularly in rivers where migration rates are high. Conventional attempts to map and measure shifts in the position of rivers usually requires the manual digitization of satellite imagery using Geographic Information Systems (GIS); this type of analysis is time-consuming so can only be applied to a handful of bridge sites, using a small number of satellite images.

This project leverages the cloud computing platform Google Earth Engine (GEE) to upscale hazard monitoring assessments at large bridges in the Philippines using Earth observation (EO) data. The team designed a user-friendly web-application that enables stakeholders to monitor the relative risk of river migration by analyzing thousands of satellite images. The "InfraRivChange" web-application uses freely available satellite imagery from Landsat (30 m spatial resolution) and Sentinel (10 m spatial resolution).

The project demonstrates the workflow and shows results from the Gamu Bridge on the Cagayan River (Landsat imagery), Itawes Bridge on the Chico River (Landsat imagery) and Don Mariano Marcos Bridge on the Lagben River (Sentinel imagery). Outputs can be used by key decision-makers (e.g., the Department of Public Works and Highways, DPWH) to assess the relative risk of river migration at sites of critical bridge infrastructure.

The project recommends that the "InfraRivChange" web-application can be used as a low-cost remote sensing approach to monitor shifting rivers at sites of critical bridge infrastructure. The web-application can be applied to other critical infrastructure adjacent to rivers (e.g. road, rail and pipelines) and extended elsewhere to other dynamic riverine settings.

Monitoring and Evaluation in Drought-Proofing Plans: Exploring the Potential of a Social Audit Framework

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A people-centric approach is pivotal for building disaster resilient infrastructure. However, it is not just sufficient to include the community in its construction but also facilitate their participation in monitoring and evaluating the infrastructure.

Using two case studies of participatory monitoring and evaluation (M&E) models for disaster resilient infrastructure, NREGA Social Audits and Seva Mandir Gram Vikas Committee model, principles for effective M&E for resilience were identified. The principles include empowering the community to monitor water security infrastructure; iterative, regular, and flexible evaluation; and institutionalizing feedback loops for learnings generated in the M&E process among others.

A key takeaway is that participatory approaches, combined with multi-dimensional indicator tracking, can help build a loop of learning which can identify vulnerabilities in time. This holds relevance for organizations such as the National Rainfed Area Authority or donor-led resilience infrastructure projects, which can adapt their expert-led evaluation techniques with components such as public hearings.

Long-term engagement of the community can then be institutionalized as the community has a long horizon presence in the region of developed infrastructure and has the greatest incentive with continued water security and disaster resilience in the region. It is this alignment of incentives with resilience which could be harnessed by well-designed participatory M&E models.

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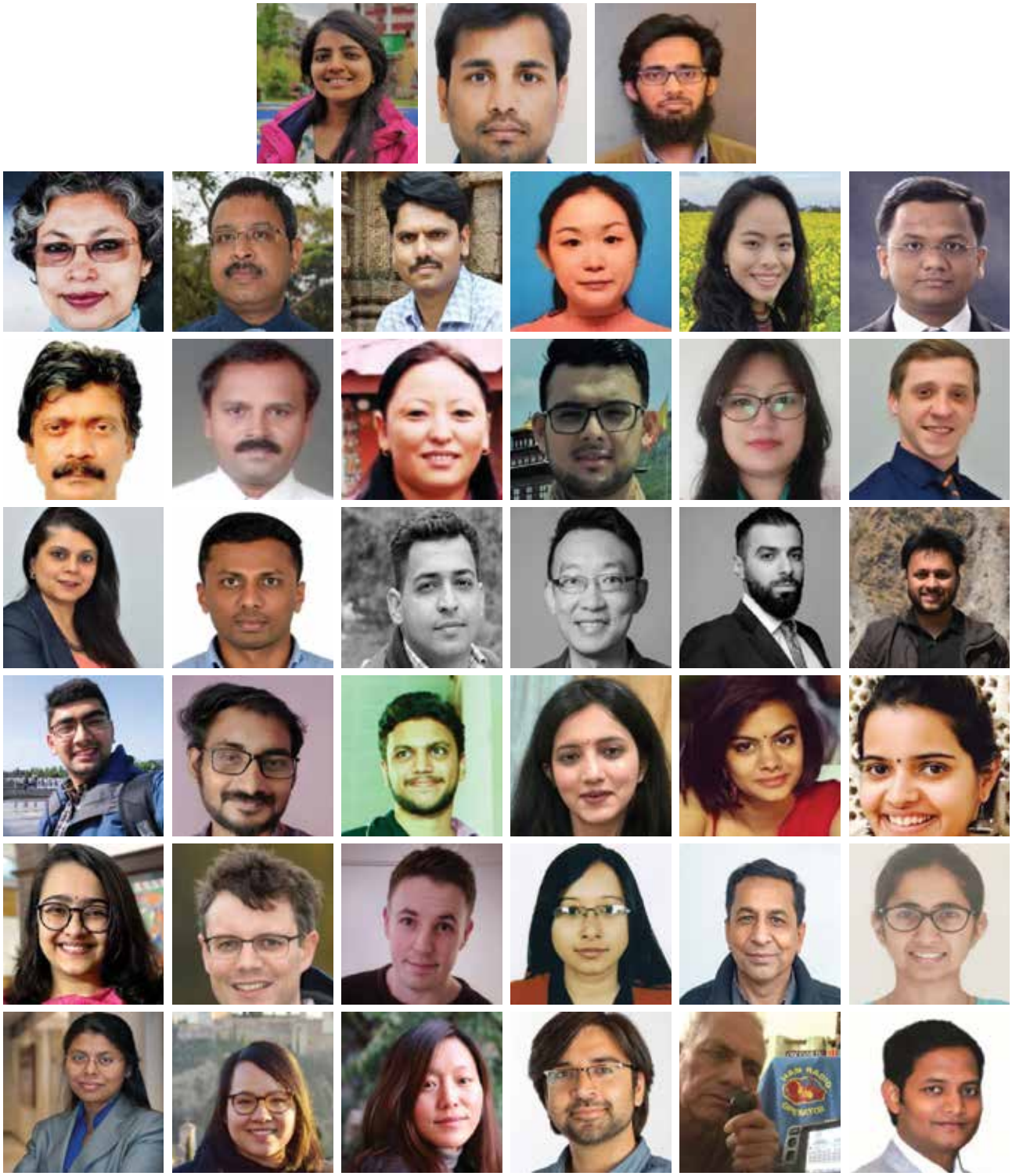

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