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Assessment of Urban Resilience as an Approach towards Urban Sustainability: A Case of Gurugram India.

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Abstract: ***Indian cities are complex and interdependent system, extremely vulnerable to threats from both natural risks and manmade disasters caused by the growing urban population, migration, depleting resources and terrorism. There are abundant evidences on resource consumption and emissions, biodiversity and land use change to show that Indian cities are responsible for a large part of unsustainable trends which push the planet beyond its ecological boundaries. With expedited urbanization, it becomes imperative to prioritise vulnerability assessment in order to increase resilience and thus attain sustainability. Recent studies indicate that the resilience framework is not consistent; they have either been applied in a natural resource context or focused on a single factor such as socio- economic vulnerability or structural weakness of physical components. Secondly, there is lack of resilience framework for developing nations or local contexts as the applicability of results from developed countries are problematic to instrument technically or theoretically at native scale. Given the diversity of interpretations and application of the resilience assessment in complex urban systems, this paper looks at factors and parameters that influence the Indian cities with major focus on Gurugram.(the third wealthiest city in India, by per-capital income with a massive population but such phenomena growth has overwhelmed city planning even with the availability of funds).The paper further explores the resilience assessment framework based on the five defined and measurable domains including social (education equity, transportation access, health coverage, communication capacity), economic (employment, income, housing capital), institution (migration plan, flood coverage, political fragmentation by Indian institutions such as National Institute of Urban Affairs (NIUA), physical (e.g. water, sanitation, housing and land use), spatial (elevation, spatial and temporal indicators), human (e.g. literacy rate, health insurance) and Environment (e.g. ecosystem services, environmental policies).Various case examples are used to suggest that urban resilience can be conceived as a multidisciplinary framework to analyse the reactive, adaptive and transformative capacities of (and within) the complex urban system of Indian cities.***

Keywords: Urban Resilience, Urban Sustainability, Multidisciplinary Framework, Social Equity, Adaptability.

I. INTRODUCTION: RESILIENCE

The term ‘resilience’, roots in disciplines such as physics, psychology and ecology and has been widely used in scientific and political discourse on sustainable development and urban disaster reduction. The origins of the concept of resilience are nebulous and controversial according to the literature. Part of that is keen on identifying its first employment in the field of psychology and psychiatry, linking resilience to Norman Garmezy, Emmy Werner and Ruth Smith. Interestingly, more recent researches highlighted probable previous uses of the concept, dating back till the first century B.C. in the poem “Nature of Things” by Lucretius. In contrast to this view, Alexander identifies its origins in the Classical literature by noteworthy authors such as Seneca the Elder, Pliny the Elder, Ovid, Cicero and Livy .From an etymological viewpoint resilience finds its root in the Latin verb “resilīre”, meaning “to jump back”.

Resilience is a multi-disciplinary and complex concept, hence its analysis and formulation cannot leave aside some related notions such as vulnerability, adaptive capacity and recoverability, especially concerning the built environment issue in face of disruptions. In contrast, the term ‘vulnerability’ tends to characterize in negative terms as a system (for instance, economic sector, city, infrastructure, population) that incapable to cope with contrary effects (Romero Lankao & Qin, 2011). The urban vulnerability research is mainly focused on general environmental change such as political economy, natural stressors and ecological resilience (O’Brien et al., 2009). The studies conducted in the past attempted to answer why and how urban populations are vulnerable, but these researches did not account how to experience and influences from varying stressors work (Parnell et al., 2007; Satterthwaite et al., 2007; Pelling, 2011).

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Later, according to Romero-Lankao and Romero Lankao and Qin (2011) viewed urban vulnerability as an active practice grounded on the incapability of a municipal to manage with stressors which directed to the evolving tender of resilience science. Resilience, on the other hand, reflects a change from vulnerability to response capacity building. Yet, the concept has mainly discussed in related to climate change adaption and disaster management perspective rather than addressing wider sustainability challenges. Therefore, researchers have called to address urban resilience beyond climate change focusing on the holistic approach (Ostadtaghizadeh et al., 2015) .

Cities are an interdependent and complex system, tremendously vulnerable to fears from both natural risks caused by a growing urban population, high population density and terrorism. These made cities to rethink how people and infrastructure are protected and prioritized and climate will affect long terms growth and development, the city of Gurgaon, the third wealthiest city by per-capital income with a massive population but such phenomena growth has overwhelmed city planning even with the availability of funds. (Sahu et al., 2015) The links between poverty and exposure sensitivity attributes are more nuanced in Gurgaon hence much more vulnerable. This city has witnessed enormous change in the last two decades thanks to the proximity to Airport and other economic drivers. The study of resilience keeping in mind the complexity of the urban systems is much needed here. In comparison to any other Indian cities, the transportation system and urban infrastructure and overall quality of life (social inequality, unsafe environment, non-existent public realm) have been below par (Sahu et al., 2015).

A study is required particularly in the Gurgaon's millennium city in demand to drive the research for urban resilience and drill a step onward by: initially implementing an method concentrated on larger stresses and scale shocks, and flowing effects through multiple scales as well, comprising circumstances wherever trade-offs in resilience might happen, and then emphasizing the statement that resilience per se is not the aim in efforts in the direction of sustainability, and that resilience in a specific situation may not continuously share the progressive associations of sustainability. Understanding resilient in import ant as emphasized by the Godschalk (Godschalk, 2003), a resilient city as a capability of surviving and functioning even under extreme stress owing to a supportable network of human groups and physical systems.

II. URBAN RESILIENCE AS AN IMPORTANT DEVELOPMENT IMPERATIVE

Half of humanity i.e about3.5 billion people live in cities today and by 2030, 60% of the world's population will live in urban areas. The pace of urban growth transformation of global land use is staggering. It is estimated that 1.4 million persons move into urban areas every week. From 2000 to 2030, urban expansion is accelerating 27 fold as compared to 1970-2000 and is expected to add 1.2 million square kilometres, an area equivalent to the entire surface area of South Africa (NAS, 2012). Most of this expansion, nearly 95% - will occur in developing countries, and will be characterized by informal and unmanaged growth (OECD, 2017).

Urbanization has the potential to lift people out of poverty and increase prosperity. Large cities generate about 75% of global GDP today and will generate 86% of worldwide GDP growth between 2015 and 2030 (Woetzel, 2016). Population growth and rising per capita income are key drivers, accounting for 58 % and 42 % of growth among large cities between 2000 and 2012 (Woetzel, 2016). Rapid urbanization and unmanaged growth, however, tend to generate unsustainable land use, which is nearly impossible to change after a city grows. It is also associated with high levels of population exposure, especially for the poorest segments, to chronic stresses and shocks including environmental shocks (e.g., floods and earthquakes) and social stresses and shocks (e.g. crime and violence, conflict induced population influx).

The urban poor are disproportionally affected by chronic stress and shocks. By 2030, an estimated 325 million extreme poor will be living in the 49 countries most prone to disasters, and they will disproportionately suffer from shocks (Shepherd, et al. 2013). In these countries, the poorest and most vulnerable will live in the most exposed areas–often in informal settlements on the edge of cities –that have poor access to early warning or adequate infrastructure (ODI, 2016). Efforts to reduce poverty and disaster risks are complementary. Estimates for 89 countries find that if all natural disasters could be prevented next year, the number of people in extreme poverty those living on less than $1.90 a day would fall by 26 million (World Bank, 2017). These risks can undermine sustained economic growth and social progress.

III. COMPREHENDING THE RESILIENCE FRAMEWORK

Based on the reviewed literature, it is perceived that the present research of Resilience framework is still uneven (Cerè et al., 2017). Resilience, in general, is widely considered as a system's capacity to proactively adapt to external disturbances and recover from them. However, the existing resilience framework research is still quite fragmented and the links behind various studies are not straightforwardly accessible.

This is because studies either applied Resilience Assessment in a natural resource management context and or focused on a single factor such as socio-economic vulnerability(Cutter et al., 2003; Kusumastuti et al., 2014; Carreño et al., 2012; Salgado-Gálvez et al., 2016; Frigerio et al., 2016) or structural weakness of physical components (Cimellaro et al., 2010; Gülkan & Langenbach, 2004). Yet, there is a lack of holistic studies accounting for applying it to urban areas. The paper by Koren et al. (2017) proposed urban system resilience from the perspective of four basic components which affect the system in the circumstance of a usual disaster such as structure, Open space, buildings and community or could be broadly grouped into two basic components including physical and social. Refer to table:1 for disparity in the way resilience models have been used in the literature for assessment of resilience to natural hazards.

Furthermore, a study done by Tyler and Moench (2012) develops a framework which incorporates empirical and theoretical knowledge of the aspects contributing to resilience with procedures for transforming those ideas into exercise. The framework contains urban systems characteristics, institutions that relates agents and systems, the agents (organizations and people), and patterns of experience to climate change. Moreover, a paper Yoon et al. (2016) develops a methodology for assembling a set of indicators determining Community Disaster Resilience Index (CDRI) in relation to social, human, economic, institutional, and environmental factors. Moreover, a paper discusses for an improved prominence on the institutes of management and risk governance in understanding the urban resilience. This moves the study of vulnerability away from attention on individuals to also deliberate risk management rules as co-productive of vulnerability and resilience in the City (Zaidi & Pelling, 2015).

For instance, the study Romero-Lankao et al. (2016) applied a framework of livelihood to illustrate the households in urban Mumbai by the assets and also utilised fuzzy logic approach with an logical order procedure to inspect the effect of exposure, poverty, capacity, and sensitivity on vulnerability. On a similar note, the study by Yenneti et al.(2016) established a composite urban vulnerability index (CUVI) grounded on 13 pointers that form the vulnerability in the urban society and findings shed light on a substantial concentration of social vulnerability in Asian and central States. DasGupta and Shaw (2015) developed a five-dimensional community resilience framework by assessing 19 coastal communities resilience against climate-related disaster in Indian Sundarbans. The author used a systematic questionnaire to survey officials and found the extreme coastal blocs were less resilient. Kumar et al. (2016) conducted a climate change vulnerability study in Bangalore considering three mechanisms, sensitivity, exposure, and adaptive capacity using Spatial Multi-Criteria Evaluation (SMCE). Findings showed that about 91% of the zone is experiencing a high degree of climate vulnerability.

Table 1: Comparison of the different models used for Resilience Assessment in Literature over a decade.(source: compiled by the author)

Index/Model	First Author	Year Published	Study location	Hazard Approach	Methodology of tool development /participatory process	Domains & no. of indicators
Coastal Community Resilience (CCR)	Coutney CA	2008	Indian Ocean region (Thailand,Srilanka,India,Indonesia and the Maldives	Coastal Hazard	Participatory Process Working	Governance (4), Society & Economy (4), Coastal Resource Management (4), Land Use & Structure Design (4), Risk Knowledge (4), Warning and Evacuation (4), Emergency Response (4),Disaster Recovery(4)
Climate Disaster Resilience	Shaw R	2009	Nine cities from Different	Climate Induced Hazards :	Unclear	Natural(2), Physical(8), Social (5),Economic (6) , Institutional(4)

Index (CDRI)			Asian Countries	cyclones, floods, heat wave, drought, landslides		
	Parvin GA	2011	Bangladesh , Dhaka City			Natural(5), Physical(5), Social (5), Economic (5), Institutional(5)
	Jorein J	2012	India, Chennai			Natural(5), Physical(5), Social (5),Economic (5), Institutional(5)
	Prashar S	2012	India ,Delhi			Natural(5), Physical(5), Social (5),Economic (5), Institutional(5)
Baseline Resilience Index for Communities (BRIC)	Cutter SL	2010	USA, Fema Region IV	Multihazard	Disater Resilience of Place (DROP0	Social (7),Economic (7), Institutional(8), Infrastructure (7), Community Capital (7)
Modified Baseline Index for Comminities (BRIC)	Hiete M	2012	Germany	Multi Hazard	Trapezoidal Fuzzy DEMATEL	Social (7),Economic (7), Institutional(8), Infrastructure (7), Community Capital (7)
PEOPLES	Renschier CS	2010	USA, New York	Unclear	Unclear	Population & Demographics, Environmental Ecosystem, organised Governmental Services, Physical Infrastructure, Lifestyle & Community Competence , Economic Development, Social – Cultural Capital.
Climate Disaster Resilience Index (CDRI)	Mayunga JS	2013	USA Texas	Coastal Hazards	Theortical framework Matrix	Social Capital (9), Economic Capital (6), Human Capital (25), Physical Capital (35), Natural Capital (10)
Community Resilience Index (CDI)	Kafle SK	2012	Indonesia	Coastal Hazards	Unclear	Process (10), Outcome (25)
Conjoint	Cohen	2013	Isreal	Emergencies	Literature	unclear

Community Resiliency Assessment Measure (CCRAM)	O				reviews and DELPHI	

Each model is developed in theoretical or conceptual isolation from the others. Thus while there is some overlap in domains/content, differences are also present. For example, the social domain in the BRIC and Climate-DRI, but this is excluded from the Community-DRI . The models can also be differentiated with regard to the domain names and how variables are distributed between them. They also mix demographic (e.g., education, disability) and structural characteristics (land use, housing type) with social and psychological (e.g., social capital) characteristics.

The diversity evident in the above table:1 highlights a need for the development of a common conceptual or theoretical framework from which systematic study can develop. In the absence of the latter, the confusion over the use of the term and how it is assessed and developed will continue.

The models can also be criticized for the lack of inclusion of specific social and psychological factors (e.g., self- and collective-efficacy, sense of community) that have been empirically demonstrated to influence adaptation. The models are also lacking in attempts to quantify the relationships and inter dependencies between variables and particularly between levels of analysis. For example, in the BRIC it could be hypothesized that levels of education and communication capacity could predict levels of political engagement, civic involvement and advocacy

IV. RESILIENCE & INDIAN CITIES

In India, there are few studies that addressed resilience, but all these studies have looked at vulnerability from the socio-economic aspects. Secondly, the recent systematic review, studies had identified a number of challenges in the development of resilience indicators including (1) selection of the input (2) standardization of data (3) criteria weights determination (4) understanding relationship between (5) aggregation of criteria (6) validation of results and finally conducting uncertainty and sensitivity analyses (Beccari, 2016; Rufat et al., 2015). Thirdly, these studies failed to account spatial indicator as part of their framework (DasGupta & Shaw, 2015) nor used robust analyses such as FDM, ANP or DEMATEL method to quantify and weight interdependent and multiple domains and indicators. Fourthly, Finally, not much attention has been paid to the multiple stakeholder participation in the development of the framework (de Brito & Evers, 2016). Finally, although CPDP under the UNDP flagship has conducted an awareness campaign at the local level Campaigin (2019), that's not sufficient to address the sustainability. There is a lack of vulnerability / resilience framework at the local level as the applicability of results from developed countries, or developing countries are problematic to instrument technically or theoretically at the native scale. Besides, the concept of CDR is still not been clearly conceptualized and assessed (Ostadtaghizadeh et al., 2015).

With this background, the proposed study develops natural disaster resilience assessment framework based on the five defined and measurable domains including social (e.g. education equity, transportation access, health coverage, communication capacity), economic (e.g. employment, income, female employment, housing capital), institution (e.g. migration plan, flood coverage, political fragmentation by Indian institutions such as National Institute of Urban Affairs (NIUA), physical (e.g. water, sanitation, housing and land use), spatial (elevation, spatial and temporal indicators), human (e.g. population with more than high school education, health insurance) and Environment (e.g. ecosystem services, environmental policies). The proposed study will use a combination of fuzzy Delphi method and Analytic Network process technique (Guleria & Edward, 2012) or Trapezoidal Fuzzy DEMATEL or the PEOPLES and CCRAM method to identify

V. CONCLUSIONS

Resilience can have desirable and undesirable consequences. Thus, resilience cannot be viewed as a normative desirable goal, but as a descriptor of complex systems dynamics. A shared or common definition of the concept and how it can be measured is required to provide the foundation for the development of the concept and to guide research. The concept has mainly discussed in related to climate change adaption and disaster management perspective rather than addressing wider sustainability challenges. Therefore, researchers have called to address urban resilience beyond climate change focusing on the holistic approach .

There are clear gaps in the knowledge and technology that need to be addressed for the advancement of spatial resilience theory and its application. Integrating adaptation and mitigation response actions to climate change in urban-level policies requires comprehensive information on vulnerability patterns, yet a majority of local governments and decision makers in various cities in developing nations lack spatially explicit information on climate change vulnerability and its key drivers. Although we are in the era of 'big data',we rarely have data of sufficient temporal and spatial extent or resolution for comprehensively understanding system dynamics – this is especially true for temporal data. The lack of agreement on how the resilience concept translates into a measurable framework creates problems not only with regard to the practical implementation of resilience within at-risk communities, but also for systematic research and the development of policy.

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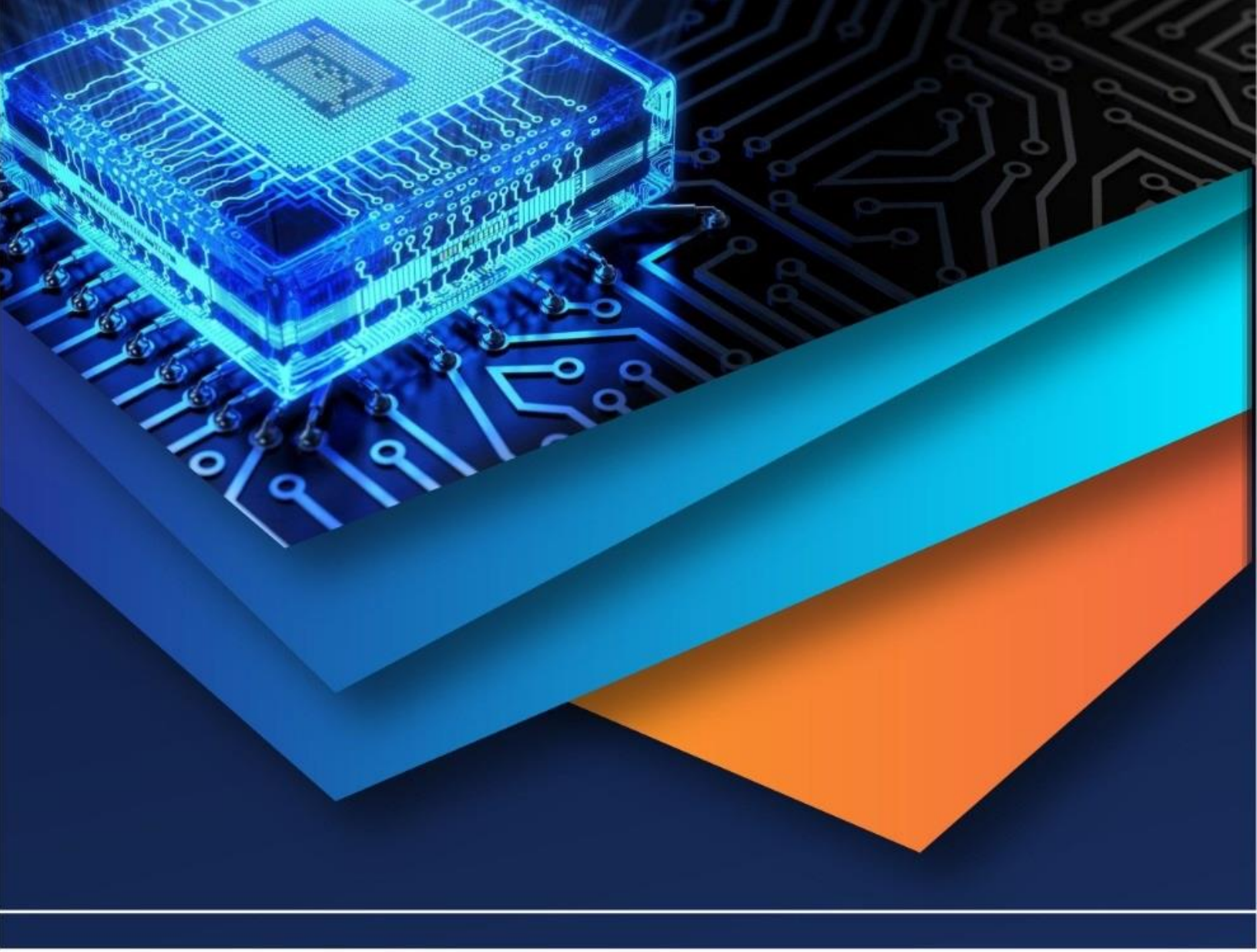

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