Economics of Disaster Resilient Community Housing: Case of Cyclones in India

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Abstract: As communities are becoming increasingly vulnerable to natural hazards, owing to global warming, the trends observed in the loss of human lives and property damage suggests that communities in India may not be resilient enough to extreme weather events (EWEs).
Hence, disaster resilience planning is expected to include an in-depth assessment of a community's interwoven social, political, and economic systems and how they are supported by the built environment. Housing is a significant dimension of infrastructure, that when fails, affects communities and occupants adversely. The study weaves around housing of communities and associated vulnerabilities and tries to attempt a framework that addresses these, and provides an accessible channel to financing bodies that seek to provide aid for the housing sector and vulnerable occupations and populations.

Through various frameworks, quantitative and qualitative, and case examples of cyclones in the past, indicators have been derived, a ranking of which has been obtained through expert survey. Solutions to these indicators are enlisted, and associated costs have been identified against each element. The framework attempts to place this study for EWS housing in Odisha, India, which is a economically weak state of the country, and is adversely affected by recurrent cyclones. Inputs for the framework have been prepared for a hypothetical scenario using data from Cyclone Fani (2019) and the output costs were compared to similar investments by financing bodies for similar projects.

The outcome helps observe that heavier investments towards the frontline of an EWE can make communities resilient towards cyclones, thereby significantly avoiding the need for rescue, recovery, relief and reconstruction. If the population is socio-economically stable, aware and lives in houses that are structurally stable and can withstand strong winds, destruction and casualties at massive scale are easily avoidable.

Keywords: Cyclones; Extreme Weather Events; Economics of Disasters; Disaster Resilience; Housing.

Introduction

Making resilience in communities operational for disaster risk reduction strategies and policies may raise critical challenges. Some of these have been found to be the definition of development of indicators that can adequately measure this concept; how this concept should be mapped; and the appropriate unit of analysis to be used.

The concept of disaster resilience has gained wider interest and popularity after the adoption of the Hyogo Framework for Action 2005-2015: Building the resilience of nations and communities to disasters. Since the adoption of the Hyogo Framework, the main goal of hazard planning and disaster risk reduction has shifted to focusing more on building community resilience rather than only reducing vulnerability.[1] Unsafe housing has been identified by Vahanvati and Beza [2] as the primary reason for housing collapse or damage associated fatalities in the event of a disaster. Apart from loss of life, disasters also cause overall economic losses due to damage to

housing. High vulnerability of housing settlements is also the result of government policies which do not strictly prohibit occupation of disaster-prone areas and expansion of residential pockets (authorized and unauthorized) in other risk-prone areas in the absence of clearly laid down land-use policies.[3] Some problems faced by housing during EWE;

- Damage or total loss of more than 12 lakh housing units on an average every year due to EWE
- Underdevelopment and changing poverty profiles
- Government policies which do not strictly prohibit occupation of risk-prone areas
- Absence of clearly laid down land-use policies
- Majority of housing comprise non-engineered category of constructions
- Low capacity of inhabitants to respond to disaster

Need of the Study

A major segment of the built environment in the affected area does not have the ability to remain in service after significant hazard events occur. Even as most communities try to rebuild as quickly as possible to restore damaged buildings and infrastructure, sometimes the enforcement of safety codes tends to get ignored, due to shortage of time to develop improved reconstruction plans. The significant amount of funding available for rebuilding becomes a lost opportunity without a plan to improve the communities' housing resilience.
Hence, a comprehensive economic framework for resilience, proposed as a study in this paper, aims at improving the current anticipated performance of the housing of the coastal communities during the disaster and in the response/recovery phase, to the desirable performance.

Objectives of the Study

The principal aim of the study is to develop an economic framework for incorporating comprehensive resilience in the built and social environment of coastal communities affected by recurrent cyclones. The objectives to achive the aim are;

1. To assess the physical and social implications of extreme weather events on communities and housing, and review the frameworks that are currently being used to implement resilience
2. To identify vulnerability indicators for housing specific to recurrent cyclones, derived from literature
3. To develop a framework for economics of disaster resilient housing in cyclone affected communities

Research Methodology

Vulnerability indicators are derived, aligned along 4 critical dimensions of resilience indicators, namely, Built Infrastructure, Vulnerable Populations, Social/ Economic Factors and Critical & Environmental Infra/ Policies framework. These vulnerability indicators are surveyed by disaster management field experts by means of survey, to attain Impact Coefficients and thereby Relative Importance Index. Solutions and corresponding costing for each of these indicators are identified in the form of relevant Government schemes that address these issues and can be validated as well as invested in. The economic framework, as a result, has been divided into three stages – Stage 1 (Highest Impact/ Coeff. 5 or 4), Stage 2 (Moderate Impact/ Coeff. 3) and Stage 3 (Low Impact/ Coeff. 2 or 1). Each cost for an indicator/ stage implies reduced vulnerability/ increased resilience. The framework is then applied on a hypothetical scenario, to understand the costing implication of achieving disaster resilient housing.

Literature Review

Vulnerability of Housing and Infrastructure to Disasters

Disasters alone do not kill people, but the collapse of unsafe buildings and infrastructure play a major role. Hence, unsafe infrastructure and housing has identified as the main reason for collapse or damage associated fatalities in the event of a disaster, as highlighted by Vahanvati and Beza. [2] Apart from loss of life, housing and infrastructure damage also contributes to the overall economic losses caused by disasters, at both household and national scales. According to World Bank estimates, damage to housing was almost 20 times greater in LDCs than in developed settings. [4] Consequently, disaster-related housing and infrastructure damage threatens to undermine economic development in developing nations by forcing all other development projects to be put on hold until housing and infrastructure is recovered. As a result, housing and infrastructure vulnerability to disasters threatens to destroy the physical, social, emotional and economic fabric of the residents of such communities. While reducing vulnerabilities in housing and infrastructure, i.e. tangible assets, it is also essential to address the diversity of community residents' needs, aspirations and the complexity of disasters.

Disaster Resilience and its Importance

The concept of resilience has gained significance within the disaster management prevention and reconstruction programs, since its introduction in 1970s. The concept may broadly refer to the society, system or area's ability to cope with, adapt to and prepare for future hazards. Disaster resilience can also be seen as the key priority of reconstruction policies and practices. [5]

Disaster Resilience has been defined by Walker and Salt [6] as below –
"The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to 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." [6]
Enhancing the resilience of people, housing and infrastructure is reliant on relationships between building practices, traditional knowledge and how people respond to their geographical settings.
The primary stakeholders of resilience programs are the beneficiaries, and the changing nature of community formation amid the complexities of a disaster context poses tremendous challenges to these stakeholders.
Further, as defined by Kapucu et al. [7] three-time frames within the disaster management cycle can be identified, when resilience is most evident.
These are –

- Prior to a disaster – anticipatory resilience
- During a disaster – responsive resilience
- A long time after a disaster – adaptive resilience

Also, the pre-, during- and post-disaster resilience are closely interrelated. For instance, people with pre-existing community networks prior to a disaster have shown to recover faster (i.e. post-disaster resilience). However, in post-disaster context enhancing resilience can become a more conscious task as people are likely to be open to changes or new ways of thinking. [7]

Vulnerability Indicators

Based on Literature Review on major Cyclones in the East Coastline of India in the previous decade, the most significant indicators of vulnerability for housing were identified, which were categorised under 4 Critical Dimensions, namely - Built Infrastructure, Critical and Environmental Infrastructure, Vulnerable Populations, Social Factors. The indicators have been listed below, along with their impact coefficients and Relative Importance Index (RII), as results and analysis of the survey conducted.

Table 1: Vulnerability Indicators

S.No.	***Indicator***	***Impact Coeff.***	***RII***
1.	Low Quality of Construction Material Used	5	0.90
2.	Non-Adherence to Building Standards and Regulations/ Universal Design	4	0.82
3.	Absence of Multi-Hazard Resilient Design/ Construction	4	0.78
4.	Lack of Structural Design and Stability	5	0.93
5.	Lack of Maintenance	3	0.69
6.	Low Economic Stability of household	4	0.76
7.	Un-authorised occupation of land	3	0.56
8.	Inadequate Provision of housing under Affordable Housing Schemes	3	0.62
9.	Absence of Designated Safe/ Unsafe Land Use	2	0.52
10.	Absence of Early Warning Systems/ Lack of communication channels	5	0.87

Through the survey aimed at receiving inputs for impact coefficient against each vulnerability indicator, it was observed that while the coefficient values that receive the maximum inputs were considered as most likely values, the RII number helped assign a weightage that helps in ranking or identifying the most severe impact causing factors for each parameter in a recurrent-cyclone prone region.

Development of Economic Framework

Intent of the Framework

The intent of this framework is to bind the indicators of vulnerability for cyclone prone communities identified through case examples and literature, into a single, easily accessible financing framework, that focuses only on achieving inherently resilient housing for communities.
The framework focuses on providing a feasible set of parameters and their associated costs, that can be used to identify the underlying problems in recurrent-cyclone affected regions; problems that have been observed in the previous decade, yet have not been worked on, or significantly improved to bring major changes in the existing scenario.

Inputs for the Framework

The framework uses inputs in the form of number of persons and households who are eligible for government funding schemes, affordable housing and beneficiary led construction. Further, blocks or districts that require Housing Facilitation Centers, to assist construction of houses for the weaker sections of the society, through decision making, knowledge management, incorporation of vernacular construction techniques, achieving structural stability, and quality control.

Data Collection for Framework

The inputs in the framework against each indicator are the solutions suggested to overcome the vulnerability and achieve resilience. These solutions are in terms of design, planning, changes at policy level and social infrastructure. Government schemes that have been proposed for upliftment have been identified to complement these solutions.

The schemes (in brief) are as follows –
1. Government Schemes for Beneficiary Led Construction of Houses
2. Indira Awas Yojana (IAY) for Upgradation of Kutcha Houses and Construction of New Houses using Vernacular Techniques
3. Affordable Housing in Partnership (AHP)
4. Slum Rehabilitation – a solution to Unauthorised Occupation of Land
5. Development of Housing Facilitation Centres that aid decision making, quality control and maintenance
6. Cost of Early Warning Dissemination System along Coastline
7. Government Schemes that benefit vulnerable occupations
8. Government Schemes that benefit various BPL (Below Poverty Line) categories of society

Application of Economic Framework on Needs Based on Aftermath of Cyclone Fani 2019

Inputs Required to Develop the Case

The framework needs to assess the number of individuals, families and households affected due to Fani. The number of houses also includes the current shortage of housing for the urban and rural poor, and aims to eradicate houselessness amongst the communities.

Furthermore, as observed, policy level implementations and revisions, along with need for Knowledge Management are also important to the final outcome from the framework.
The data has been sourced from Cyclone Fani: Damage, Loss and Needs Assessment, Govt. of Odisha, 2019. [8]

Table 2: Inputs for Framework

S.No.	*DESIGN/ INTERVENTION/ SOCIAL SOLUTIONS*		*COST*
1.	Beneficiary Led Construction (Stand Alone Houses) - RCC		314 Cr
2.	Beneficiary Led Construction (Stand Alone Houses) - Load Bearing Structure		235 Cr
3.	Affordable Housing Schemes (Govt.) - Affordable Housing in Partnership (AHP) (EWS area upto 30 sqm)	New Houses proposed for projected increase in population	750 Cr
4.	Indira Gandhi National Old Age Pension Scheme (IGNOAPS)		370 Cr
5.	Indira Gandhi National Widow Pension Scheme (IGNWPS)		74 Cr
6.	Indira Gandhi National Disability Pension Scheme (IGNDPS)		126 Cr
7.	Early Warning Dissemination Systems (EWDS) along Coastline		121 Cr
8.	Incentivised Stand Alone Houses - using Vernacular Techniques	Upgradation of Kutcha Houses	662 Cr
9.	Slum Rehabilitation (EWS area upto 30 sqm)	To avoid unauthorised occupation & houseless-ness (worst affected)	1451 Cr
10.	Replacement of wooden country craft with Fibre Reinforced Plastic boat		91 Cr
11.	Cycle with ice box		2 Cr
12.	Motor Cycle with ice box		3 Cr
13.	Auto rickshaw with ice box		16 Cr
14.	SHGs		10 Cr
15.	Odisha State Govt. Scheme for Housing Facilitation Centres		49 Cr
	TOTAL		**4274 Cr**

Results and discussion

Comparing Results with Similar Resilience Investments

Table 3: Comparing Results with Similar Investments

S.No.	Organisation	Total Investment	Parameters/ Components
1.	**World Bank** National Cyclone Risk Mitigation Project - Phase I (Odisha and Andhra Pradesh)	**$ 359 million** (US$1 = INR46.17 then) Rs. 1657 Cr **7 years** (2011- 2017)	a) EWDS b) Shelters c) Embankments d) Knowledge Creation - studies, assessments, training and capacity building activities e) Disaster Preparedness
2.	**World Bank** Andhra Pradesh Disaster Recovery Project (Andhra Pradesh)	**$250 Million** **5 years** (2015-2020)	a) Resilient electrical network b)Restoration of connectivity and shelter infrastructure c) Restoration and protection of the beach front d)Restoration of environmental services and facilities and livelihood support e) Capacity building and technical support for disaster risk management
3.	**World Bank** National Cyclone Risk Mitigation Project – Phase 2 (West Bengal, Kerala, Karnataka, Goa, Maharashtra and Gujarat)	**$ 387 million** **6 years** (2015- 2021)	a) Resilient coastal electrical connectivity b) strengthening emergency recovery capacity
4.	**World Bank** Coastal Disaster Risk Reduction Project (Tamil Nadu and Puducherry)	**$ 337.2 million** **5 years** (2013- 2018)	a) permanent houses b) evacuation shelters and routes c) resilient electrical networks d) curriculum development on disaster risk reduction for schools

Economics of Achieving Disaster Resilience

Reducing Disaster Risk and Enhancing Resilience through Financing

Often financing towards Disaster Resilience and Risk Reduction may not find significant reasons for integration into the economics of national development, since costs are unknown, projections and predictions may not be accurate, awareness and risk consciousness amongst the populace is low, and countries often focus on response and recovery more than resilience and reduction.

More importantly, the expectation of international aid at the time of crisis discourages frontline investment in Disaster Resilience and Risk Reduction. The opportunity costs may be unclear, and since the resilience benefits are long term, these may not materialize for years, thereby diverting funds to problems that need immediate resolution.

Therefore, it becomes essential to assess the economic benefits or losses of a budgeting/ financial model so as to gain confidence and direct the investments towards disaster resilience programs.

Conclusions

The research, based on the concept of gaining more from resilience than reconstruction, tries to build around the patterns and recurrence of extreme weather events, specifically cyclones in the Eastern Coast of India. While the state of Odisha is repeatedly struck by cyclones of varied intensity, it has been observed that devastating cyclones have wreaked havoc on the state in the past. Further, Odisha being amongst the poorer states of the country, the rural population lives primarily in kutcha houses or incorrectly implemented vernacular techniques. These houses often give way when encountered by cyclones, and are again constructed using the same techniques. While codes and regulations exist and speak widely of the vernacular, engineered, non-engineered and semi-engineered designs, there are hardly any means of making the knowledge accessible to these communities.

Housing in these communities is a significantly contributing factor to the safety of the population in these communities. As observed in the case examples of Cyclones and Recovery/ Disaster Risk Reduction programs funded by international bodies and banks, most investments are towards achieving infrastructural resilience, providing shelters and funding towards recovery and rescue operations. However, few speak of resilience of housing in communities.

The research builds upon these prompts, and an exhaustive list of indicators is derived, which encompasses the social, economic, structural and policy-level factors that make these communities vulnerable. These indicators are subject to ranking and impact assessment through an expert survey, using which a three-stage framework is developed.

Solutions are proposed for each indicator, corresponding to which a government scheme is identified, which makes the framework easily accessible, feasible, with validated data inputs, and urges external financing bodies to invest in these communities.

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