URBAN RESILIENCE AND SUSTAINABILITY

THROUGH PERI-URBAN ECOSYSTEMS

Integrating Climate Change Adaptation and Disaster Risk Reduction

PROCESS GUIDANCE AND TRAINING HANDBOOK

GORAKHPUR ENVIRONMENTAL ACTION GROUP
ACCCRN Asian Cities Climate Change Resilience Network
THE ROCKEFELLER FOUNDATION

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This Process Guidance and Training Handbook on Urban Resilience and Sustainability through Peri-Urban Ecosystems has been developed by Gorakhpur Environmental Action Group (GEAG) under the Asian Cities Climate Change Resilience Network (ACCCRN) initiative of The Rockefeller Foundation, USA. The Rockefeller Foundation launched the ACCCRN in 2008 to help cities strengthen their capacity to prepare for, withstand, and recover from the projected impacts of climate change. Today, ACCCRN is a leading regional network connecting professionals and communities across Asia to build inclusive urban climate change resilience (UCCR) that focuses on poor and vulnerable people affected by climate change. GEAG being an ACCCRN partner has implemented various pilot interventions in eastern India on ground issues pertaining to urban climate change resilience planning, peri-urban agriculture and ecosystems for enhancing urban resilience and disaster risk reduction. This training manual which is a handbook of practice guidance along with implementation manual has been developed for wider use and dissemination of the learnings and experiences generated through these pilot interventions.

Acknowledgement
The authors are grateful to ACCCRN and The Rockefeller Foundation for supporting the interventions by GEAG which has led to the development of this Training Handbook. The lessons of these interventions are important to be utilized and mainstreamed into the policy planning and capacity building process to address urban and peri-urban issues in the context of changing climate and recurring disasters.

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Foreword

Urban resilience is the capacity of persons, communities, institutions, businesses, and systems within a city to endure, adapt, and cherish no matter what kinds of persistent stresses and acute shocks they experience. Nurturing resilience in the face of ecological, socio-economic and political uncertainties and mitigating risk of disasters and extreme events have become key agenda for academics and policy decision across disciplines, sectors, and scales. Attaining and maintaining resilience has become an important goal for cities, particularly in the face of climate change. Urban areas inhabit majority of the world's population. In addition to operation as nodes of resource consumption (and discharges) and as sites for innovation, congregations and centre of powers, cities and towns have become the living laboratories for resilience, both in theory and in practice.

Interdependence and inter-relatedness of urban and peri-urban areas and their systems including in particular the ecosystems, form the backdrop in understanding urban carrying capacities accounting their supportive and assimilative strengths. Therefore, mainstreaming integration of climate change adaptation and disaster risk reduction into a broader framework of urban resilience needs to recognize the roles of ecosystems, particularly those in the peri-urban areas. Infrastructure and engineered systems, their redundancy, sustainability, reliability and operability, calls for greater understanding and integration of ecological infrastructure along the social resilience in peri-urban areas of a city or major township.

The Gorakhpur Environmental Action Group (GEAG), along with its collaborators across local authorities and governance, research and planning fraternities, have been undertaking strides by implementing pilots and case studies on urban resilience in a number of cities in coastal, hilly and other parts of India, supported under the ACCCRN initiative of The Rockefeller Foundation. National Institute of Disaster Management has been associated in drawing the lessons of some of the studies concerning mainstreaming of CCA-DRR into local level developmental planning process, leading to culmination in training strategies, training modules and policy inputs.

This book volume on 'Urban Resilience and Sustainability Through Peri-urban Ecosystems' is an attempt to bring diverse relevant issues and knowledge under a common ambit of CCA-DRR integration for resilient development of cities and towns, by recognizing, promoting and utilizing the ecosystem services, along welfare of local inhabitants, and enduring business continuity in their multi-sectoral, multi-level and multi-faceted forms. We wish the publication serves a good reference document for researchers, practitioners and academic fraternities. We are thankful to Dr. Muralee Thummanukuddy (DRR Chief, UNEP Geneva), and Prof. Dilanthi Amaratunga (Professor, Head of Global Disaster Resilience Centre, University of Huddersfield, UK) for their review inputs in improving the document.

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Abbreviations and acronyms

AMRUT	Atal Mission for Rejuvenation and Urban Transformation
AUWSP	Accelerated Urban Water Supply Program
DFID	Department for International Development
EIA	Environment Impact Assessment
EPRS	European Parliamentary Research Service
GEAG	Gorakhpur Environmental Action Group
GGGI	Global Green Growth Institute
GHG	Green house gas
GIM	Green India Mission
IIHS	Indian Institute for Human Settlement
MEA	Millennium Ecosystem Assessment
MoUD	Ministry of Urban Development
NAPCC	National Action Plan on Climate change
NMSA	National Mission on Sustainable Agriculture
NTPU	National Taipei University, Taiwan.
NUA	New Urban Agenda
OECD	Organization for Economic Co-operation and Development
PUA	Peri Urban Agriculture
PURPLE	Peri Urban Regional Platform Europe
SAZ	Special Agricultural Zones
SCM	Smart Cities Mission
SEA	Strategic Environment Assessment
SDG	Sustainable Development Goals
UNDESA	United Nations Department of Economics and Social Affairs
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNEP	United Nations Environment Program
UNDP	United Nations Development Program
UN HABITAT	Unite Nations Human Settlement Programs
ULBs	Urban Local Bodies
UIDSSMT	Urban Infrastructure Development Scheme for Small and Medium Towns
VIUC	Vegetable Initiative for Urban Clusters
WSUD	Water Sensitive Urban Design

Introduction

The continued rapid growth of cities inexorably, causing many to think that inevitably their environmental impact will worsen, raises a number of persistent questions. The urbanization and sprawl engulfing land with swallowing demands including more and more rural areas, has caused a highly dynamic and un-organized transit for peri-urban areas which are yet to be recognized clearly in legal or planning definitions, and more so in terms of their significance, in extending carrying capacity to the cities and urban activities, through the assimilative and supporting capacities of their ecosystems, besides buffering risk of natural and anthropogenic disasters, along with the implications of climate change.

There are concrete ways to improve the decision-making process to guide cities toward the aspired benefits. These include assessment and planning tools and mechanisms, policies and regulations, project cycle management with environmental decisions, cost-benefit etc. However, there is not as yet a systematic approach mainstreamed to incorporate issues of peri-urban land-use and ecological strengths and weaknesses in terms of contribution towards urban resilience against climatic and disaster risks. Most cities and towns not only in developing countries particularly of Asia Pacific, but also many in the developing nations, are suffering with hydro-climatic disasters or like situations almost regularly. This challenging situation has grown more in past two decades, which has witnessed a fast growth of cities around the world and migration from rural and country sides across various jurisdictions, driven by many factors including social aspirations, pull and push both factors, and social, conflict, disasters, and several other causes. Climate change is behind many of these causative factors as it aggravates both – hazards and vulnerability.

Biggest sufferer in land-regime, of this growing challenge and nexus, are the peri-urban areas which continue to provide ecosystem support services but struggle for recognition by the city or regional environmental planners or policy makers. A number of pilot interventions have been undertaken to study and document the ground issues pertaining to peri-urban challenges, role of ecosystems, issues of livelihood, disaster risk reduction and adaptation, where The Rockefeller Foundation supported

programmes were significant in India as well. Asian Cities Climate Change Resilience Network (ACCCRN) project supported interventions of climate resilience and adaptation programmes through improved planning process in several cities where reference to peri-urban systems emerged prominently. Gorakhpur Environmental Action Group (GEAG) as a key player has been undertaking several studies and projects in many parts of the country.

Lessons of these studies are important to be utilized and mainstreamed into the policy planning and capacity building process to address the gap areas in understanding, practice and capacities of key stakeholders in addressing the issues of peri-urban and urban-planning with emphasis on role of ecosystems in enhancing resilience of the land, people, resources, infrastructure and associated economic interventions. With the objective, and the case studies and experiences available in background, a handbook of practice guidance and training module along with implementation manual, has been developed, for wider use and reference. While developing the document has utilized a range of other literature, data and information, from published and unpublished sources, all the original sources are sincerely acknowledged.

1 Understanding Urban and Peri-urban Ecosystems

1.1 Urbanization: An Overview

Cities are like "economic growth machines" and propel to prosperity of a nation by proving platforms for businesses, governance, administration, rural and peri-urban productivities. Ecologically, cities are complex systems that show distinctive ecological characters, patterns, processes, disturbances and subtle impacts (Mariana,2008). Cities are prominently composed as built environments with high human density (Millennium Ecosystem Assessment, 2005) which is highly managed by humans to satisfy their needs and demand.

The world is in pace of sustained and sprawling urbanization. This has led to major social, economic and resultant environmental changes, also with repercussions on increasing or diminishing risk of natural hazard impacts or vulnerability of land and people on climate change implications. The world's population today has already reached seven billion and as projected by United Nations by 2050 the planet will be home to almost nine billion people (UNDESA, 2012). The world is under the sustained process of urbanization pulling more people under city centers. A report from United Nations projects that world's urban population which is 3.2 billion in 2011, will grow by 72% by 2050 (UNDESA, 2015). Currently, cities are home to 50% of world's population and is expected to grow by 75% by 2050 (UNDESA, 2012), which will have huge impact on environment and demand for water, land, energy and food will increase substantially. Most of this growing population will be absorbed into rapidly growing cities, notably in Asia's fast developing economies (Bentham, 2011). A UN report projected that most of the population growth expected in urban areas will be concentrated in the cities and towns of the less developed regions (figure 1.1).

There is substantial increasing trend in number of megacities,[1] increasing globally and more than half in Asia-Pacific, i.e., 17 out of 28 (UN HABITAT, 2015), three of which are in India.[2] Asia, in particular, is projected to see its urban population

1 Megacities are defined as cities with population more than 10 million.
2 Three megacities in India are Delhi, Mumbai and Kolkata.

increase by 1.4 billion. The urban population in Asia is already growing by 44 million (UNESCAP, 2015) people per year pressurizing urban supply and municipal utilities. When it comes to water supply, sanitation system, energy supply, land use, food production and consumption most Asian cities have reached a critical situation of jeopardy to the very objective of sustainable development.

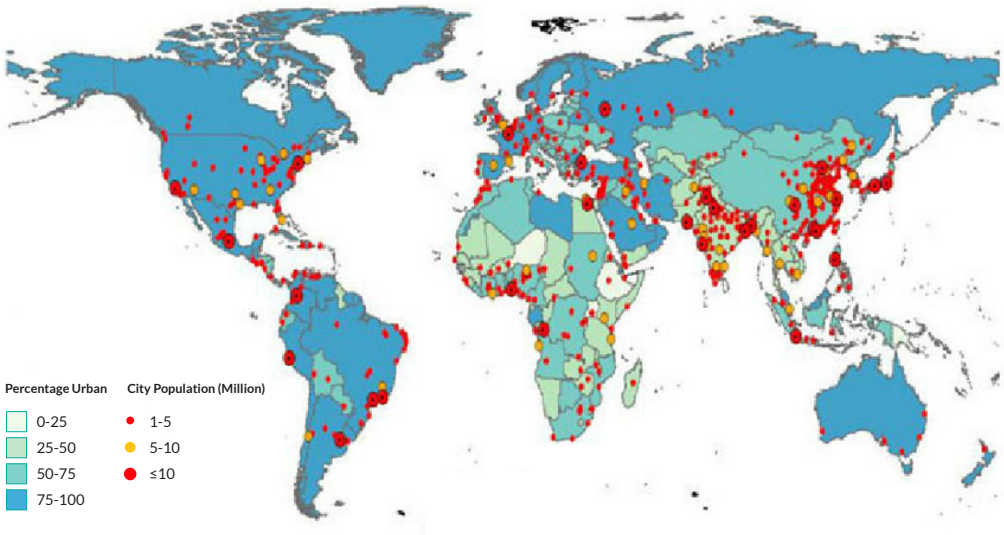

Figure 1.1: World Urbanization Prospects: 2025 (Source: UNDESA, 2009)

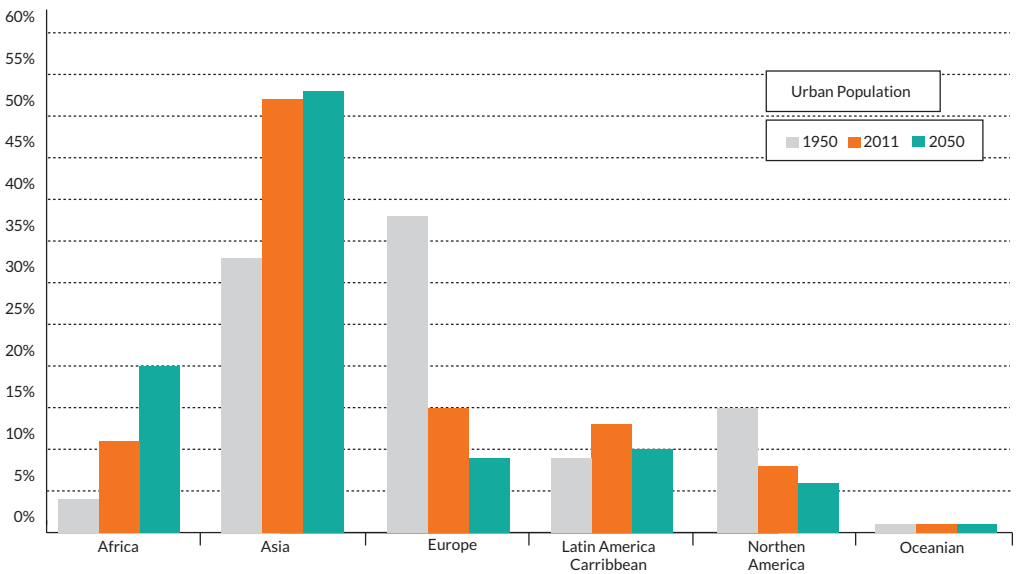

Figure 1.2: Distribution of the world's urban population by major area (Source: UNDESA, 2012).

Urbanisation and associated peri-urbanisation is widespread in India. However, the underlying processes and resulting impacts at its peri-urban interface is much less understood. Peri-urbanisation, a dynamic process that changes the land use in the margins of growing cities and towns (large and small), often displaying a form, structure and interaction that is unique and geared to support the urban centre, across many sectors.

These huge urban agglomerations exceed the carrying capacity (Mathur and Sharma, 2016) of the region and require enormous amount of water, energy and food within a small area to support them. Supporting the Malthusian Theory on carrying capacity many Ecologists give arguments in the favor that economic growth is increasingly based on the depletion of "natural capital", increasing pollution levels and declining biodiversity (Rees, 1992; Meadows et al., 1974). But no nation can survive for long if natural resources of a state are exhausted or polluted. It was explained in "Limits to Growth" that global equilibrium could be designed (Meadows et al., 1974) to alter the negative growth trend and establish a harmony between economic and ecological stability (Tayal and Singh,2016b) that is sustainable, thus forming the basis for sustainable development.

Figure 1.3: A glimpse of peri-urban region in India

The peri-urban area, due to its dynamic nature, has often fallen between the cracks of "rural" and "urban" development planning. In light of the emerging complexities of increased urbanisation in India, many are of the opinion, that the peri-urbanisation needs a critical review and new perspectives of understanding.

1.2 Peri-urban: A Landscape in Transition

Defining 'peri-urban' system prevailed in the academic literature ran across multiple thoughts sometimes leading to confusion. Peri-urban has neither geographically nor conceptually well defined. Generally, these are considered as transitional zones from rural to urban region (Dutta, 2011; Narain et al., 2013; Mitra et al., 2015), encompassing characteristics of the both regions, respectively. Located between the outer limits of urban and regional centres, they are the fastest growing region in the world. The dynamic nature of the peri-urban environment is the key feature, wherein, social forms and arrangements are created, modified and discarded (Iaquinta and Drescher, 2000). The outward expansion of cities, changes in land use pattern and occupations have transformed the rural hinterland into semi-urban areas. Inhabitants of these peri-urban regions are vulnerable and increasingly threatened by deteriorating quality of ecosystems leading to resource scarcity and a host of problems that very often have no solution in the short run (GEAG Issue Brief 1, 2016).

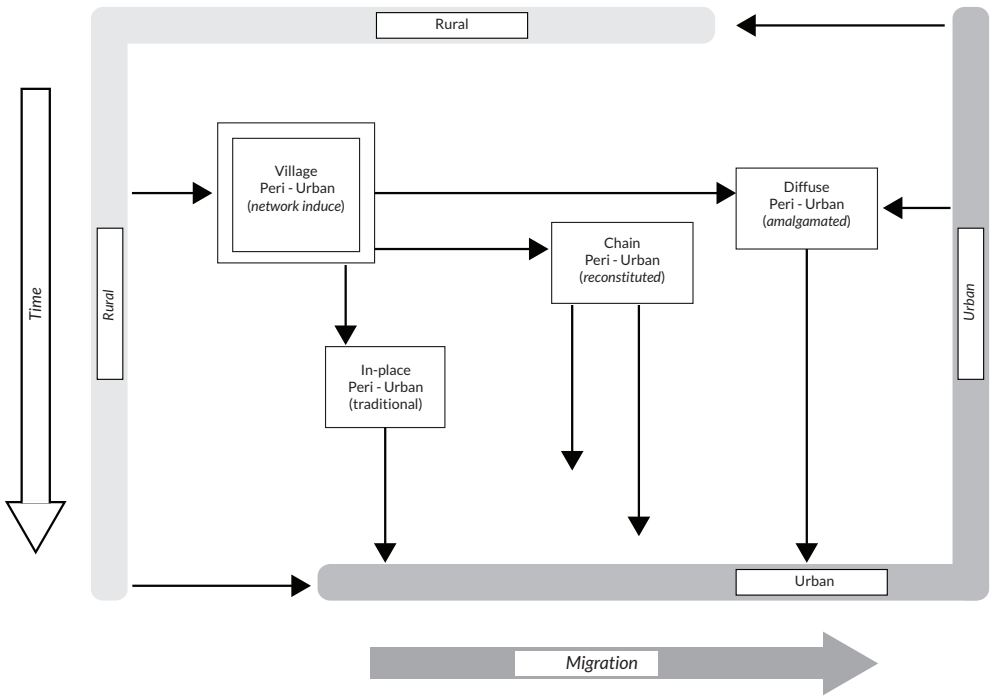

Figure 1.4. Peri-urban typology and institutional contexts (Source: Iaquinta and Drescher, 2000).

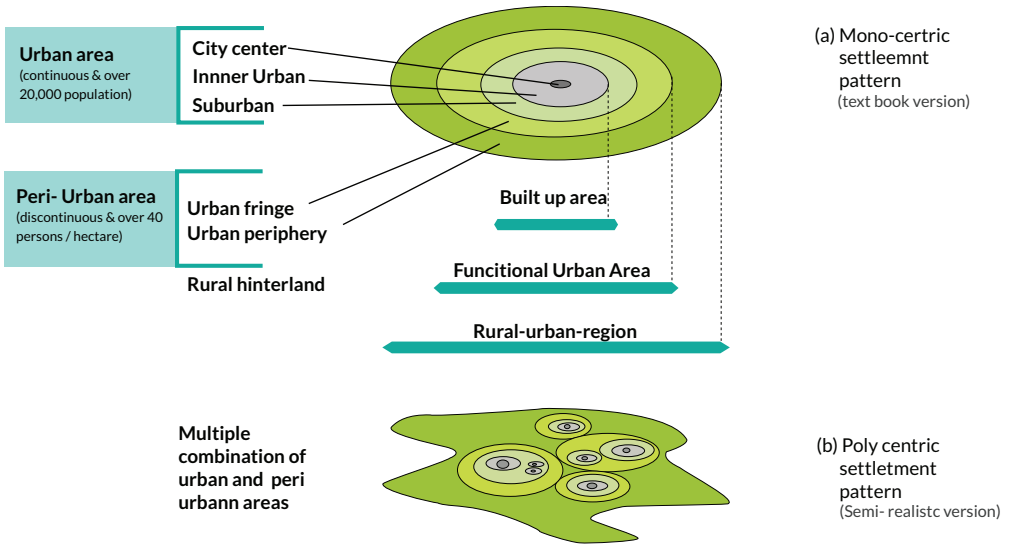

Figure 1.5. An emerging trend of peri-urban sprawl in Europe (Source: Piorr et al., 2011).

A new kind of space dynamism of urban-peri-urban land-use is emerging in Europe. The Peri-urban contains the urban fringe and urban periphery and is located in betzween the urban and rural areas. It is here in this in-between-space that major demographic, economic and land use shifts will take place, presenting the urban regions with several challenges of sprawl, air- and spatial quality and accessibility (Piorr et al., 2011). In France and Europe, peri-urban forests are subject to high social demands for recreational purposes. These demands form avenues for frequent visits of people for sports or rest. Local governments have succeeded in creating new wooded parks close to cities that are highly appreciated by the people and tourists. New approaches targeting health and peace benefits may also be observed on the part of both individuals level and at the health sector level. These new approaches indicate the existence of a wellness function in peri-urban forests.

Located between the outer limits of urban and regional centres and the rural environment; peri-urban areas represent a wide range of uses, such as water catchments, forestry, recreation, and productive farming, as well as offering a unique ambiance and lifestyle (Narain et al., 2013; Mitra et al., 2015). They are considered important in the context of food security, water and energy security, economic security, market linkages and provide breathing space for recreational activities. Peri-urban agriculture provides livelihood security and increases household income (Thornton, 2008), along with supplying nutritious and healthy food to the city residents as well as vulnerable populations living in the area, and its role in terms of various ecosystem services are vital (Thornton, 2008; Mitra et al., 2015).

The peri-urban is a fast-changing, semi-natural ecosystem which provides natural resources for growing cities in terms of water bodies, open and green lands, and orchards. Peri-urbanisation leads to usurpation of ecologically sensitive lands for housing and other

Box 1.1. Varying Perceptions on Peri-urban

As evident from the literature, very often authors didn't attempt or attempt specific ways to define what peri-urban means, yet they use peri-urban as a substantive category or phenomenon in their work (e.g., Holland *et. al.*, 1996; Clough, 1996). The "implicit definition", thus, indicate a variety of understanding:

- Peri-urban is different from urban.
- Peri-urban is often specifically associated with the urban fringe.
- Peri-urban carries a largely negative connotation.
- Peri-urban is, in some fashion, connected to being urban.
- Peri-urban has a demographic component, related to population size or density.
- Peri-urban has a geographic component, often reduced to proximity to a city.
- Peri-urban has a temporal component owing to urban growth and expansion and to improvements in transportation.
- There are multiple types of peri-urban environments.
- The factors that make an area peri-urban may derive from market or use relations or may rest on deeper underlying processes (e.g. sociocultural, demographic, propagation of urban attitudes).

construction activities. These change the face of agriculture, reduce open spaces, and enhance pressure on natural resources like water. These areas are marked by a lack of hygiene and sanitation infrastructure, industrial effluence, air pollution and inadequate provision of basic services. Often, the solid waste of a city is dumped in peri-urban areas (Marshal et al., 2009; Mitra et al., 2015).

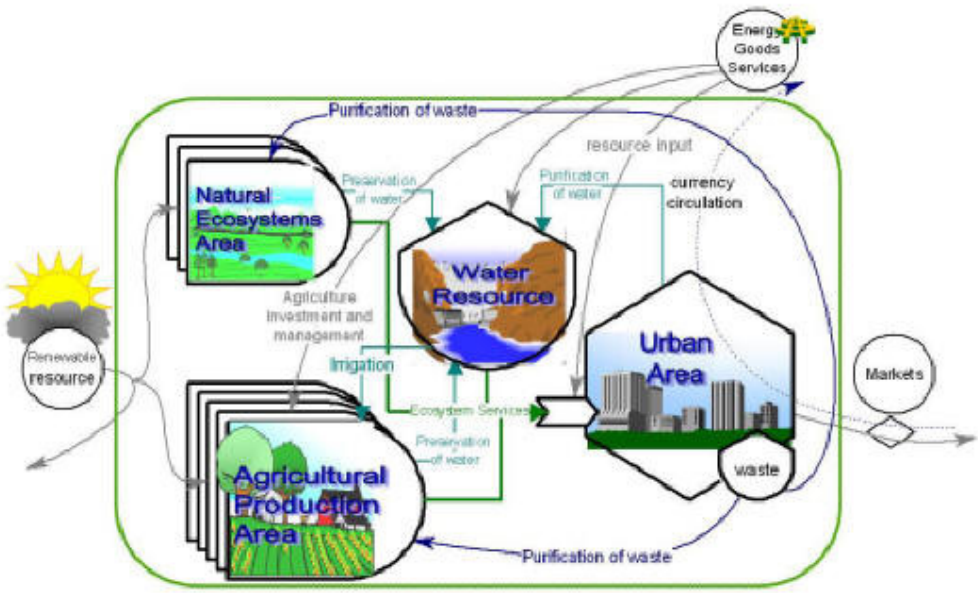

Figure 1.6: Various ecosystem services provided by peri-urban region. (Source: NTPU, PU-GEC, 2009).

Table 1.1. Issues of peri-urban areas

Issues	Details
Physical	• Lack of infrastructure • Non-contiguous development • Lack of basic amenities
Financial	• More investment compared to returns • Lack of financial resources
Governance	• Multiplicity of authorities • Lack of coordination
Environmental	• Depletion of environment due to over burden • Degradation of ecosystem services • Waste dumping sites • Contaminated water resources • Poor quality soil

(Source: Authors).

As the cities grow and expand, the peri-urban areas become part of the cities and new peri- urban areas are formed. This phenomenon in India is creating severe problems in terms of infrastructure delivery resulting into inheritance of physical underdevelopment. In comparison to the enormous growth and environmental stress these peri-urban areas absorb, by virtue of their spatial adjacency to city proper, their own conditions are dismal. There is lack of identity and proper planning and management across all sectors of governance, finance and infrastructure delivery when pertains to peri-urban areas, and more particularly the ecosystems.

Table 1.2. Strategic framework for planning and innovations in peri-urban sustainable development

	Challenges	Opportunities	Innovation
Infrastructure	• Incrementality • Maintainability • Poor connectivity of all social & physical infrastructure • Poor quality of housing	• Availability of land • Availability of natural resources • Integrated planning	• Growth containment strategy • Land information systems • Technology enhancement like - Solar roadways
Energy	• Poor quality of electricity • Increasing energy demand • Poor systems of energy distribution • High generalized cost of transport	• Energy efficient buildings • Energy efficient transport • Energy efficient planning • Energy management	• Renewable • Distributed micro-grids • Hybrid power system • Energy from waste - biomass

	Challenges	Opportunities	Innovation
Social conditions	• Sudden socio-economic change • Lack of sense of ownership/ participation • Lack of adequate employment opportunities	• Local participation • Availability of human resources • Opportunity to provide skills training	• Livelihood opportunity • Peri-urban commons • Inclusive planning! participatory
Governance	• Defining peri-urban areas • More political will for development • Increasing problem of security	• Parameterization of peri-urban areas • Data creation: land database • Transparency of land transactions and allocation of resources • Public participation	• enhancing local economy with more linkages with urban core • Technical capacity building of local body
Environment	• Degradation of natural assets • Solid waste disposal and management • Ground water contamination • Ecosystem threats • Urban heat islands • Air pollution • Degrading quality of life	• Less local SW generation • Rain water harvesting • Use of biodegradable material resources • Policies to reward and penalize citizen in order to safeguard the environment • Carbon trading • Air quality improvement	• Reduce/reuse SW • Creating baseline status of environment • Monitoring of resources • Public participation of SW management • Technologies to develop renewable and green energy • Improvement of air quality

Note: SW- Solid Waste (Source: IITB, 2013)

However, the peri-urban fringes also have huge potential as they will be the future urban areas. This situation calls for in-depth understanding of the challenges and opportunities these peri-urban areas harbour. There is need to identify the areas of innovation required to transform these urban fringes. This roundtable is aimed at looking into these issues and finally come up with the possible strategic research areas needed to make these peri-urban areas self-sustaining. A summary of issues, challenges and opportunities based strategic framework is suggested in table 1.2.

1.3 Urban and Peri-urban Ecosystems as Resources and Buffer

Peri-urban ecosystems are increasingly at risk of degradation and loss as natural resource consumption and waste in peri-urban areas increase due to rapid urbanization and increasing human activity. Cities do not operate in isolation but within a "sphere of dependence" on

surrounding areas and their ecosystems (GEAG, Issue Brief 2, 2016). As such, the degradation of these ecosystems results in loss of ecosystem services that support urban and peri-urban populations.

- **Water provision:** This is often the most important service lost, as polluting above-ground rivers and lakes destroys accessible sources of surface water. Dumping of sewage and solid/liquid waste in peri-urban areas contaminates the ground water, leading to spread of many diseases. Population growth increases demand for this diminishing water supply, and water tables drop as underground aquifers fail to recharge.
- **Flood buffers:** In many cases, this is one of the most valuable services threatened, as illegal construction on areas which are demarcated as open/green belts prevent natural drainage and exacerbate floods. Acute water logging and floods compounds the risk of property damage and loss of life.
- **Waste treatment:** Wetland destruction undermines the ability of the ecosystem to filter refuse from water supplies. Effluents from peri-urban industry, excessive untreated human waste, and garbage pollute the remaining waterways.
- **Food production:** As the urban fringe expands, industry and housing developments (both formal and informal) replace productive agricultural land, which often displaces poor farmers and can lead to lower volumes and higher food prices, particularly in cities that are highly dependent on nearby agricultural supply.
- **Climate and air quality regulation:** Peri-urban land supports green vegetation cover that absorbs air pollution and ambient heat, but the clearing of vegetation slows the process of filtering toxic compounds from the local atmosphere. As landscapes that used to be permeable and shady become dry and solid, a "heat island" effect can occur, leading to higher temperatures in a region.
- **Fuel wood and timber:** Deforestation removes a source of fuel wood and timber that nearby farmers depend upon.

Managing the environment of this interface is pertinent in present context, because various ecosystem services provided by these transition zones have significant impact for sustainability of both urban and rural development. Thus, it becomes important to understand the demographic trends, socio-economic change, ongoing process of urbanization, expected climate change, impact on natural resources and livelihoods in these transition zones. New multi-level and collaborative Governance Systems are required to manage the resilience of these ecotones. The United Nations' Sustainable Development Goals (Goal No.11) also emphasizes on making cities inclusive, safe, resilient and sustainable by implementing integrated policies and plans for resource use efficiency and adaptation to climate change (UN, 2016) which is not possible without protecting these peri-urban regions.

Peri-urban areas are undergoing rapid change and now offer true environmental services just outside but near the cities and towns. These new areas relieve productive forests and reserved ecosystems including protected areas, of excessive tourism pressures. Suburban parks and other ecosystems including water bodies, agriculture farms and horticulture nurseries, etc.

offer significant facilities to satisfy crowds and are greatly appreciated by the visitors. They are used for sports and recreation. However, in some of the peri-urban regions, expectations are more demanding and complex, under the impact of developed European nations.

New health demands are emerging, and forests and water-bodies, are increasingly seen as contributing to health, by individuals but also by institutions whose perception of forests is changing. Role of peri-urban forests as sources of wellness is a concept that needs to be studied further and applied to other environments such as mountains, coasts, etc. The environmental and forestry sectors are now expected to manage such new social demands, notably by collaborating with the health (along urban and rural development) sector. These demands constitute above all a flattering recognition of the value of peri-urban forests.

1.4 Challenges of Urban and Peri-urban areas

The challenge of this rapid urbanisation trend in India is alarming and in urgent need for attention. Rapid urbanization combined with inadequate provision of basic need services are increasing the vulnerabilities of populations living in most Indian cities. Secondary cities are growing at an unprecedented pace. These cities are the hub of opportunities where large scale migration takes place for fulfilling aspirations and in anticipation of better livelihoods. Due to these socio-economic factors, including population pressure and poverty, urban regions have seen a large influx of population from rural areas and this has led to the rapid growth of new urban centres.

Peri-urban ecosystems have been victims of increasing urbanisation and adversely impacting the resilience capacities of secondary cities. GEAG with the support of The Rockefeller Foundation did a scoping study on the condition of peri-urban regions of four secondary cities in India namely, Gorakhpur, Basirhat, Saharsa and Jorhat (Bhatt et al., 2016). The study came out with loss of significant ecosystem services in these cities faced due to urbanization and related challenges. The findings have been summarised in the table below.

Many environmental challenges are exacerbated within the urban landscape, such as storm-water runoff and flood risk, chemical and particulate pollution of urban air, soil and water, the urban heat island, and summer heat waves. Urban trees, and the urban forest as a whole, can be managed to have an impact on the urban water, heat, carbon and pollution cycles (Livesley et al., 2016). Many environmental or “biogeochemical” challenges exist within the urban landscape. Some key challenges revolve around the management of:

- Urban catchment hydrology and storm water runoff,
- Chemical and particulate pollution of urban air, soil and water,
- Carbon sequestration, and
- The urban heat island and enhanced summer heat waves

Table 1.3. Urbanization and its impact on secondary cities

Changes in Ecosystem	Gorakhpur (Uttar Pradesh)	Basirhat (West Bengal)	Saharsa (Bihar)	Jorhat (Assam)
Water bodies	82 % Natural water bodies like ponds, lakes are encroached	30% ponds are contamination by restricted hybrid fish (*Clarias gariepinus*) rearing.	7 water bodies are encroached out of total 19	10.09% individual ponds and 2.3 % common water bodies lost
Agriculture	7.2% agricultural area converted into residential area	10-15% change in land use converted to fish ponds	125 brick kiln developed on the agriculture land around the city	1.05 % agricultural area converted into residential area
Horticulture/ orchards	3.3 per cent area of orchards converted to housing construction	Old Mango orchards cut down and used for residential building	No orchards in peri urban area	Old plantation orchards are cut and sold for construction purposes
Forests	No change	Very little forest cover left in peri urban area	No forest cover in peri urban area	30 hectare of forest land is converted into commercial buildings
Open spaces / vacant land	15 percent area is covered by unauthorized colonies	7.23 % of open areas converted into housing and roads	841 illegal new houses were constructed	1.63% of area covered by housing and encroached
Flood plains	33 per cent flood plain area converted into residential area	54 acre of land along the bank of the Ichamati river is mostly encroached for brick kiln and housing	City have no master plan	No demarcation of flood plain in the master plan
Bamboo plantation	N/A	8-10 % of bamboo plantation area are left out and converted to buildings	N/A	Presently 30-35% of bamboo plantation area is shrinking in peri urban areas.

(Source: Bhatt et al ., 2016)

1.5 Mainstreaming Poor and Marginalized into Sustainable Growth

Urban growth based on migration and the absorption of rural areas into the urban has led to immense issues ranging from impoverishment, water and sanitation insecurity, ill-health, malnutrition, loss of fertile land, food insecurity, social insecurity, gender inequality as well as over-concentration in slums and squatter settlements that also often get flooded as well as prone to other disasters. It is an important observation that the peri-urban systems in India and many Asian or African nations are very different from those in Europe or American countries. Most of these urban poor people work in informal sector, give services to the city but does not get the due acclaim or remuneration. On the other hand some of the populations in these regions attain larger benefits of city in proximity and the natural resource or allied production systems under their control. Thus, there are contradicting examples as well.

However, poor are disproportionately affected due to the loss of peri-urban ecosystem to their propensity to live in peri-urban areas, high ecosystem dependence, and the economic impacts of land use changes. Peri-urban areas tend to be occupied largely by the low-income families and are typified by several illegal settlements and slums. In addition, peri-urban areas are poorly served by urban infrastructure and experience worse hygiene and sanitation conditions.

The economic impacts of land use change are disproportionately absorbed by the poor because of their high vulnerability to service or habitat loss, and the economic cost of lost land is high due to lack of resources, influence, or alternatives for income, housing, or basic services. The peri-urban poor depend on local ecosystems for basic services because there are no alternatives, and the loss of their lone source can inflict heavy costs. Women, minorities, and children are disproportionately vulnerable to peri-urban ecosystem loss because women are directly involved in peri-urban agricultural activities. Destruction of peri-urban ecosystems therefore disproportionately impact women, as they are less likely to have alternative sources for food, nutrition or income. Relationship between urban growth and its implications on peri-urban areas in terms of livelihood alterations have been shown in figure 1.7.

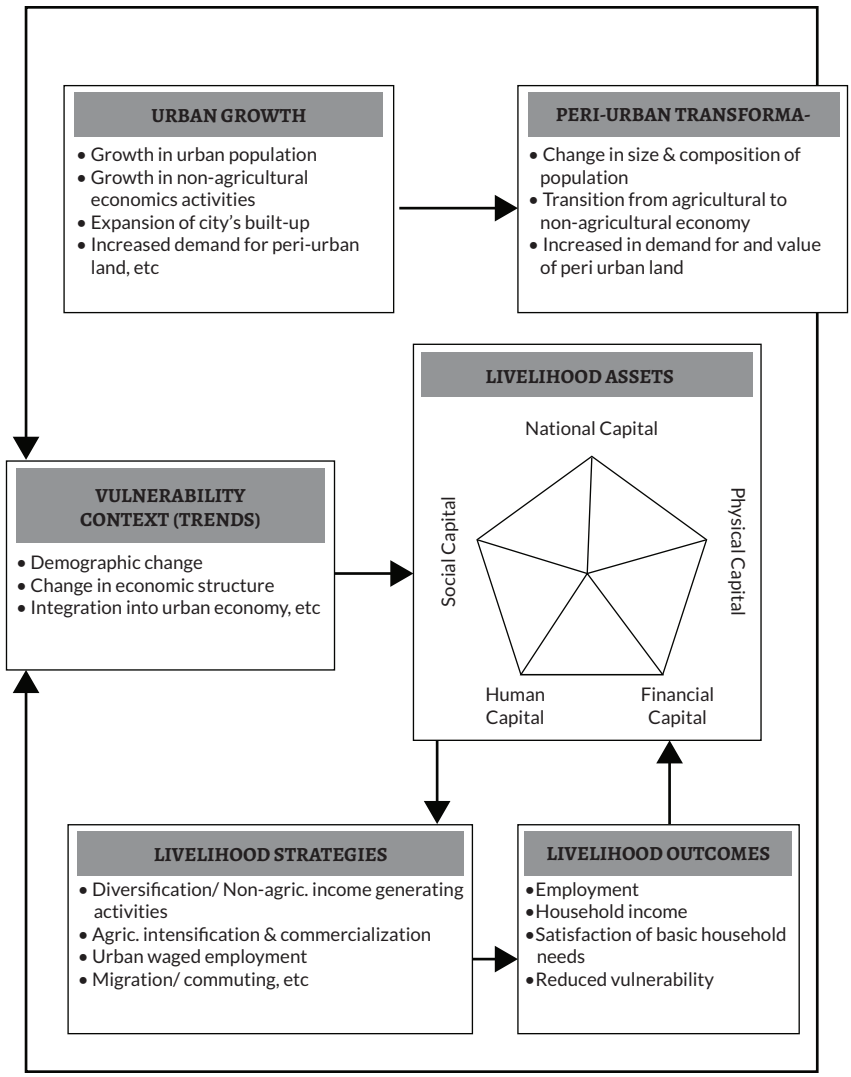

Figure 1.7. A suggestive framework on the effects of urban growth on peri-urban Livelihoods (Source: Oduro et al., 2017; Modified after DFID's Sustainable Livelihood Framework).

The vulnerability due to loss in ecosystem services also extends to urban populations that depend on the ecosystem services provided by peri-urban areas. The benefits that urban population derive from peri-urban ecosystems in terms of air regulation, water provision, food for sale, and protection from floods and water logging are hampered. Loss of food production for urban markets resulting from peri-urban ecosystem degradation also contributes to rising food prices, affecting all urban inhabitants, but disproportionately impacting the poor.

1.6 Needs and Opportunities of Resilience through Peri-urban Ecosystems

Ecosystems are dynamic complexes of living communities and their non-living environment interacting as functional unit. Ecosystems are basis of life and livelihoods and provide essential ecosystem services for existence and socio-economic well being under four major categories: provisioning, regulating, supporting and cultural services (Gupta and Nair, 2012). According to Millennium Ecosystem Assessment Report, 2005, approximately 60% of the ecosystem services have been degraded or used unsustainably and protection from natural hazard is one of those degraded services. One of the important findings of the report says that in the past 50 years humans have changed ecosystems more rapidly and extensively than in any comparable period of human history which has resulted into substantial and irreversible loss in the diversity of life on earth. The term "Ecosystem Based Disaster Risk Reduction" refers to the use of natural environment or systems as a way to buffer worst impact of changing climate, extreme weather events and related hydro-meteorological disasters. The basic objective of the approach is to maintain the resilience of natural ecosystems and their services to help communities to survive and cope up with the extreme events.

Climate change is known to increase disaster risks by precipitating frequency and intensity of hazards and adding new layer of hazards, besides increasing the factors of people's vulnerability in two ways: through ecosystem degradation, reductions in water and food availability leading to food and health insecurity, and changes to livelihoods from increasing numbers of weather and climate hazards (Sudmeier-Rieux, 2013).

The relationship between ecosystems and cities are interlinked and is often a two-way process. Ecosystems provide a multitude of physical and environmental services to cities and their residents which also help in enhancing city's resilience. However, the cities, which are rapidly urbanising and experiencing unplanned development is leading to a threatening decline in ecosystems. This is impacting the resilience of several cities. The 'extractive' nature of urbanisation places a low premium on preserving the ecosystem, affecting not only the livelihoods of those directly dependent on it but also the city itself. Talking of peri—urbanisation, this is leading to usurpation of ecologically sensitive lands for housing and other construction activities. These change the face of agriculture, reduce open spaces and green zones, and enhance pressure on natural resources like water. These areas are marked by a lack of hygiene and sanitation infrastructure, industrial effluence, air pollution and inadequate provision of basic services. The peri-urban areas which provides ecosystem services to urban areas, are become the dumping grounds for urban solid waste, sewerage, etc., which is leading to environmental degradation, groundwater contamination and adversely impacting the livelihoods and the health of people residing in the peri-urban areas.

BOX 1.2: Ecosystem services

- **Provisioning services,** the material that people extract directly from ecosystems such as food, water, forest products etc.
- **Regulating services,** which modulate changes in climate and regulate floods, drought, disease, water quality, etc.
- **Cultural services,** which consist of recreational such as tourism, aesthetic and spiritual benefits etc.
- **Supporting services,** such as soil formation, photosysnthesis and nutrient recycling etc.

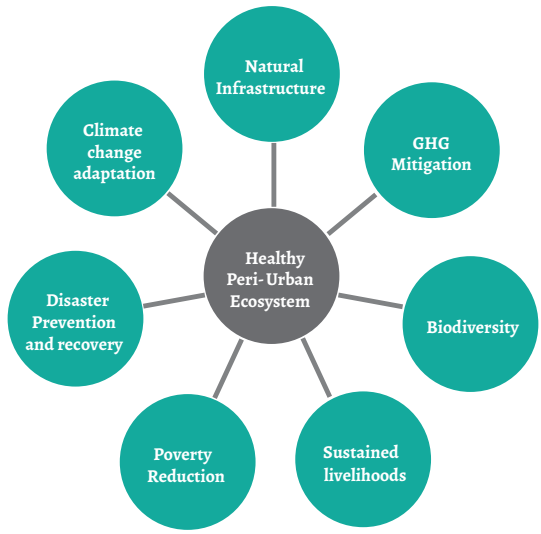

Figure 1.8. Peri-urban ecosystems and role in resilience (Source: Authors).

Urban trees in pervious spaces, or engineered —water sensitive urban design (WSUD) systems, have a role to play in rethinking how we manage urban catchment hydrology. Urban forest ecosystem service and function: at the tree, street, and city scale. Green infrastructure, defined as vegetation systems intentionally designed to promote environmental quality, can reduce the intensity of heat islands by providing shade and evapo-transpirational cooling. Urban trees are perhaps the most effective and least costly approach to urban heat island mitigation and adaptation (Norton et al., 2015; Solecki et al., 2005) (Figure 1.9).

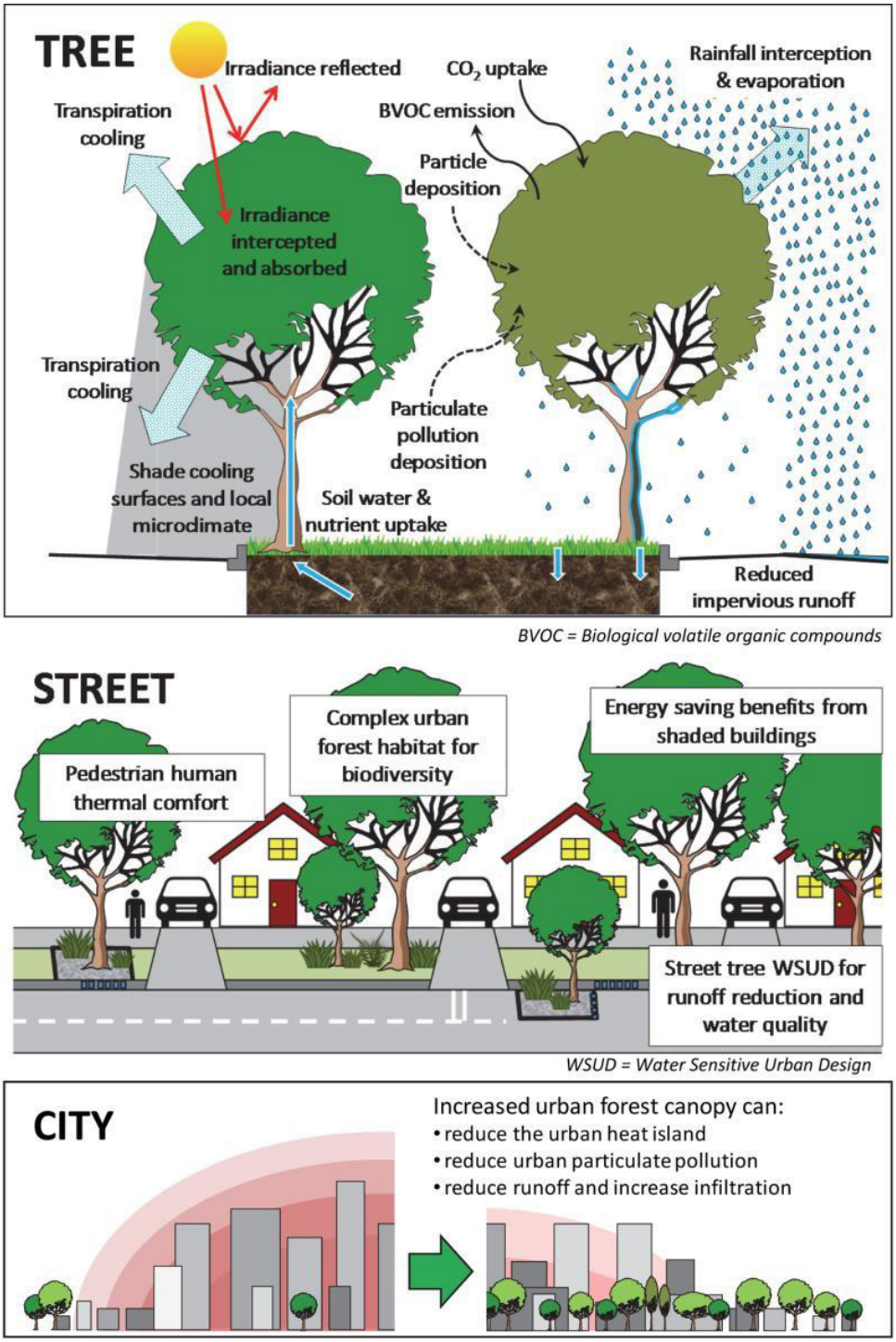

Figure 1.9. Role of urban forestry at tree, street at city level, against hydro-climatic risks (Source: Livesley et al., 2016).

2 Resilient Urban-Development Through Peri-urban Ecosystems

2.1. Resilient Development – Urban and Peri-urban

Defining what the development community means by "resilience" remains a significant issue. Every society throughout the world is facing growing climate-related risks that threaten assets, livelihoods, and overall well-being. These challenges are especially pressing in developing nations, where vulnerability to climate-related impacts is comparatively high and coping capacity very often is low. A development-first approach builds climate resilience through development strategies that reduce poverty by increasing food security, enhancing social cohesion, and strengthening governance that is inclusive of marginalized and impoverished people. Definitions of resilience continue to focus on linking it to crisis or disaster risk mitigation and response. Put another way, resilience is about how communities respond to stresses. How "stresses" are defined is one way in which resilience can move beyond simply disaster risk management.

Traditionally, stresses would be defined as natural or man-made disasters, but in the globalized world it must include far more. Resilience is an important aspect of achieving long-term, broad-based economic growth in the developing world. Development practitioners are beginning to recognize that resilience should be strengthened across the full spectrum of programs and projects in order to achieve success. In recent years, the concept of low-carbon, climate-resilient development has emerged as a key way of framing policy and action to address climate change, capturing the need for mitigation and adaptation efforts to be fully integrated into development planning and implementation.

A peri-urban area is an ever-changing zone of both interaction and transition due to its localization adjacent to the edges of the city where many complex socio-economic processes take place. Therefore, its capacity of resilience is mainly influenced by

its input-output dynamics with the adjacent urban area on one hand, and with its following purely rural systems. Building urban and peri-urban resilience to natural hazards and climate extremes first and foremost requires a move away from current reactive approaches and toward the development and implementation of effective local planning and management systems to support better quality of life.

BOX 2.1. Resilience: Key Points

- Resilience is the ability of a system, community, or society exposed to hazards to resist, absorb, accommodate, and recover from the effects of a hazard promptly and efficiently.
- Residual risk and uncertainty have to be managed in a way that is both flexible and robust, using design solutions that build on investments in risk information, strategic communication, cross-sectoral coordination, and a well-planned response and recovery strategy.
- The urban poor are particularly vulnerable to the impacts of climate change and natural hazards due to the location of their homes and livelihoods and the lack of reliable basic services.
- The phases of disaster risk management—mitigation, preparedness, disaster, response, recovery, and reconstruction—each offer practical opportunities to enhance resilience.
- Risk mitigation is part of the resilience approach. With the general aim of increasing preparedness and the capacity to respond to a disaster and swiftly recover from its impacts, resilience goes beyond mere mitigation.
- Risk can be reduced by reducing the exposure and vulnerability of people or assets that are linked to their geographical location, the structure of the built and natural environment, operational and institutional arrangements, and management of the fiscal impacts of natural hazards.
- Social resilience is the capacity of individuals within a community or society to cope with and adapt to disturbances or changes.
- Land use planning and ecosystem management are relatively low-cost "no regrets" approaches to managing disaster risks effectively, especially for small and medium-sized urban centres that lack resources and capacity.
- The resilience of urban infrastructure and services is critically important for emergency response and the quick recovery of a community and its economy. The design of critical systems needs to take into account the possibility of failure through redundant and backup measures so that they can deal with failure in ways that are least damaging to the society.
- Risk information provides a basis for prioritizing risk reduction measures. Sharing hazard and risk information with stakeholders is critical in managing the risks facing urban communities and sectors.
- Creating an enabling environment for communities to participate and make decisions based on adequate risk information and tools fosters the collective resilience of an urban system.

Source: Jha et al., 2013

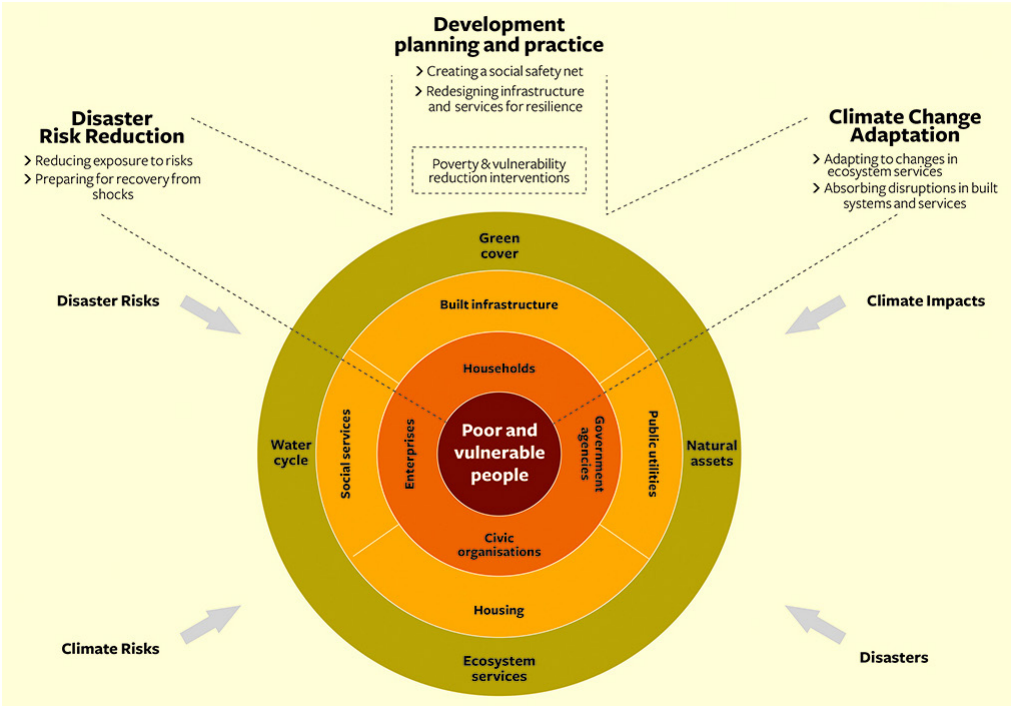

Figure 2.1. An integrated understanding of planning interventions that reduce the vulnerability of people, built assets and natural assets to climate and disaster risks (Source: UNDP / IIHS, 2013).

2.2. Ecosystem Services of Urban and Peri-urban Regions

Natural systems have been referred as humanity's "life-support system" providing essential "ecosystem services" for existence and socio-economic well being (The Millennium Ecosystem Assessment, 2005). Ecosystem services are the benefits that people and communities obtain from ecosystems. These include "regulating services" such as regulation of floods, drought, land degradation and disease, along with "provisioning services" such as food and water, "supporting services" such as soil formation and nutrient cycling, and "cultural services" such as recreational, spiritual, religious and other non‐material benefits. Decline in ecosystem services influence the resources available to the people and hence lead to increasing vulnerability to hazards and decrease the disaster resilience.

The relationship between ecosystems and cities is multi-layer, and is often composed of two-way processes. Ecosystems provide a multitude of physical and environmental services to cities and their residents which also help in enhancing city's resilience. However, the cities, which are rapidly urbanising and experiencing unplanned development is leading to a threatening decline in ecosystems. This is impacting the resilience as being witnessed in several cities. The 'extractive' nature of urbanisation places a low premium on preserving the ecosystem, affecting not only the livelihoods of those directly dependent on it but also the city itself.

BOX 2.2. Special Agricultural Zones

Special Agricultural Zones (SAZ) are special carved out agricultural areas, by Governments, that provides farmers with special technology support for increasing agricultural productivity and to simultaneous increase their income. The State of Uttarakhand in India, became the first state to set up SAZs in 2011.

According to Prof.MS Swaminathan, FRS, peri-urban agriculture provides great opportunity where the land can be converted into SAZ and can contribute to promote food security, economic security, maintain biodiversity, save indigenous knowledge and promote cultural diversity for sustainable and equitable development (Balaji, Jan 4, 2008) and, thus, increase the urban resilience.

Talking of peri-urbanisation highlights on trends leading to usurpation of ecologically sensitive lands for housing and other construction activities. These change the face of agriculture, reduce open spaces and green zones, and enhance pressure on natural resources like water. These areas are marked by a lack of hygiene and sanitation infrastructure, industrial effluence, air pollution and inadequate provision of basic services. The peri-urban areas which provides ecosystem services to urban areas, are become the dumping grounds for urban solid waste, sewerage, etc., which is leading to environmental degradation, groundwater contamination and adversely impacting the livelihoods and the health of people residing in the peri-urban areas.

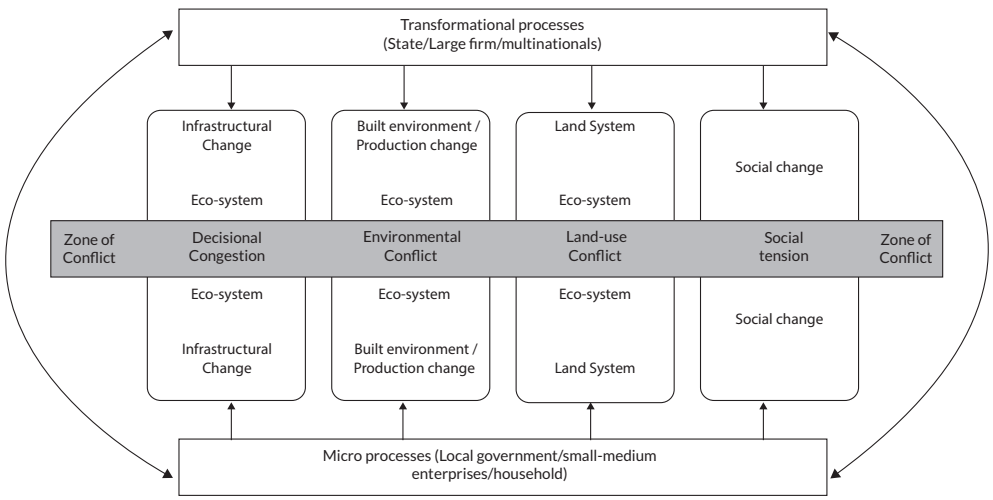

Figure 2.2. Model of decision processes in the peri-urban and extended areas (Source: Mcgee, 2008).

Maintaining the health of ecosystem is crucial to developing the resilience of the urban and peri-urban regions. Changes in ecosystem services affect people living in urban areas both directly and indirectly. Unsustainable urban development threatens the very availability of key services like the availability of water, air and water quality, waste processing, and many other qualities of the ambient environment. Agriculture practiced within urban boundaries

contributes to food security, healthy land and soil is the source of livelihood particularly to vulnerable groups, wetlands in the urban vicinity absorbs extra water and buffers flood, urban parks and open spaces provides recreational and aesthetic values to city dwellers etc. are few services that peri-urban regions provides to the well being of the human kind. Centrality of ecosystems and environmental issues in peri-urban investment decisions and planning is shown in figure 2.2.

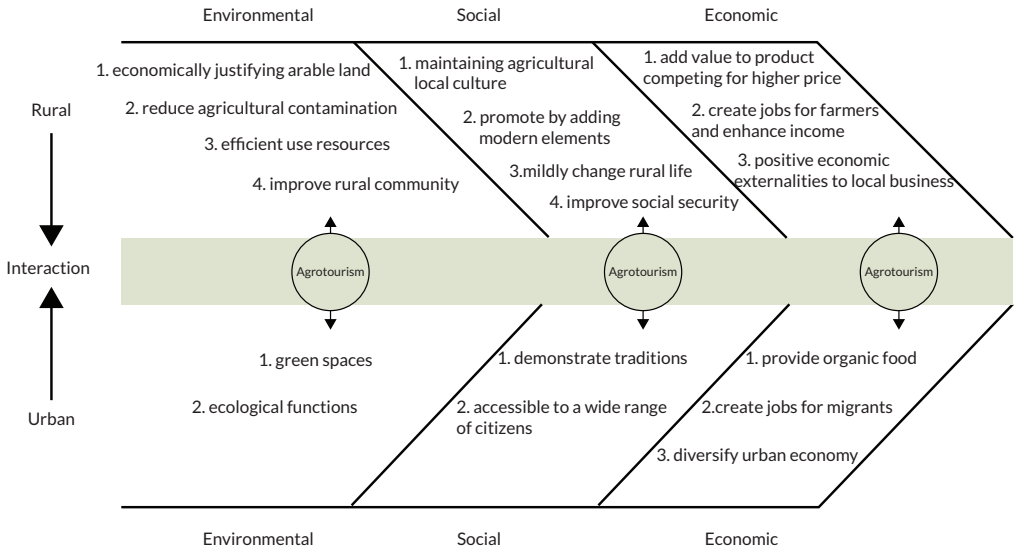

Figure 2.3. Strategic profile mapping of agro-tourism as benefit of peri-urban ecosystems (Source: Yang et al., 2010).

2.3. Urban and Peri-urban Agriculture and Food Security

A resilient city is one that has developed capacities to help absorb future shocks and stresses (Narain et al., 2013;Mitra et al., 2015). Peri-urban agriculture is multi-functional and has a number of ecosystems that provide ecological, social and economic services to the city (Bhatt et al., 2016). According to European Parliamentary Research Service (EPRS), urban and peri-urban agriculture has been defined as the "cultivation of crops and rearing of animals for food and other uses within and surrounding the boundaries of cities, including fisheries and forestry" (EPRS, 2014). Food and Agriculture organization defines Urban Agriculture as "small areas within the city for growing crops and raising small livestock or milk cows for own consumption or sale in near markets". Interestingly, the agriculture in peri-urban areas have more than crop or food production benefits, and agri-tourism on the lines of eco-tourism has a growing trend visible in many countries (figure 2.3, Yang et al., 2010).

Peri-urban agriculture refers to "farm areas close to towns/cities which operate intensive, semi or fully commercial farms to grow vegetables and other horticulture, raise poultry and other livestock and produce milk and eggs" (FAO, 2001). Urban and peri-urban agriculture

particularly in the context of developing countries, play a crucial role in diversifying urban diets and providing environmental services in urban and peri-urban areas (Nambi et al., 2014).

Table 2.1: Ecosystem services of peri-urban agriculture

Provisioning	Regulating	Supporting	Cultural
Dependable access to adequate and nutritious food (food security)	Minimizes the impact of urban heat island	Preservation and creation of green spaces helps in augmentation and sequestration of carbon	Creates urban open space in city edges and provides aesthetic look
Important source of income for urban poor (Economic security)	Helps in absorbing extra water at the time of flood and saves urban areas from inundation		A well maintained peri-urban site provides way for eco-tourism e.g. bird sanctuary.
Less transportation infrastructure require to bring food into the city premises, thus reducing the supply chain			

(Source: Authors)

Cities around the world have adapted pro Urban Agriculture Policies (Sahasranaman, 2016) like the City of Minneapolis, Seattle, Cleveland in Ohio and have supported PUA that not only supplies food to cities but help in shaping urban growth (Brinkley, 2012). Urban Agricultural Policy Plan of Minneapolis city was adopted in 2011 with an objective to build strong local food system and promote healthy lifestyle along with improving community gardens and food markets which sell locally and regionally grown foods (MPLS Plan, 2011). In a developing country like India, The Government had launched a scheme on "Vegetable Initiative for Urban Clusters (VIUC)" during 2011-12 for addressing concerns related to demand and supply side of vegetables, enhancing productivity and encouraging establishment of efficient supply chain in urban and peri-urban clusters (Ministry of Agriculture, 2013). Similarly, under National Mission for Sustainable Agriculture, which is one of the eight missions of National Action Plan on Climate Change (NAPCC) aims at promoting sustainable agriculture by catering three key dimensions, namely, water use efficiency, nutrient management and livelihood diversification (NMSA, 2010).

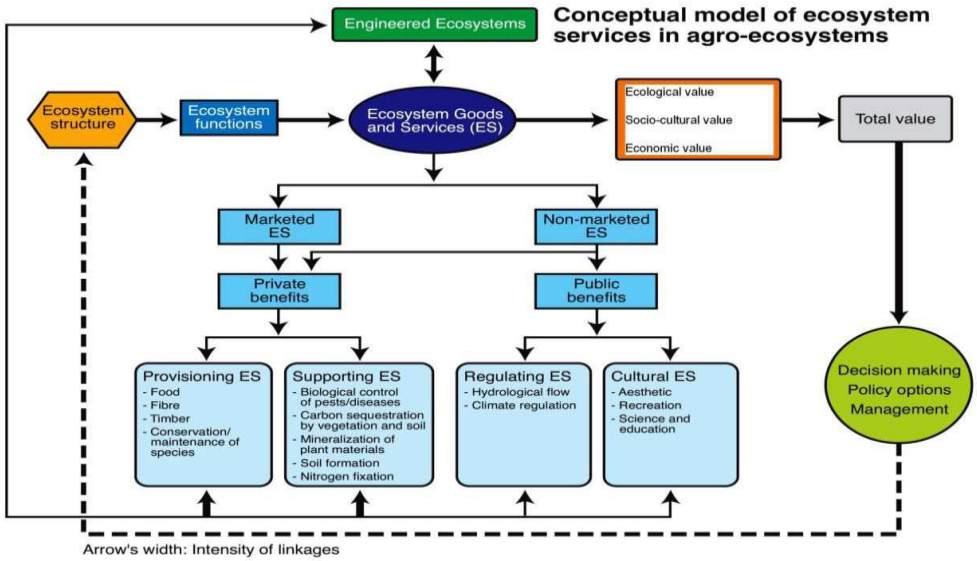

Figure 2.4. Ecosystem services in agricultural landscape (Source: Sandhu and Wratten, 2013).

2.4. Resilience to Natural Hazards

Asia-Pacific region is one of the world's most disaster prone areas and had experienced more than 1600 natural disasters (UNESCAP, 2015) in the last decade which is 40 percent of the global total. Each year natural disasters of varied typology (hydro-meteorology, biological, climate induced disasters etc.) kill thousands of people and causes huge economic destruction. According to the ESCAP 2015 report, out of the total disasters reported in the last decade, approximately 500,000 people lost their life, 1.4 million were affected and $523 billion economic damage was reported.

Healthy and robust ecosystem is one of the best defence against any natural disasters and also contributes towards the resilience (Gupta and Nair, 2012; Singh et al., 2013). However, unsustainable pattern of development along with anthropogenic climate change have weakened the health of these ecosystems. This reduced their capacity of protecting human populations and landscapes from the impact of natural hazards. Approximately 60% of the ecosystem services have been degraded or used unsustainably and protection from natural hazard is one of those degraded services (MEA, 2005). One of the important findings of the report says that in the past 50 years humans have changed ecosystems more rapidly and extensively than in any comparable period of human history which has resulted into substantial and irreversible loss in the diversity of life on earth.

Integrated management of land, water and living resources that promotes conservation and sustainable use provide the basis for maintaining ecosystem services, including those that contribute to reduce disaster risks. Sendai Framework for Action, Sustainable Development

Goals as well as Paris Climate Agreement has laid emphasis on building resilience by protecting natural ecosystems. According to one of the study done in the Mississippi Alluvial Valley in US, restoring wetlands on crop fields result in a net increase of ecosystem services including green house gas mitigation, nutrient mitigation and waterfoul recreation and therefore net benefit to the society (Jenkins et al., 2010). It has been studied that some coastal ecosystems including mangroves forests, coral reefs and salt marshes, help to reduce the risks associated with coastal hazards such as storm surge and coastal flood. Such ecosystem also provide a host of associated ecosystem services which may be lost if natural systems are replaced by built structures (McIvor et al., 2012). A study conducted by the scientists at the University of Delhi and Duke University has shown that coastal villages in Odisha with the widest mangrove belts suffered fewer deaths, compared to those with narrower belts or no mangroves in the devastating cyclone of 1999 (Das et al., 2009).

The State of Louisiana has adopted policy guidelines for using natural wetlands to assimilate nutrients in secondarily treated municipal effluent, thus utilizing ecosystem services of natural wetlands. In addition to water quality improvement, wetland assimilation provides additional ecosystem services, including increased vegetative productivity, surface accretion, and carbon sequestration (Jae Young Ko et al., 2012). The floodplain wetland system provides several ecosystem services, key being regulation of hydrological regimes, groundwater recharge, water quality improvement, support to biodiversity and life support system, effective in flood control, waste water treatment, reducing sediments loads, low input sustainable agriculture, fisheries development, tourism and valuable for educational and scientific interest and recreational benefits. River floodplains have been reported as potential sites to mitigate extreme events in the hydrological cycle (Mitsh and Gosselink, 2000). Figure 2.5 presents an ecological framework on significant of ecosystems in peri-urban and urban systems in reducing hazard factors as well as underlying aspects of vulnerability.

Table 2.2: Mapping eco-technology for hazard mitigation

Ecosystems	DRR Function
Mountain Ecosystem	Vegetation cover and root structures protect against erosion and increase slope stability by binding soil together, preventing landslides.
	Forests protect against rockfall and stabilise snow reducing the risk of avalanches
	Catchment forests, especially primary forests, reduce risk of floods by increasing infiltration of rainfall, and delaying peak floodwater flows, except when soils are fully saturated
	Forests on watersheds are important for water recharge and purification, drought mitigation and safeguarding drinking water supply for some of the world's major cities
Wetlands and floodplains	Wetlands and floodplains control floods in coastal areas, inland river basins, and mountain areas subject to glacial melt.
	Peatlands, wet grasslands and other wetlands store water and release it slowly, reducing the speed and volume of runoff after heavy rainfall or snowmelt in springtime
	Coastal wetlands, tidal flats, deltas and estuaries reduce the height and speed of storm surges and tidal waves.
	Marshes, lakes and floodplains release wet season flows slowly during drought periods
Coastal Ecosystem	Coastal ecosystems function as a continuum of natural buffer systems protecting against hurricanes, storm surges, flooding and other coastal hazards – a combined protection from coral reefs, seagrass beds, and sand dunes /coastal wetlands/coastal forests is particularly effective.52 Research has highlighted several cases where coastal areas protected by healthy ecosystems have suffered less from extreme weather events than more exposed communities
	Coral reefs and coastal wetlands such as mangroves and salt marshes absorb (low-magnitude) wave energy, reduce wave heights and reduce erosion from storms and high tides.
	Coastal wetlands buffer against saltwater intrusion and adapt to (slow) sea-level rise by trapping sediment and organic matter
	Non-porous natural barriers such as sand dunes (with associated plant communities) and barrier islands dissipate wave energy and act as barriers against waves, currents, storm surges and tsunami.

Ecosystems	DRR Function
Dryland ecosystem	Natural vegetation management and restoration in drylands contributes to ameliorate the effects of drought and control desertification, as trees, grasses and shrubs conserve soil and retain moisture
	Shelterbelts, greenbelts and other types of living fences act as barriers against wind erosion and sand storms
	Maintaining vegetation cover in dryland areas, and agricultural practices such as use of shadow crops, nutrient enriching plants, and vegetation litter increases resilience to drought
	Maintaining vegetation cover in dryland areas, and agricultural practices such as use of shadow crops, nutrient enriching plants, and vegetation litter increases resilience to drought

(Source: Modified after Estrella et al., 2012.)

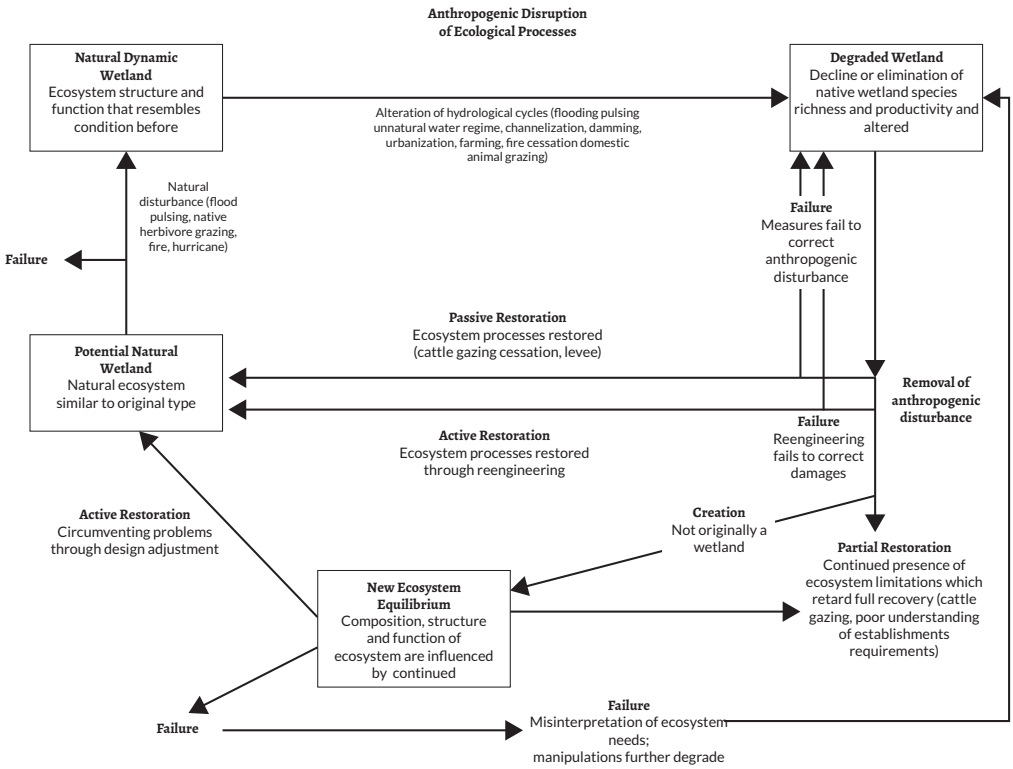

Figure 2.5. Role of ecosystems (e.g. wetlands in ecosystem sustainability and resilience against natural hazards, for example, flooding) (Source: Bene et al, 2017).

2.5. Green Growth Mechanism, Forestry and Carbon Neutrality

Green growth today is an outcome of policy response to the economic and environmental crisis (Dis et al., 2014; OECD, 2015) and owes its conceptual origin to the Asia and Pacific region (UNESCAP, 2014). The impetus on the Green growth concept was given in the United Nations Conference on Environment and Development, popularly known as "Rio+20 conference" in 2012 that encouraged each country to consider the implementation of green economy policies in the context of sustainable development and poverty eradication (UNESCAP, 2014). Global Green Growth Institute, which is an outcome of the conference, is focusing on new model of economic growth, which is founded on the principles of social inclusivity and environmental sustainability. Some of the universally accepted definitions of Green Growth as given by international organizations are as below:

Table 2.3. Definitions of green growth

Organization	Definition
UNESCAP	Growth that emphasizes environmentally sustainable economic progress to foster low-carbon, socially inclusive development.
OECD	Fostering economic growth and development, while ensuring that natural assets continue to provide resources and environmental services on which our well being relies.
World Bank	Growth that is efficient in its use of natural resources, clean in that it minimizes pollution and environmental impacts and resilient in that it accounts for natural hazards and the role of environmental management and natural capital in preventing natural disasters
UNEP	Economy that results in improved human well being and social equity, while significantly reducing environmental risks and ecological scarcity
GGGI	A growth paradigm characterized by balance of economic growth and environmental sustainability

(Source: Compiled from various sources)

Cities are responsible for a significant part of green house gas emission (UNECE, 2011) and thus have a key role to play in the global agenda for addressing the challenge of climate change (Kamal-Chaoui and Alexis, 2009). The main sources of GHG emission attributable to cities are energy use in buildings, electricity supply, transportation and waste generation. Growing and unplanned urbanization will lead to significant increase in energy use and carbon emissions particularly in Asia and Africa where urban energy use is based on carbon intensive energy sources (Nedkov et al., 2016). Green growth and carbon neutral concept in the context of city is an important mechanism that will overcome many challenges with regard to technology, governance and finance (Merk et al., 2012). Urban Green Growth is relatively a new approach in developing countries like India which integrates social and economic objectives with environmental goals (ICLEI-South Asia., 2015). Peri-urban regions see a growing potential for green services through various schemes and missions like Green India Mission, REDD+, social and urban forestry etc. Urban and peri-urban landscapes and green infrastructure

is of key importance as source of range of benefits like air filtration, city climate regulation and carbon storage, connectivity between natural systems and social cohesion (Nedkov, et al., 2016). Reduced Emissions from Deforestation and Forest Degradation Plus (REDD+) is a conservation mechanisms of forests to reduce greenhouse gas emissions caused due to deforestation and forest degradation (Ali, et al., 2010).

Box 2.3: Green India Mission (GIM)

GIM launched in 2014, is one of the eight Missions outlined under National Action Plan on Climate Change in India. The mission aims at protecting, restoring and enhancing India's diminishing forest cover and responding to climate change by a combination of adaptation and mitigation measures. The mission emphasizes on increasing the forest and tree cover by 5 million ha, as well as increasing the quality of existing forests by 5 million hectare in 10 years time period. It not only focuses on carbon sequestration but also on multiple ecosystem services like biomass, biodiversity, water along with provisioning services like fuel, fodder, timber and non-timber forests produce, thus, increasing the options for forest based livelihoods for almost 3 million households. It emphasis on eco-restoration of degraded open-forests, restoration of grasslands and wetlands along with improvement in forest and tree cover urban/peri-urban lands, marginal agricultural lands through agro forestry and social forestry.

Forests are precious national green assets and play a vital role in ensuring ecological security and sequestrating carbon and, thus, reduce the GHG emissions profile of the nation. According to India's State of Forest Report (ISFR) 2015, the total forest and tree cover of the country is 24.16 percent of the total geographical area (forest cover 21.34% and tree cover 2.82%) which is almost 10 percent less than the area designated under National Forest Policy of India, 1988. According to the draft National Forest Policy, 2016; last few decades have witnessed a decline in forest quality, impacts of climate change, intensifying water crisis, increase in forest related disasters including forest fire and decrease in the resilience of forest dependent community. Green India Mission through its various initiatives is determined to improve the India's forest cover as well as enhance annual CO2 sequestration by 50-60 million tonnes by 2020 (MOEF, 2014). The Mission while addressing its goals, also includes a focus on improving forest and tree cover in 0.20 million hectares of urban and peri-urban lands. Engaging urban population with various government plans and schemes of greenery and forestry can improve awareness and willingness (Livesley et al., 2016) to tackle various environmental issues. Green infrastructure, therefore, has to be integrated and mainstreamed into the central planning, governance and implementation mechanisms for urban and peri-urban areas, recognizing the well evidenced benefits in terms of moderation of heat island, flood risk, water scarcity, aesthetics, wind buffers, etc. as shown in figure 2.6.

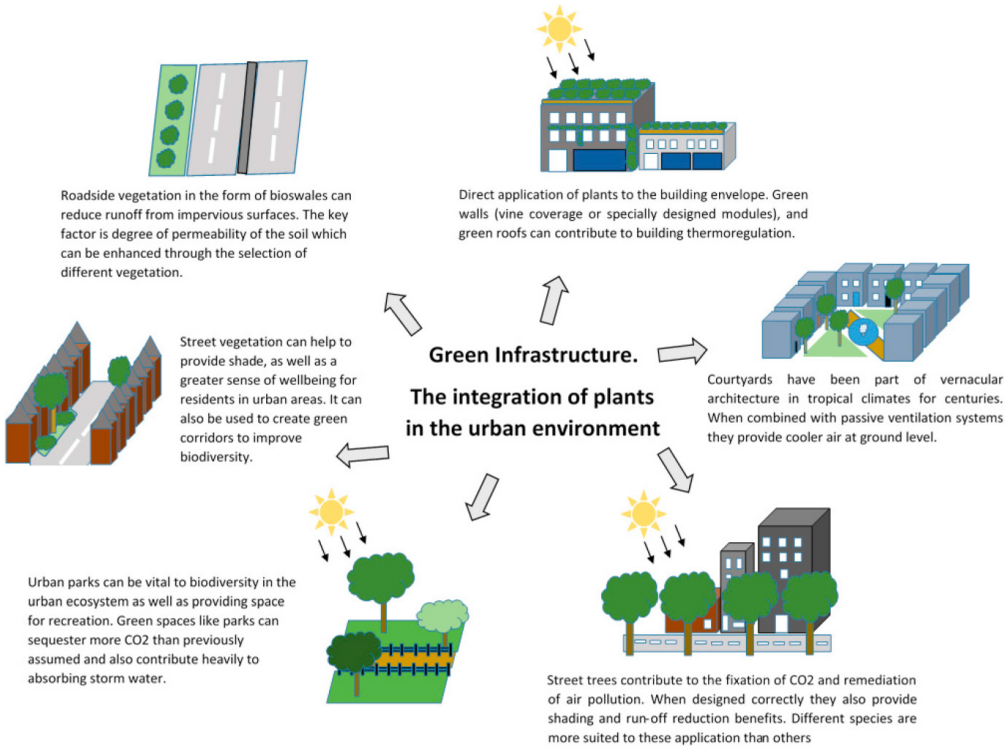

Figure 2.6. Green infrastructure needs and justification science for integration into mainstream planning and urban/peri-urban governance (Source: Wootton-Beard et al, 2016).

2.6. Water Resilience and Sanitation Challenges

Water is a critical natural asset of a nation which is fundamental to life and livelihood, food security and socio-economic development. India supports 17% of the world's population but has only 4% of renewable water resources (National Water Policy, 2012). As the pressures of population growth, urbanization and economic activities converge on water requirement, along with the projected impacts of climate change, the water sector will increasingly face the challenge of bridging the demand-supply gap. In addition, there are challenges of frequent floods and droughts in one or other part of the country causing deaths and destruction on large scale.

Government of India in the Ministry of Water Resources has estimated the country's water requirements to be around 1093 Billion Cubic Meter (BCM) for the year 2025 and 1447 BCM for the year 2050. With projected population growth of 1.6 billion by 2050, the total available water resources would barely match the total water requirement of the country. While, the per capita water availability has declined by 69% from 5200 m^3 in 1951 to 1588 m^3 in 2010, as

per the projections made it will decrease further to 1191 m^3 by 2050. The facts indicate that India is expected to become 'water stressed' by 2025 and 'water scarce'[3] by 2050.

Steady population growth is exerting stress on both surface as well as ground water and crisis will aggravate with changing climate and unplanned urbanization. Strong measures are required to conserve water resources and land conversion as concretization by real states developers is taking away the natural recharge zone of the aquifers. In most cities, water supply is sourced from long distances and the length of pipeline determines the cost including the cost of pumping water. Due to the lack of local resource, water is conveyed from the nearest source to the city. Thus, peri-urban ecosystems play a vital role in providing cities with drinking water as they ensure flow, storage and purification of water (TEEB, 2011). Healthy vegetation and green spaces in the city vicinity influence the quantity of water availability locally.

Urban sanitation is one of the sectors that face the greatest challenge, where the services are concentrated within municipal limits and disposal activities extend into peri-urban areas. Urban sanitation in India faces many challenges. Nearly 60 million people in urban areas of India, still lack access to improved sanitation arrangements, and more than two-thirds of wastewater is let out untreated into the environment, polluting land and water bodies. To respond to these environmental and public health challenges, urban India needs to address the full cycle of sanitation, i.e. universal access to toilets, with safe collection, conveyance and treatment of human excreta.

Considering water and sanitation in the peri-urban settings is critical since arises from the fact that there are social, economic, environmental and institutional interactions between urban and rural areas are captured in this interface. Many of the processes of change in urban-rural flows take place, leading both to problems and to opportunities not only for peri-urban communities but also for the sustainability and resilient development in the adjacent rural and urban systems. The peri-urban interface often acts as an 'environmental sink' for liquid and solid waste from the denser urban core. Urban wastewater can be used for peri-urban irrigation as well as for peri-urban industrial cooling systems. Hence, a broad based integrated water management interventions which build on these problems and opportunities, along the aspects of sanitation, waste management and in appropriate linkages with the public health system is critical.

The peri-urban interface is associated with both rural and urban features and consists of highly heterogeneous and rapidly changing socio-economic groups. Thus, the needs and demands of local populations and producers for water and sanitation services are also quite diverse and change over time. The identification of these needs is more complex than in either urban or rural areas due to the particular mix of newcomers and long-established dwellers, and also because farming, residential and industrial land uses often coexist.

Hence, the peri-urban context in city and its extended areas has to be taken into account it its planning considerations of shifting and growing fringes which have not only historically

3 According to UN-Water, an area is experiencing 'water stress' when annual water supplies drop below 1,700 m^3 per person. When annual water supplies drop below 1,000 m^3 per person, the population faces 'water scarcity'.

provided land (and often livelihoods) to a changing and highly heterogeneous population, including a disproportionate number of poor households and producers, but frequently also provide essential ecological and environmental services to the urban hub, including aquifer replenishment, other sources of water and 'environmental sinks' for liquid and solid waste from the urban core. However, the official data and contents of urban master planning usually tend to exclude these areas, largely because they do not fall within the jurisdiction of the larger, more central and urbanised city lands (Allen et al., 2006).

3 Policies, Pathways and Tools

3.1. Policy Framework for Ecosystem Based Urban Resilience and Adaptation

The world today is experiencing unprecedented urbanization and sprawl due to concentrated developmental activities (Ramachandra et al., 2012) and increased economic opportunities in the cities. Asia Pacific region is presently home to more than two billion urban residents and is projected to rise to 64 percent by 2050 (UNESCAP, 2015). Positively, the phenomenon has raised the living standards of people but with significant negative consequences on natural resources base of the nations (Gupta and Nair, 2012).

Increasing demand and non- sustainable management of resources have increased man's ecological footprint (Meadows et al., 1974; Mathur and Sharma, 2016; Rees, n.d.) that have caused degradation of ecosystem in many regions. Human's have altered various ecosystem services and impacted the primary productivity (MEA, 2005). Desertification and soil degradation have reduced the water and land productivity, decreased water table and has increased the occurrences of extreme climatic hazards (Gupta and Nair, 2012) such as heat waves and erratic rainfall. This has also produced other externalities such as climate change and enhanced green house gas emissions, thus decreasing the resilience of the system. There are significant literatures available to support the fact that ecosystem services are vital for livelihoods (Gupta et al., 2016; Mitra et al., 2015; Gupta and Nair., 2012; MEA, 2005) as well as for resilience to climatic shocks. Thus, there is urgent need to rethink the urban policy in a more holistic way taking the cognizance of regional and local perspectives which is required for sustainable, inclusive and resilient urban future (UNESCAP, 2015).

Sustainable urban development has been gaining global momentum and has become centre point for Sustainable Development Goals discussion (Biggs et al., 2015; UNESCAP, 2015). Ecosystem based approach for urban adaptation and resilience has been very well placed into Sustainable Development Goals 2030. The goal 11 of SDG refers urban ecosystems and emphasizes on making cities inclusive, safe,

resilient and sustainable by implementing integrated policies and plans for resource use efficiency and adaptation to climate change. SDG Goal 13 is related to climate action, while SDG Goal15 talks about life on land that lays emphasis on integrating ecosystem based approach in local planning and developmental processes (UN, 2016).

BOX 3.1. Defining Urban Resilience

Urban resilience may be defined as "the ability of cities to tolerate alteration before reorganizing around a new set of structures and processes" (Alberti et al., 2003).

"Resilient cities in the light of climate change should be able to develop plans for future development and growth, bearing in mind the climate impacts that the urban systems are likely to face" (Prasad et al., 2009).

"Building resilience also means strengthening capacities of social agents to access urban systems and to develop adaptive responses", (Opitz-Stapleton and MacClune, 2012:4).

According to OECD, 2016 policy document, "resilient cities are those able to absorb, adapt, transform and prepare for past and future shocks and stresses in order to ensure sustainable development, well being and inclusive growth. It is made up of seven building blocks-adaptive, robust, redundant, flexible, resourceful, inclusive and integrated." (OECD, 2016).

A resilient city is "one that is able to respond positively to numerous emerging challenges that interact with each other to exacerbate the overall impact, such as climate change, disaster events, rapid urbanization and poverty" (Mitra et al., 2015).

BOX 3.2.SDG Goal 11

The Goal 11(a) of SDG exclusively supports positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional developmental plans (UN, 2016).

The Paris Climate Agreement, 2015 recognized the importance of all level of governments in addressing the impacts of climate change. The Sendai Framework for Disaster Risk Reduction (SFDRR), which has been built on the Hyogo Framework as follow-up, recognizes the importance of local government and decision making in disaster risk reduction (UN Habitat, 2016). UN HABTAT has come up with a National Urban Policy Tool (ibid)) for addressing climate change issues in cities and human settlements. The main focus of the tool is to empower national and local governments, and other stakeholders to effectively develop policy framework to address urban climate change focusing on mitigation, adaptation and urban governance.

Table 3.1. National Urban Policy Tool

Focus	Recommendations
Promoting low –carbon urban development (Mitigation)	Encourage and support the development of local level plans and strategies to reduce greenhouse gas emissions
	(i) Increasingly obtain energy from low-carbon and renewable sources, including via the decentralized or distributed provision of energy, while also (ii) promoting the more efficient consumption of energy
	(i) Encourage development patterns that are more conducive to reduced greenhouse gas emissions, including by minimizing travel distances. At the same time: (ii) promote more sustainable modes of transportation.
	Reduce greenhouse gas emissions by promoting: (i) more sustainable design and construction of new buildings, and (ii) retrofitting of existing buildings
	Make municipal management of solid and liquid wastes more sustainable.
Building Climate Resilience (Adaptation)	Promote applied research into the risks associated with the impacts of climate change, as well as other hazards, in urban areas. Provide for the use of findings to inform decisionmaking
	Encourage and support the development of local level climate change vulnerability assessments that include an analysis of climate resilience and adaptive capacity, to inform policy-making at all levels. Promote multi-hazard assessments.
	Promote the mapping of hazards, including of climate-related hazards that may evolve over time.
	Plan human settlements, regulate land use, and provide critical infrastructure and services in a way that takes into account risks and builds resilience, including climate resilience. To this end, encourage and support local level plans and strategies to build climate resilience.
	Prioritize actions that build the resilience of vulnerable and marginalized communities. When possible upgrade slums and informal settlements in situ so as to build resilience to shocks and stresses, including those brought about by climate change impacts.
	As part of adaptation efforts, promote the protection and restoration of ecosystems and natural buffers.
	Provide for regional planning as one means to protect ecosystems and guard against 'mal-adaptation'.
Addressing Urban Climate Governance	While encouraging local autonomy, coordinate national and local action in addressing climate change in urban areas. Undertake collaborative action when appropriate.
	Provide resources for, and build the institutional capacity of, urban managers to address climate change.
	Promote public awareness of climate change, including of co-benefits and economic opportunities.
	Ensure that national urban policies, laws, regulations, investment plans and so on are fully consistent with national policies for addressing climate change.

(Source: UN HABITAT, 2016).

3.2. Governance and Institutional Mechanisms

Policy frameworks for peri-urban sustainability in relation to urban resilience can not ignore rural-urban and livelihood linkages. Thus, policies at national, sub-national and local level are important. An example of policy fields related to wastewater application, a common phenomenon, in peri-urban areas is depicted in figure 3.1. The peri-urban areas, commonly known as "transition zone" are characterized by not only geographical , but also social and institutional transition (Narain et al., 2013; Saxena and Sharma, 2015). Saxena and Sharma, 2015 have termed these areas as "degenerated periphery" which is largely associated with basic problems like poor infrastructure, low economic activities, poor land use planning, encroachment, waste dumping ground, slums proliferation, legal and law order problem as well as absence of political system. The problem of peri-urban spaces and related ecosystem is largely a governance issue. Though the region provides with various services to the city like fresh food products, labour, water, open spaces etc. but itself lacks attention, at least in the discourse of officials and policy makers in developing countries like India (GEAG Issue Brief-1, 2016). A major challenge in urban and peri-urban contexts is the lack of coordination between various line departments. Forest, land and water bodies are managed by different departments; cities are managed by municipalities and peri-urban areas by Panchayats. In India, there is no separate department for urban or peri-urban agriculture or provisioning of extension services. There is no coordination between different departments in sharing data, nor does a common platform for discussing issues or a coordinated action plan for governance exist (GEAG Issue Brief-1&2, 2016). This is largely because a need to do so has never been felt and we are ok to operate with the age old system that defines urban and rural as different entities ignoring the rapidly thinning line between the two particularly due to technological penetration and growing aspirations of the rural population. Also , while peri-urban areas have long contributed the ecosystem services to urban areas, this is a 20 century phenomena when the urban sprawl has started engulfing the largely rural peri-urban areas and changing the functional as well as physical dynamics of peri-urban areas. Policies have so far been ignorant to these changing dynamics and the need for an integrative governance set up that can look at peri-urban and rurban change and safeguard the interests of these communities, land and ecosystem. Panchayat jurisdiction is not sufficient and effective to resolve the problems of city expansion (Saxena and Sharma, 2015).

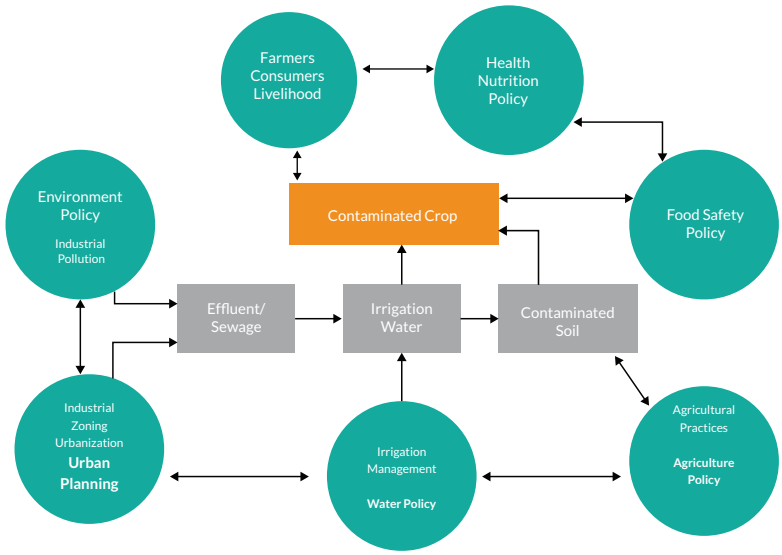

Figure 3.1. Policy attributes and linkages for wastewater application in peri-urban agriculture (Source: Marshall et al., 2009).

BOX 3.3. New Urban Agenda

New Urban Agenda (NUA), which is a set of new global standards for Sustainable Urban Development is an outcome of United Nations Conference on Housing and Sustainable Development, 2016, (Popularly known as Habitat III conference)held in Quito, Equador. The agenda lays emphasis on mobilizing on global community along with focusing on all levels of human settlements, including small rural communities, villages, market towns, intermediate cities and metropolises for social and economic growth. One of the major impetus of NUA is to systemize the alignment between cities and towns and national planning objectives in their role as drivers of economic and social development.

The development in peri-urban areas is generally governed by multiple agencies including Town Panchayat, Panchayat, municipalities, Town and Country Planning and other development authorities. The lack of roles and responsibilities of all such authorities are not clear in these transition zones (Saxena and Sharma, 2015). Peri-urban areas generally lie beyond or between legal and administrative boundaries of central cities, which weakens the capacity of government authorities to regulate economic activities (Narain et al., 2013). Even the examples like setting up of National Capital Region ignored the governance and policy related needs of the transitioning rural-urban interface in particular the peri-urban and urban fringes.

3.3. Developmental Plans and Programs

Various urban ecosystem services, either directly or indirectly are managed by different ministries and departments at national, state and district levels. Matters pertaining to urban development are the responsibility of State Governments as per the constitution of India. The 74th Constitutional Amendment Act has further delegated many of these functions to urban local bodies (ULB) for management at city level. However, Ministry of Urban Development, Government of India, plays an important role in formulating various policies, programs and schemes for urban development in the country. The first central level efforts to provide drinking water in towns and cities were undertaken in Sixth Five year Plan (1979) through Integrated Development of Small and Medium Towns followed by Accelerated Urban Water Supply Program (AUWSP) during Eighth Five Year Plan. Jawaharlal Nehru National Urban Renewal Mission (JnNURM) in 2005 was a landmark shift in urban sector that laid emphasis on the preservation of water bodies, adequate water supply and replacement of old and worn out pipes in 63 identified cities. Urban Infrastructure Development Scheme for Small and Medium Towns (UIDSSMT) is a component of JNNURM and includes all urban infrastructure development including water supply and sewerage in small and medium towns. The other important initiatives in urban water system are Atal Mission for Rejuvenation and Urban Transformation (AMRUT) and Smart Cities Mission (SCM). Some of the important programs and policies having linkages with various ecosystem services have been given in the table 3.2. It should be noted that these are all inherently 'urban' scheme and did not extend to peri urban areas at present.

Table 3.2. Mission/Programs/Schemes of MoUD addressing different urban issues

Programs/schemes	Issues addressed
Atal Mission for Rejuvenation and Urban Transformation (AMRUT)	(i) Augmentation of water supply system, rehabilitation of old water supply system, rejuvenation of water bodies, and groundwater recharge (ii) Universal metering (iii) Review of building by laws which will include formulation of solar policy and action plan for having solar roof top in buildings having an area greater than 500 sq.m and all public buildings (iv) Policy and action plan for rainwater harvesting structures in all commercial, public buildings and new buildings on plots of 300sq.m and above. (v) Energy and water audit (including non-revenue water)
Smart Cities Mission (SCM)	(i) Water management through the use of smart meter, leakage identification and water quality management. (ii) Energy management through smart metering, encouraging renewable sources of energy, energy efficient and green buildings technology. (iii) Convergence with Ministry of New and Renewable Energy for Off-Grid and Decentralized Solar Application Scheme.

Programs/schemes	Issues addressed
Jawaharlal Nehru National Urban Renewable Mission (JNNURM)	(i) Replacement of old and worn out pipes (ii) Water supply (iii) Preservation of water bodies (iv) NRW reduction toolkit developed to check water loss
Urban and Regional Development Plans Formulation and Implementation (URDPFI)	(i) Provisions for Rainwater harvesting (ii) Conservation of water bodies (iii) Improving water supply system (iv) Improving energy efficiency (v) Strategic plan for new and renewable energy and alternate sources of energy to meet the city demand (vi) Smart grid system to check electricity losses
National Mission on Sustainable Habitat (NMSH)	(i) Promotion of energy efficiency in commercial and residential sector by formulation of model building byelaws, Energy Conservation Building Codes (ECBC) and harmonizing it with National Building Codes (NBC), mandating certification of energy performance of all buildings, support for green demonstration projects (ii) Amendment of building byelaws to make rainwater harvesting mandatory in all states (iii) Mandating water audit and energy audit for water utilities (iv) Providing water supply to uncovered area
Urban Infrastructure Development Scheme for Small and Medium Towns (UIDSSMT)-Component of JNNURM	(i) Infrastructure development for water supply (ii) Preservation of water bodies
Public Private Partnership (PPP) Program	Two projects related to schemes related to 24x7 water supply project in Nagpur city is being implemented under PPP framework. The projects are: (i) Schemes related to rehabilitation plan to implement 24x7 water supply project for Nagpur city under PPP framework (ii) lifting water from Pench reservoir to Mahadulla by mortar lined MS pipeline in Nagpur
State Level Benchmarking (SLB)	(i) Identify minimum set of standard performance parameter for the water sector, define framework for monitoring and operationalize the framework in phased manner (ii) Out of 28 indicators, 9 indicators deals with water supply system and include water connections, per capita supply, metering, NRW, continuity of water supply, quality and cost recovery

Programs/schemes	Issues addressed
Scheme for Satellite Towns around seven megacities	(i) Develop urban infrastructure facilities including drinking water under JNNURM (ii) To enhance the sustainability of urban infrastructure facilities by implementing reforms like energy audit, water audit, capacity enhancement for improved operation and maintenance (iii) Formulating building bye laws which shall incorporate provisions for rainwater harvesting, reuse and recycle of waste water
Central Public Health and Environmental Engineering Organization (CPHEEO)	(i) Provide valuable guidelines to PHED, water boards and municipal bodies to supply safe and clean water in adequate quantity and conveniently. (ii) Optimal use of available water resources, prevention and control of water wastage and effective demand management through water conservation practices (iii) Improving water supply management by minimizing losses and wastage and unaccounted for water (UFW) now known as NRW.
International Cooperation	(i) MoU (with The Netherlands) for Integrated Water Resource Management aimed at augmenting supply of potable water, Energy efficient and sustainable built-forms (ii) MoU with The State of Israel in the field of water that include long term planning, development, improvement and sharing technologies; Matters related to quality standards for drinking water and wastewater treatment (iii) MoU with The Federal Republic of Germany for improving energy efficiency (iv) MoU with Japan for water management in urban areas including waste water management

(Source: Ministry of Urban Development. http://moud.gov.in/cms/schemes-or-programmes.php)"

3.4. Master Plans and Land Use Planning

Peri-urban region is witnessing deteriorating quality of environment, loss of biodiversity and diminishing landscapes. The peri-urban areas are not 'the waiting room' (Mitra et al., 2015) or 'lagging areas' (PURPLE, 2004) and therefore, it is pertinent to find a balance between quality of live and urban development pressures. A holistic urban development is not possible without developing the regions around it to maintain steady input/output flow of materials. Thus, there must be a strategic and transformative process to foster sustainable, equitable as well as inclusive development of urban and peri-urban regions. Urban master plans and regional plans are considered to be blue print and needs revisiting by city planners and experts. The approach must be multidisciplinary, engaging experts from all fields as well as communities in the planning and management process. Its high time we start engaging with people who know rural planning and are well aware of the transitioning rural dynamics that have lot of implication on the 'nature' of peri-urban.

BOX 3.4. Land Use Planning

Land use planning is a public policy exercise that designates and regulates the use of land in order to improve a community's physical, economic, and social efficiency and well-being. By considering socioeconomic trends as well as physical and geographical features (such as topography and ecology), planning helps identify the preferred land uses that will support local development goals. The final outcome is allocation and zoning of land for specific uses, regulation of the intensity of use, and formulation of legal and administrative instruments that support the plan. A land use plan may be prepared for an urban area, a rural area, or a region encompassing both urban and rural areas (Source: Trohanis and Geoffery, 2010).

The complexity of urban expansion results in fragmented policy and planning coupled with inequality in investment and unsustainable patter of development (Maheshwari et al., 2014). Due to transitional nature and rapid change in the landscapes the peri-urban ecosystem in our country faces unique challenges. In general, landuse/landcover of the area has great impact on the natural resources of the region. Natural areas like water bodies, forest land and agricultural fields have been converted for township development, habitation and industrial activities. Master plans have failed because they are rigid and obsolete. They lack dynamic planning features and lack monitoring and evaluation of the 'fit' of the land use proposed as compared to rapid expansion and population growth. They have been unable to cope up with the pace of growth of Indian cities. Lack of regional planning approach has led to haphazard proliferation of slums. As per the 12th Five Year Plan of India very few Indian cities have 2030 master plans that take into account basic services like water, sanitation, food, transportation, roads etc. This is the time to move a step ahead from master plans towards an integrated development of "smart cities" which aims at developing the urban ecosystem by strengthening institutional, physical, social and economic infrastructure (Gupta et al., 2016). Peri-urban requires new land tenure models (Armstrong and Lopes, 2014) and innovative agriculture forms that conserve nature, infrastructure and serve communities.

Strategic urban planning of cities directly supports resilience and encourages urban sustainability in many ways. Integrating peri-urban regions in the core planning process have manifold benefits. Planning in a holistic way can reduce population vulnerability to climate change and disaster risks by facilitating improved access to resources, services and amenities (Malhotra and Sharma, 2010).

Ministry of Urban Development (MoUD) has already taken a step by releasing a new Urban and Regional Development Plan Formulation and Implementation Guidelines (URDPFI) in 2015. The objective of this plan is to promote and facilitate planned and integrated urban development in all cities of the country. As per URDPFI guidelines urban and regional planning system has been divided into two parts i) core area planning and ii) specific and investment planning as shown in the figure 3.2.

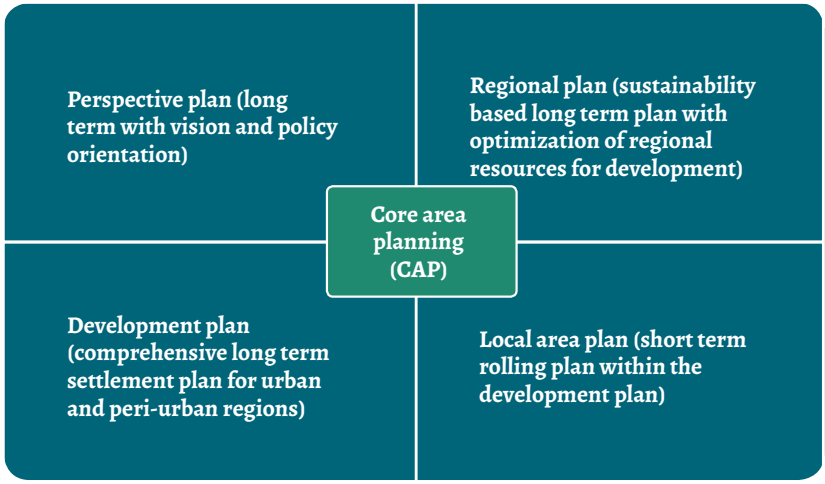

Figure 3.2. Planning aspects for core areas in urban and peri-urban systems (Source: Authors)

Thus, guidelines are intended to comprehensive and reference for various aspects of planning by various stakeholders. Also the fact remains that although URDPFI guidelines acknowledge and guide regional development and peri urban areas, the governance system at present particularly the mandates and jurisdictions of the urban local bodies do not support these action. Hence, cities and towns need to be designed to be compact and connected, with energy efficient transport, green buildings, easy and secure access to water and food.

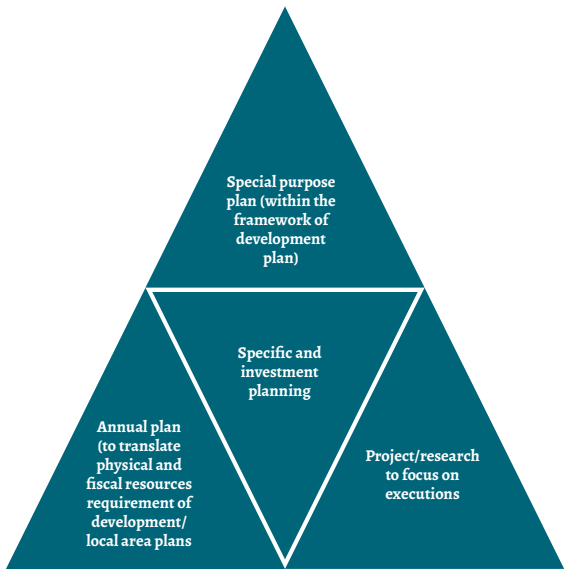

Figure 3.3. Specific and investment planning aspects (Source: Authors)

Case Study 1: Land use change in the millennium city, Gurugram

Gurgaon (Gurugram) is a largest city of the Haryana state of India, which is urbanizing and expanding very fast. With the advent of economic reforms and modernization in 1990s, the cultural and ecological landscape of the city has undergone rapid change. The recent developmental pattern of Gurgaon is attributed to the development of real estate. Many multinational companies in automobiles and software sector have found their way into the city premises due to the availability of high level of infrastructure of airways, railways, highways, medical and educational institutions in its close proximity. There has been huge influx of population largely from neighboring states like Delhi, Uttar Pradesh, Punjab and Rajasthan in the city because of various employment opportunities in retail, information technology, real estate and different other industries.

Trend of Urbanization in Gurgaon

As per the census report of 2011, the total population of Gurgaon is 1.5 million and urban population is more than one million. According to the report of National Capital Region Planning Board (NCRPB), a unit of Ministry of Urban Affairs, the district has seen growth of 73.96% in population from 2001 to 2011, while the same from 1991 to 2001 was 44%. The growth in rural population from 2001 to 2011 is 15.82% while that in urban population is 293.9%. With a decadal growth rate of more than 250%, this increase in population has created a demand for better utility services which has altered the land use change in the Gurgaon city and its peri-urban areas.

Developmental trend and change in land use

The urban pull and rural push factors have changed the land use pattern of Gurgaon significantly, which in turn have changed the socio-economic status of the city. With increase in urbanization, there has been shift from agricultural activities to non-agricultural one. The agricultural land has declined from 78.03 per cent in 1971-81 to 61.11 per cent in 2011 showing a decrease of 17 percent in last five decades.

The acquisition of agricultural land for non-agricultural purposes has brought huge economic transformations in the millennium city. The principal government stakeholders like Town and Country Planning Department, Industrial development corporations, Haryana Urban Development Authority etc. are playing pioneer role in this developmental process. Looking into the population growth and urbanization trend of Gurgaon, the city has been planned for the projected population of more than 4 million by 2031 (Town and country Planning Department, Haryana). According to the Master Plan of 2031, out of the total planned area 49 percent is reserved for residential purpose, 14 percent for industrial, 6 percent for institutional, 5 percent for commercial, 13 percent for transport and communication and 17 percent for other purposes including public utilities, open spaces etc. With the extension of municipal limits, a number of villages have also been incorporated into the master plan.

Landuse - landcover of the area has great impact on the natural resources of the region. Natural areas like water bodies, forest land and agricultural fields have been converted for township development, habitation and industrial activities as evident from the figures above which has huge repercussions on the water resources of the millennium city. The supply does not suffice the present demand and ground water is also depleting at a very fast pace.

3.5. Role of Environmental Impact Assessment and Strategic Environmental Assessment

Although global ecosystem services have been assessed by a number of comprehensive reviews have examined, there were few studies which focused on assessing urban ecosystem services. As more than half of the world's population lives in cities, understanding the dualism of the provision of and need for urban ecosystem services is of critical importance (Haase et al., 2014). Cites and their regions form hubs for people, infrastructure and commerce, requiring extensive resources and putting intense pressure on the environment (Grimm et al., 2008). Urban landscapes are the everyday environment of the majority of the global population (>51 %), including nearly 80 % of European and US citizens, almost 50 % of Asians and >90 % of Latin Americans (UN 2012; Haase, 2014).

Unstoppable increase in the number and size of cities and the ensuing transformation of virgin landscapes on different scales pose significant challenges for reducing the rate of biodiversity loss and related ecosystem functionality and ensuring human welfare. Plants, animals, and microorganisms, that is, biodiversity, is the basis of all ecosystems and the services they provide. However, urban areas also provide a range of benefits to sustain and improve human livelihood and the quality of life through urban ecosystem services (TEEB, 2011). In several instances and as seen commonly, development of physical infrastructure has been promoted at the expense of ecological infrastructure. Hence there is need for local urban authorities to practice environmentally sustainable urban development where the improvement of the quality of life in a city, includes ecological, cultural, political, institutional, social and economic components without leaving a burden on future generations.

There is a need to conserve existing ecosystems like wetlands in which ecological services are improved so that people can enjoy nature, including clean air and water, and even listen to birds sing beautifully. Environmental impact assessment, sometimes called as Environmental Assessment (EA) should be made an integral part of the project approval procedure for local government and other authorities. EA is one of the policy innovations, as an anticipatory mechanism, designed to contribute to the integration of economic, social and environmental concerns in the development process in a balanced way as key to the attainment of sustainable development at or above the project level (Suparb et al., 2008). If applied at the project level, it is termed traditional reactive environmental assessment, while if applied above the project level it is known as strategic environmental assessment (SEA). Rapid urbanization needs to be modified with advance assessment by adopting environmental impact assessments as part of an incremental system to integrate environmental considerations into the planning and approval process of development activities and use the EIA as a major policy instrument within the environmental regulatory system (Sharid and Mohammad, 2004). Environmental Impact Assessment law in China applies it on land use planning and related policy decisions and projects. Such decisions tools will have a direct impact on regional land use patterns, and then affect the regional eco-environmental quality. Currently, the researches on theories and methodologies for environmental impact assessment of land use planning are hotspots in the fields of plan environmental impact assessment. Plan EIA is a process in between the project

EIA and the SEA. The plan EIA offers significant opportunities to recognize the importance and risks associated with the peri-urban ecosystems for the people and their resources in the area, comprising urban and/or peri-urban.

Ecological suitability analysis of land use is a comprehensive application of ecology, earth science, system science, environmental science and computer science to analyze land development and utilization suitability for seeking the best pattern and planning of land use. A more sophisticated practice of analyzing the impact of cities has been developed to calculate the city's Ecological Footprint (Rees, 1992). This utilizes the ecological understanding of how a city extracts food, water, energy and land from a bioregion (and beyond) and requires ecosystem services to absorb its wastes. Besides, EIA, SEA, ecological footprint, other environmental policy tools of assessment like – Life cycle analysis, Natural Resource Accounting, Environmental Auditing, Risk and Vulnerability Analysis, also offer significant opportunities for improving not land-use decisions but the financial – investment, public and private decisions, which will have significant bearing on the ecosystems inside the city jurisdiction and even more on the peri-urban systems.

4 Capacity Needs, Strategies for Urban Resilience and Sustainability Through Peri-urban Ecosystems

Urbanization in present times is mostly driven by unsustainable pattern of resource use, energy extraction and change in land use pattern, with social and political aspirations in the backdrop besides lack of inadequate understanding on techno-legal regime and wider gaps in implementation target versus ground realities. As per the UN 2016 report one in every three people will live in cities by 2030. With this growing trend, unplanned urbanization, especially in developing countries of Asia and Africa, will pose new challenges for socio-economic and environmental well-being, jeopardizing the very essence of sustainable development and inclusive growth. In this context, developing capacities of different stakeholders for understanding peri-urban spaces and its linkages with developmental parameters is very essential.

Sustainable Urban Development is only possible by identifying gaps in the existing process and systems and developing capacities of the same. The several milestones achieved post 2015 at global level emphasizes on systematic approach towards long term capacity across governance, institutions, inter and intra departmental levels and various stakeholders including communities to deal with various uncertainties. The table below highlights rationale for capacity development as per international conferences and seminars.

Table 4.1. Understanding international perspectives on the importance of capacity needs and training related to Sustainable Urban Development

International Conferences	Overall development agenda	Major highlights with reference to cities and urbanization and capacity development
United Nations Sustainable Development -2015	Popularly known as 2030 Agenda for Sustainable Development, recognizes strategies to build economic growth by addressing social needs, talking climate change and environment protection.	Goal 11.3. talks about sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management Goal 11.A. Support socio-economic and environmental links between urban, peri-urban and rural areas by strengthening, national and regional development planning Goal 13.1 talks about strengthening resilience and adaptive capacity to climate related hazards and disasters Goal 13.3. emphasis on building institutional capacities on climate change mitigation and adaptation
United Nations Framework Convention on Climate Change, 2015	Popularly known as Paris Agreement, provides a roadmap for climate actions that will reduce emissions and build climate resilience.	Recognizes the importance and urgent need to enhance the provision of technology, finance and capacity building support to mitigate climate change at global level
Sendai Framework for Disaster Risk Reduction-2015	Recognizes the role of state to reduce disaster risk by involving other stakeholders including local governments and private sectors with seven targets and four priorities for actions	Priority 2 of the framework particularly talks about strengthening disaster risk governance to manage disaster risk at national, regional and global level by fostering collaboration and partnership
Montreal Declaration, 2017	Aims to address local and global issues related to cities and effectively implement the Paris Agreement on Climate Change	Commitment by urban governments and cities mayor of the world towards implementation of Paris Agreement on climate change, New Urban Agenda, Goal 11 of SDGs safe, resilient and sustainable urban world.

International Conferences	Overall development agenda	Major highlights with reference to cities and urbanization and capacity development
United Nations Conference on Housing and Sustainable Urban Development-2016	Popularly known as Habitat III conference highlighted the important challenges of cities, towns and villages related to planning and management and their contributions in achieving SDGs. The party adopted the New Urban Agenda (NUA) for achieving sustainable urban development	Emphasis on people centered, gender responsive and integrated approaches to urban and territorial development by implementing policies, strategies, capacity development and actions at all level. NUA recognizes the importance of effective implementation through strengthening the capacity of sub national and local governments to manage resources of urban, metropolitan and territorial concerns.

(Source: Compiled from various sources).

4.1. Rationale capacity needs at National level

Unplanned urbanization, deteriorating ecosystem, frequent disasters and the coping capacities have identified the gaps in the existing process and systems of various stakeholder groups. Increasing intensities of climate induced disasters and related impacts of climatic variability pose additional challenges to development and overall wellbeing of communities (Gupta et al., 2016). Looking into the capacity gaps, a systematic approach towards long term capacity building across governance levels and stakeholder groups is required. Various environmental and disaster management plans, policies and acts emphasizes on the need of the capacity building of different stakeholders. National Action Plan on Climate Change 2008, National Environment Policy 2006, Disaster Management Policy 2009 and National Disaster Management Plan of 2016 has specific provisions of capacity building related to urban and peri-urban ecosystems. National Disaster Management Plan of 2016 is one of the recent and excellent planning frameworks of India in the field of disaster management. The plan has been align with the Sendai Framework of Disaster Risk Reduction 2015-2030, Sustainable Development Goals and Paris Agreement on Climate Change and places enormous emphasis on improving the governance of disaster risk reduction and climate change adaptation. Capacity development has been incorporated as an important theme across all the thematic areas of action and includes training programs, curriculum development, awareness, mock drills and large scale disaster response exercises.

Need of capacity assessment, resource mobilization, training, education and information, is therefore, core agenda for in-making paradigm on sustainable urban development. Higher education and research/innovation capacities are the basic requirements for evolution of discipline from theories to practical solutions, development of professional expertise, trained professionals, and soundness in decisions and actions. Organizations and reorganization of systems, framework, tools, mandate, accountability and authorities at various levels also form part in the capacity building for the sustainability of efforts (Concept note, NIDM). The components of capacity building and trainings have also been envisaged in policy, act and various guidelines of National Disaster Management Authorities (Gupta et al., 2016).

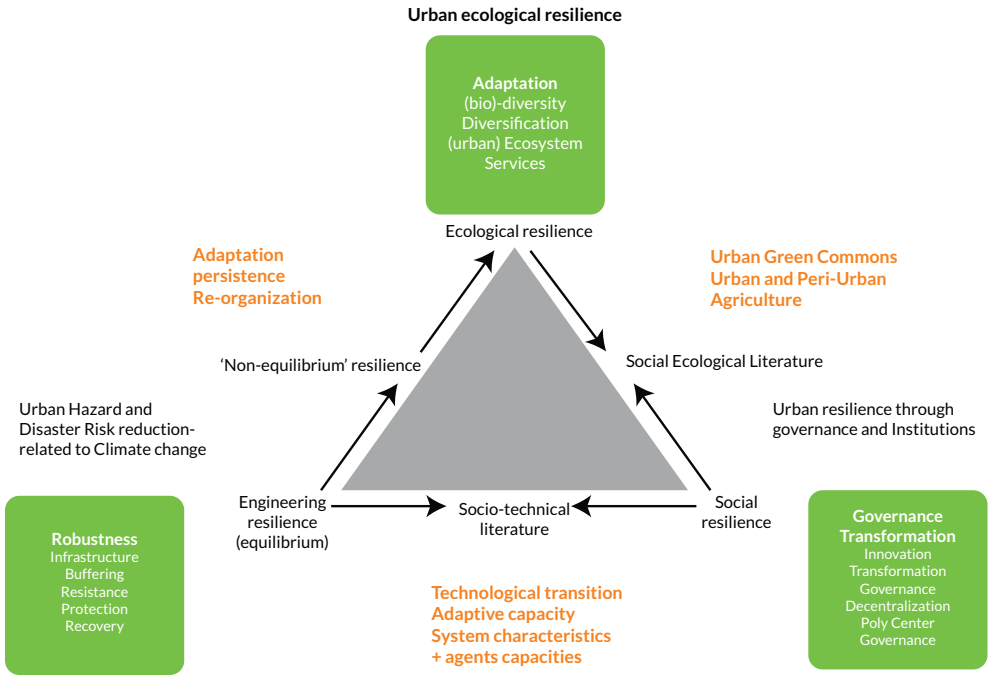

Figure 4.1. Static map of the resilience narratives related to urbanization (Source: Béné et al., 2017).

4.2. Strategic areas for capacity development and training needs

There is a need for sector specific trainings in respect of urbanization, ecosystem based CCA and DRR for the stakeholders at different level as expressed through figure 4.1. The sector specific training strategy could be as below:

Table 4.2. List of training needs related to Sustainable Urban Planning

Nature/type of training	Training needs related to CCA-DRR
Sensitization/ Awareness Generation	• Periodic conduct of awareness and sensitization programmes on urbanization, DRR & CCA issues at State, Deptts, District, Sub-Division, Block and Panchayat levels. • Programme on the basics of Urban ecosystem
Trainings on Generic topics	• Ecosystem based climate change adaptation and disaster risk reduction • Environmental Health with respect to Disasters, Emergencies and Conflicts • Legal framework and policies for Disaster Mitigation and Management • Integrating Climate Change Adaptation and Disaster Risk Management • Urban Risk Management • Housing and Personal Safety and Local Emergency Preparedness
Trainings on specific tasks	• Low cost and disaster resistant housing construction • Forestry and Disaster Management • Impacts of Natural Disasters on Wildlife and Mitigation Strategies • Landslide mitigation by modern techniques including bioengineering • Forest Fire Management for Joint Forest Management Members • Emergency Management for Dams and Reservoirs • Water and Sanitation Management with respect to post disaster response • Conducting Hazard Risk Vulnerability and Capacity (HRVC) assessment with respect to DRR & CCA
Specialized trainings on Cross Cutting themes	• Gender and urbanization • Mainstreaming of DRR & CCA in Development Planning • Geo Informatics and urbanization • Ecosystem Approach in Mitigation and Management of Hydro-climatic disasters • Climate Change and Disaster Management • Integration of Disaster Risk and Climate Change Resilience in urban and rural Development Policies & Programmes • DRR strategies for sustainable development – planning and policy instruments • Creation of culture of safety through Knowledge and Education • Forestry as livelihood in climate change adaptation • Use of solar energy as climate change adaptation • Climate Change and Impact of Vector borne diseases

(Source: Based on Training needs assessment of Tripura State (draft)).

Table 4.3. Strategic areas for capacity needs (market oriented approach)

Intervention models	Training need and intervention areas
Rural Perspective-Localized actions from a rural perspective	Decentralized water and sanitation Land-based livelihoods Rural-urban economic enterprises Natural resources management
Regional perspectives	• Rural-urban market information • Food supply and distribution to cities • Urban and peri-urban agriculture • Urban impacts and ecological foot print on various ecosystems
Urban perspectives	• Urban planning and management systems • Land use and transport • Land regularization and housing • Urban agriculture and green spaces • Infrastructure and sanitation • Health, pollution and disaster management

(Source: Adapted (with changes) from Allen 2011).

5 Case Studies

5.1 State of Peri-urban Ecosystems in Gorakhpur, Uttar Pradesh- GEAG Experience

GEAG has been working in the peri-urban areas of Gorakhpur on conserving agriculture and ecosystems for building urban resilience under the ACCCRN initiative of the Rockefeller Foundation.

Brief profile of the city: Gorakhpur, a secondary city, located in eastern Uttar Pradesh at the confluence of rivers Rapti and Rohin, has grown rapidly into an economic and institutional hub in the region. Its proximity to Himalayas has made the city susceptible to floods and water logging due to multiple factors such as bowled shaped topography and lower riparian city of river Rohini, due to which there is discharge of excess water from adjoining country Nepal. These problems

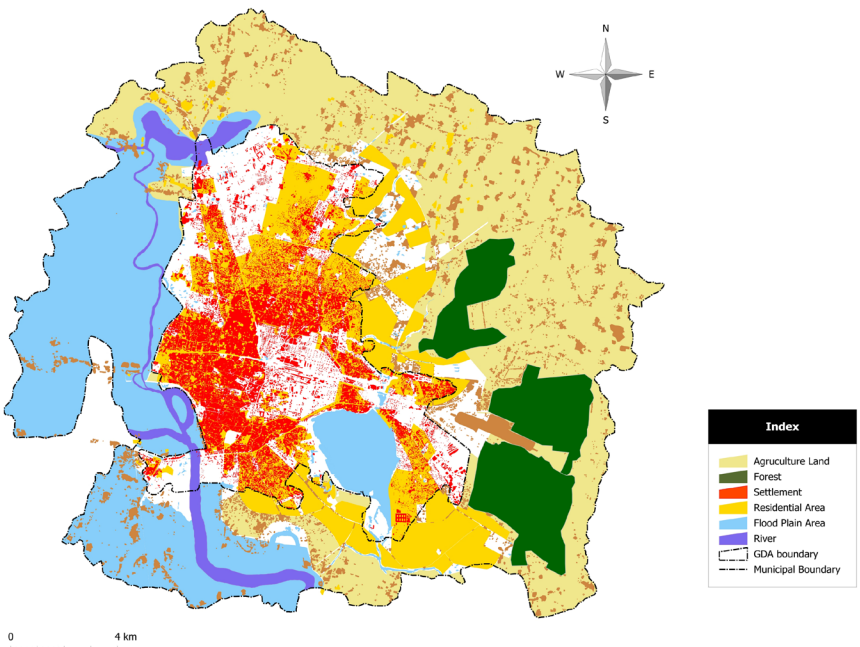

Figure 5.1: Gorakhpur city and its periphery

are further exacerbated by climate uncertainties, impacting the livelihoods of poor and marginalized communities. Climate projections have indicated that the intensity of extreme rainfall in Gorakhpur is likely to increase in the coming years causing significant flooding in the city. Climate change is likely to increase the intensity of similar rainfall events by 10 to 20% in the future. The peri-urban areas of Gorakhpur are particularly prone to recurring floods and waterlogging for 2 to 3 months every year due to which small and marginal farmers suffer from crop losses.

Problem locale in the city: In the peri-urban areas of Gorakhpur, 8089 hectares of land is prone to flood. This is in the western part of the city and gets inundated every year. In spite of flood plains and being a no construction zone, the rapid encroachment is being manifested in many parts. As per the satellite images of two-time period (2002 and 2015), 267.42 hectares (33%) of land has been converted into built-up area. The north, north-east, east and south-eastern part of the city periphery are free from water logging and flood. This segment accounts 11558.17 hectares which is marked as agriculture land/green land. The city is growing in this direction. Due to rapid urbanization, the land mafias (builders) are more active in this zone and converting the open spaces/agriculture lands into residential area. The rapid urbanisation occurring in Gorakhpur is straining the natural resources and is

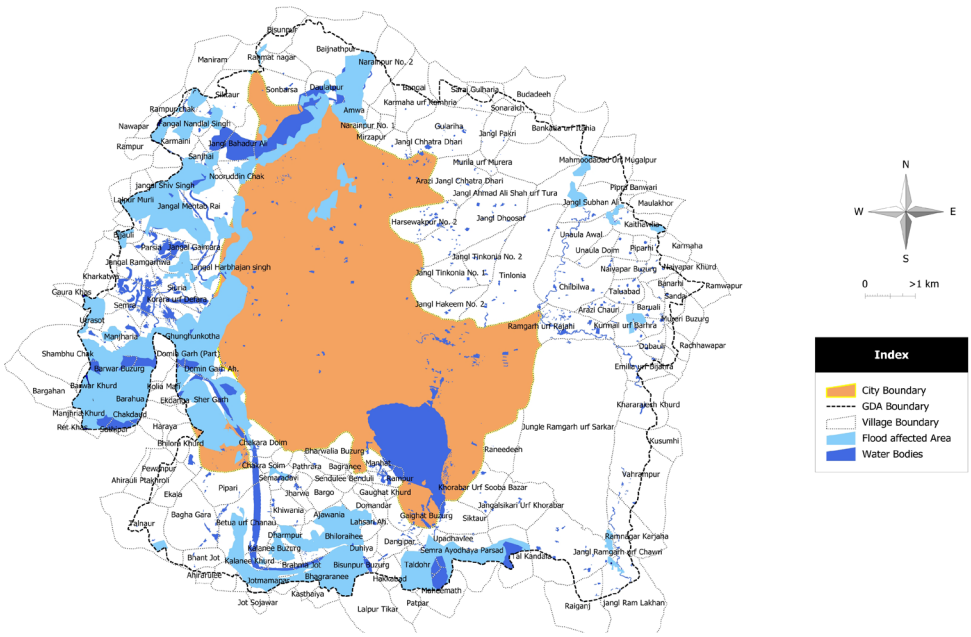

Figure 5.2: Peri-urban Gorakhpur - flood affected areas

absorbing the existing agricultural land on the periphery of the city leading to decreased green/open spaces, interrupted supply of food items to cities, disrupted livelihood patterns, and reduced natural drainage of excess storm water. Large scale conversion of agriculture land for non-agriculture uses is exacerbating climate change risks by increasing water logging and run-off.

About 54% of the peri-urban area represented in the Gorakhpur city Master Plan-2021 for agricultural use, has a population of 0.1 million of which a significant proportion belongs to small and marginal farmers' category. These farmers are hit by several problems of flood and waterlogging, sewage dumping, increasing cost in agriculture, changing land use patterns and governance issues which make them socially and economically vulnerable.

The peri-urban spaces had provided vital ecosystem services such as recharging water bodies and acting as buffers. These services, and their contribution to the city's resilience, are being lost. Supporting services, including nutrient dispersal and cycling, seed dispersal, and primary production have been altered, changing the nature of all other services. The people in Gorakhpur's peri-urban villages now increasingly rely on the market for food and medicines and other goods. There is an acute fuel shortage, leading to reliance on expensive sources of energy and electricity.

The solution: Peri-Urban Agriculture – Strategy for Building Urban Resilience in Gorakhpur

GEAG undertook the initiative which sought to mitigate flood risks through maintenance of open spaces by strengthening peri-urban agriculture based livelihoods around the city of Gorakhpur. While the initiative aimed at enhancing incomes and increasing food security for low-income residents, it also targeted to influence citywide land use planning decisions towards the goal of developing greater flood resilience. Today, peri-urban agriculture in Gorakhpur city of India represents a practical mechanism for diversifying urban livelihoods, particularly those of poor and marginalised communities, ensuring the availability of local food supplies, particularly vegetables and fruits and maintaining open areas that can serve as flood buffers. The land use pattern and ecosystem services in these areas are maintained to promote climate resilient peri-urban agriculture with innovative methods. This has resulted in securing livelihoods of small and marginal farmers, enhancing agricultural productivity and ensuring urban food security.

5.2 State of Peri-urban Ecosystems in Jorhat, Assam

Jorhat is a secondary city located in the north-eastern part of Assam. The city is located on the Bohgodi and Tarajan rivers which are tributaries of river Brahmaputra. Jorhat is one of the fastest-growing cities in Assam. The peri-urban areas of Jorhat are particularly prone to recurring floods and water logging for two to three months every year, because of which small and marginal farmers suffer from crop losses. Climate change is likely to increase the intensity of similar rainfall events by 5-10 % in the future. Climate projections have indicated that the intensity of extreme rainfall in Jorhat is likely to increase in the coming years, which will cause

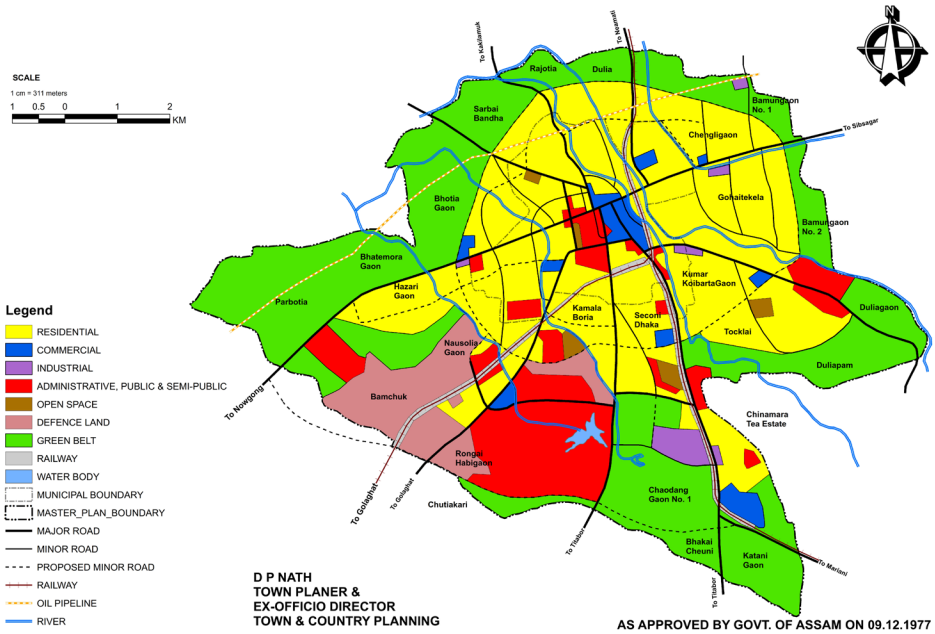

Figure 5.3: Jorhat city and its periphery showing green

significant flooding in the city and peri urban areas. Flooding occurs in most of the village which are in low-lying areas.

Between 1962 and 2005, major land use changes have taken place both in residential and commercial areas in Jorhat Municipal Area. The vacant land decreased from 87.35 hectares to 39.88 hectares. In case of roads and railways, the land area has increased from 55.95 hectares in 1962 to 81.78 hectares in 2005. The area under parks and playgrounds has decreased from 15.39 hectares to 14.09 hectares.

Similarly, vacant land meant for open and green areas and water bodies have also decreased. All these land use changes are mainly due to urbanisation and new settlements. It is observed that covered areas have increased at a faster rate, which ultimately reduced the capacity of surface flow. As a result, surface water accumulates more and rushes to depressed areas resulting in waterlogging in the city.

The following table presents the current situation of peri-urban ecosystems in Jorhat, which is alarming:

Table 5.1. Peri-urban ecosystems in Jorhat, Assam

Ecosystem	Current Situation
Water bodies	Before 10-15 years, 60-70% of the households in villages had their own waterbodies like ponds but they are only left with presently 30-32% water bodies. The main causes for decreasing of water bodies are the contamination of ponds, high land value, climate change (less rain fall), urbanization pressure.
Bamboo plantation	Bamboo and wood was rampantly used to construct houses a decade ago but now mainly RCC structures are being constructed. This is due to lack of bamboo availability and bamboo plantation area in the peri-urban areas has reduced by 30-35%.
Forest	The forest cover has also reduced because of constrictions taking place which has also impacted the natural habitat for animals.
Tea estate	No change in land use
Horticulture/ orchards	Old plantation cut and sold out for housing and commercial buildings.
Agriculture	Rain fed farming, only rainy season crop harvested (paddy), mainly grown for own consumption of farmers.
	No irrigation facility in the all peri-urban areas; only some parts have the facility of Government deep bore wells (approx. 8-10% crops receive irrigation services and the rest 90% crops depend on rain water)
	No market oriented farming practices in the areas
	Farmers are not aware of other farming system like integration farming and other climate resilience techniques.

(Source: GEAG, 2016)

Peri-urban agriculture in Jorhat is also facing threats of land use change and distressed selling of land because of low income from agriculture. The ecosystems are also shrinking which used to provide much of the inputs at no cost for agriculture. GEAG is working with the peri-urban farmers in Jorhat and supporting them in learning new techniques of low external input and climate resilient agriculture, tea gardening at small scale for small land holding small and marginal farmers, integrated farming systems with combinations of crop-horticulture, horticulture-fisheries, animals-fishery-crop, growing high value crops like vegetables, citrus fruit cultivation, increasing crop diversity, and so on.

5.3 State of Peri-urban Ecosystems in Basirhat, West Bengal

The peri-urban areas of North 24-Parganas are experiencing rapid urbanization due to the neighbouring Bangladesh border. With the spread of urban sprawl, a drastic change in land use land cover and socio-economic environment has been taking place. Huge migration and rapid urbanization has resulted in the loss of critical ecosystem services. The city is also witnessing a clear impact of climate change in the form of erratic rainfall, high temperatures and humidity, impacting lives and livelihoods of people. Some of the key changes witnessed in

the peri-urban ecosystems of Bashirhat are that, that rapid land use change is taking place and in the last 10 years, 5-8% of agriculture land has been converted to residential buildings. There is a huge shrinkage in water bodies due to rampant encroachment and about 30% ponds are contaminated due to hybrid fish rearing. Drinking water is a major issue impacting health of the urban poor people.

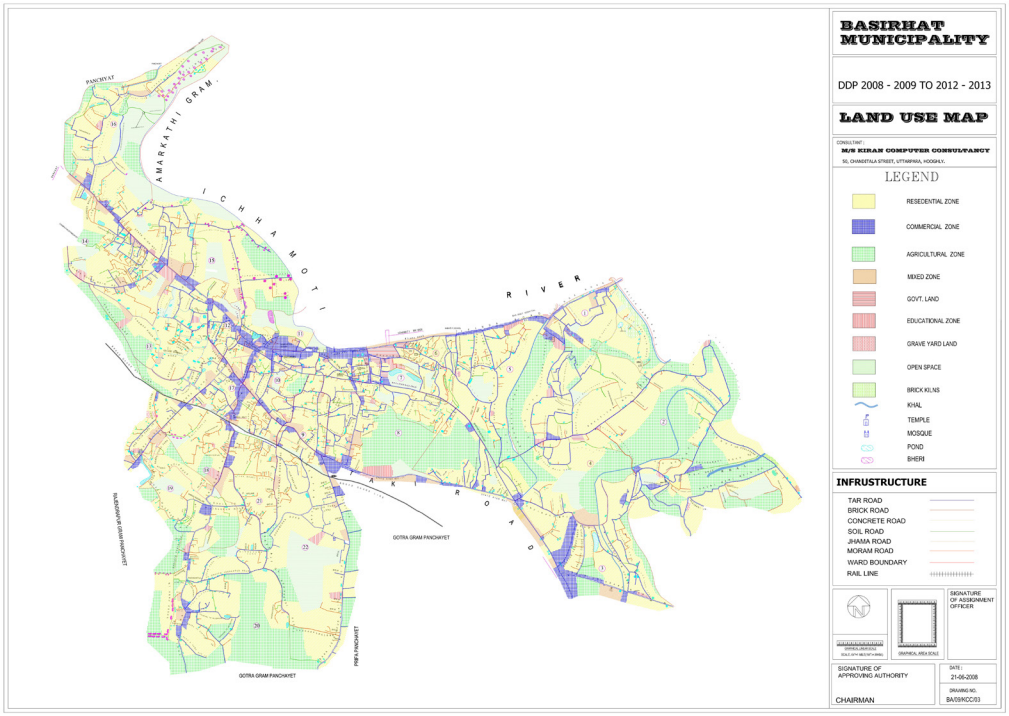

Figure 5.4: Basirhat Municipality demarcating green

The current problem in Basirhat peri-urban area is the reduction in the area for agricultural activities and continuous waterlogging, impacting the flood resilience of the city. One of the main reasons behind these two problems is that people have shifted from traditional fishing practices to rearing hybrid fish in the last decade or so. Earlier, the fish which was in demand locally was bred but now people have started rearing catfish as that is more commercially viable. Catfish is usually reared in dirty water which contaminates the environment and the groundwater.

5.4 State of Peri-urban Ecosystems in Saharsa, Bihar

Saharsa is a city and a municipality in the Saharsa district in the state of Bihar in the north of the country, east of the Kosi River. It is the administrative headquarters of the Saharsa District, and is in the Kosi Division. Saharsa is also the name of the assembly constituency, which contains the city and neighbouring parts of the district. Saharsa and its surrounding areas are a

flat alluvial plain forming part of the Kosi river basin. This makes the land very fertile. However, frequent changes during the Kosi, one of the largest tributaries of the Ganges, have led to soil erosion. Saharsa is hit by floods almost annually, causing a significant loss of life and property. In Saharsa district, the main problems of the people are poverty, unemployment, and literacy. The Kosi floods of 2008 have been a landmark event in the history of disasters in Bihar.

The land use pattern in the peri-urban area of Saharsa is mostly agriculture which is degrading at a very fast pace. As per the land use data of Saharsa, approx. 47.19% of the area is declared as open space which comprises of 37.58% agricultural land, 2.26% water bodies and 7.35% open space. In Saharsa, a lot of the poor population reside on the fringes of the city, between the embankment and the river Kosi. Most of the construction is taking place in the open lands of peri-urban areas for safe houses which can protect people from floods. People occupy hazardous low lying flood prone areas as these are relatively cheap or less restricted, and on the other hand, the encroachment on open lands and natural ecosystems is furthermore increasing the flood vulnerability of the city and aligned areas. Another critical factor degrading the ecosystems in the peri urban areas of Saharsa are the brick kilns. There are about 125 brick kilns in the peri urban area which are degrading the top soil, causing erosion, and encroaching over the open spaces.

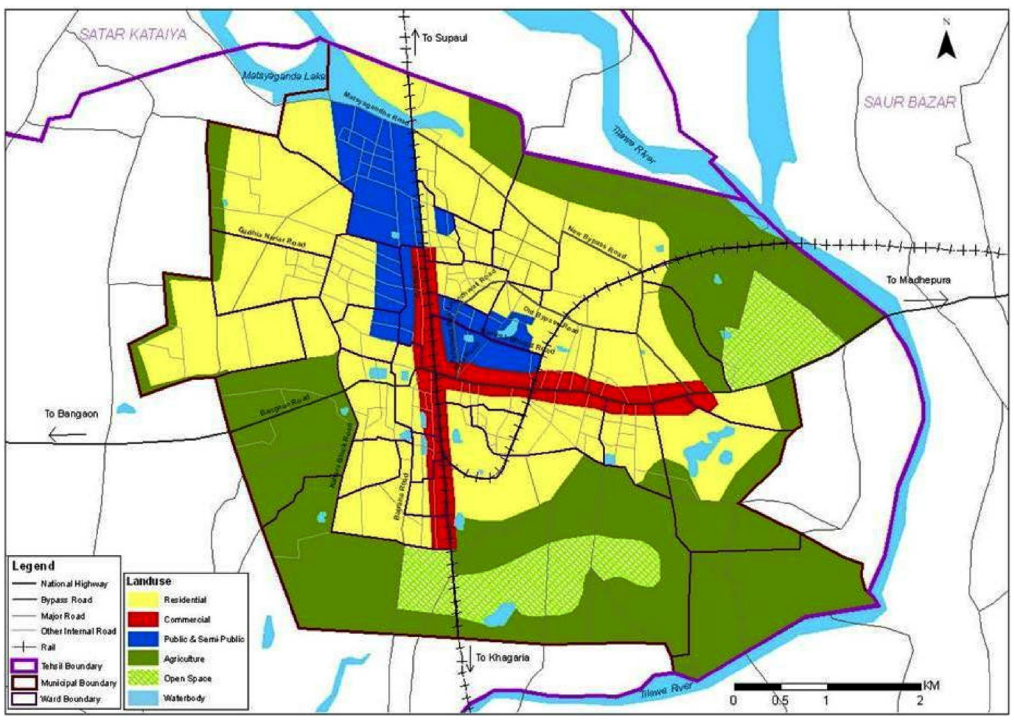

Figure 5.5: Saharsa Land Use

Climate resilient agriculture is being promoted in the peri-urban area to ensure farmers with better livelihoods and to enhance the resilience of the city by conserving open and green spaces.

5.5 Local Specific Case Study

Ecosystem Services for Disaster Risk Reduction: Wetlands of Okhla Bird Sanctuary, Delhi

Wetland ecosystems are part of our natural wealth. According to Ramsar Convention, they provide us with services worth trillions of US dollars every year entirely free of charge making a vital contribution to human health and well being. Wetlands are one of the most productive ecosystems of the world which along with supporting unique flora and fauna provides range of ecosystem services (MA, 2005). Wetland ecosystems also contribute to reducing disaster risk by serving as natural protective barriers or buffers and thus mitigating hazard impacts (Gupta and Nair, 2012). Well managed ecosystems can provide natural protection against common natural hazards, such as landslides, flooding, wildfires, storm surges and drought (Rieux et al., 2009). Ecosystem decline increases disaster risk both by reducing the ability of an ecosystem to act as a natural buffer, as well as by reducing people's resilience by reducing their bases for livelihoods such as food, medicine and construction materials (ProAct Network, 2008). A study was conducted to understand the role of wetland ecosystem in East Delhi to analyse the present state and the services provided by these systems. The study also analyses the role of ecosystem in reducing the risk of water and climate related disasters like flood, drought and epidemics. Besides this, the study is an attempt to analyse the importance of these services and suggest various opportunities for protecting these ecosystems and challenges in Delhi and its vicinity.

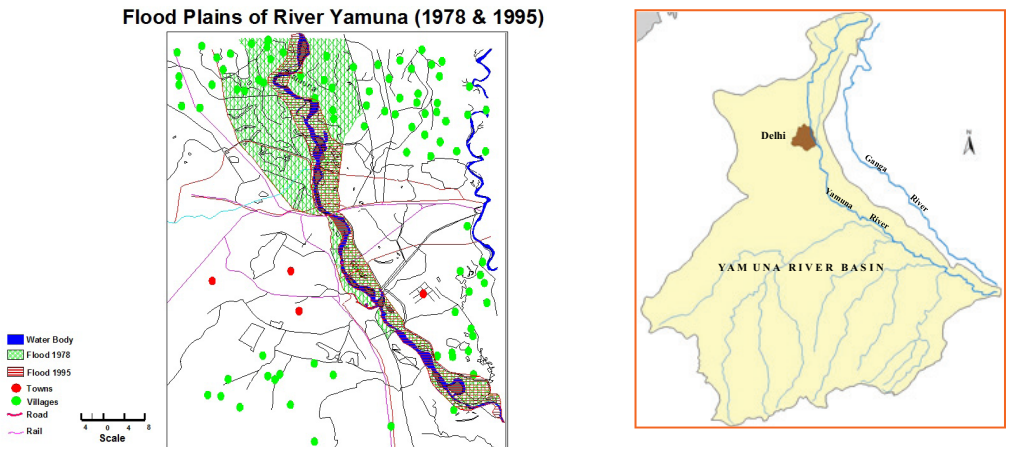

Figure 5.6: Flood plains of river Yamuna and Yamuna river basin (Source: Singh et al., 2013)

The Case Study Area

Delhi, the capital city of India lies between 28.38^0 N and 77.12^0 E in latitude and longitude respectively. The River Yamuna (Fig 5.6), a major tributary of Ganges, is one of the key natural infrastructures of Delhi city. The total length of the river in the city is 50 Km between its entry at Palla and exit at Jaitpur. Its floodplains extends to an area of 94.84 km^2 comprising forests, agriculture land, settlements and lakes/ponds and can hold lot of water-about 2 billion cubic meters. The maximum width of the active floodplain is observed near Okhla where a large quantum of water is brought through Hindun cut. Despite high urban stress, the floral diversity of the floodplains include 74 species of macrophytes and 90 species of phytoplankton, whereas the faunal diversity constitutes 62 species of zooplankton, 55 species of benthos, 36 fish species and 131 bird species (*Source: Wetland International-South Asia)*.

Delhi region has suffered major floods during 1924, 1947, 1967, 1971,1975,1976,1978, 1988, 1993, 1995, 1998 and 2010. The 1978 was the worst ever flood in Delhi when water Level reached at 207.49 m (danger level is 204.83 m) with discharge 2.53 lakh cusec at old Railway bridge (7.0 lakh cusec discharge was released from Tajewala) when130 villages and 25 urban colonies in Delhi were submerged in water. As per the map of flood prone areas prepared by central water commission, Delhi has been classified into thirteen zones based on the flooding risk in relation to incremental rise in the water level of the of the Yamuna. Beside this, the Delhi flood control order (2011) also divides the NCTD into four flood sectors, namely Shahdra, Wazirabad-Babrapur, Alipur and Nangloi-Najafgarg sectors. A detailed analysis of the eight flood affected villages during 2010 September, from the North Delhi, it is evident that the area witnessed tremendous land use land cover changes over past two decades. During the September 2010, rainfall in Delhi was 359.7 mm which 180% more than the normal rainfall. Urban floods are becoming a perennial feature of the city due to inadequate drainage, uncontrolled development and land use changes particularly in the Yamuna Flood Plain.

Methodology

Transect walk was carried out across the corridor of river Yamuna in Delhi to identify and explain the relationships among floodplain, natural vegetation, cultivation, human activities & settlement pattern and understand the various ecosystem services provided by the wetland. Transect walk helped us to understand natural resources, present land use pattern, vegetation, changes in the physical features and cropping systems, and so on in villages Public resources, land use, social differentiation and mobility in urban communities (de Zeeuw, 2004). A survey was also conducted to have view of communities living on the fringes of wetland on disasters faced by them and ecosystem services provided by the wetland. Experts view (academicians, ecologist, practioners, and bureaucrats) on the integration of ecosystem services and DRR were also taken. Scoring was done (on the basis of number of hazards addressed by one ecosystem service) for analysing the ecosystem services and DRR aspects addressed and based on the scores importance were attached as high (4-5), medium (3) and low (<3). In this study five is the highest score.

Discussions: Ecosystem services of wetland of East Delhi

The availability of water near Okhla throughout the year helps to maintain minimum water level required for functioning of the floodplain. The surplus water during monsoon percolates down and helps to control floods and maintain moisture regimes during lean period. Bio accumulation of key nutrients in floodplain helps to reduce pollution stress thereby leading to development of rich biodiversity habitat. Okhla Bird Sanctuary (notified in 1990 by UP Govt.) situated in Gautam Budha Nagar is rich in avifaunal diversity and presently inhabits more than 145 bird species include 22 species of resident water birds, 44 species of resident terrestrial birds, 43 species of migratory water birds and 26 species of terrestrial migratory birds. The sanctuary covers rich aquatic, semi-aquatic and terrestrial habitat where more than 25 species of aquatic plants, 110 species of terrestrial plants including herbs, shrubs, climbers, grasses and trees have been recorded (Source: Divisional Forest Officer, Gautam Budha Nagar, UP, 2012).

Communities residing in the floodplain derive their basic needs like water for drinking, irrigation and domestic purposes from the floodplains of Yamuna. For drinking purpose hand pump is available and water depth is found to be 10-15ft. For irrigation bore wells are used. The source of livelihood of the communities is agriculture and labour. The floodplain is very fertile and supports lots of vegetables, horticulture and floriculture. Vegetables grown are lobia, cauliflower, cabbage, bottleguard, lady's finger, onion, potato, spinach, corn and bitter guard. It was surprising to the researchers to find out that cultivators used urea, DIP and other chemical fertilizers in their field. Community didn't complain about diseases caused by water however dengue outbreak has been reported after monsoon and flood in the entire city.

The key services from the wetland ecosystems in East Delhi

Table 5.2: Ecosystem services provided by wetland of Delhi

Ecosystem Services		Comments
Regulating		
E1	Storing excess water during heavy rainfall	Safe passage of excess waters in the city
E2	Ground water recharge	Source of surface and ground water which is much needed to meet the city's growing needs of water for domestic, industrial and agricultural uses.
E3	Disease regulation	Helps in control of water borne diseases
E4	Carbon Sequestration	Act as an essential carbon storage and thus help in climate change mitigation
E5	Shelter belt	Provides a potential shelter belt against advancing land degradation

E6	Thermal regulation	Regulates thermal currents in the city where summer temperatures are today becoming unbearable with every passing year in the context of climate change and global warming.
Provisioning		
E7	Livelihood Support	Production and sell of vegetables and fruits like water chestnut, lotus root, green vegetables are key means of sustenance particularly for slum dwellers
E8	Fisheries	Hardy and tolerant fish species found in the river stretch except in upstream of Wazirabad barrage where still major and minor carps are found The fish species found are rohu, katla, mrigal, channa, singada etc.
E9	Water for drinking, domestic purpose and irrigation	Source of drinking water to major part of the city. Also provide water for irrigating crops
Supporting		
E10	Support heavy nutrient load	Vegetation such as water hyacinth and different grass species like Typha, Phragmites carca, Lamphrophyla etc. are found that take up nutrients received from the nearby drainage and thus help in controlling water pollution
E11	Sediment retention and accumulation of organic matter	Organic fertilizers are made from the water hyacinth after processing. Also bio fuels by briquetting have been made.
Cultural		
E12	Recreational	Okhla Bird Sanctuary in Gautam Buddha Nagar provides a source of recreational activities. More than 145 species are reported from Okhla out of this about 50% are migratory birds, 36% are resident birds and rest are vagrant sightings. A variety of both native and exotic species of plants are found in the sanctuary
E13	Educational	Source of formal and informal education and training, Many school children visit the bird sanctuary along with researchers and scholars.
E14	Aesthetic	Wetland provide scenic beauty

(Source: Singh et al., 2013)

Exposure and Risks

The Flood plains of river Yamuna in Delhi are critically threatened due to biotic, abiotic and huge urbanisation pressures. Biotic stress includes uncontrolled siltation and weed infestation, uncontrolled discharge of waste water, industrial effluents etc. Abiotic stress includes encroachment resulting in shrinkage of area, anthropogenic pressures leading in habitat destruction and loss of biodiversity etc. Rapidly increasing urbanisation with limited integration of values and functions of floodplains in developmental planning has led to their fragmentation. Flows in the river are drastically reduced due to upstream abstractions

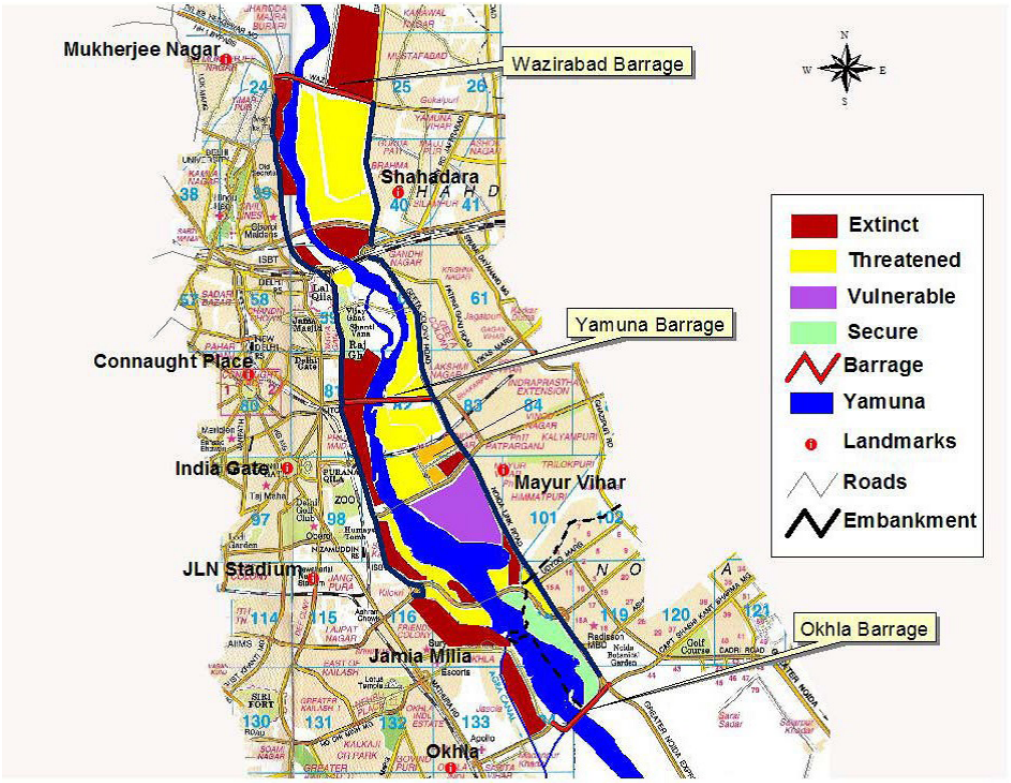

Figure 5.7. Vulnerability map showing present State of river bed in Delhi (Source: Yamuna Jiye Abhiyaan, 2007)

for irrigation, industrial and domestic water supply. Conversion of floodplain areas for developmental activities like NOIDA toll bridge, Akshardham Temple, Millennium depot, Delhi Secretariat, Commonwealth games infrastructure etc. are making the region more vulnerable. From risk perspective, degradation of floodplains is increasing flooding risks to the city along with stresses related to food and water scarcity.

In 2010 the city witnessed one of the worst floods because of heavy rainfall coupled with development within the natural course of the river. Yamuna water entered Delhi after being released from *Tajewala* and *Hathnikund* barrages up North, the water had lesser area to accommodate itself on the floodplain since a chunk of the floodplain–the size of the Commonwealth Games Village–was no longer available to the river that it was for centuries.

As evident from the above figure 5.7 the entire river bed in the west between the ring road and stream has been lost due to various construction and developmental activities. A tour through the Yamuna flood plain gives the glimpse of encroached wetland. Indraprastha thermal power plant was established on the bank of the river to discharge waste generated directly into the flowing water. Samadhis of our several leaders and politicians had been built in the floodplain between Nigambhod Ghat and Rajghat. Millennium Bus Depot (Asia's biggest depot) which was constructed during Common Wealth games, remain flooded for almost three months

because of no drainage system in 2010 and ironically it happened just before a month for games to commence. Ponds, near Barakullah drain have disappeared due to bridges and flyovers and have now been converted into parks full of water hyacinths showing eutrophied condition. The important lung space of the city has been lost converting it into heat island.

Many marginalised communities depend upon the ecological services provided by the wetland to meet their day to day requirements (Table 5.2). Migratory birds that come to Okhla Sanctuary used to rest at Gautam Buddha Park which has now been converted into concrete political park. Ecologist and Conservationist Mr. T K Roy say that Gautam Buddha Park has negatively affected the species diversity and also the duration of stay of migratory species has lessened. The reason is non availability of tree species for nesting and food. The species that have not been sighted in the sanctuary from last 5-6 years are paradise flycatcher, Egyptian vulture and great spotted eagle.

Unplanned urbanisation has drastically altered the drainage characteristics of natural catchments by increasing the volume and rate of surface runoff. Drainage systems are unable to cope up with the increased volume of water and are often encountered with the blockage due to indiscriminate disposal of solid wastes. Twenty prominent sewage and drainage system that carries the untreated loads of in and around Delhi is increasing the vulnerability of the sanctuary. Total quantity of sewage generated in Delhi is around 2,871 MLD whereas the capacity of sewage treatment plan is 1,478 MLD only. The figure clearly indicates that 1,393 mld of untreated sewage is directly discharge into the river *(Source: Wetland International-South Asia*). The table 5.3 provides how the floodplain has been addressing various hazards and helped in disaster risk reduction.

Table 5.3. Disaster Risk Reduction function of Yamuna floodplain

Addressing Hazard		
H1	Flood	Addressing flood hazard by means of spread and passage of flood waters during the monsoon every year and exceptional floods once every decade or more (1978, 1988, 1995, 2010).
H2	Epidemics	Addressing epidemics like dengue and malaria
H3	Drought	Addressing meteorological drought in the capital by supplying water for irrigation during lean period
Reducing Vulnerability		
V1	Physical vulnerability	Reducing physical vulnerability by providing buffer to build in infrastructure like irrigation system, municipal water supply, sanitation and drainage by checking land degradation both to the people as well as of the ecosystem
V2	Economic vulnerability	Reducing economic vulnerability by providing stable source of income from fruits, vegetables and fisheries

V3	Livelihood vulnerability	Reducing vulnerability of local people who are dependent on wetland for their livelihood like vegetables and fruits along with addressing issue of food security. Also reducing vulnerability of the people who are dependent on fisheries for their livelihood support
V4	Environment Vulnerability	Reducing environmental vulnerability by checking water scarcity, providing suitable environment for fish breeding, taking nutrient loads from the drainage system etc. around the city.
Increasing Capacity		
C1	Governance	Strengthens knowledge and policy environment which in turn helps strengthening governance and hence increasing the capacity to address disaster in a holistic way. It helps traditional DM professionals and engineers recognise DRR benefits of ecosystems
C2	Society and economy	Communities are engaged in diverse and environmentally sustainable livelihoods resistant to hazards.
C3	Land use management and structural design	Effective land use and structural design that complement environmental, economic, and community goals and reduce risks from hazards.
C4	Risk Knowledge	Leadership and community members are aware of hazards and risk information is utilized when making decisions.
C5	Warning and evacuation	Community is capable of receiving notifications and alerts of flood, warning at-risk populations and individuals acting on the alert.
C6	Emergency Response	Mechanisms and networks are established and maintained to respond quickly to flood and drought disasters and address emergency needs at the community level
C7	Disaster Recovery	Plans are in place prior to hazard events that accelerate disaster recovery. Engage communities in the recovery process and minimize impacts

(Source: Singh et al., 2013)

Opportunities and challenges of Integrating Ecosystem Approach in Disaster Risk Reduction

Ecosystem approach to DRR is widely advocated as second paradigm shift in disaster management, as it directly links with the livelihood of the people and sustainability of their resources (Gupta, 2012). This calls for emphasis on natural resource management, ecosystem services, land-use and adaptation to climate change within the strategies of disaster prevention, preparedness and post-disaster relief and recovery process (National Policy on Disaster Management, 2009, section 5.1.6). Most of the floodplains have been encroached for various developmental projects, however, there are opportunities available for developing ecosystem approaches for reducing disaster risks due to climate change in Delhi and nearby areas. In the table below an effort has been made to integrate ecosystem services in DRR framework.

Table 5.4: Integrating Ecosystem services and Disaster Risk reduction of the wetland of East Delhi

Ecosystem Services		DRR aspects addressed	Scoring	Importance
E1R	Storing excess water during heavy rainfall	H1, V1, C3,C5	4	High
E2R	Ground water recharge	V4	1	Low
E3R	Disease regulation	H2	1	Low
E4R	Carbon Sequestration	V4	1	Low
E5R	Shelter belt	V1	1	Low
E6R	Thermal regulation	V4	1	Low
E7P	Livelihood Support	V2, V3, V4, C1, C2	5	High
E8P	Fisheries	V2, V3, V4	3	Medium
E9P	Water for drinking, domestic purpose and irrigation	H3,V1, V4, C3	4	High
E10S	Support heavy nutrient load	V4	1	Low
E11S	Sediment retention and accumulation of organic matter	V1, V4, C1, C3	4	High
E12C	Recreational	C1	1	Low
E13C	Educational	C4	1	Low
E14C	Aesthetic	V4	1	Low

(Source: Singh et al., 2013)
Note: R, P S and C stands for regulating, provisioning, supporting and cultural services of ecosystem respectively.

The table above clearly shows that each of the ecosystem services addresses one or more aspects of DRR. Out of 14 ecosystem services provided by the wetland of East Delhi four are highly important (E1R, E7P, E9P and E11S), one holds medium importance (E8P) and rest are of low importance. The scoring and importance attached does not discourage the other ecosystem services provided by the wetland rather it gives the priority for such services that can be integrated in the DRR framework.

Conclusion

Wetlands on the corridor of Yamuna have become one of the most threatened ecosystems and are rapidly diminishing due to anthropogenic activities. Pressure for conversion of wetlands for developmental purposes is very high especially in case of urban riparian wetlands. These wetland ecosystems provide many tangible and intangible benefits on a sustainable basis not only to the urban society but also to the associated dependent ecosystems. According to Dr. David Pithart, we can consider river floodplain as a tool for mitigation of flood waves or extreme low discharges, only if a floodplain management and structure respect this natural function. Recognizing the importance of wetland ecosystems,

the National Environment Policy (NEP), 2006, contains an unambiguous assertion of the need for a holistic view of wetlands, which looks at each identified wetland in terms of its causal linkages with other natural entities, human needs, and its own attributes. The ecosystem approach to disaster risk reduction advocates for sustainable ecosystems management as strategy to reduce exposure and vulnerability, through hazard mitigation or regulation as well as enhancement of livelihood capacities and resilience.

Note: Reference for more detailed understanding of the case study is following:

Singh, S., Nair, S.S., & Gupta, A.K. (2013). Ecosystem Services for Disaster Risk Reduction: A Case Study of Wetland in East Delhi Region, India. Global Jour. on Human Social Science, Geog., Geo-Sciences, Env. and Disaster Mgt, 13 (4), 37-47.

6 Training Module Urban Resilience and Sustainability through Peri-Urban Ecosystems

6.1 Training Design and Training Plan

Background and Contexts

Recognizing the importance and components of urban resilience, in the context of disasters, climatic risks and sustainable development, and the services that the peri-urban ecosystems provide in form of providing resources, buffers and capacities that help reduce the underlying factors of vulnerability in these areas, it becomes critical to enhance the capacity of key stakeholders including professionals, officials, researchers, planners and beneficiaries at different levels to understand, appreciate, assess, plan and integrate ecosystem based approaches for urban and peri-urban resilience into developmental planning and practices. Chapters 1 to 5 including case studies on different aspects of peri-urban ecosystems, offer a systematic conceptual and practice framework for urban resilience through peri-urban ecosystem services.

In order to support and facilitate capacity building programmes, targeting key stakeholders, a detailed training manual with specific modules has been worked out, with more focus in developing countries context. Since the focus on peri-urban ecosystems and their resilience for the cause of resilient and sustainable development of cities or urban areas, is an emerging focus, and is as yet less worked out theme, a detailed training design and training plan has been developed, based on the understanding of training needs – performance gaps of stakeholders and systematic approach to training. Given the above backdrop, the learning modules have been designed to focus on following two central research questions:

What are the systemic factors within regions (urban/peri-urban) that contribute to resilience or exacerbate vulnerability? Detailed analysis in a specific geographic region/rural-urban level to improve the ability to identify practical points where

ecosystem based interventions could build resilience as well as the capacity of the specific departments that might need to be involved in developing peri-urban regions, and

What specific policy innovations could help to address the vertical gap between the integrated national policy framework and local contexts and the horizontal gap among actions within sectoral development programs to integrate ecosystem services contexts of peri-urban dichotomy within the system and practice? In answering this, we intend to focus on the local, regional, state and international perspectives on the challenges associated with these rural-urban transition zones.

Objectives of the Training

Aim -

Is to promote, support and facilitate capacity building – training interventions, on sustainable peri-urban interface and integration of ecosystem based approaches into planning process towards resilient urban development planning and practices.

At the end of the training the participants will be able to -

1. Define the linkages of healthy urban and peri-urban ecosystems with CCA, DRR and sustainable development objectives, and associated impacts and challenges with special focus on cities/town and regional planning.
2. Identify and state the scope and pathways for developing sustainable urban development plans with resilience as a central theme, in terms of natural hazards, water, health, livelihood and economic concerns.
3. Analyze approaches, process and tools of urban/peri-urban ecosystem concerns for urban resilience against climatic and disaster risks, through policies, law, strategies and effective governance at sub-national and local levels.
4. Enumerate on the Resilience and its practical framework, with reference to urban master plan practices, and reference to natural resources (water, agriculture, environmental health, etc.) and state on the ecosystem benefits through field appreciation.
5. State on social vulnerability factors in context with ecosystem benefits for enhancing resilience of communities, while considering issues pertaining to poor and marginalized, occupations and livelihood, gender, etc., and through case analysis.

Target Groups/Audience

The module is developed looking to the performance gaps and training needs of the following target participants:

1. Senior to middle level officials from the state and district line departments and local governance system, and members of respective committees related to DRR, climate change, environment, health, special area/local development, etc.,

2. Executives / professionals from other Government agencies / boards, programmes / schemes, including public sector undertakings,
3. Members / representatives of non-governmental and community organizations engaged in activities related to assessment, planning, implementation or monitoring of any aspect of disaster management, environment and development,
4. Faculty members / professionals from training, education and research centres and other master trainers related to environment / ecology, disaster management, rural development, urban planning, health, forestry, land and water, agriculture, housing, etc., and
5. Private Sector: Officials/ professionals involved in water supply, environmental-health, waste management, power, industries, communication, risk management, corporate social responsibility, etc.

Contents and Structure of the Module

This training module(s) on resilient urban development concerns into planning, considering ecosystem service based benefits from peri-urban and associated urban/rural interface, offers a training tool along with course guidelines and contents for promoting an integrated approach for practice and capacity development.

This is to enable the participants in a holistic view of addressing challenges posed by the climate change and extreme events through development process. The Module provides a good mix of theoretical and practical exercise developed from a range of literature available on the subject across a range of sources. The Training Handbook consists of five modules:

1. Urban and peri-urban ecosystems: Issues and roles
2. Ecosystem approach for resilient urban development
3. Legal, policy and institutional mechanisms
4. Integrated development of urban and peri-urban region
5. Community perspectives for climate change adaptation and disaster risks management in peri-urban region.

The details of learning units are following:

Module 1: Urban and peri-urban ecosystems: Issues and Roles

LU (A) Urbanization, trends of urbanization, peri-urban contexts and definitions

LU (B) Understanding risks and challenges of urban and peri-urban areas: Climate change, disaster risks and vulnerability: livelihood, economic, environmental

LU (C) Sustainable urban development planning: Role of peri-urban ecosystem

Module 2: Ecosystem approach for resilient urban development

LU (A) Ecosystem roles in resilience - Agriculture, Water, Environmental-health, Energy and Carbon Neutrality

LU (B) Resilience against natural and anthropogenic disasters

LU (C) Understanding challenges of degrading ecosystem services (Group Exercise)

Module 3: Legal, policy and institutional mechanisms

LU (A) Peri-urban spaces and governance

LU (B) Peri-urban regions into plans, policies and schemes of government

LU (C) Sector cluster strategies (agriculture, irrigation, urban development, environment and social welfare): Group exercise

Module 4: Integrated development of urban and peri-urban areas

LU (A) Urban master plans, town and country planning, urban land-use planning

LU (B) Sustainability of water resources and agriculture in peri-urban landscapes

LU (C) Field visit: Appreciation of Ecosystem Services for DRR and Climate Resilience

Module 5: Community perspectives for climatic and disaster risk management through peri-urban ecosystems

LU (A) Understanding community vulnerability (marginalized sections, gender, etc.) and capacity of responding to climate change implications

LU (B) Developing climate change response and disaster risk reduction planning and activities concerning peri-urban ecosystem

LU (C) Group exercise: Case study - simulation

Conclusion: Summing-up, Post-training assessment and Course Follow-up/ Recommendations.

Tips to use the Module for Training

Each learning unit has been developed to enable capacities (knowledge and skills) through discussions, presentations and involvement of the trainee groups. Following are the important methods that can be applied to make the learning easy and interesting for the participants:

1. **Question-Answer/Quiz Sessions:** these sessions have been kept to evaluate understanding of concepts of urbanization, peri-urbanization, ecosystem services, disasters, climate change and development.
2. **Group discussions/work:** Group activity is included in each learning unit to facilitate knowledge on developing skills related to analysis, planning and formulating strategies.
3. After each group work, a **presentation session** has to be included, to motivate the participants in knowledge grasping, participation and sharing.
4. **Table-top/classroom exercises** to enhance ability of focused discussion in the group.
5. **Field Visit** to be organized, to facilitate understanding of data collection, group reality and situation analysis.
6. **Case studies** to provide live examples from the field so that knowledge could be connected with the ground reality.

Selection of Trainees: The criteria for selecting the trainees are following:

Target level of Trainees	Senior to Middle level officials/professionals/agency representative
Nature of the Group	Heterogeneous (from various departments, agencies and academic institutions), with representation of women colleagues.
Qualification	At least graduation and preferably post-graduation, having written and spoken ability in English/Hindi. Computer knowledge is desirable.
Medium of Instructions	Mainly English with blend of Hindi/local or vernacular language.

Pre-requisite for the Trainer/Course Faculty

A team consisting of minimum three faculties may be required to organize the training programme. One of the team members shall be from the region where training is being planned. Other criteria for course faculty/trainer may be as follows:

Eligibility	Expert of Urban issues and related ecosystem as well as Disaster Management with a good knowledge on Environment & Climate change/Natural Resource Management and Developmental Planning Issues
Training Approach	Friendly and informal approach and have ability to involve heterogeneous group at a single platform
Challenges to be addressed by the trainer	Motivating the participants to bring them at similar level of knowledge and experience sharing.
Strategies to overcome the challenges	Provide reading materials during registration (or preferably can be mailed in advance). Involve the participants through group exercise, video clippings and quiz sessions, etc.

Expected Benefits

1. Capacity of the Government officials/ DM Professionals/Environmental Scientists and Managers/Planners and other stakeholders developed in understanding issues of urban and peri-urban ecosystems, CCA and DRR mainstreaming into developmental planning.
2. The overall capacity of administration, academic institutions and non-governmental organizations improved in planning, coordination and strategy making.
3. Overall sensitization of departments to understand peri-urban issues and their role in addressing these issues with more abilities.
4. Improved ability to collaborate with the each other both horizontally and vertically for achieving sustainable development at urban level.

Instructions for Use of Training Modules

1. A module can be implemented at local, project, municipality, state level or departmental level (National or state/UT level with suitable modification utilizing its flexibility). For example, city administrators can take lead in organizing training programs for such heterogeneous group through coordinating with the line departments, academic institutes and other agencies. At national level, courses may be organized by the Ministries or concerned Institutes like NIDM, NIUA, NIRD, Universities and/or leading NGOs, whereas at state level the course may be organized by State Administrative Institute, SIRD, WALMI, Forest Institute, Ecology Commission, Environment Directorate, Council for Science & Technology or Disaster Management Institute/Centre.
2. Learning shall be facilitated by a trained trainer in relevant subject and preferably in a Training of Trainers (ToT) course on this module. Appropriate resource persons shall be selected and invited as speakers/moderators for taking up the case studies and field surveys based technical sessions. It is advisable to conduct a Training of Trainers (ToT) courses in every State in order to build their capacities in conducting training programs at sub-national level.
3. A learning unit includes case studies, group work, etc. The course facilitator shall ensure that the module has been taught in the light befitting the target group's background, time and as per the resources available.
4. Entire module is designed in a way to complete it within the given duration of about 5 days (flexible), depending upon the field visit exercise.
5. At the end of the training, a feedback session shall be conducted by the facilitators in order to understand the opportunities and shortcomings of the Module. These feedbacks shall be complied and appropriately included in the future training programs.

Action Plan/Post-Training Assignment

It is well understood that training has more impact on the ground if a mechanism for follow-up is in place. During the activities in this module, participants review the gaps identified

throughout the training in order to identify the changes they might be able to make in their own departmental/organizations' work. Working as a group, they will:

- Identify areas for future action;
- Develop criteria for prioritizing future actions;
- Prioritize these actions according to the criteria;
- Create an action plan (and framework for writing an assignment)
- Assignment submission guidelines.

This Module presents an opportunity for capturing the motivation that participants have at the end of training and for them to return home with a tool – the action plan – to help them to focus on changes they want to make when faced with the day-to-day challenges of work. The action plan should help them build these changes into their routines, creating demands and eventually those of the department/organization.

6.2 Pre-Training Assessment

Context and Description of the Session

The session shall consist of either written or oral question-answer/discussion round or under the perception level of the participants before and at the entry level of the training course. This would be repeated at the end of the course (post training session) during valediction to understand the impact of the course by facilitation a comparison of entry and exit behavior of the participants. A film can also be shown to trigger the expression of participants prevailing knowledge and/or perception on aspects of climate change and disaster risks.

Learning Objectives	Methodology
• To compare the entry and exit behavior of the trainees • To evaluate the knowledge and skills gained from the training • To assess perceived competency of participants on urban and peri-urban issues and various ecosystem services and resilience against disaster risks • To carry out a formal internal evaluation methodology using questionnaires	• Question-answers • Discussion • Ice-breaking games • Film Show- (for e.g. Khet Chorab Nahi)

Guidance

- Questionnaire based assessment of the participants perception at the entry level (and also at the exit level) may be carried out.
- The questions shall be identified / framed by the course director/coordination team looking into the course module's scope, participants profile and duties/background, and context of the film being screened.
- It is advised that the course coordinator / trainers keep pre-developed notes as own tips and hints for delivering course session.
- The resource person for this session is expected to have a broad knowledge of all aspects associated with urbanization, urban and peri-urban ecosystems, climate change and disaster risks and the national and international framework for dealing with the subject, ideally a team of two or three resource persons drawn with background of environment & ecological science, urban ecological planning, and geo informatics, having prior experience in disaster management, climate resilience, adaptation and sustainable development.

6.3 Module 1 :Urban and Peri-urban Ecosystems: Issues and Roles

This is basic training module on resilient and sustainable urban development through peri-urban ecosystems as an overview or refresher course for sensitization of developmental, disaster management and climate resilience professional/officials, practitioners and other officials of general administration, industrial associations /corporations, academicians, NGOs, etc. towards integration of peri-urban regions into the development processes.

There are 3 learning sub-units envisaged to draw this module:

LU(a) Urbanization, trends of urbanization, peri-urban context and definitions
LU(b) Understanding risks and challenges of urban and peri urban regions: climate change, disaster risks, livelihood vulnerability, economic vulnerability, environment vulnerability
LU(c) Sustainable urban planning and role of peri-urban ecosystem

Learning Objectives

- To define urbanization, state its causes and main effects on environment and ecosystems.
- To describe peri-urbanization, rural-urban ecotones and its challenges in the context of changing climate, environment and disasters.
- To describe various ecosystem services of urban and peri-urban ecosystem.
- To describe the needs of vulnerable and marginalised section of the society and mainstreaming them into sustainable growth.
- To explain the main approaches to address sustainable and resilience urban planning and role of peri-urban ecosystem.

Guidance	Methodology
• Sharing expectations from both sides, from participants as well as from the faculty/ trainers and course director/coordination team is important to start from and finally arrive at a common point of learning scope to be fulfilled during the course. • Other expectations regarding punctuality of the participants during the sessions and associated activities, response, discipline, etc. need to be shared during this information round	• Film on a ecosystem services, urban and peri-urban ecosystems - Khet Chorab Nahi : Our Land, Our Life • Perception check questionnaire (or question-answer session) • Lecture/power point presentation • Case study (preferably based on film) • Group exercises • Experience sharing • Discussion

LU (A): Urbanization, Trends of urbanization, Peri-urban contexts and Definitions

Context and description of the Session

This session focuses on the conceptual understanding of urbanization and its trend, peri-urban ecosystems and its importance in the present context of growing population and increased economic opportunities. Currently, half of the world's population is living in cities, largely seeking increased economic opportunity to sustain them. Urban population was 29 percent in the world 60 years back, while today it is 50 percent and as per the projections, by 2050 it will grow by 72 percent. The point of concern is that most of this growing population will be absorbed into rapidly growing cities, notably in Asia's fast developing economies including India. By 2014, a 55 percent (UNESCAP, 2015) of the worldwide urban population was living in Asia and the Pacific. Though urbanization has positively contributed in lifting people out of poverty but this development is neither inclusive nor sustainable because most of the Asian cities are more vulnerable to natural disasters and the projected impact of climate change.

An analysis of Indian census data from 1901 to 2011 shows that number of urban agglomeration/ towns and cities has grown from 1827 in 1901 to 7935 in 2011 and population residing in these urban areas has increased from 25.8 million in 1901 to 377 million in 2011, making 31.16 percent of the total population of the country. As of 2015, 400 million people reside in urban India and by the year 2050, the number of people living in Indian cities is expected to be about 840 million, which is more than double. As stated by Dutta (2006), India's urbanization has been termed as "over-urbanization" or "pseudo-urbanization" because of inordinately large population size in big cities leading to virtual collapse in the urban services followed by basic problems in the field of housing, sanitation, slums, water, infrastructure as well as quality of life. The current pattern of urbanization is actually taking place on the fringes of cities (better known as peri-urban areas), wherein, putting pressures on Municipal Corporation for the supply of basic amenities. Rapid and unplanned urban growth leads to multiple transformation-physical, social-economic, cultural and functional on the city fringes. These transformations affect the resilience of the city by irreversible change in ecosystems and services they provide.

Learning Objectives

- To learn basic concepts of urbanization and its trends
- To learn issues of degradation of ecosystem services and its impact
- To know peri-urbanization and its inter-linkages with urban ecosystem.

Methodology

- Lecture and power point presentation
- Question-answer sessions
- Discussion

Guidance

- The first session include theoretical mode of teaching. However, informal discussions shall be facilitated by the trainers to make the sessions interesting.
- A table-top exercise and quiz session have been suggested to facilitate the discussions.
- The session could be divided into three presentations i.e., Concept & terminologies, Issues of urbanization and ecosystem services of peri-urban region.
- Handout on urban and peri-urban ecosystem, urbanization and its trends and ecosystem terminology may be given to the trainees.

Recommended Readings

- UNDESA (2012).World Urbanization Prospects: The 2011 Revision. Department of Social and Economic Affairs, Population Division. United Nations, New York. Retrieved from http://esa.un.org/unup/pdf/wup2011_highlights.pdf
- Dutta, P. (2006). Urbanization in India. Retrieved from http://www.infostat.sk/vdc/epc2006/papers/epc2006s60134.pdf
- Census of India. 2011. Size, Growth Rate and Distribution of Population. (See http://www.censusindia.gov.in /2011-provresults/data_files/india/Final%20PPT%202011_chapter3.pdf.

LU (B) Understanding Risks and Challenges of Urban and Peri-urban Areas

Context and description of the Session 1

Peri-urban areas are considered as transitional zones from rural to urban region and represent a wide range of uses, such as water catchments, forestry, recreation, and productive farming, as well as offering a unique ambiance and lifestyle. The outward expansion of cities, changes in land use pattern and occupations have transformed the rural hinterland into semi-urban areas. Inhabitants in these peri-urban regions are under high vulnerability with the increasingly threatened by deteriorating quality of ecosystems leading to resource scarcity and a host of problems that very often find no solution in the short run.

Managing the environment of this interface is pertinent in present context, because various ecosystem services provided by these transition zones have significant impact for sustainability of both urban and rural development. Thus, it becomes important to understand the demographic trends, socio-economic change, ongoing process of urbanization, expected climate change, impact on natural resources and livelihoods in this transition zones. New multi-level and collaborative Governance Systems are required to manage the resilience of these ecotones. The United Nations' Sustainable Development Goals (Goal No. 11) also emphasizes on making cities inclusive, safe, resilient and sustainable by implementing integrated policies and plans for resource use efficiency and adaptation to climate change2 which is not possible without protecting these peri-urban regions.

Learning Objectives

- To describe risks and challenges of peri-urban region.
- To learn about different ecosystem services provided by peri-urban region.
- To analyze relationship between ecosystem services of peri-urban region in the context of sustainable development

Methodology

- Lecture
- Power point presentation
- Question-answer sessions
- Case study-Gorakhpur peri-urban region

Guidance

- It is important for trainers to develop a conceptual understanding of various ecosystem services and its linkages with urban and peri-urban regions
- It is recommended to read articles on urban ecosystem in the context of developing nations and develop an analytical framework for trainees to understand the concepts.
- Articles from the recommended readings can be taken as references.

Recommended Readings

- Narain, V., Anand, P. and Banerjee, P. 2013. 'Periurbanization in India: A review of the literature and evidence', Report for the project – Rural to Urban Transitions and the Peri-urban Interface. SaciWATERs. India
- United Nations SDGs (http://www.un.org/sustainabledevelopment/cities/)
- Mitra, A., Wajih, S., and Singh, B.(2015). *Wheezing ecosystems, livelihood services and climate change resilience in Uttar Pradesh*. IIED, working paper series 18:2015.

4 United Nations SDGs (http://www.un.org/sustainabledevelopment/cities/)

LU (c) Sustainable Urban Development Planning: Role of Peri-urban Ecosystem

Context and description of the Session

Peri-urban areas of cities experience significant land transformation, due to expansion of urban core. Rapid and unplanned urban growth leads to multiple transformation-physical, social-economic, cultural and functional on the city fringes. Due to lack of basic knowledge about the urbanization process and its long term ecological impacts, urban and regional planners in developing countries have not been able to analyze, consistently, much less manage and restore the ecosystems in peri-urban areas.

India is growing very fast in terms of population as per the recent projections made by United Nations. Therefore, proper planning needs to be done by taking the cognizance of projections otherwise the country will face unprecedented level of urbanization and unmanageable concentration of population. Master plans have failed in our country because they are usually much rigid and obsolete. They have been unable to cope up with the pace of growth of Indian cities. Lack of regional planning approach has led to haphazard proliferation of slums. As per the 12th Five Year Plan of India very few Indian cities have 2030 master plans that take into account basic services like water, sanitation, food, transportation, roads etc. This is the time to move a step ahead from master plans towards an integrated development of "smart cities" which aims at developing the urban ecosystem by strengthening institutional, physical, social and economic infrastructure. Ministry of Urban Development (MoUD) has already taken a step by releasing a new Urban and Regional Development Plan Formulation and Implementation Guidelines (URDPFI) in 2015. The objective of this plan is to promote and facilitate planned and integrated urban development in all cities of the country. As per URDPFI guidelines urban and regional planning system has been divided into two parts i) core area planning and ii) specific and investment planning

Learning Objectives	Methodology
• To identify key functions of peri-urban region in urban planning and process. • To know key policy documents on sustainable urban planning of Govt. Of India like URDPFI, master plans, Town and country planning, and other regional plans	• Case study presentation • Question answer sessions • Video clipping of process documentation • Film on Gorakhpur floods-ISET, GEAG, NIDM
Guidance	**Recommended Readings**
• The session is intended to cover basic concept of sustainable urban planning and develop a critical thinking to allow for group discussion and reflections. • Hand out on Gorakhpur case study can be given to the participants	• Gupta, A.K., Nair, S.S., Wajih, S.A., Chopde, S., Gupta, G. and Aggrawal, G. (2014). Mainstreaming Climate Change Adaptation and Disaster Risk Reduction into District Level Development Plans. NIDM New Delhi (India), GEAG Gorakhpur (UP, India) and ISET, Colorado (US), P 114.

6.4 Module 2 : Ecosystem Approach for Resilient Urban Development

Maintaining ecosystems health is crucial to resilience of urban settings. The four types ecosystem services that include supporting, provisioning, regulating and cultural services enhance the redundancy and flexibility of urban systems and provides buffer against shocks, disasters and climate change induced stresses. For the cities to be livable as well as sustainable there is a need to maintain natural resource base more particularly in the peri-urban areas surrounding cities, and there is often a limit to ecosystems within cities and towns. But the ecosystems upon which these services depend are increasingly under threat due to unplanned urbanizations, encroachment of land and diminishing green spaces, amidst lack of emphasis by government or communities on their roles in protecting people – their land, assets, resources, livelihood and health.

Water cycle management, groundwater-surface water connectivity, biodiversity, food security of cities, agriculture and allied activities, storm water management, drought management, ecotourism, innovative approaches for urban water management, etc. are few examples of ecosystem services that need to be explored in this learning module. The various ecosystem services provided by peri-urban regions are following:

- Regulating: Disaster risk management, e.g. flood control, drought reduction; mitigating urban heat island impact; air and water purification
- Provisioning: Food security, water security
- Supporting: Waste management, soil improvement
- Cultural: Creates urban open space in city edges and provides aesthetic look

There are 4 learning units delineated to draw this module:

LU(a) Ecosystem roles in Resilience – Agriculture, Water, Environmental-health, Energy and Carbon Neutrality
LU(b) Livelihood and urban economic resilience, linking peri-urban micro enterprises to city markets (diversification of economy)
LU(c) Resilience against natural and anthropogenic disasters
LU(d) Identifying ecosystem services under different categories (Regulating, provisioning, supporting and cultural): Group exercise

Learning Objectives

- To define and state various ecosystem services for effective planning and implementation in urban and peri-urban settings.
- To analyse different roles of ecosystem services in building resilience in different sectors, and cross sectoral contexts.
- To describe integration of ecosystem services in disaster risk reduction planning and policies in a holistic, participatory, inclusive and sustainable manner.
- To enumerate adaptation practices used by the local communities to reduce impacts of climate change and disasters.

Guidance	Methodology
• This module includes knowledge sharing sessions on various ecosystem services provided by urban and peri-urban regions. • The facilitators shall have in depth systems knowledge.	• Lecture/power point presentation • Case study (preferably based on film) • Group exercises • Experience sharing • Discussion

Learning Unit (A): Role of Peri-urban Ecosystem Services in Urban Resilience

Context and description of the Session

To improve and manage urban resilience it is pertinent to recognize various functions of peri-urban ecosystems. The services can be explored sector wise under following heads:

Peri-urban agriculture and food security: The ecosystem services, rendered by peri-urban regions, like agriculture play significant multiple roles in urban sustainability as well as resilience, ranging from food security to disaster management. Peri-urban agriculture refers to "farm areas close to towns/cities which operate intensive, semi or fully commercial farms to grow vegetables and other horticulture, raise poultry and other livestock and produce milk and eggs" (FAO, 2001). Urban and peri-urban agriculture particularly in the context of developing countries, play a crucial role in diversifying urban diets and providing environmental services in urban and peri-urban areas (Nambi et al., 2014). Conversion of agricultural spaces in the peri-urban regions impacts the city adversely and lack of policy framework for peri-urban agriculture impacts urban locales and marginalized section of the society.

Water security: Steady population growth is exerting stress on both surface as well as ground water and crisis will aggravate with changing climate and unplanned urbanization. Strong measures are required to conserve water resources and land conversion as concretization by real states developers is taking away the natural recharge zone of the aquifers. In most cities, water supply is sourced from long distances and the length of pipeline determines the cost including the cost of pumping water. Due to the lack of local resource, water is conveyed from the nearest source to the city. Thus, peri-urban ecosystems play a vital role in providing cities with drinking water as they ensure flow, storage and purification of water (TEEB, 2011). Healthy vegetation and green spaces in the city vicinity influence the quantity of water availability locally.

Energy security: Peri urban areas can give an important contribution in meeting the energy demand of cities. The many possibilities in the use of energy resources, mainly connected in a distributed generation network, can promote the transition to energy systems able to guarantee high levels of sustainability and resilience. The location of cogeneration and waste to energy plants at the edge of the urban areas is a matter of interest, being them close enough to the heat consumers to allow a convenient and efficient energy transmission and at the same time not affecting densely populated areas. In order to seize the opportunities that peri urban areas offer from the energy point of view, it is necessary to consider on the one hand the reciprocal relationships they have with the city, and on the other hand the relationships that link the production and consumption of the different resources involved.

Health security: Peri-urban ecosystem provides with various health mitigation strategies ranging from air purification to reduction in noise level as well as urban temperature regulation. Air pollution from domestic heat, industries, transportation and solid waste burning affects environmental quality and human health in cities. Vegetation and green spaces helps in removing pollutants from the atmosphere and thus help in improving air quality of the region. Similarly, trees and soils helps in attenuating noise pollution through absorption, deviation, reflection and refraction of sound which causes stress due to heavy traffic, construction works and other human activities in cities (WHO, 2011).

Economic security: Urban and peri-urban agriculture along with providing food and nutritional security also enhances livelihoods security for urban and rural poor. For these marginalized communities, agriculture forms a key part of diverse livelihood strategies such as a source of income from selling produce, or as employment as farm laborers (Mitra et al., 2015).

Green growth and carbon neutrality: Cities are responsible for a significant part of green house gas emission (UNECE, 2011) and thus have a key role to play in the global agenda for addressing the challenge of climate change (Chaoui et al. 2009). The main sources of GHG emission attributable to cities are energy use in buildings, electricity supply, transportation and waste generation. Growing and unplanned urbanization will lead to significant increase in energy use and carbon emissions particularly in Asia and Africa where urban energy use is based on carbon intensive energy sources (Lamia and Robert, 2009). Green growth and carbon neutral concept in the context of city is an important mechanism that will overcome many challenges with regard to technology, governance and finance (Merk et al., 2012). Peri-urban regions see a growing potential for green services.

Learning Objectives	Methodology
• To know the different ecosystem services provided by peri-urban regions • To learn various schemes and plans for financial inclusion • To learn how different services can reduce disaster risks and mitigate climate change	• Lecture • Power point presentation • Question answer sessions • Discussion
Guidance	**Recommended Readings**
• The session will cover various ecosystem services of peri-urban regions which will provide trainees with different approaches for the implementation of DRR-CCA measures from various ongoing schemes to protect landscape in transition. • In this context trainees shall understand that with ongoing population growth, overuse of natural resources, and climate change impacts costs of disasters will likely increase. This is one of the mechanisms for mitigating climate change and reducing disaster risks. • Handouts containing brief description on ecosystem services of urban and peri- urban regions may be given to the participants.	• Nambi, A.A., R. Rengalakshmi, M. Madhavan and L. Venkatachalam. (2014). Building Urban Resilience: Assessing Urban and Peri-urban Agriculture in Chennai, India. [Padgham, J. and J. Jabbour (eds.)]. United Nations Environment Programme (UNEP), Nairobi, Kenya. • Kamal-Chaoui. L., and Alexis. R. (eds.) (2009), "Competitive Cities and Climate Change", OECD Regional Development Working Papers N° 2, 2009, OECD publishing, © OECD. • Government of India (2011) Report of the Working Group on Urban Strategic Planning. 12th Five-year Plan Steering Committee on Urban Development & Management. New Delhi: Ministry of Housing and Urban Poverty Alleviation, Government of India. • Gupta, A.K., Nair, S.S., Wajih, S.A., Chopde, S., Gupta, G. and Aggrawal, G. (2014). Mainstreaming Climate Change Adaptation and Disaster Risk Reduction into District Level Development Plans. NIDM New Delhi (India), GEAG Gorakhpur (UP, India) and ISET, Colorado (US), P 114.

Learning Unit (B): Resilience against Natural Hazards and Disaster Prevention

Context and description of the Session

Healthy and robust ecosystem is one of the best defenses against any natural disasters that contributes towards resilience (Gupta and Nair, 2012; Singh et al., 2013). However, unsustainable development along with anthropogenic risks and climate change implications has severely diminished the health of these ecosystems, and hence, reduced their capacity to protect against natural hazards. According to Millennium Ecosystem Assessment Report, 2005, approximately 60% of the ecosystem services have been degraded or used unsustainably and protection from natural hazard is one of those degraded services. One of the important findings of the report says that in the past 50 years humans have changed ecosystems more rapidly and extensively than in any comparable period of human history which has resulted into substantial and irreversible loss in the diversity of life on earth.

Integrated management of land, water and living resources that promotes conservation and sustainable use provide the basis for maintaining ecosystem services, including those that contribute to reduce disaster risks. SFDRR, Sustainable Development Goals as well as Paris Climate Agreement have laid emphasis on building resilience by protecting natural ecosystems.

This session can be discussed in detail by taking the case example of Gorakhpur city in flood mitigation, or other such case studies.

Learning Objectives

- To learn about hazard profile of cities and peri-urban regions due to indiscriminate and haphazard urbanization and land use change.
- To identify various regulating services of peri-urban ecosystem that helps in mitigating natural hazards.

Methodology

- Lecture
- Power point presentation
- Question answer sessions
- Discussion

Guidance

- This session is intended to give background on how role of healthy ecosystem in mitigating hazards.
- It provides many hands on examples, most which are also presented in detail in the session handout.
- Handouts containing brief of policies and plans

Recommended Readings

- Gupta, A.K., Nair, S.S., Wajih, S.A., Chopde, S., Gupta, G. and Aggrawal, G. (2014). Mainstreaming Climate Change Adaptation and Disaster Risk Reduction into District Level Development Plans. NIDM New Delhi (India), GEAG Gorakhpur (UP, India) and ISET, Colorado (US), P 114.

Learning Unit (c): Understanding challenges of degrading ecosystem services (Secondary Cities Context, Group Exercise)

Context and description of the Session
Peri-urban ecosystems have been victims of increasing urbanisation which is adversely impacting the resilience capacities of secondary cities. Gorakhpur Environmental Action Group with the support of Rockefeller Foundation did a scoping study on the condition of peri-urban regions of four secondary cities in India namely, Gorakhpur, Basirhat, Saharsa and Jorhat. The study revealed on significant loss of ecosystem services in these cities resulting due to urbanization and related challenges. For developing an understanding of participants on identification/assessment of these challenges, divide the class room in the groups of four. Each group shall be given case study of four secondary cities as mentioned above. Each group shall identify the challenges of degradation based on four ecosystem services (provisioning, regulating, supporting and cultural). The outcome of the group work/recommendations shall be discussed in the class.

Learning Objectives	Methodology
• To promote experienced hands on identification of issues related to urbanization and its impact on ecosystem services (with example of the secondary cities).	• Chart paper, sketch pens • Case study hand outs • Power point presentation • Discussion

Guidance
• Divide the class into 4 groups. Provide relevant material such as state profile, institutional setup, case study hand outs, agencies and NGOs, types of disasters, state DM Plans, state map etc. • Each group shall conduct preparation strategy for the same state, so that innovative ideas could be evolved. • The groups shall identify the nodal in-charge, stakeholders viz. line departments, local technical agencies, NGOs and academic institutes which could be involved into the planning process. • Propose an institutional structure for implementation of the project including monitoring committee, project cell and approving committee etc. • Also, draw a time-line chart with achievable mile stones.

6.5 Module 3 : Legal, Policy and Institutional Mechanisms

Peri-urban areas are geographical areas near the city edges, mostly transitional zones, changing from rural to peri-urban and are in the process of becoming urban in the near future. They are located between the outer limits of urban and rural environment; and represent a wide range of uses, such as water catchments, forestry, eco-tourisms, recreation and productive farming, as well as offer unique ambience and lifestyle. However, due to lack of clear cut conception and related concrete policies from national and to local, they have been the most threatened areas with regards to land use changes, biodiversity and climate change. There is an institutional and legal confusion over the management of this transitional land that does not come under the municipal jurisdiction nor village panchayat. Since they are keys to developing city's resilience and rural prosperity, there must be a strategic, participatory governance approach local as well as state and national level to environmental planning and development of the peri-urban areas. The real challenge lies in recognizing peri-urbanity and entering and influencing official discourse.

Learning Objectives

- To appreciate and enlist techno-legal and institutional framework for effective planning, implementation and finance for peri-urban regions.
- To analyse inclusion of multi-sectoral plans into the developmental process and mitigation measures through schemes and projects for enhancing the development of peri-urban regions.
- To describe integration of disaster risk reduction planning and policies in a holistic, participatory, inclusive and sustainable manner for peri-urban region.
- To enumerate on adaptation practices used by the local communities to reduce impacts of climate change and disaster risks, and associated stresses.

Guidance	Methodology
• This module includes knowledge sharing sessions on various schemes and programmes being run in the specific states. • The facilitators shall have in depth knowledge of legal mechanisms, various schemes and policies.	• Lecture/power point presentation • Case study • Group exercises • Experience sharing • Discussion

Learning Unit (A): Peri-urban Spaces and Governance

Context and description of the Session

Analysis of pattern of urbanization and related projections indicate on the fact that due to space constraints in cities, urban development is moving into the countryside (Maheshwari et al., 2016), and as result the peri-urban areas become the part of cities and new peri-urban areas are formed (Bhatt et al., 2016). The lack of basic knowledge and timely information of the urbanization process and its long-term ecological impacts constrain development planning authorities in analyzing, managing and restoring peri-urban ecosystems (Bhatt et al., 2016; Dutta, 2012; Narain, 2007). Left unaddressed, the process leads to rural-urban synergies breaking down, environmental degradation and rising urban inequities and poverty (Prakash, 2012) which could be worsened by the impact of climate change (Mitra and Singh, 2011).

Urban expansion into peripheral areas restructures its development, into unplanned peri-urban areas that undergo land use and occupational changes. They are in the vicinity of large cities and are centres of intense economic activities, but beyond municipal jurisdiction, placed in rural areas but with urban characters. Basic services such as water supply and sanitation, garbage disposal and collection, street lightning and cleaning etc. are not the part of rural bodies neither municipality. Amidst glittering cities adorned with malls and supermarkets, these city fringes represent the sad example of haphazard development, deteriorating quality of life, water pollution, land encroachment and becoming waste disposable sites for cities.

In general, however, despite calling them 'rural' a peri-urban area is defined administratively according to whether the locality falls within the boundaries of the city's master plan or otherwise. This leads to many administrative issues. A major challenge to better environmental governance in urban and peri-urban contexts is the lack of coordination between various line departments. Forest, land and water bodies are managed by different departments; cities are managed by municipalities and peri-urban areas by panchayats. In India, there is no separate department for urban or peri-urban agriculture or provisioning of extension services. There is no coordination between different departments in sharing data, nor does a common platform for discussing issues or a coordinated action plan for governance exist.

In a process of sustainable ecosystem-based urbanisation, democratic good governance that is based on the principles of equity becomes critical. The weak and the marginalised need a voice and must be heard. However, despite legislation to the contrary this rarely happens. The 74th Constitutional Amendment which came into force in 1992, is a watershed development in urban policy initiatives in India. This is because for the first time in the history of urban governance, the municipal bodies were provided the Constitutional Status of the third tier of government. It also sanctioned the involvement of its urban citizens in planning their future and improving their present. But in real terms it meant the citizens voted in elections once every five years, and citizens' rights, development needs, priorities and goals were forgotten until the next elections. In effect, a top-down approach to development masquerades as a 'bottom-up' approach, further alienating and marginalising the excluded. Good governance and all that goes with it (accountability, transparency and process ownership) is little more than a formality in the hands of the elected elite and participation, at best, is passive. Urban planning in India is a state subject and under the 12th schedule of the 74th Amendment Act, it has been mandated to municipal corporations and municipalities, while regional planning is to be done by state governments.

As per the constitutional mandate, district and metropolitan development plans must ensure coordinated spatial planning, sharing of natural and other resources, integrated provision of infrastructure and environmental conservation. These areas need guidelines to synchronise bottom-up and top-down approaches.

Learning Objectives	Methodology
• To know the governance issues and its constraints of peri-urban areas • To identify reasons for exclusion of peri-urban regions from urban and rural • To learn how governance intervention can reduce risks of peri-urban region	• Lecture • Power point presentation • Question answer sessions • Discussion
Guidance	**Recommended Readings**
• The session will cover governance issues of peri-urban regions and provide trainees with conceptual understanding. • In this context trainees shall understand that with ongoing population growth, urbanization, overuse of natural resources, and climate change impacts costs of disasters will likely increase. • In this context, governance and institutional analysis is an important instrument for decision making. • Handouts containing brief of policies and plans.	• GEAG policy briefs • UN HABITAT (2016). Addressing climate change in National Urban Policy: A policy Guide for low carbon and climate resilient development.

Learning Unit (B): Peri-urban into Plans, Policies and Schemes of Government

Context and description of the Session
Various ecosystem services in urban and peri-urban settings, either directly or indirectly, are managed by different ministries and departments at national, state and district levels. Matters pertaining to urban development are the responsibility of State Governments as per the constitution of India. The 74th Constitutional Amendment Act has further delegated many of these functions to urban local bodies (ULB) for management at city level. However, Ministry of Urban Affairs, Government of India, plays an important role in formulating various policies, programs and schemes for urban development in the country. The first central level efforts to provide drinking water in towns and cities were undertaken in Sixth Five year Plan (1979) through Integrated Development of Small and Medium Towns followed by Accelerated Urban Water Supply Program (AUWSP) during Eighth Five Year Plan. Jawaharlal Nehru National Urban Renewal Mission (JNNURM) in 2005 was a landmark shift in urban sector that laid emphasis on the preservation of water bodies, adequate water supply and replacement of old and worn out pipes in 63 identified cities. Urban Infrastructure Development Scheme for Small and Medium Towns (UIDSSMT) is a component of JNNURM and includes all urban infrastructure development including water supply and sewerage in small and medium towns. The other important initiatives in urban water system are Atal Mission for Rejuvenation and Urban Transformation (AMRUT) and Smart Cities Mission.

Learning Objectives	Methodology
• To import knowledge on the importance of cross sectoral partnerships for successful socio-economic and political challenges in peri-urban regions	• Lecture • Power point presentation • Question answer sessions • Discussion
Guidance	**Recommended Readings**
• This session is intended to give background on how CCA can be mainstreamed into both development policies and DRR strategies / action plan. • It provides many hands on examples, most which are also presented in detail in the session handout. • Handouts containing brief description on policies and plans.	• Gupta, A.K., Nair, S.S., Wajih, S.A., Chopde, S., Gupta, G. and Aggrawal, G. (2014). Mainstreaming Climate Change Adaptation and Disaster Risk Reduction into District Level Development Plans. NIDM New Delhi (India), GEAG Gorakhpur (UP, India) and ISET, Colorado (US), P 114.

Learning Unit (c): Sector Cluster Strategies (Agriculture, Irrigation, Urban development, Environment, Social Welfare Sectors) – Group exercise

Context and description of the Session
For enabling the participation on identification of intervention themes for mainstreaming peri-urban regions into developmental plans, divide the class room in the groups of five. Each group may be given with the details of any ongoing flagship scheme from agriculture, irrigation, urban development and environment (and forests), and social welfare. Each group shall propose mainstreaming of various measures into the ongoing schemes of the government to be included in peri-urban development. The same shall be discussed in the class and finalized as draft recommendations.

Learning Objectives	Methodology
• To create experienced hands on identification of sectoral gaps and delineate integration of peri-urban regions into development planning. • To learn mainstreaming of various ongoing schemes and plans into peri-urban regions	• Chart paper, sketch pens • Different developmental plans • Power point presentation • Discussion

Guidance
• Divide the class into 5 groups. Provide relevant material such as state profile, institutional setup, database on different departments, agencies and NGOs,main highlights of schemes and programs . • Each group shall conduct preparation strategy for the same state, so that innovative ideas could be evolved. • The groups shall identify the nodal in-charge, stakeholders viz. line departments, local technical agencies, NGOs and academic institutes which could be involved into the planning process. • Propose an institutional structure for implementation of the project including monitoring committee, project cell and approving committee etc. Identify the schemes/projects running within the departments and propose measures for mainstreaming DRR & CCA concerns. • Identify visible gaps and issues in various plans. • Also, draw a time-line chart with achievable mile stones.

6.6 Module 4 : Integrated Development of Urban and Peri-urban Areas

Peri-urban regions often witness deteriorating quality of environment, loss of biodiversity and diminishing landscapes. However, peri-urban areas are not 'the waiting room' (GEAG, 2015) or 'lagging areas' (PURPLE, 2004), and therefore, it is pertinent to find a balance between quality of life and urban development pressures. A holistic urban development is not possible without developing the regions around it to maintain steady input/output flow of materials. Thus, there must be a strategic and transformative process to foster sustainable, equitable as well as inclusive development of urban and peri-urban regions. Urban master plans and regional plans are considered to be blue print and needs revisiting by the architects and experts. The approach must be multidisciplinary, engaging experts from all fields as well as communities in the planning and management process.

There are 3 learning units delineated to draw this module:

LU (A) Urban master plans, town and country planning, urban land use planning
LU (B) Sustainability of water resources and peri-urban agriculture in peri-urban landscapes
LU (C) Field visit: Appreciation of ecosystem services for DRR and climate resilience

Learning Objectives

- To explain the approaches and methods for peri-urban and their implementation in the context of urban risk management and climate change adaptation.
- To describe the nature, extent of threat and significance of countermeasures required for urban and peri-urban risk mitigation.
- To identify the various management interventions required to deal with urban and peri-urban risks
- To explain the need and nature of integration of peri-urban risk concerns into the urban development process to achieve the goal of sustainable development

Guidance	Methodology
• This session aims at discussing the what, why and how of mainstreaming peri-urban concerns into city development. • The facilitators shall have in depth knowledge of various master plans and regional plans	• Lecture/power point presentation • Case study • Field visit • Experience sharing • Discussion

Learning Unit (A). Urban Master Plans and Land Use Planning of Peri-urban Regions

Context and description of the Session

The complexity of urban expansion results in fragmented policy and planning coupled with inequality in investment and unsustainable patter of development (Maheshwari et al., 2014). Due to transitional nature and rapid change in the landscapes the peri-urban ecosystem in our country faces unique challenges. In general, land use / land cover of the area has great impact on the natural resources of the region. Natural areas like water bodies, forest land and agricultural fields have been converted for township development, habitation and industrial activities. Master plans have failed because they are rigid and obsolete. They have been unable to cope up with the pace of growth of Indian cities. Lack of regional planning approach has led to haphazard proliferation of slums. As per the 12th Five Year Plan of India very few Indian cities have 2030 master plans that take into account basic services like water, sanitation, food, transportation, roads etc. This is the time to move a step ahead from master plans towards an integrated development of "smart cities" which aims at developing the urban ecosystem by strengthening institutional, physical, social and economic infrastructure (Gupta et al., 2016). Peri-urban requires new land tenure models (Armstrong and Lopes, 2014) and innovative agriculture forms that conserve nature, infrastructure and serve communities.

Learning Objectives

- To appreciate the importance of urban planning in mitigating disaster and climatic risks.
- To learn strategic planning process which allow local authorities to identify and focus on key disaster risk reduction priorities and explore what resources (human, economic, technology and natural) are available locally.

Methodology

- Lecture
- Power point presentation
- Question answer sessions
- Discussion

Guidance

- It is important to think about implementing concrete disaster risk reduction measures throughout the entire planning process rather than waiting until the plan is completed.
- Priority should focus on actions for which resources and local capacity already exist, those which can and will quickly demonstrate visible results.
- This will motivate all stakeholders and create awareness on the importance of disaster risk reduction in the city.
- When this is recognized through collective consensus, the chances are much greater that the actions will have implementability, and with productive and sustainable fate.
- Hands out on plans and policies can be given to participants (See Annex 1)

Recommended Readings

- Bandyopadhyay, Chandrani (2014). Training Module on Urban Risk Mitigation. National Institute of Disaster Management, New Delhi, P-138.
- NIDM (2014). Mainstreaming Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA) into City Development Plans (CDPs).
- Maheshwari,B., Singh, V.P., and Thoradeniya,B. (2016)(Eds). Balanced Urban Development: Options and Strategies for Liveable Cities. Water Science and Technology Library. Western Sydney University

Learning Unit (B). Sustainability of Water Resources and Agriculture in Peri-urban Landscapes

Context and description of the Session
Peri-urban areas are catalyst for agricultural innovation and water resources management, and hence, proper management can be a win-win situation to both, i.e., urban communities as well as rural communities on the city fringes. "Special Agriculture Zone" which is a concept given by Prof. MS Swaminathan, FRS, may be mapped out in master plans where priority is to be given to dairy and pulse crop, that require lesser water and overcome three kinds of deficiency in urban areas - under nutrition, protein hunger and hidden hunger. The Department of Agriculture may be roped in by city planners for providing further assistance in terms of extension services to peri-urban farmers so that their income can be increased, to result into improved economic security. The State of Uttarakhand had pioneered and became the first "SAZ" state in the country. The concept of home gardens, genetic gardens etc. can be applied in the planning process. While planning, watershed approach can be applied in the city master plans. Watersheds, which are the subsets of larger ecosystem, are geo-hydrological unit comprising of all land and water within the confines of a drainage divide. These watersheds provides with many goods and services (regulating, provisioning, supporting and cultural services) that are required to sustain our livelihood. Adopting a watershed approach provides information about the availability of water, natural flow patterns and developing strategy for resource conservation and its optimized usage. Watershed is an important tool for studying the ecology of the city (Grimm et al., 2000).Watershed approach focuses on all water concerns and uses the concept of hydrology rather than political boundary to define the geographic planning area. Philadelphia in United States was one of the first municipalities of the world to embrace watershed approach during 1990's which was highly recognized and acknowledged for innovative Storm Water Management (Manarano, 2011). One of the case studies come from Australia, where to manage the shortage of water, Coca Cola Company invested in water-use efficiency in the management of watershed and springs (Rasul and Sharma, 2015). Ongoing urban development in the city of Calgary in Alberta (Canada) has affected watershed dynamics by altering riparian and wetland ecosystems. Therefore, watershed planning has been identified as a critical concern for land use planning in the city (O2 Design, 2012).

Learning Objectives	Methodology
• To be able to state on the importance of urban agriculture systems and watershed management at city level for addressing urban resilience. • To enhance knowledge on interaction between urban areas and the surrounding ecosystem and provide an overview of the different actors and institutions at sub-national level. • To enable trainees to identify and understand tools for urban ecosystem management and planning.	• Lecture • Power point presentation • Case study: SAZ Uttarakhand, SAZ Karnataka , watershed management at city level • Question answer sessions • Discussion

Guidance	Recommended Readings
• In this session trainees shall learn about the importance of sustainable agriculture and water resources management for urban regions and understand that the urban ecosystems and the periphery are important factors which determine urban disaster risk. • They should be sensitized on important factors for adequate urban (ecological) planning to minimize disaster risk, the involved actor groups and institutions.	• Estrella, M. & Saalismaa, N. (2012).The Role of Ecosystem Management for Disaster Risk Reduction. In Gupta, A.K., & Nair, S.S (Eds.), Ecosystem Approach to Disaster Risk Reduction (pp.5-44). National Institute of Disaster Management, New Delhi. • Gupta, A.K. and Nair, S. S. (Eds.).(2012). Ecosystem Approach to Disaster Risk Reduction. National Institute of Disaster Management, New Delhi. • Millennium Ecosystem Assessment, (2005). Ecosystems and Human Well-being: Synthesis. Island Press, Washington, DC. • Sudmeier-Rieux, K. (2013).Ecosystem Approach to Disaster Risk Reduction: Basic Concepts and Recommendations to governments, with a special focus to Europe. European and Mediterranean Major Hazards Agreement (EUR-OPA). • Singh, S., Nair, S.S., & Gupta, A.K. (2013). Ecosystem Services for Disaster Risk Reduction: A Case Study of Wetland in East Delhi Region, India. Global Jour. on Human Social Science, Geog., Geo-Sciences, Env.Disaster Mgt, 13 (4), 37-47.

Learning Unit (c). Appreciation of Ecosystem Services for DRR and Climate Resilience

Context and description of the Session

The last session of this module is aimed to give field exposures to the participants. It is better to plan a field visit at the end of module as a touristic/excursion outreach of the participants which will have a clear link to the module contents. Various activities and discussions during field visit will help clarify the doubts of participants and enhance their knowledge on concepts and issues. While planning the visit, the trainer needs to assess the feasibility of visit. Appropriate objectives and context of the visit needs to be identified. The field visit can be carried out at any place relevant to this module and where appropriate field visit sites are available.

The following criterion must be followed while choosing a field visit site:

- The site selected must be relevant for the module contents and previous experience of participants. The focus should be learning of new concepts and methodologies.
- The logistical feasibility like distance, accessibility, security and costs, etc. must be kept in mind.

A proposed field visit with Methodology and Learning Objectives is given here. Likewise, other field visits may be carried out as per the place/region where the course will be administered:

Field visit to a wetland site which may be a natural wetland or a constructed wetland may be conducted to enable the participants to understand the role of ecosystems and ecosystem services in disaster risk reduction and mitigation (floods, droughts, disease outbreak, etc). The visit will enable the participants to become familiar with the concepts of **Eco-DRR**; Community Based Disaster Risk Reduction **(CBDRR)** and importance of **land-use planning in DRR**. It will enable the participants to understand the challenges in implementing ecosystem approaches and advantages of protecting the ecosystems for livelihood of the people.

"Wetland ecosystems are crucial to our natural wealth. They provide us with services worth trillions of US dollars every year entirely free of charge making a vital contribution to human health and well-being (Ramsar Convention, 1971,). Wetlands are one of the most productive ecosystems of the world which along with supporting unique flora and fauna provides range of ecosystem services (MA, 2005). Wetland ecosystems contribute to reducing disaster risk by serving as natural protective barriers or buffers and thus mitigating hazard impacts (Gupta & Nair, 2012). Well managed ecosystems can provide natural protection against common natural hazards, such as landslides, flooding, wildfires, storm surges and drought (Rieux et al., 2009)" (as in Singh et al., 2013).

Methodology:

- A well planned preparation in terms of logistics and preparation of participants is required prior to the field visit. The resource persons, communities and other stakeholders who will be consulted during the visit should be informed prior to visit so that they can understand the purpose of visit and help to achieve the goal of this visit.
- The trainer should give an introduction of the site to be visited. The discussion should clearly mention the objectives of the field visit followed by a Question/ Answer session to satisfy the queries of participants.
- The participants will be divided into groups with tasks assigned on different aspects, to cover multiple dimensions of ecology and disaster risks. For example a group may be assigned the task to interact with the community members living along the wetland site.
- Transect walk should be carried out across the wetland site to identify and explain the relationships among floodplains, natural vegetation, cultivation, human activities & settlement pattern and understand the various ecosystem services provided by the wetland. It will help to understand the natural resources, current land-use pattern, vegetation, changes in the physical features and cropping systems, social differentiation and mobility in urban/rural communities living there.
- The trainers should facilitate the participants to understand how unsustainable land use planning degrades the natural infrastructure.
- A field survey will help to understand the perception of communities living on the fringes of wetland on ecosystem services provided by the wetland and disasters faced by them. This will also give knowledge about CBDRR where communities are involved in sustainable management of natural resources and trying to adapt to climate change to improve the livelihood resilience.
- The participants will prepare brief reports after returning from field visit and give a power-point presentation on the next day so that each and every participant will be able to learn about all the objectives of this visit.

Learning Objectives	Methodology
• To understand the role of ecosystems and ecosystem services in hazards and disaster risk reduction and mitigation in urban/rural areas. • To analyse the vulnerability of natural infrastructure due to natural and anthropogenic causes (disasters either natural or climate induced, unsustainable land use planning & developmental activities in urban areas). • To identify community based methods for DRR along the natural infrastructure that increase community resilience to climatic risks. • To define the needs and modes to integrate Eco-DRR in urban planning processes	• Lecture/Presentation cum briefing about the field visit • Group Discussion/Formation • Field survey documents • Travel Map/ Route Map • Cameras • Case studies relevant to the planned visit • Film Shows/ Slide Show of relevant pictures

Guidance	Recommended Readings
• The participants are requested to wear comfortable sports shoes while transect walk. The trainer should inform about field visit in advance so that participants can prepare accordingly. • **Resource Persons:** Field visit resources may include field guides with diverse areas of expertise. For example: Ecologists, Conservationists, Social Experts and Ornithologists etc. who are well aware about the present field visit site. These resource persons can guide the participants to understand the socio-ecological aspects in a better way. • **Field Survey:** A small survey questionnaire can be prepared before proceeding for the field visit so that participants can interact with communities living around and the officials present there. The resource team & the participants can interact with the communities in flood plains. This will help to understand the concept of CBDRR and achievement of Objective 3. • **Presentations:** The trainer should encourage participants to explore beyond the objectives of field visit and take photographs so that presentations can become more effective. • **Research Proposals:** The participants should be encouraged to submit research proposals after coming back from field visit so that the issues requiring further scientific research may come in limelight. They should give a brief Statement of Purpose & a Research Methodology based on their observations.	• Singh, S., S.S. Nair & A. K. Gupta (2013) Ecosystem Services for Disaster Risk Reduction: A Case Study of Wetland in East Delhi Region, India. National Institute of Disaster Management, India. Global Journal of Human Social Science. Management. Volume 13, Issue 4, Version 1, 12p. • Gupta, A.K. and Nair, S. S. (Eds.) (2012). Ecosystem Approach to Disaster Risk Reduction. National Institute of Disaster Management, New Delhi. • CNRD-PEDRR (2013) Disasters, Environment and Risk Reduction – Eco-DRR Master's Module, Instructor's Manual. Cologne and Geneva: Center for Natural Resources and Development, Partnership on Environment and Disaster Risk Reduction.

6.7 Module 5 : Community Perspectives for Climatic and disaster risk Management through Peri-urban Ecosystems

Urban growth based on migration and the absorption of rural areas into the urban has led to immense problems ranging from impoverishment, ill-health, malnutrition, loss of fertile land, food insecurity, water insecurity, social insecurity, gender inequality as well as over-concentration in slums and squatter settlements that also often get flooded as well as prone to other disasters. Most of these urban poor work in informal sector, give services to the city but does not get the due acclaim or remuneration. Exploring the opportunities to strengthen peri-urban and urban agriculture based livelihoods, empowering the deprived groups especially small and marginal women farmers by forming community organizations, multi-disciplinary and integrated land-use planning, diversification of economy for the marginalized group for livelihood security can be explored under this module.

This learning unit basically aims to build understanding on community specific issues of climate change impacts, identification of vulnerable areas, capacity to respond on time to climate related disasters and develop a vision for resilient community. There are three learning units delineated to draw this module:

LU(A) Understanding community vulnerability (marginalised section, gender) and capacity to respond to climate change
LU(B) Developing a climate change response and disaster risk reduction planning and activities in peri urban ecosystem
LU(C) Group exercise: case study simulation

Learning objectives

- To enable participants to describe community vulnerability and capacity to respond to changing climate in peri-urban regions.
- To identify mechanisms to address specific vulnerabilities of peri-urban areas and its habitants.
- To describe the importance of capacity building and awareness generation at community level.
- To develop a vision for resilient community.

Guidance	Methodology
• This session is intended to consider poor and marginalised community's perspective in peri-urban regions, and hence, emphasis should be given on examples and case studies for mainstreaming it into development plans.	• Lecture/power point presentation • Case study • Group exercises • Experience sharing • Discussion

LU (A). Understanding Community Vulnerability (Poor and Marginalized Sections, Gender, etc.) and Capacity to Respond to Climate Change

Context and description of the sessions
Impacts of unplanned or poorly planned urbanization coupled with extremes of climate change are not the same for all peri-urban residents. The poor and marginalized sections like small farmers, labour class and women are disproportionately affected by the decline of peri-urban ecosystem due to their propensity to live in peri-urban areas, high dependence on ecosystem services, and the economic impacts of land use change. Mostly, the peri-urban areas tend to be occupied by low-income families and are typified by illegal settlements, slums and unorganized businesses. In addition, peri-urban areas are poorly served by urban infrastructure, lack of municipal services and experience worse hygiene and sanitation conditions. In order to effectively reduce vulnerability of marginalized section of the society, holistic and inclusive response to changing climate, favorable institutional mechanisms, market connectivity, developing package of practices for better agricultural activities etc. in peri-urban region is must to build resilience communities to withstand the range of shocks and stresses that they are exposed to.

Learning Objectives	Methodology
• To identify vulnerable communities living on the city fringes. • To describe the impact of unplanned urbanization and changing climate on identified vulnerable communities. • To identify various coping mechanisms to better deal with the situation and mainstream into sustainable development.	• Power point presentation • Discussion • Case study presentation • Question answer sessions
Guidance	**Recommended readings**
• Trainer may identify specific examples, and references from the case studies. • Trainer may ask the participants to cite specific examples from participant's localities, concerning vulnerable groups in peri-urban settings and their proneness to disasters and climatic risks.	• Narain, V. 2010. 'Periurban water security in a context of urbanization and climate change: A review of concepts and relationships', Peri Urban Water Security Discussion Paper Series, Paper No. 1, SaciWATERs. • Douglas, I. (2006). Peri-urban ecosystems and societies: transitional zones and contrasting values. In: McGregor, D., Simon, D. & Thompson, D. (eds) The Periurban Interface: Approaches to Sustainable Natural and Human Resource Use. Earthscan, VA, USA.

LU (B). Developing Climate Change Response and Disaster Risk Reduction Planning and Activities Concerning Peri-urban Ecosystem

Context and description of the sessions

Peri-urban areas are complex hybrid systems in which the essence of urban and rural communities are blended together. Analyzing livelihood activities, natural resources management and adaptation strategies in peri-urban region offer both opportunities and challenges for enhancing marginalized people adaptive capacity.

The framework to understand community vulnerability in peri-urban regions and capacity to respond to shocks as well as building adaptation is four inter-related strategies given as below:

- Promotion of climate-resilient livelihoods strategies in combination with income diversification and capacity building for planning and improved risk management;
- Disaster risk reduction strategies to reduce the impact of hazards, particularly on vulnerable households and individuals;
- Capacity development for local civil society and governmental institutions so that they can provide better support to communities, households and individuals in their adaptation efforts; and
- Advocacy and social mobilization to address the underlying causes of vulnerability, such as poor governance, lack of control over resources, or limited access to basic services.

Learning Objectives	Methodology
• To identify climate resilient livelihood strategies for vulnerable communities. • To describe various capacity development mechanisms which can provide support services to communities in their adaptation efforts.	• Power point presentation/lecture • Discussion • Question-answer sessions • Experience sharing
Guidance	**Recommended readings**
• It is important for trainers to explain and appreciate the concepts of diversification of livelihood and economy and how it can be used in climate change adaptation process, and in linkage with peri-urban ecosystems and urban resilience.	• Ricci, L. (2011). Peri-urban livelihood and adaptive capacity: The case of Dar Es Salaam. http://bieb.ruaf.org/ruaf_bieb/upload/3813.pdf

LU (C) Group exercise: Case study simulation

Context and description of the sessions
The last session of this module is intended to long lasting impact of this learning activity. It is also a kind of evaluation of trainees on their learning from previous sessions. The session may be planned in form of some/set of activities where different ideas for developing resilient communities can be thought of. Activity 1: A case study handout The class can be divided into four groups based on four ecosystem services as Provisioning group, Regulating group, Supporting group and Cultural group. A case study handout on peri-urban ecosystem and services of peri-urban regions can be selected by the trainers and given to participants. The groups as per the name are asked to identify the respective ecosystem services from the same and outline the linkages in reducing the vulnerability of communities along with climate change adaptation mechanisms. After the group has finished the task, one representative from each group can give presentation based on their understanding of the concepts.

Learning Objectives	Methodology
• To apply the knowledge gained through previous LUs.	• Discussion • Case study handout • Oral presentation
Guidance	**Recommended readings**
• Participants may be asked and encouraged to share their experiences of lessons learnt in building resilient communities in peri-urban regions, in their regions of living, work, past research/studies, etc.	• Bhatt, Seema., Singh, A., Mani, N., 2016. Peri-Urban Agriculture and Ecosystems: Resilient Narratives. Published by GEAG, Gorakhpur. • Singh, S., Nair, S.S., & Gupta, A.K. (2013). Ecosystem Services for Disaster Risk Reduction: A Case Study of Wetland in East Delhi Region, India. Global Jour. on Human Social Science, Geog., Geo-Sciences, Env. Disaster Mgt, 13 (4), 37-47.

6.8 Conclusion: Summing-up, Post-training Assessment & Course Follow-up / Recommendations

Context and description of the sessions

Participant's feedback on the program-design, contents, learning and resources, are important for the continuous improvement of the course and its delivery. Besides, it also generates many innovative ideas and options for diversifying the courses for effective and objective course deliveries. Feedback of the course faculty/coordinators on the course participants and overall conduct of the course will also be important at the end. A pre-developed feedback format shall be given to the participants for their entries before the valedictory session, which shall be later analyzed and be used in developing summary course-report.

Valedictory session is important which can be chaired by the host institute's Director/Head or Secretary/Commission of Urban or Rural Development, Relief/Labour/Environment, Mayor or Municipal Commissioner as appropriate or a senior academic faculty on related subject. Alternatively the course Director shall preside the session. A brief course report following the welcome note will be followed by few brief feedback rounds from the participants and messages of long-term interaction and continuous learning on the subject. Valedictory session shall aim at generating the feeling that the training objectives shall be fulfilled by putting in-use of the lessons discussed in the course, and by initiating a process of improving the delivering on routine basis towards effective risk management and response. A formal vote of thanks shall be given at the end to express gratitude towards the participant's organizations, host institution, collaborators, resource persons, associates, team and all other whose contribution was important in making the course a success.

Learning Objectives	Methodology
• To review and understand the suitability of course design and contents for future courses • To review and enlist the possible improvements/changes and diversifications in the course design and deliveries • To assess possible cooperation, network and future strategies of applying the course lessons in line functions and practice.	• Brief addresses • Discussion. • Course feedback and lessons • Course brief-report • Roadmap for implementing knowledge and skills • Broad guidelines for future strategies

Guidance

- Course coordinator shall coordinate the session with positive attitude for furthering the integration and development of peri-urban ecosystems into developmental plans and policies by generating long-term and effective strategies of cooperation among stakeholders at different levels.
- Coordinator shall extend thanks to all including dignitaries, team of faculty and all associates personally after the session.

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Notes

About Organizations

Gorakhpur Environmental Action Group (GEAG)

Gorakhpur Environmental Action Group (GEAG) is a voluntary organization working in the field of environment and sustainable development since 1975. Ever since its inception, GEAG has been actively engaged in implementing several development projects addressing livelihood issues of small and marginal farmers, particularly women, based on ecological principles and gender sensitive participatory approach. Besides, GEAG has accomplished several appraisals, studies, researches at the micro and macro levels as well as successfully conducted a number of capacity building programmes for various stakeholders including women farmers, civil societies groups and government officials etc.

GEAG has established its identity in North India as a leading resource institution on sustainable agriculture, participatory approaches, methodologies and gender. Acknowledging its achievements, GEAG was awarded with the Lighthouse Activity Award by UNFCCC in 2013. GEAG also holds the Observer status to Green Climate Fund. (www.geagindia.org)

The Rockefeller Foundation

The Rockefeller Foundation supports work that expands opportunity and strengthens resilience to social, economic, health and environmental challenges, affirming its pioneering philanthropic mission since 1913 to promote the well-being of humanity. In climate change, the Foundation develops services and strategies to protect those with the least means from an imperilled environment and changing global climate. The Rockefeller Foundation envisions a world with Smart Globalization – a world in which globalization's benefits are more widely shared and social, economic, health, and environmental challenges are more easily weathered.

The Rockefeller Foundation supports work that enables individuals, communities, and institutions to access new tools, practices, resources, services, and products. Additionally the Foundation supports work that enhances resilience in the face of acute crises and chronic stresses, whether manmade, ecological, or both. (www.rockefellerfoundation.org)

Asian Cities Climate Change Resilience Network (ACCCRN)

The Rockefeller Foundation launched the Asian Climate Change Resilience Network (ACCCRN) in 2008 to help cities strengthen their capacity to prepare for, withstand, and recover from the projected impacts of climate change. This effort has resulted in insights into the process and range of actions that are needed to confront these dynamic shifts affecting urban areas. ACCCRN began with a focus on 10 cities in Vietnam, India, Indonesia, and Thailand. City-led projects include establishing end-to-end early warning systems in Surat, India, and storm and flood resistant credit and housing in Da Nang, Vietnam.

Today, ACCCRN is leading regional network connecting professionals and communities across Asia to build inclusive urban climate change resilience (UCCR) that focuses on poor and vulnerable people affected by climate change. Several ACCCRN cities are now members of the 100 Resilient Cities Network, bringing these lessons and best practices to other cities around the world. (www.acccrn.net)

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