

Making Cities Resilient Towards Disasters and Climate Change

Shipra Panwar¹ and D. R. Sahu²

ABSTRACT

India is one of the world's major theatres of disasters both natural and human induced. India's geo-climatic conditions as well as its high degree of socio-economic vulnerability make it one of the most disaster prone countries in the globe. The country is highly vulnerable to floods, droughts, cyclones, earthquakes, landslides, avalanches and forest fires. Out of 28 states and 9 union territories in the country, 27 of them are disaster prone and about 60 cities and towns are found located in seismic zones which show high vulnerability while many cities/towns are located nearby coastal area and are susceptible to cyclones. About one fourth urban population resides in informal settlements and slums which are highly vulnerable to natural disasters. Urban centres are witnessing frequent natural disasters mainly flooding as result of natural and human factors. The lack of proper urban drainage, appropriate urban strategic planning and futuristic vision are also causing disasters in urban centres. Thus, it is the imperative need for mainstreaming disasters and climate change into the urban development plans, mission mode urban development schemes and making cities resilient towards disasters and climate change. Against this backdrop, present paper purports to examine the disaster vulnerability, policy perspective and urban resilience in India. The paper is based on secondary data and pertinent literature.

Key Words: *Disaster Management, Climate Change, Urban Resilience, Urban Flooding*

Introduction

India is one of the major countries which witness natural and human induced disasters very frequently. Floods, droughts, cyclones and earthquakes cause severe loss to human lives and physical resources. Communal riots, ethical conflicts, fires, epidemics, accidents, terrorism and insurgency led disasters compound the country's chronic troubles. The social and economic progress achieved over decades can be significantly devastated and degraded by the disasters (Singh, 2014). Government alone cannot manage disasters, hence corporate houses, private entities and civil society organized agencies have been

¹ *Post Doctoral Fellow (ICSSR), Deptt. of Sociology, University of Lucknow, Lucknow*

² *Professor, Department of Sociology, University of Lucknow, Lucknow*

making efforts to mitigate and prevent disasters. India is one of the world's major theatres of disasters. The continent of Asia is vulnerable to disasters strikes and within Asia, 24 percent of deaths due to disasters occur in India. Floods and high winds account for 60 percent of all disasters in India. About 54 percent of sub-continent's landmass is vulnerable to earthquake. As per seismic atlas, 58 cities/towns are situated in zone five, four, and third which are more vulnerable towards seismic activities. Since 1988 six major earthquakes have struck different parts of the country. Out of 28 states, 22 states are multi-disaster prone. About 40 million hectares of land in the country has been identified as flood prone with average 18.6 million hectares of land flooded annually. About 18 percent of country's total land is drought prone. About 50 million people are annually affected by droughts and 68 percent of the total sown area is drought prone. Indian Ocean is one of the six major cyclonic prone regions of the globe. Coromandel coastline in eastern coastal region is more cyclones prone and generated 80 percent of total cyclones in this region. Planning and strategising disaster management focused on risk reduction, faces a range of challenges especially those related to estimation and quantification of costs and benefits, and the changes over temporal and spatial scales (Gupta. et. al, 2010). There are three elements of disaster mitigation viz. risk management, prevention and preparedness. Functional structure of disaster mitigation involves three elements i.e. rehabilitation, prevention and response. Response to disaster includes multiple independent organizations. Community-based organizations and NGO's have to play a crucial role in disaster management. Disaster management involves many steps and stages. Generally, it has three major stages viz. planning for prevention and mitigation; disaster response and relief; and rehabilitation and reconstruction.

Urbanization and its Implications

Urbanization is a global phenomenon experienced by developed as well as developing countries. There is migration from villages to towns and cities with results in growth of metropolitan cities since they provide multiple avenues, services and amenities viz. education, health care, employment, business and entertainment options etc. People also migrate for economic opportunities and urban life styles. Though urbanization brings about development in social, economic and cultural spheres of life, it sometimes disturbs the ecological systems. Rapid and unplanned growth of urban agglomeration generates a series of negative environmental effects. Today urban India presents a very pathetic scene. Cities have become a site of rotting garbage, degrading drainage system and shocking night soil removal system. India's life line is in danger. Many Indian rivers are heading towards an environmental disaster due to discharging of untreated sewage into water bodies. Besides, poor have practically no access to sanitary toilets and in many towns and cities, the

majority defecate in the open. The untreated sewage being dumped into the river and water bodies leads to health hazards.

As per 2011 census, 377.5 million populations, constituting 31.16 percent of the total population of the country is residing in 7935 cities and towns. About 2/3rd of its urban content are found concentrated in Class-I towns i.e. towns with more than 1 lakh population. Four mega cities viz., Mumbai, Kolkata, Delhi and Chennai with a population of more than 6 million in each, account for almost 1/4th population living in cities. Urban population of India is likely to increase by 590 million, constituting about 40% of total population by the year 2030. Increasing urbanization, expansion of habitat into unsuitable vulnerable areas, higher population density, higher housing density, vulnerable housing and buildings constructions, non-engineered unsafe construction and ageing buildings and other infrastructures are some of the facts that have increased vulnerability of hazards and disasters in urban areas. Human induced disasters such as road accidents, fires, bomb blasts, stampede, collapse of the building, bridges, etc. are also concentrated in urban areas. Climate change has also its implications on natural disasters with increased impact on urban life, services and infrastructure. Urbanization is critical to the development of country. About 31.2 percent of India's population resides in urban centers which account for about 377 million persons in absolute term. The urban population of India is likely to increase by 590 million, constituting about 40 percent of total population by the year 2030 (Table 1).

Table 1: Urbanization in India

Year	Population (Million)		Urbanization Rate (%)
	Total	Urban	
1991	856	220	26
2001	1040	290	28
2008	1155	340	30
2030	1470	590	40

Source: McKinsey, 2010

India will have the largest growing work force for the next 20 years, as 270 million Indians will join the working age population by the year 2030. Job growth in cities will be for more robust, growing at around 3.6 percent annually increasing from around 100 million today to 220 million in 2030. Cities will account for 70 percent of all new jobs created in India during 2010 to 2030 (McKinsey, 2010). Cities provide benefits beyond their own boundaries. McKinsey (2010) in its report has pointed out that 180 million people who live close to cities were benefited with the economic opportunities, markets and the connecting infrastructure in the urban centers. These people were assumed to

live in rural areas next to the about 70 largest urban centers in India. India will have 68 cities by 2030 with population of more than one million, compared with the figure of 35 in 2001. Similarly, the number of urban centers is likely to increase by 6000 in 2030. However the concentration of urban population is still in larger cities. About 57 percent of urban population of the country resides in the urban centers, comprising of less than one million populations (Table 2).

Table 2: Population Size wise Urban Population of India

Classification of Urban Centers	2008	2030
Tier-I (More than 4 Million)	93 (27.0)	155 (26.0)
Tier-II (1 Million to 4 Million)	52 (15.0)	104 (18.0)
Tier-III & IV (Less than 1 Million)	195 (57.0)	331 (56.0)
Total	340 (100.00)	590 (100.00)

Source: McKinsey, 2010

Increasing urbanization, expansion of habitat into unsuitable vulnerable areas; higher population density, higher housing density, vulnerable housing and buildings construction; non engineered unsafe construction; and ageing buildings and other infrastructure are some of the factors that have increased vulnerability of hazards and disasters in urban areas. Thus, disaster risk management includes measures which reduce disaster related losses of life, property or assets by either reducing the hazard or vulnerability of the elements at risk. Disaster management is conceptualized as the body of policy and administrative decisions and operational activities which pertain to the various stages of a disaster at all levels. Broadly disaster management can be divided into pre-disaster and post-disaster contexts (Rai and Singh, 2009). There are three key stages of activity that are taken up within disaster management. They are (i) pre-disaster-mitigation, prevention, preparedness, risk assessment; (ii) during a disaster-emergency response, relief distribution, search and rescue, shelter, medical and trauma care etc., (iii) post disaster-rehabilitation and reconstruction of disaster affected persons and areas.

An urban environment is complex primarily because of rapidly changing variables such as socio- economic and demographic indicators, land-use patterns, resource demand and utilization patterns, lifestyle changes etc. In the light of climate change, a new layer of uncertainty is added in terms of changes in precipitation, temperature and occurrence of extreme events (Singh, 2014). Urbanization is posing numerous challenges for city administrators, planners and policy makers, of which urban floods are increasingly becoming an important challenge. Urban floods are a result of inadequate or poor maintenance of storm water drains, improper planning, encroachment on drains and water bodies, occupation of low lying areas, modification of catchments and climate change.

Furthermore, there are scale mismatches; in terms of the timescales over which policy makers and urban planners operate, and scales over which projected impacts of environmental decisions, degradation, climate variability and change will manifest. Also policies and developmental initiatives in cities should enable urban systems to adjust to changes as and when they happen and accordingly respond in a way that maintains their original structure and function. Key policies, programmes and initiatives of the Government of India that offer several entry points for mainstreaming resilience, adaptation and mitigation within the urban sustainable development agenda have been discussed in this paper. In 2008, India announced the National Action Plan on Climate Change (NAPCC) listing eight priority areas for adaptation and mitigation action. Of these Missions, it is the National Mission on Sustainable Habitats (NMSH) that directly focuses on urban areas. Another important Mission by the Government of India is the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) that was launched in 2005 and was made operational till 2012. JNNURM offered numerous entry points for sustainability and climate resilience and its primary aim is to create economically productive, efficient, equitable and responsive cities. India's cities are increasingly feeling the impact of climate change and recognizing the need for adaptation as well as resilience in these urban spaces. Urban development had not been a priority for India, a country that relied heavily on rural and agricultural related economic activities. This changed in 2005, when finances were allocated to Indian cities under the Jawaharlal Nehru National Urban Renewal Mission (JNNURM). After several separate initiatives and schemes to address urban problems and several five year plans, JNNURM emerged as a flagship scheme, which adapted reform based funding approach that could help ULBs receive funds for infrastructure development and basic services for urban poor whilst updating their own capacities and systems by implementing mandatory reforms. However, JNNURM did not look at climate change as one of the priority areas for the cities, which was quite understood considering contemporary challenges in Indian cities verses knowledge of climate change impacts that was not clear, uncertain and looked distant. It was only recently when the National Action Plan for Climate Change was released that a separate mission on cities and climate change looked at the issue in an integrated manner. The government made provisions for developing seismic resistant urban infrastructure and sustainability of municipal services, including sanitation services under AMRUT, Smart City Mission, Swachh Bharat Mission, Namami Gange, Prime Minister Housing for All and HRIDAY while government has emphasised on capacity building and urban resilience.

Policy Perspective

Over the past two decades, there has been an increase in disaster occurrences costing human and economic losses. This is due to the ever increasing vulnerabilities of people to natural disasters. The need is felt to reduce disaster

risks by improving capabilities of people and ensuring preparedness, mitigation and response planning processes at various levels. The objective is to look at the entire cycle of disaster management in reducing risk and linking it to developmental planning process. In the past, disasters were viewed as isolated events, responded to by the Governments and various agencies without taking into account the social and economic causes and long term implication of these events. In short, disasters were considered as emergencies. The recent disasters and its socio-economic impact on the country at large, and in particular the communities has underscored the need to adopt a multi dimensional approach involving diverse scientific, engineering, financial and social processes to reduce vulnerability in multi-hazard prone areas. In view of this, the Government of India has brought about a paradigm shift in its approach to disaster management. The change is from “relief and emergency response” to a balanced approach covering all phases of the Disaster Management Cycle. The approach acknowledges disaster management as a part of the development process, and investments in mitigation are perceived to be much more cost effective than relief and rehabilitation expenditure. In this regard, Government of India has taken various initiatives in area of disaster preparedness, mitigation and response through networking of various institutions, institutional capacity building, and policy interventions at all levels.

Community participation and community ownership risk reduction is one of the key factors in reducing vulnerabilities of people and minimizing the loss. The Government of India’s focus Community Based Disaster Preparedness (CBDP) approach promotes community involvement and strengthening of their capacities for vulnerability reduction through decentralized planning process. This document deals with the concept, component and some of the best practices in India. Disaster Management is the responsibility of the states, with the Central Government playing a supportive role. The basic responsibility for undertaking rescue, relief and rehabilitation measures in the event of natural disasters is that of the state governments concern, particularly the district administration. The role of Central Government is supportive in terms of supplementing physical and financial resources and complementary measures in sectors such as warning, transport and inter-state movement of staple foods. Ministry of Home Affairs, Government of India is responsible for coordinating relief operations during natural disasters. The Ministry receives early warnings and forecast from the Indian Meteorological Department and Central Water Commission on a continuing basis. Other Ministries, Departments and Organizations, with primary and secondary functions for disaster management, constitute a Crisis Management Group. A Nodal Officer, nominated from each Ministry or Department is responsible for preparing a sectoral action plan or emergency support function plan for disaster management.

India has vast network and strong policy and legal framework of disaster management at national, state and district level. National Disaster Management Authority (NDMA) was constituted under the Disaster Management Act of 2005 to draft policies and guidelines on disaster management, approval and coordination the implementation of plans for disaster preparedness and management at the Central, state and ministerial levels. The authority is headed by the Prime Minister. However, the authority has been ineffective in carrying out most of its functions. The Act also ensures measures by the various wings of the Government for prevention and mitigation of disasters and prompt response to any disaster situation. The Act also provides for setting up of a State Disaster Management Authorities (SDMAs) under the Chairmanship of the Chief Ministers and District Disaster Management Authorities (DDMAs) under the Chairmanship of Collectors/District Magistrates/Deputy Commissioners. The National Disaster Response Force (NDRF) has been constituted by up-gradation/conversion of eight standard battalions of Central Para Military Forces. National Disaster Response Fund has been created under Section 46 of the Disaster Management Act, 2005 for meeting the expenses for emergency response, relief and rehabilitation due to any threatening disaster situation or disaster. NDRF is constituted to supplement the funds of the State Disaster Response Funds of the states to facilitate immediate relief in case of calamities of a severe nature. Most of the states are largely lethargic in creating a disaster response mechanism as mandated by the Disaster Management Act of 2005. A few states have dedicated separate full-fledged department of Disaster Management, State Policy and Disaster mechanisms. There are grossly inadequate institutional arrangements and dedicated funds for training and capability building of representatives and officials of local governments for disaster management, though these bodies are playing crucial role in disaster management.

The objectives of the National Policy of Disaster Management are:

- To promote a culture of prevention, preparedness and resilience at all levels through knowledge, innovation and education;
- To encourage mitigation measures based on technology, traditional wisdom and environmental sustainability;
- To mainstream disaster management into the developmental planning process;
- To establish institutional and techno frameworks to create an enabling regulatory environment and a compliance regime;
- To ensure efficient mechanism for identification, assessment and monitoring of disaster risks;

- To develop contemporary forecasting and early warning systems backed by responsive and fail-safe communication with information technology support
- To ensure efficient response and relief with a caring approach towards the needs of the vulnerable sections of the society;
- To undertake reconstruction as an opportunity to build disaster resilient structures and habitat for ensuring safer living;
- To promote a productive and proactive partnership with the media for disaster management.

The Prime Minister, Shri Narendra Modi gave Ten-Point Agenda in at the Asian Ministerial Conference on Disaster Risk Reduction, 2016, at New Delhi which has also been incorporated in the NDMP. The ten key elements consist of the following:

- All development sectors must imbibe the principles of disaster risk management;
- Risk coverage must include all, starting from poor households to SMEs to multi-national corporations to nation states;
- Women's leadership and greater involvement should be central to disaster risk management;
- Invest in risk mapping globally to improve global understanding of Nature and disaster risks;
- Leverage technology to enhance the efficiency of disaster risk management efforts;
- Develop a network of universities to work on disaster-related issues;
- Utilise the opportunism provided by social media and mobile technologies for disaster risk reduction. Build on local capacity and initiative to enhance disaster risk reduction;
- Make use of every opportunity to learn from disasters and, to achieve that, there must be studies on the lessons after every disaster;
- Bring about greater cohesion in international response to disasters.

National Cyclone Risk Mitigation Project

The Government of India was approved NCRMP Phase-I for Andhra Pradesh & Odisha in January 2011 to address the vulnerability of the coastal community to cyclones, who are generally poor and are from the weaker section of the

society. The project aims at minimizing the vulnerability to the cyclone and making people and infrastructure disaster resilient. The NCRMP Phase-II was approved for implementation in the States of Goa, Gujarat, Karnataka, Kerala, Maharashtra and West Bengal during July, 2015.

Arpad Mitra Scheme

The NDMA has approved a Centrally Sponsored Scheme focusing on training community volunteers in disaster response in the 30 most flood-prone districts of 25 states in India. The aim of the scheme is to train community volunteers with the skills that they would need to respond to their community's immediate needs in the aftermath of a disaster, thereby, enabling them to undertake basic relief and rescue tasks from emergency situations such as floods, flash floods, and urban flooding, when emergency services are not readily available.

Sustainable Reduction in Disaster Risk

In order to build the capacity of the most hazardous districts in the most vulnerable states, the Government of India has launched a project on sustainably reducing disaster risks in selected districts. The project aims at strengthening community and local self-government's preparedness and response in the ten most multi-hazard vulnerable districts, two each in five identified states of Uttarakhand, Assam, Bihar, Himachal Pradesh and Jammu & Kashmir.

MRDS

Mobile Radiation Detection Systems (MRDS) is introduced to handle Radiological Hazards in Metros/Capital Cities/Big Cities in India envisages to detect unclaimed radioactive materials/substances and save public from its hazardous effects, NDMA has chalked out a plan to provide States/UTs Mobile Radiation Detection Systems to be deployed in Metros/all Capital Cities and Big Cities in India and also train personnel as 'Trainer of Trainers'.

LRMS

Landslide Risk Mitigation Scheme (LRMS) envisages financial support for site specific Landslide Mitigation Projects recommended by landslide prone States, covering "disaster prevention strategy, disaster mitigation and R&D in monitoring of critical Landslides" thereby leading to the development of Early Warning System and Capacity Building initiatives. The Scheme is under preparation.

FRMS

Flood Risk Mitigation Scheme (FRMS) covers activities like (a) Pilot Projects for development of model Multi-Purpose Flood Shelters and (b) Development of

River Basin specific Flood Early Warning System and Digital Elevation Maps for preparation of Inundation Models for giving early warning to the villagers for evacuation in case of flood. Under the Scheme, financial support is to be provided to the Flood prone States for undertaking pilot scheme in respect of above two activities. The Scheme is under preparation.

NERMP

National Earthquake Risk Mitigation Project (Preparatory Phase) has been approved as a Centrally Sponsored Plan Scheme with to be implemented within a period of two years (2013-15). The main activities of project included techno-legal regime; institutional strengthening; capacity building of practicing architects, engineers and masons in earthquake resistant construction techniques; and public awareness and sensitization at national level and all vulnerable states.

Urban Flooding

Urban centres are witnessing frequent flooding by different types like river floods, flash floods, coastal floods, release of excess water from reservoir or failure of dam on the upstream side, increase in intensity of rainfall, blockage of drainage system due to silting, dumping of waste material at the inlets of drainage, encroachment over natural drainage, shrinking of water bodies etc. It has large economic and social impacts. The man-made causes are responsible for recurring and prolonged floods in cities like Mumbai, Chennai, Bangalore, Kolkata, Ahmadabad, Surat, Patna, Jamshedpur, Gurgaon etc. Floods result from the overflow of land areas, temporary backwater effects in sewers and local drainage channels, creation of unsanitary conditions, deposition of materials in stream channels during flood recession, rise of groundwater coincident with increased stream flow, and other problems. In most of the cities the sewerage and drainage network is old while the condition of sewerage system is found to be poor. The local governments cannot cope with the volume of increasing water. Urban flooding is also caused by heavy rainfall due to climate change. Urban flooding has large economic and social impacts. Urban floods are a great disturbance of daily life in the city. Roads may be blocked for hours; people are struck in their houses or workplaces. The urban infrastructure and service delivery mechanism gets badly affected due to urban flooding.

Increasing trend of urban flooding is a universal phenomenon and it poses a great challenge to city administration and urban planners across the globe. Problems associated with urban floods range from relatively localized incidents to major incidents, resulting in cities being inundated from a few hours to several days. Therefore, the impact can also be widespread, including temporary relocation of people, damage to civic amenities, deterioration of

water quality and risk of epidemics. The problems posed by urban flooding are quite challenging and aggravate with continuous climate change, with its adverse impact affecting variation in rainfall and intra-city /intra-region disparities in the distribution of rainfall. The National Disaster Management Authority (NDMA) an apex Body of Government of India with a mandate to lay down policies for disaster management decided to deal with urban flooding separately. In 2008, it formed a committee on urban floods which formulated the National Guidelines for Management of Urban Flooding. The guidelines on management of urban flooding, issued by the (NDMA) expert panel were released in September, 2010. The important action points and recommendations are as follows (NDMA, 2010):

- The Central Water Commission should maximize the real-time hydro-meteorological network to cover all urban centres to effectively deal with the problem of urban flooding;
- Use of *Doppler Weather Radars* to be expanded to cover all urban areas in the country;
- An inventory of the existing storm water drainage system to be prepared.
- Catchment to be the basis for planning and designing the storm water drainage systems in all ULBs;
- All future road and rail bridges in cities crossing drains to be designed in such a manner that they do not block the flows resulting in backwater effect;
- Every building in urban area must have rainwater harvesting as an integral component of the building utility;
- Low-lying areas in cities have to be reserved for parks and other low-impact human activities;
- Encroachments on the drain should attract penal action;
- Pre-monsoon desalting of all major drains to be completed by March 31 each year;
- Urban Flooding has to be dealt as a separate disaster, de-linking it from riverine floods which affect the rural areas;
- Suitable interventions in the drainage system like traps, trash racks can be provided to reduce the amount of solid waste going into the storm sewers;
- Inlets to be provided on the roads to drain water to the roadside

drains and these has to be designed based on current national and international practices;

- Every building in an urban area must have rainwater harvesting as an integral component of the building utility;
- Concept of Rain Gardens to be incorporated in planning for public parks and on-site storm water management for larger colonies and sites those are to be developed; and
- Flood hazard assessments should be done on the basis of projected future scenarios of intensities and duration of rainfall and land use changes.

As a part of its mandate, the National Disaster Management Authority (NDMA) has made sincere efforts to prepare the National Guidelines on Management of Urban Flooding. However, these guidelines have not referred that how to ensure successful coordination with state and district authorities. The state and district authorities deal the issue in different way. NDMA has acknowledged the increasing frequency of urban flooding and stated that the causes of urban flooding are different for each city and therefore flood management strategies need to be customized. NDMA guidelines also stress on the need to make the planning process participatory. The NDMA Guidelines are expected to boost the efforts for urban flood disaster management and the formulization of mitigation plans, and addressing the emergent issues of urban flooding.

Urban centres and rivers have an intrinsic relationship. The rivers have been at the centre of various cultural, religious, livelihood-related, and recreational avenues traditionally. However, with the change of time, urban centres have exploited rivers indiscriminately. With the rapid urbanization in cities, rivers are extensively becoming the dumping grounds for solid waste and industrial effluents, resulting into heavy blockage of natural flows of water and reduction in natural absorbing of excess rain water. Over exploitation of rivers for urban development, landscaping and development of riverfronts for destructive anthropogenic activities is common scenario in many cities located nearby rivers. The rivers have primarily been regarded as sources of water and pollution sinks. Urban rivers have always been recognized for their role in serving as water resources, protection of nature, fisheries, and provision of recreational areas with considerable contributions to landscape. These rivers within cities are highly stressed as a result of their interaction with the influencing factors within the city extent. The stresses make these rivers less resilient to the effects of climate change. Thus, river management within cities has to be addressed by urban local governments. River management projects, mostly in the form riverfront development, landscape/ recreation, installation

of Sewage Treatment Plants (STPs), ghat development, etc. are most commonly adopted by the river cities. However, these projects have adversely affected ecology, urban environment and natural flow of rivers besides recharging capacity rain water (NIUA, 2020).

Resilience in Urban Centres

Social resilience is an important component of the circumstances under which individuals and social groups adapt to environmental change. Ecological and social resilience may be linked through the dependence on ecosystems of communities and their economic activities. This analysis allows consideration of whether institutions themselves are resilient to change. Institutions in this case are defined in the broadest sense to include habitualized behaviour and rules, and norms that govern society, as well as the more usual notion of formal institutions with memberships, constituencies and stakeholders. There is a long history of examining the resilience of ecological systems and their persistence in the face of human intervention. Evidence on the history of human use of ecosystems suggests an inevitable decline in ecosystem resilience with technological lock-in and reductions in diversity (Holling and Sanderson, 1996). Analysis of vulnerability as a social phenomenon also has a long tradition within cultural geography and the critical questions of food security and famine (Watts and Bohle, 1993). It is related to the study of criticality (a concept applied spatially at different scales) and to security (Kasperson *et al.*, 1996). Social vulnerability is the exposure of groups of people or individuals to stress as a result of the impacts of environmental change. Stress, in the social sense, encompasses disruption to groups' or individuals' livelihoods and forced adaptation to the changing physical environment. Social vulnerability in general encompasses disruption to livelihoods and loss of security. For natural ecosystems, vulnerability can occur when individuals or communities of species are stressed, and where thresholds of potentially irreversible changes are experienced through environmental changes. Social vulnerability to environmental change and other causes of vulnerability can be observed at different scales and in relation to a range of phenomena such as human-induced risks or natural hazards (Klein *et al.*, 1998; Adger, 1999). Resilience increases the capacity to cope with stress and is hence a loose antonym for vulnerability. Environmental criticality 'refers to situations in which the extent or rate of environmental degradation precludes the continuation of current use systems or levels of human well being, given feasible adaptations and societal capabilities to respond' (Kasperson *et al.*, 1995). Thus criticality is a state of an area or region which incorporates various attributes including environmental degradation and some aspects of human adaptation (Kasperson *et al.*, 1995). The concept of environmental criticality is therefore applied to geographical areas or to resource systems. Analysis of vulnerability of different social groups and the institutional architecture which determines resilience in the context of environmental change is an emerging research issue (Adger and Kelly, 1999). The

resilience of an ecological system relates to the functioning of the system, rather than the stability of its component populations, or even the ability to maintain a steady ecological state (Pimm, 1984; Holling *et al.*, 1995; Perrings 1996; Gunderson *et al.*, 1997). Resilience in ecological systems is not easily observed, and there seems at present to be no agreed relationship, for example, between the diversity of ecosystems and their resilience (Pimm, 1984; Naemm *et al.*, 1994; Tilman, 1997). Thus many tropical terrestrial ecosystems have stable and diverse populations but are relatively low in resilience, while similar ecosystems in temperate regions with apparently low diversity can exhibit greater resilience. Coastal and estuarine ecosystems are typically of low species diversity since they experience periodic physical changes and have a high degree of organism mobility. Yet Costanza *et al.*, (1995) argue that such ecosystems are highly resilient because of their high levels of functional diversity. It is argued by many ecologists that resilience is the key to biodiversity conservation and that diversity itself enhances resilience, stability and ecosystem functioning (Schulze and Mooney, 1993; Mooney and Ehrlich, 1997; Tilman 1997). Ecological economists also argue that resilience is the key to sustainability in the wider sense (Common, 1995). Resource dependency relates to communities and individuals whose social order, livelihood and stability are a direct function of their resource production and localized economy (Machlis *et al.*, 1990). There are a number of elements by which the consequences of dependency can be observed: income stability and social stability and migration. The dependency of individuals within a resource system does not necessarily depend on reliance on a single crop or fish stock, but in some circumstances on dependence on an integrated ecosystem. This is particularly the case with coastal resources, as argued by Bailey and Pomeroy (1996) in the context of coastal regions of Asia: 'fishing communities are best understood as dependent not on a single resource but on a whole ecosystem. Coastal communities can be dependent to a greater or lesser degree on coastal resources for their livelihood. These resources in themselves may be diverse and incorporate tourism, fishing other extractive uses and transport. It is often argued that coastal ecosystems themselves are either more resilient or more stable, and therefore coastal communities are more resilient. But the economy is still reliant on a single coastal system. If an oil spill affects a tourism beach then it will also affect fishing stocks and have other ecological impacts. Resilience, in both its social and ecological manifestations, is an important aspect of the sustainability of development and resource utilization. Each of these social and ecological aspects has several empirical indicators, but no single indicator captures the totality of resilience.

Policymakers and developmental planners have increasingly become interested in understanding the concepts of resilience, vulnerability, and adaptation to enable proactive and better informed responses to urban disasters (Dayton and Johnson, 2004). "Urban Resilience" is the capacity of an urban center to absorb the shock of a sudden or unforeseen disaster provoked by

an event without necessitating massive extra territorial aids and resources to maintain its urban performance quality. These shocks could be of manmade origin or of natural causes such as tsunami, flood, cyclone, earthquake, landslides, etc. The quality of urban resilience or in other words its absorbing capacity depends upon the management quality of its governance system, its resources availability, its infrastructural facilities and manoeuvrability, the participative dynamics of its citizens and most importantly its visions and preparedness mechanism at all levels to counteract the disasters and emergencies. In fact, an urban center is a complex entity of a total system composed of innumerable sub-systems representing different urban elements and parameters. A good number of scientific means and knowhow's such as GIS, forecasting, simulation of scenarios and magnitude of disasters' effects, etc. are available to understand, to envision and to modelise these risks and minimize their impacts on settlements. In order to encounter the disasters and improve the resilient capacity of the settlement centers, three basic strategies are needed to be developed: (1) Anticipation and envisioning of the "causes & effects" chain that constitute the total urban system of the settlement centre; (2) Improve the early warning and preparedness capacity, infrastructural mobility and governance system; and (3) Incorporating necessary measures in the development program to rectify the planning errors (Baral, 2014).

Growing urbanization would result in an increase in dependency on urban services, economic opportunities, resources, and infrastructure. In India, while cities such as Mumbai, Bangalore, Ahmadabad, and Chennai have substantial developmental investments, medium and small towns are grappling to deal with population growth and competition for resources due to inadequate infrastructure and financial resources. (Mc Grahnan et al., 2007). A major challenge for cities facing rapid population growth is to maintain environmental sustainability. The nature of inter-linkages of services within an urban environment and consequently the highly connected nature of risks, policies relating to urban resilience and sustainability essentially need to address multiple sectors and dimensions (Nijkamp and Finco, 2000). This includes land use planning, energy management, ecosystem services, housing and transport, water supply and sanitation, health services, and waste management, inter alia.

Project planning for infrastructure needs early risk audit in its formative stages of estimating investments. Hazard and vulnerability assessment need to be more focused on risk of disaster and climate change in these estimates. In local level project planning the focus on process that captures risk concerns, risk reduction to build resilience in infrastructure is lacking (Bhatt, 2014). Resilience is proving to be a helpful way of furthering our understanding of how to improve efforts in disaster management, both in reducing the scale of

impact beforehand and in providing a better response afterwards (Sanderson, 2014). There is an urgent need to look for alternatives to produce greener and cleaner building materials, which consume fewer resources, produce lesser pollution and are environment friendly besides focusing on disaster resistance capability of construction materials. At the city level, budgetary challenges and lack of fiscal autonomy still exist as bulk of the finances still rest with the Central and state governments and not with city governments. The method of mainstreaming risk reduction and resilience planning is through climate risk screening. It is an approach for reducing climatic risks to developmental objectives and integrating adaptation options within developmental programmes at the national and sub-national levels (Tanner et al., 2007). Strong urban planning can promote resilience by ensuring optimal use of space, energy and natural resources. Flexible and adaptable climate change planning processes are crucial. Engagement; education and awareness raising campaigns are a useful element within planning for development because each activity can contribute to climate change – wasting electricity, driving cars, not recycling or reusing. Decentralized and improved urban governance is important for practical implementation of resilience and sustainability strategies. Public-private partnerships are an important and effective means of leveraging stakeholder expertise and forming partnerships for greater community benefits. Municipal bodies often do not have appropriate data to address planning needs and development. Advanced mapping, visual and spatial technologies can promote effective resource allocation and resilience strategies in cities. In order to ensure disaster resilient development in cities, there is a need for *better inter – agency coordination* across ministries and departments such as urban development, housing, water resources, environment, transport, home/ internal affairs, power, communications, municipal governance amongst others at national, state and local levels along with many non- governmental organizations and civil society (TERI,2011).

Mainstreaming Disaster Risk Reduction

Under Section 36 of the Disaster Management Act, 2005, every ministry or department of the Government of India is responsible for taking necessary measures for the prevention of disasters, mitigation, preparedness and capacity building in accordance with the guidelines laid down by the National Disaster Management Authority. The Ministries and Departments are responsible for preparing disaster management plans, integrating disaster risk reduction elements in the ongoing development schemes and providing assistance to the National Disaster Management Authority and State Governments for drawing up mitigation, preparedness and response plans. The National Policy on Disaster Management, 2009 aims to support and build a safe and disaster resilient India. The Prime Minister’s 10 point agenda for Disaster Risk

Reduction, 2016 presented a holistic approach to DRR and addressed several critical issues of disaster risk reduction.

Smart City Mission

Government of India has launched Smart City Mission on 100 selected cities of India. The Mission focuses on sustainable and inclusive development of cities. The Mission includes the components of city improvement (retrofitting), city renewal (re-development) and green field development (expansion of city). The SMART city proposals have identified projects having wide-ranging implications in terms of climate, environment and disaster risk management such as storm-water drainage, wastewater reuse, use of technology for energy and efficiency, solar rooftop, ICT based solutions - Centralized Command and Control Centers, Flood Detection Sensors, Incident Management System etc. This has the scope to address DRR and CCA concerns by mitigating the risks of heat waves and other health hazards, through considerably reducing the urban atmospheric temperature. The Mission Guidelines provide for land use planning, building by-laws and urban heat effects in designated areas. It becomes imperative for the City Disaster Management Plans (CDMP) of SMART cities to have inbuilt components for Urban DRR and Climate Change. For example, while retrofitting the roads in the flood-prone areas, it is commonly believed that cemented roads may better withstand the flooding instead of bitumen roads, and hence may be considered to increase the longevity of roads; similarly, wherever relevant and applicable suitable measures for draining water from roads need to be included during retrofitting. Retrofitting initiatives may be based on the extent of the local hazards, risks and vulnerability of the area and by including actions required to reduce risk. While designing and implementing redevelopment initiatives, disaster risk needs to be taken into consideration for designing project activities and needs to include necessary risk mitigation measures to address disaster risk/ impact in those areas. For example, while redeveloping the sewage system for the city, effective storm water drainage needs to be considered as a critical component for managing urban flooding.

AMRUT

The Government of India introduced Atal Mission for Rejuvenation and Urban Transformation (AMRUT) in 500 cities of India with focus on capacity building, reform implementation, water supply, sewerage and septage management, storm-water drainage, urban transport, and development of clean spaces and parks. The ULBs are required to incorporate resilience and securing projects against disasters, vulnerability of poor, securing engineered structural norms in the design and building standard codes. City-level Hazard Risk Assessment

based on multi-hazards such as earthquake, floods, fire, etc. may be considered while developing proposals under AMRUT. When any new infrastructure is being created to provide sewage and septage or the existing system is being revamped or rehabilitated. It needs to take into account local hazard risks and incorporate appropriate design parameters to protect the asset against such hazards. When any new infrastructure is being created to provide a water supply or the existing system, it needs to take into account local hazard risks and incorporate appropriate design parameters to protect the asset against such hazards. Towns and cities located in floodplains may give priority to improving and upgrade storm-water drains which can cater to the requirements of a flooding situation. The effort may be made to design, construct and improve the carrying capacity of the storm-water drains as per the hydrological model, especially as it appears while flooding.

HRIDAY

The scheme is being implemented in 12 cities viz. Ajmer, Amritsar, Amaravati, Badami, Dwarka, Gaya, Kanchipuram, Mathura, Puri, Varanasi, Velankanni, and Warangal. It supports the development of core heritage infrastructure projects, which shall include the revitalization of urban infrastructure for areas around heritage assets identified/ approved by the Ministry of Culture, Government of India and State Governments. These initiatives shall include the development of water supply, sanitation, drainage, waste management, approach roads, footpaths, street lights, tourist conveniences, electrical wiring, landscaping and other capacity-building citizen services. Local capacity enhancement is placed at the centre of this scheme to enable an inclusive, heritage-based industry. The projects being designed and implemented relate to strengthening infrastructure around heritage locations and roads and pavements around the heritage building. While creating new facilities related to sanitation, parking facilities etc, the local hazard risk profile should be considered and the design should contain measures to address risk due to flooding, heavy rains and seismic risk wherever applicable and relevant. At the time of the development of grounds for cultural events and festivals as well as associated infrastructure, the potential peak crowd should be considered as a key parameter and the facility should not be allowed to be used for crowds above than the authorized number, to minimize the risk of stampedes.

Swachh Bharat Mission

The Mission has issued technical guidelines for the construction of different types of toilets in different locations to address the issues of local hazards completely and to ensure a behavioural change in society for preventing open defecation. Promoting hazard-resistant construction of toilets using

appropriate construction techniques and practices is suggested. Needs of the vulnerable groups should be prioritized while constructing community assets, including assets in the schools. Hazard-resistant construction designs, especially for highly fragile areas such as the North-east, hilly regions, coastal areas and floodplains should be developed and provided for guidance. Hazard-resistant materials should be promoted for construction of toilets, for example, lightweight material such as timber in earthquake areas and waterproof material in cyclone/floods prone areas.

PMHFA

This Mission seeks to address the housing requirements of the urban poor using 'slum rehabilitation; promotion of affordable housing through credit-linked subsidy and in partnership with public and private sectors; and subsidy for beneficiary-led individual house construction/enhancement.' The lands under housing redevelopment/development could be exposed to high-hazards or environmental risk but this is not often recognised at the time of planning. Therefore, additional structural and non-structural measures must be undertaken to ensure its stability.

Conclusion

Urban centres are witnessing frequent natural disasters due to increasing population pressure, unplanned growth, default and unsustainable infrastructure development, non regulation of housing and building construction, ineffective implementation of building bylaws and building standard codes, increase in emission of CO², and poor sanitation services. The urban flooding has increased in many cities besides climate change is likely to increase the severity of loss due to flood. Thus, strong urban planning can promote resilience by ensuring optimal use of space, energy and natural resources. In order to ensure disaster resilient development in cities, there is a need for *better inter – agency coordination* across agencies and departments such as Municipal Corporation, Development Authority, Jal Sansthan, Water Resources, Environment, Transport, Electricity, as well as NGOs and civil society organization. Flexible and adaptable climate change planning processes are crucial. Decentralized and improved urban governance is important for practical implementation of resilience and sustainability strategies. Public-private partnerships are an important and effective means of leveraging stakeholder expertise and forming partnerships for greater community benefits. Municipal Corporation often does not have appropriate data to address planning needs and development. Advanced mapping, visual and spatial technologies can promote effective resource allocation and resilience strategies in the city. The method of mainstreaming risk reduction and resilience planning

is through climate risk screening. The main cause of urban flooding has been reported to be faulty design and choking of drainage system, hence there is imperative need of developing effective drainage system through focusing on storm water drainage management, regular cleaning of drains, desludging of drains, selection of resilient design and materials for construction of drains under AMRUT. The existing urban plans and mission mode schemes also need mainstreaming with disasters and climate management. Moreover, strict regulation is required for regulating land use, housing density and height of building/houses, and construction of resilient urban infrastructure. Lastly, it can be concluded that in spite of many policy/programmes were launched by the govt. of India to mitigate disasters, to making cities resilient towards disaster. Firstly, there is a need of joint efforts or responsibility of every human being and it is as important as the role of local/state/central government. Secondly, it is the high time to more focus on to include climate change perspective in all these initiatives taken or would be taken in future by the government of India.

References

- Adger, W.N. (1999) Social vulnerability to climate change and extremes in coastal Vietnam. *World Development* 27.
- Adger, W.N. and Kelly, P.M. (1990) Social vulnerability to climate change and the architecture of entitlements. *Mitigation and Adaptation Strategies for Global Change* 5.
- Bailey, C. and Pomeroy, C. (1996) Resource dependency and development options in coastal south East Asia. *Society and Natural Resources* 9,
- Baral, Hari (2014) The Urban Resilience Approach, Towards Urban Resilience, South Asia Disasters Net, Issue No. 114, July.
- Bhatt, Mihir, R. (2014) How Resilient is India's Infrastructure, Towards Urban Resilience, South Asia Disasters Net, Issue No. 114, July.
- Campbell, L. (2014) The Importance of Urban Resilience, Towards Urban Resilience, South Asia Disasters Net, Issue No. 114, July.
- Common, M. (1995) *Sustainability and policy: limits to economics*. Cambridge: Cambridge University Press.
- Costanza, R., Kemp, M. and Boynton, W. (1995): Scale and biodiversity in estuarine ecosystems. In Perrings, C., Mäler, K.G., Folke, C., Holling, C.S. and Jansson, B.O., editors, *Biodiversity loss: economic and ecological issues*, Cambridge: Cambridge University Press.
- Dayton-Johnson J. (2004), *Natural Disasters and Adaptive Capacity Working paper no. 237*, www.oecd.org
- Government of India (2019) *Mainstreaming Disaster Risk Reduction and Climate Change Adaptation in the National Flagship Programmes*, National Disaster Management Authority- UNDP, Government of India

- Gunderson, L.H., Holling, C.S., Pritchard, L. and Peterson, G.D. (1997) Resilience in ecosystems, institutions and societies. Discussion Paper 95. Stockholm: Beijer International Institute of Ecological Economics.
- Gupta, Anil K., Nair, Sreeja S., Chopde, S. And Singh, P.K., (2010) Risk to Resilience: Strategic Tools for Disaster Risk Management (Proceeding Volume of the International Workshop), National Institute of Disaster Management, New Delhi and the Institute of Social and Environment Transition, Colorado, USA.
- Gupta, V. (2005) Climate Change and Domestic Mitigation Efforts, *Economic & Political Weekly*, March.
- Holling, C.S. (1995) What barriers? What bridges? In Gunderson, L., Holling, C.S. and Light, S.S., editors, *Barriers and bridges to the renewal of ecosystems and institutions*, New York: Columbia University Press.
- Holling, C.S. (1986) The resilience of terrestrial ecosystems: local surprise and global change. In Clark, W.C. and Munn, R.E., editors, *Sustainable development of the biosphere*, Cambridge: Cambridge University Press.
- Holling, C.S. and Sanderson, S. (1996) Dynamics of (dis)harmony in ecological and social systems. In Hanna, S.S., Folke, C. and Mäler, K.G., editors, *Rights to nature*, Washington DC: Island Press.
- Jain, A. (2014) Cost Effective Green Building Techniques for Disaster Resilient Cities, *Towards Urban Resilience*, South Asia Disasters Net, Issue No. 114, July.
- Kasperson, J.X., Kasperson, R.E. and Turner, B.L. (1996): Regions at risk: exploring environmental criticality. *Environment* 38(10), 4–15.
- Kasperson, R.E., Kasperson, J.X., Turner, B.L., Dow, K. and Meyer, W.B. (1995): Critical environmental regions: concepts, distinctions and issues. In Kasperson, J.X., Kasperson, R.E. and Turner, B.L., editors, *Regions at risk: comparisons of threatened environments*, Tokyo: United Nations University Press.
- Klein, R.J.T., Smit, M.J., Goosen, H. and Hulsbergen, C.H. (1998) Resilience and vulnerability: coastal dynamics or Dutch dikes? *Geographical Journal*
- Machlis, G.E. and Force, J.E. (1988) Community stability and timber dependent communities. *Rural Sociology* 53.
- Machlis, G.E., Force, J.E. and Burch, W.R. (1990) Timber, minerals and social change: an exploratory test of two resource dependent communities. *Rural Sociology* 55.
- McGraham G, Deborah B, and Bridget A. (2007) *The Rising Tide: Assessing the Risks of Climate Change and Human Settlements in Low Elevation Coastal Zones*. *Environment and Urbanization* 19(1).
- McKinsey (2010) *India's Urban Awakening: Building Inclusive Cities, Sustaining Economic Growth*, McKinsey Global Institute Seoul.
- Mooney, H.A. and Ehrlich, P.R. (1997) Ecosystem services: a fragmentary history. In Daily, G., editor, *Nature's services: societal dependence on natural ecosystems*. Washington DC: Island Press.
- Naemm, S., et al. (1994) Declining biodiversity can alter the performance of ecosystems. *Nature* 368, 734–37.

- NDMA (2010) National Disaster Management Guidelines Management of Urban Flooding, National Disaster Management Authority, New Delhi.
- Nijkamp P and Finco A. (2000) Evaluation of Complex Resilience Strategies for Sustainable Cities. Edited by P Gejo, Padova: CESET.
- NIUA(2020) Mainstreaming Urban River Management Into Master Plans , NIUA-Namami Gange Mission, Ministry of Housing and Urban Affairs, New Delhi.
- Pelling, M. (1998) Participation, social capital and vulnerability to urban flooding in Guyana. *Journal of International Development* 10.
- Perrings, C. (1996) Ecological resilience in the sustainability of economic development. In Faucheux, S., Pearce, D. and Proops, J., editors, *Models of sustainable development*, Cheltenham: Edward Elgar.
- Pimm, S.L. (1984) The complexity and stability of ecosystems. *Nature* 307.
- Rai, Nishith and Singh, A.K (Ed.) (2009) *Disaster Management in India*, New Royal Book Company, Lucknow.
- Sanderson, David (2014), *Towards Urban Resilience*, Towards Urban Resilience, South Asia Disasters Net, Issue No. 114, July.
- Schulz, R., & Hanusa, B.H. (1976) "Long-term effects of control and predictability-enhancing interventions: Findings and ethical issues", *Journal of Personality and Social Psychology*, 36, 1194-1202.
- Schulze, E.-D. & Mooney, H.A., (1993) *Biodiversity and ecosystem function*. Berlin: Springer Verlag.
- Singh, A.K. (2014), *Urban Risks in Uttar Pradesh*, Towards Urban Resilience, South Asia Disasters Net, Issue No. 114, July.
- Tanner T M, et.al. (2007) ORCHID: Climate Risk Screening in DFID India. Synthesis Report. www.ids.ac.uk
- TERI (2011), *Mainstreaming Urban Resilience Planning in Indian Cities: A Policy Perspective*, TERI-Rockefeller Foundation, New Delhi.
- Tilman, D. (1997) Biodiversity and ecosystem functioning. In Daily, G.C., editor, *Nature's services: societal dependence on natural ecosystems*, Washington, DC: Island Press, 93-112.
- Watts, M.J. and Bohle, H.G. (1993) The space of vulnerability: the causal structure of hunger and famine. *Progress in Human Geography* 17, 43-67. Zimmerer, K.S. 1994: Human geography and the new ecology: the prospect and promise of integration. *Annals of the Association of American Geographers* 84.