"Infrastructure Resilience: An Emerging issue of Disaster Risk Reduction"

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Abstract

Flash floods, sizzling temperatures, droughts and intense cyclones are likely to occur in India due to climate change and will continue to devastate regions in the world. Natural disasters have a significant impact on the quality of life by destroying food crops and livestock, as well as shelter and other parts of the built environment, and forcing households and communities to relocate. Their most devastating effect, though, is the toll they take on people and the instantaneous consequences. As a result of human intervention in natural processes, the destructive force and frequency of natural disasters have increased considerably. Disasters disturb people's lives by upsetting their routines. Direct effects on commercial real estate and infrastructure can result in production shortages.

The Disaster Cycle Disasters are complex emergencies requiring external assistance due to lack of adequate own resources of the society to recover. Disasters recur periodically in many regions of the world. While the exact timing and extent of future disasters can rarely be predicted, the expectation of their occurrence in the form of future risk can and should be incorporated into development efforts in disaster-prone areas. Reconstruction and recovery itself can therefore be construed as risk mitigation in preparation for the next expected disaster event. In addition, activities during any of these phases shape the circumstances and the available policy options during the next.

The aim of this paper is to understand the interrelationship between disasters and developmental infrastructural projects.

Keywords: *Disasters and Infrastructure, Risk Reduction, Risk & Disasters, Disaster Vulnerability*

1. Introduction

Since the start of civilization, natural calamities have been a part of human history. There are several natural calamities that are beyond human control. They're bound to bring with them the terrible consequences of human extinction. As a result of human intervention in natural processes, the destructive force and frequency of natural disasters have increased considerably. Disasters disturb people's lives by upsetting their routines. As a result of high winds and flooding, tropical cyclones cause widespread damage in specific areas. Direct effects on commercial real estate and infrastructure can result in production shortages. Certain disasters, such as Hud-Hud, have a severe impact on key infrastructure, such as electricity, water supply, and roadways, depending on the intensity of the disaster. Several trees fell, obstructing highways and destroying neighboring structures, causing damage to the airport, showroom automobiles, and city electrical poles. Infrastructure loss/damage is a sort of economic effect caused by disaster.

India is a disaster-prone country. With increasing global warming, the disaster has become frequent than it was earlier where natural disasters hit once or twice in a year. Since pre-independent there were only local laws in tackling disaster events. Disasters like cyclones, floods, landslides etc., affects both humans and animals. People are forced to become homeless. Houses have been damaged or have collapsed. Industries have been stymied. Floodwater has submerged crops. Domestic and wild animals both perish. In coastal areas, boats, fishing nets, and other items are lost or damaged. Following a flood, illnesses such as malaria and diarrhea are widespread. Potable water is contaminated and can be scarce at times. When food grains go missing or deteriorate, obtaining supplies from outside sources becomes difficult.

Systemic hazards are posing a challenge to emergency relief organizations' ability to contain and reduce the spread and scale of disaster impacts on communities around the world. International rules, such as those issued by the United Nations, are a good place to start The Sendai Framework for Disaster Risk Reduction reflects the international community's commitment to disaster risk reduction. There is a need for research on ways to limit exposure and susceptibility while also addressing the underlying risk causes. Critical infrastructure, which includes assets and networks that are critical to society's operation, such as electric power plants and roadways, presents a unique challenge for recognizing new types of disaster risk. critical infrastructure disruptions

can escalate crises triggered by natural hazard events, creating cascading effects by which emergency relief is challenged by non-linear and exponential multiplication of secondary crises.

The word "disaster" means a catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or manmade causes, or by accident or negligence which results in substantial loss of life or human suffering or damage to, and destruction of, property, or damage to, or degradation of, environment, and is of such a nature or magnitude as to be beyond the coping capacity of the community of the affected area.

Disaster risk is created by the interaction of natural hazard a potentially damaging natural phenomenon and vulnerability, the conditions and processes that define the susceptibility of a community to natural hazard. Risk mitigation can target either of these risk components. For instance, the likelihood of the occurrence of certain types of natural hazards, such as floods, can be influenced by human activity, such as the maintenance of natural drainage courses or the construction of levees. Reducing vulnerability to natural hazards, in turn, is in many cases easier to achieve than targeting hazards themselves, and in some cases, it is the only available option for disaster risk mitigation.

Restoring livelihoods and creating new economic opportunities is of fundamental importance to all in a post-disaster context. The aim of disaster management law is to improve the humanitarian response to both man-made and natural disasters. Disasters impact negatively on infrastructure projects as the cost involved in building the infrastructure destruction, loss of land and harm to people living in the vicinity of the site of disaster is huge and difficult to re-gain normalcy. The destruction caused by disasters possess significant challenges in re-building the basic infrastructure to the original state.

Tropical cyclones strike Asia and the Pacific region more frequently than any other part of the world, and they are frequently accompanied by severe flooding. Riverine flooding continues to be a common occurrence in the region that causes substantial damage every year. The dangers of flash floods are also growing more prevalent. Urban flooding has become a major potential hazard in terms of its economic and social impact as a result of the rapid urbanisation process and uncoordinated infrastructure development.

Environmental degradation taking place in many countries of the region only intensifies the damage inflicted by natural disasters. Deforestation, erosion, overgrazing, overcultivation and incorrect agricultural practices and the degradation of natural buffers amplify the effects of natural hazards. Land degradation and desertification pose a serious threat in the region in the wake of growing populations and enhanced food demand.

2. Physical Infrastructures

Dams are defined as physical structures built across a stream or a river to control or store water for various purposes which may include water supply, flood control, increasing river depth for navigation of barges/ships, or for recreational use. Traditionally, dams were seen as a means to overcome the vagaries of rainfall to benefit agriculture and mitigate droughts and floods. In India, man-made structures for irrigation have existed since time immemorial.

3. Effects of Disasters on Infrastructures

The most prevalent natural disasters that effect human society and economy are extreme precipitation events, landslides, and floods. Floods are becoming more common in India as a result of recent changes in climatic circumstances combined with increased human activity. Floods not only destroy property, but they also kill people and animals. Flood damage has grown in recent years compared to earlier periods, owing to increased flood frequency, encroachment of flood plains, and other anthropogenic activities such as mining, deforestation, and so on. Disasters had a significant impact on critical infrastructure, such as electricity, water supply, and roadways etc., Seaport is a critical coastal infrastructure serving important economic purposes but at the same time is unprotected to a wide range of natural perils or hazards including tropical cyclones.

Among the many disasters, cyclones have increased in frequency and severity at an alarming rate in the last two decades, which is related to climatic change. The state administration has made significant progress in reducing the number of people killed in the state, but an increase in economic losses and damage to key infrastructure has been a source of concern, with the power sector being the most important of all critical infrastructures.

The importance of good infrastructure in minimizing the effects of natural disasters has long been recognized by numerous authors. Infrastructure can be defined in

many forms. Community infrastructure consists of both physical infrastructure and organisational infrastructure or "hard" and "soft" assets of societies. Infrastructural Resilience, in general terms, refers to "the ability of a system exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management". The effectiveness of a resilient infrastructure rests on its ability to anticipate, absorb, adapt to, and/or rapidly recover from a potentially disruptive event.

Environmental degradation is a process that reduces the capacity of the environment for meeting the social and ecological objectives, and related needs. The potential effects of degradation vary, and may contribute to increase in vulnerable conditions along and intensity in occurrence of natural hazards.

4. Legal infrastructure

Legislation: Although this is not usually addressed at the national level as a disaster preparedness issue, the legal environment can greatly influence the resilience of women and men to disasters both in terms of the general legal structure and in terms of specific disaster-related regulation. It is particularly important to have concerns such as those considered below recognised in the legal system in advance of any disasters occurring, to avoid effective discrimination in the urgency of the relief phase, and in reconstruction when the deadline for aid registration is tight. Of wider importance is that provisions such as allowing for equal property and inheritance rights, or sensitising law enforcement officers to domestic and sexual violence brings empowerment and with it, better disaster resilience, on a broader scale. One fundamentally important step towards improving disaster resilience is to recognise in legislation the inheritance rights of both genders in an equitable manner.

Tenth Five Year Plan (2002-07) recognizing disaster management as a development issue for the first time & Eleventh Five Year Plan also came up with a number of 0guidelines and disaster management continuum today comprises of six elements. Prevention, Mitigation and Preparedness in pre-disaster phase, and Response, Rehabilitation and Reconstruction in post-disaster phase.

5. Constitutional Provisions

Constitutional and Legal framework constitutes the foundational pivot around which

different aspects of an activity are interwoven. Conceptually, legal arrangements refer to the framework of laws, executive orders, and other legal instruments that set the ground rules for governmental and non-governmental activities related to disaster mitigation and management.

The right to life and personal liberty is guaranteed in Article 21 of the Indian Constitution. It imposes a positive obligation on the state to take all reasonable precautions for disaster prevention, preparedness, and mitigation. The Supreme Court has liberally interpreted Article 21 to broaden the scope of life, and it can be said to be the repository of all important human rights. "Furthermore, Article 38 directs the state 'to promote the welfare of the people. Article 51 requires states to fulfil their international treaty obligations'. India is a signatory to a number of international environmental treaties, many of which include provisions for disaster management. Aside from that, the state is responsible. Even other than this, State is responsible under the doctrine of *parens patriae*. The Doctrine of *parens patriae* imposes an obligation on the State or sovereign authority to protect persons under disability. This doctrine which was originally applicable to the king has been applied by Courts in a number of cases to make the State responsible for providing relief to victims of disaster.

Article 43 of the Indian Constitution "The State shall endeavour to secure, by suitable legislation or economic organisation or in any other way, to all workers, agricultural, industrial or otherwise, work, a living wage, conditions of work ensuring a decent standard of life standard of life and full enjoyment of leisure and social and cultural opportunities and, in particular, the State shall endeavour to promote cottage industries on an individual or co-operative basis in rural areas."

According to Article 47 of the Constitution which provides that 'one of the primary duties of the State is to raise the level of nutrition and the standard of living of the people, there is considerable moral force and authority in this provision to persuade the State Governments and the Government of India to attempt at ensuring that the people, particularly those in drought affected areas, are provided adequate food grains and a cooking medium for the preparation of their meals'.

Entries in Schedule VII of the Constitution (List I), the State governments are allotted funds to meet financial expenditure on meeting identified natural calamities based on the Finance Commission's recommendations. The two entries in the State List that are remotely related to disaster management are entry 14, which deals with agriculture,

including pest and plant disease prevention, and entry 17, which deals with water, including water supply, drainage, and flood control.

6. Disaster Management Act, 2005

The Government of India (GOI), Ministry of Home Affairs (MHA) and United Nations Development Program (UNDP) signed an agreement in August 2002 for the implementation of "Disaster Risk Management" Program to reduce the vulnerability of the communities to natural disasters, in identified multi– hazard disaster prone areas. Goal of this agreement is "Sustainable Reduction in Natural Disaster Risk" in some of the most hazard prone districts in selected states of India"

In 2005, the Indian legislature passed the National Disaster Management Act. This Act frames the development towards a proactive disaster management system. It mandates the creation of a number of policies, plans and organizations for a coherent and multi-level disaster management system. At the national level, it established a National Disaster Management Authority (NDMA) and also created the National Executive Committee. The mandate of the Committee includes the development of a National Disaster Management Plan to be approved by NDMA. Every ministry and department in the Government of India is obliged to mainstream disaster management into their policies, and to prepare a disaster management plan. The National Institute of Disaster Management was put in charge for heading the national efforts in training and research. A National Disaster Response Force, supervised by the National Authority, a National Fund for Disaster Response and a National Mitigation Fund are also established.

As per the Disaster Management Act 2005, each SDMA (State Disaster Management Authority) can establish a State Disaster Mitigation Fund (SDMF), review mitigation works and approve disaster management plans of the departments. As a result, the national mitigation funds do not flow into the SDMF which would have been beneficial for carrying out mitigation work. The National Disaster Management Authority was established to spearhead the development of a disaster-resilient culture.

Powers and functions of National Authority: National Authority shall have the responsibility for laying down the policies, plans and guidelines for disaster management for ensuring timely and effective response to disaster, lay down policies on disaster management; lay down guidelines to be followed by the different Ministries or Departments of the Government of India for the purpose of integrating the measures

for prevention of disaster or the mitigation of its effects in their development plans and projects; coordinate the enforcement and implementation of the policy and plan for disaster management.

7. State's Liability

The Government schemes like Indira Awas Yojana (IAY) and other government welfare and development schemes, will also be reexamined to ensure hazard safety. Building codes will be updated every five years as a mandatory requirement and also put in the public domain. Training of engineers, architects, small builders, construction managers and artisans has already been started and needs to be intensified at the State and District level. Central Ministries/Departments concerned and the State Governments should create dedicated project teams to speed up the reconstruction process. State governments will have to lay emphasis on the restoration of permanent livelihood of those affected by disasters and special attention to the needs of women headed households, artisans, farmers and people belonging to marginalised and vulnerable sections.

Apex Court Stated in the case of Gaurav Kumar Bansal and Ors. v Union of India (UOI) and Ors 'it is absolutely necessary for the NDMA constituted at the national level and the State Disaster Management Authority at the State level to be ever vigilant and ensure that if any unfortunate disaster strikes there should be total preparedness and that minimum standards of relief are provided to all concerned. However, it would be advisable for the NDMA to regularly publish its Annual Report (the last one on our record is of 2013-14), to review and update all plans on the basis of experiences and to make its website ndma.gov.in multilingual so that all concerned may benefit'.

8. International Frame Work

A number of global frameworks for catastrophe risk reduction have been created in recent decades (DRR). The Hyogo Framework for Action 2005–2015, as well as its successor document, the Sendai Framework for Disaster Risk Reduction, enacted in Japan on March 2015, provide general recommendations for minimizing natural disaster risks.

9. Hyogo Frame Work

Between 2005 and 2015, the Hyogo Framework for Action (HFA) served as the global

template for disaster risk reduction activities. In 2005, during the World Conference on Disaster Reduction in Kobe, Hyogo, Japan, the HFA was adopted. Its goal was to significantly reduce catastrophic losses by 2015, both in terms of lives and in terms of communities' social, economic, and environmental assets.

The approval and execution of Hyogo Frame work Action was a pivotal moment in the development of regional strategies, plans, and policies, catalyzing National and local DRR activities and enhancing international cooperation. The HFA aided in the development of catastrophe risk reduction organizations, policies, and legislation. Stakeholders at all levels improved their risk assessment and detection, disaster preparedness, response, and early warning capabilities.

Sendai Framework:

The Sendai Framework for Disaster Risk Reduction (DRR) 2015–2030 included infrastructure resilience as one of the seven global goals (UNISDR 2019). The fact that two of the four priorities directly relate to resilient infrastructure development, namely "investing in DRR for resilience" through collaboration between public and private entities and "enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation, and reconstruction," emphasizes the importance of quality infrastructure (UNISDR 2019).

The Sendai Framework for Disaster Risk Reduction aims to achieve, over the next 15 years, a substantial reduction of disaster risks and loss of lives, livelihoods, and health and the economic, physical, social, cultural, and environmental assets of people, businesses, communities, and countries by preventing new disaster risks and reducing existing ones through the implementation of integrated and inclusive measures that strengthen resilience (SFDRR 2015). This goal calls for a strong integration of DRR into development, including mountain development

10. Resilience of Infrastructure

Disasters cause primary and secondary impacts on the environment, affecting natural processes, resources and ecosystems, thereby creating conditions for future disasters or for a complex environment related emergency. Currently, emphasis is being placed on developing resilient infrastructure that can withstand calamities while still remaining operational during emergencies. Society needs resilient infrastructure systems to resist and recover quickly from natural and human-caused disasters, but electric power, transportation, and other infrastructures are all highly sensitive and interdependent.

At neighbourhood and regional dimensions, new ways to characterising the resilience of sets of infrastructure systems are critically needed.

"Sufficient and well-built infrastructure, such as high-quality power and transportation networks, can mitigate the effects of natural disasters in terms of both human loss and economic damage. At the same time, the failure of infrastructure nodes such as airports or power plants can have far-reaching consequences that extend far beyond the actual extent of the hazard. Before a disaster strikes, the international community must increase investments in critical infrastructure. We currently place far too much emphasis on short-term relief following disasters and far too little emphasis on ensuring that resilient infrastructure is in place before hazards occur".

In Ashok Kumar v. Delhi Disaster Management Authority and Others Court held that in accordance with the statutory provisions of the Section 66 of the Disaster Management Act, 2005 Disaster victims are entitled for the compensation and the same shall also be paid in accordance with law after proper identification of the victims, as early as possible and practicable.

Despite the ecological richness and the contribution to economy, coastal and marine areas are under stress due to increased commercial exploitation, biotic and abiotic pressure, urbanization and industrialization, infrastructure growth and impacts of climate change. This is affecting the coastal ecology, and thereby, the livelihood, health and well-being of the coastal population; affecting in turn prospects for sustained economic growth. Coast is subject to severe hazards including weather events, tsunami, oil spills, erosion, flooding, drought, etc. and resilience of the communities to extreme weather variability had been low, mostly because of impoverishment.

The experiences of the Republic of Korea and Japan demonstrate the importance of investing in infrastructure in order to mitigate the effects of disasters. However, investment in disaster management infrastructure falls into two categories: (a) investment in infrastructure to support sustainable socioeconomic development; and (b) investment in infrastructure for reconstruction and recovery.

India is a fast urbanizing growing country, ensuring the resilience of essential infrastructure is critical to the country's sustainable progress. The infrastructure can be categorized into majorly Object-oriented system and Network oriented system. Public emergency services like hospitals, police station and fire station etc., can be previewed as object oriented where as crucial necessities of daily life such as power, gas and water

can be known as network-oriented system Prevention and mitigation contribute to long-term safety improvements and should be included in catastrophe management plans. India's government has made mitigation and prevention critical components of its growth strategy. As a result, the tenth five-year plan includes a comprehensive chapter on catastrophe management. The strategy emphasizes the importance of incorporating mitigation into the development process if development is to be sustainable. The vital infrastructure serves as the backbone for not only saving human lives but also decreasing physical and financial losses. Resilience of the network-oriented system needs to be prioritized.

"Critical infrastructures can be defined either individually or as a combination of physical structures, facilities, networks and other assets which provide services that are essential to the social and economic functioning of a community or society". Infrastructure development and investment has played a critical role in furthering social and economic development. The ability of a resilient infrastructure to foresee, absorb, adapt to, and/or quickly recover from a potentially disruptive event determines its effectiveness.

Building Back Better Recovery and reconstruction activity is clearly demarcated by temporal indicators, taking place as it does in the wake of natural disasters, and by its focus on longer-term needs beyond the immediate survival necessities of disaster victims. At the same time, the boundaries between relief and recovery can become blurred if relief arrangements such as the erection of temporary shelters become a longer-term feature, effectively acting as recovery structures when resource scarcity or political failure hinders durable reconstruction. The links between reconstruction activity and preparedness are yet stronger. While reconstruction used to be viewed as a one-time response to a specific disaster, it is increasingly recognised that building back better, with a view to strengthening resilience against future disasters, has great advantages both economically and in terms of quality-of-life improvements. Building back better encompasses a number of dimensions with gender-specific implications, beyond the erection of strengthened physical infrastructure. It involves paying express attention to a range of issues from compensating women for the losses of their tools and assets that is often overlooked, through providing childcare for fathers and for mothers, to supporting the formation of men's and women's groups and strengthening human development.

In India the enormous number of people living in low-lying and coastal areas, as well as the substantial inter-annual variation associated with hydro-meteorological hazards, a high-quality disaster-control infrastructure is urgently needed. Disasters cause enormous losses in life, livelihood, property, and the environment in India, preventing growth. Our disaster mitigation and response plans and mechanisms are frequently limited by legal issues. Disaster Control Infrastructure is a type of infrastructure designed to safeguard people and property in hazard-prone areas from the effects of the hazard. River embankments, sea walls, dikes, storm surge barriers, cyclone shelters, and other structures are included in the Disaster Control Infrastructure. The design of these infrastructure systems is based on a knowledge of past hazard patterns and predicted extreme hazard event return periods.

Furthermore, effective climate and disaster risk reduction activities require access to information and knowledge, as well as the availability of capability. Infrastructure development decision-makers, investors, and practitioners need access to actionable data and expertise that allows them to establish policies, programs, and projects that support their climate and development goals. Furthermore, given the numerous uncertainties connected with climate change and its consequences, as well as the complex requirements for successful climate and disaster risk management, all infrastructure development stakeholders must be aided in strengthening their capacity to plan, develop, design and implement climate-resilient policies and programs or projects.

The Coalition for Disaster Resilient Infrastructure (CDRI), which is being hosted by India and includes countries, the United Nations (UN), banks, the private sector, and research agencies, is focusing on infrastructure resilience through capacity building, partnerships, research, and knowledge management. CDRI also contributes to the UN Sustainable Development Goals (SDGs), particularly SDG on creating resilient infrastructure, which aim to make the world a better place for everyone by 2030. Restoring livelihoods and creating new economic opportunities is of fundamental importance to all in a post-disaster context.

Honourable Apex Court opined that "The aesthetic use and pristine glory of our country's natural resources, environment, and ecosystem cannot be eroded for private, commercial, or any other use unless the courts find it necessary, in good faith, for the public good and in public interest to encroach upon the said resources."

11. Conclusion

Sustainable development requires a systematic and integrated risk management approach in order to avoid or reduce future losses. **Restoring livelihoods and creating new economic opportunities is of fundamental importance to all in a post-disaster context. Community infrastructure consists physical infrastructure and organisational infrastructure i.e. "hard" and "soft" assets of societies.** It is evident that disaster management is not a stand-alone endeavor; rather, dealing with disasters and emergencies in the country necessitates a well-structured, people-centered, coordinated, and integrated effort. They can act swiftly in a cohesive and efficient manner once they've been educated, and their capacities are limitless. If we wish to improve our systems professionalism and effectiveness in dealing with disasters and decrease the impact of catastrophes on human life and property in India, there is dire need to strengthen the infrastructure facilities.