Training Module
on
Urban Risk Reduction and Resilience:
A Comprehensive Approach
(Specialized Course for Practitioners)

GUJARAT INSTITUTE OF DISASTER MANAGEMENT
BUILDING RESILIENCE

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Gujarat Institute of Disaster Management

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Message

Dear Readers,

Gujarat has witnessed rapid population growth, especially in urban areas. Cities like Ahmedabad, Surat, Vadodara, and Rajkot have seen substantial increases in population due to migration from rural areas and other states. Gujarat is known for its industrial development, including sectors such as textiles, petrochemicals, pharmaceuticals, and manufacturing. This industrial growth has led to the establishment of industrial clusters and special economic zones, attracting investment and generating employment opportunities.

While urbanization brings several opportunities for economic and social development, it also poses various challenges. Rapid urbanization has put a strain on existing infrastructure, including transportation, water supply, waste management, and healthcare. Inadequately planned and managed cities pose new risks that jeopardize existing development achievements. Insufficiencies in infrastructure and services, unsafe housing conditions, and inadequate healthcare services can transform natural hazards into full-fledged disasters.

Looking to this, a training module on '**Urban Risk Reduction and Resilience: A Comprehensive Approach**' is developed focusing on the crucial task of building resilient cities. It will provide a comprehensive understanding of urban risks, their underlying causes, and effective strategies for risk reduction and management. Further, through interactive training sessions, case studies, and practical exercises during the training based on this module will give insights into best practices and innovative approaches for creating sustainable and resilient cities.

I take the opportunity to thank Shri Mukesh Puri IAS (former Addl. Chief Secretary, UD& UHD) and Shri. Ashwini Kumar IAS, Principal Secretary, Urban Housing and Urban Development Department, for the invaluable support in the development of training module. We are also thankful to Shri. Prakash Dutta, Officer on Special Duty & Joint Secretary, UD&UHD, Shri. D. J. Jadeja, Chief Town Planner, Town Planning and Valuation Department and other officers for their valuable contribution for the development of the module. I appreciate the efforts of GIDM team especially Shri. Nisarg Dave and Mr. Shubham Daberao along with the Resilience Innovation and Knowledge Academy (RIKA) India team - Ms. Ambika Dabral and Ms. Krishnakali Ghosh.

I sincerely hope that this training module will be useful to trainees, researchers and professionals in urban sector. GIDM remains committed to upholding the standards of excellence and will continue to deliver meaningful educational experiences with the aim of BUILDING RESILIENCE in Gujarat.

(Dr. Rajiv Kumar Gupta)
Director General
Gujarat Institute of Disaster Management

Abbreviations

CBDM	Community-Based Disaster Management
CBOs	Community-Based Organisations
CCA	Climate Change Adaptation
CDMP	City Disaster Management Plan
CDP	City Development Plan
DM	Disaster Management
DRR	Disaster Risk Reduction
EbA	Ecosystem-based Adaptation
Eco-DRR	Ecosystem-based Disaster Risk Reduction
GAR	Global Assessment Report on Disaster Risk Reduction
GIDM	Gujarat Institute of Disaster Management
GIS	Geographic Information System
GSDMA	Gujarat State Disaster Management Authority
HFA	Hyogo Framework for Action
HRVA	Hazard Risk and Vulnerability Assessment
HUDCO	Housing & Urban Development Corporation Ltd
ISDR	International Strategy for Disaster Reduction
JICA	Japan International Cooperation Agency
NAPCC	National Action Plan on Climate Change
NBC	National Building Code
NbS	Nature based Solutions
NDMA	National Disaster Management Authority
NGT	National Green Tribunal
NIDM	National Institute of Disaster Management
NIUA	National Institute of Urban Affairs
SAPCC	State Action Plan on Climate Change
SFDRR	Sendai Framework for Disaster Risk Reduction
TCPO	Town & Country Planning Organization
UDA	Urban Development Authority
UD & UHD	Urban Development & Urban Housing Department
ULB	Urban Local Body
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UNISDR	United Nations International Strategy for Disaster Reduction
UNDRR	United Nations Office for Disaster Risk Reduction

Content

About the Training Module

"Make India disaster resilient across all sectors, achieve substantial and inclusive disaster risk reduction by building local capacities starting with the poor and decreasing significantly the loss of lives, livelihoods, and assets in different forms including economic, physical, social, cultural, and environmental while enhancing the ability to cope with disasters at all levels." (NDMA, 2019)

The National Disaster Management Authority has formulated a long-term vision based on resilience for India. As the urban population in India increases each year due to economic growth rates in cities, labor requirements, wages, attracting rural-urban migration it is important to strengthen urban systems to cater to the population. Improvement in disaster risk management and building resilience can minimize losses in the future. Achieving urban resilience requires ongoing capacity building as an iterative process of design-application-learning-adjustment. An essential component of capacity building is training. Because of the nature of the work that needs to be done before, during and after a disaster, training is very important in disaster risk reduction. Climate-related disasters are often exacerbated in cities than rural, majorly by interactions between urban infrastructure systems, growing urban populations, cultures, and economic activities. Most people find it overwhelming to deal with the speed, scope, and damage of a crisis, which lowers the quality of the response. Thus, it becomes crucial to provide the designated responder with focused training and capacity building. On the other hand, disaster management goes beyond the scope of reaction and has an impact on all facets of society.

This training module on Urban Risk Reduction and Resilience: A Comprehensive Approach aims to address the vision and support the policy makers and urban practitioners with an ability to prepare for enhancing urban resilience. It has been developed with inputs from key stakeholders from the Urban Development and Urban Housing Department of Government of Gujarat. The ToT model is envisaged to act as multiplier of trainers in the state; thereby creating a self-sustaining process involving knowledge transfer. The module is divided into three parts: Basic Course, Specialized Course for Policymakers, and Specialized Course for Practitioners.

Context

Cities are becoming hotspots of extreme events with increased concentration of people, economic activity, social and cultural interactions, as well as environmental and humanitarian effects. This poses enormous sustainability challenges for housing, infrastructure, basic services, food security, health, education, decent jobs, safety, and natural resources, among other things. The United Nation's Decade of Action highlights the need for urgent action on sustainable development, including in the area of urban resilience. Several SDGs are directly related to urban resilience, including SDG 11, which calls for inclusive, safe, resilient, and sustainable cities. The temperature targets set by Paris Agreement to limit global warming to below 2 degrees Celsius above pre-industrial levels needs actions to improve the resilience of urban areas which are vulnerable to the impacts of climate change extreme weather events, and heatwaves.

The number of disasters occurring around the world has increased by a factor of five over the last 5 decades, acerbated by rapid urbanisation, extreme weather, climate change. The Centre for Research on the Epidemiology of Disasters report states that around 3.9 billion population was exposed to various natural hazards in the year 2018 (EM-DAT, 2019). It also reports Asian continent is the most vulnerable to hazards events, owing to various factors such as population, location, and so on. In India, the urban population is rapidly increasing with over 34% of population living in urban areas with a significant proportion of population living in informal settlements, which lack basic services, such as

water, sanitation, and waste management, and are highly vulnerable to disasters and climate impacts. Similar circumstances exist in Gujarat, where 2.57 crore people, or 42.6% of the state's total population, live in urban areas (Census 2011). Gujarat is one of the most urbanized states in India with the urban population increasing from 34 percent in 1991 to 48 percent in 2020.

As rapid urbanization becomes a key driver for the state's economic growth it is essential to have an integrated and accountable urban governance system that can create greener urban footprints, and improve disaster risk management and resilience to climate change. A disaster results in death, property loss, loss of assets and livelihood, as well as destruction and devastation. A proactive, well-coordinated administrative framework is necessary for disaster management, as is a community that is alert, informed, and engaged. Preparing a group of skilled and dedicated employees at all levels may create a proactive, effective, and integrated administrative system. The personnel assisting in a catastrophic situation must draw on their understanding of best practices and intervention techniques. Personnel from Urban Local Bodies (ULBs) will become more aware of the unique demands and activities needed after receiving training on the many manifestations of urban disasters. This training will complement novel frameworks such as SFDRR encouraging building the knowledge of government officials at all levels, and thereby help in achieving global and national goals. The overall objectives of the training are:

- Provide knowledge of urban systems and their resources, resilience, and impacts of climate and disaster risks, and thereby act as a spring for further knowledge multiplier
- Familiarize participants with tools, legislation, and frameworks for the assessment and development of urban resilience
- Infuse informed decisions and systems thinking for improving the quality, efficiency, sustainability, and resilience of urban services
- Improve the readiness of local administrators and stakeholders inter alia increase their knowledge on the key roles and responsibilities to build urban resilience
- Provide participants with the knowledge to formulate effective city development, management plans, and policies for climate change and urban resilience

Target Users

Trainers in the disaster management and/or urban development sector can employ this training module for providing state and local government officials with training on urban risk reduction and resilience. Professionals in the fields of urban development and disaster management can use the module for independent study as well. The key target users are:

- Officials from departments like Urban Development and Urban Housing Development Department, Town Planning and Valuation Department, Gujarat State Disaster Management Authority, Commissionerate of Relief etc.
- Practitioners like Engineers, Architects, Planners from autonomous bodies, and urban local bodies (ULBs)
- Policymakers like Chief Officers and Municipal Commissioners
- Elected officials of urban local bodies, and
- NGOs working on urban issues

Structure of Training Module

The Training Module is designed to cater to varied stakeholders and users at state and local level in the state of Gujarat. The participants are expected to belong to diverse academic background, professional fields, and even different nations. Considering their varied level of understanding and

familiarity with DRR and CCA, the Training Module offers three types of course, namely, Basic, Specialized for Policymakers and Specialized for Practitioners. Each course is a combination of a training sessions, individual & group exercises and case studies. Tables below provides the overall structure of the Training module detailing the type of courses offered and constituent sessions and learning units under each course. The learning hours of each course are also indicated.

The entire Training Module is divided into three parts namely: Basic, Specialized for Policymakers and Specialized for Practitioners. This document covers the Specialised Course for Practitioners.

Basic Course

Day 1	Day 2	Day 3

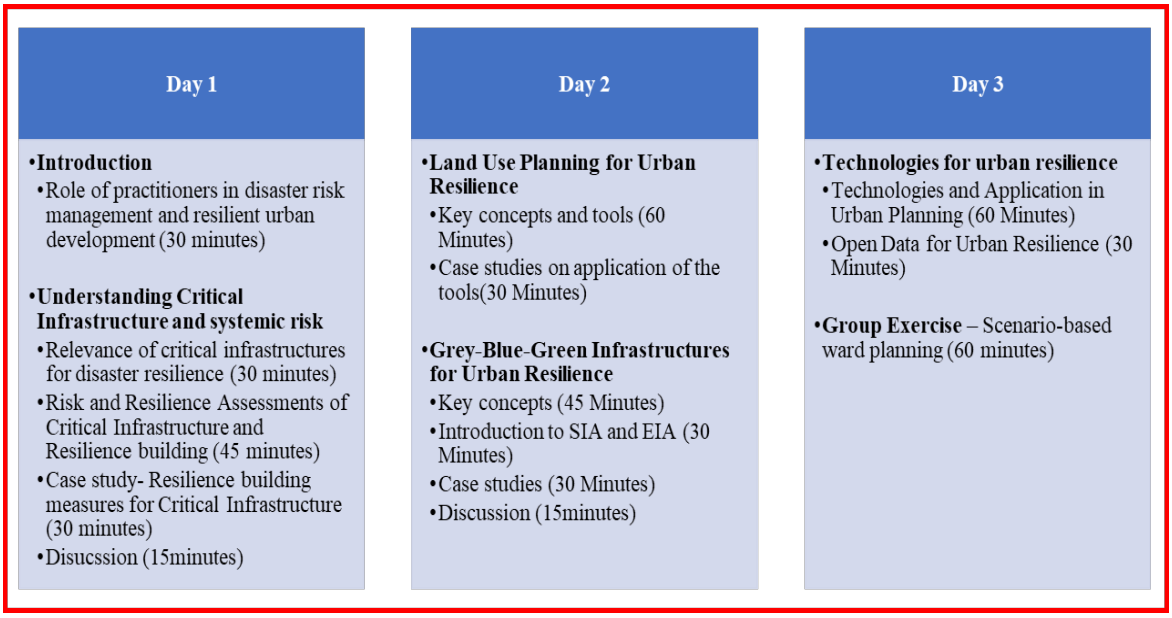
• **Introduction to DRM and CCA**
  • Key concepts in Disaster Risk Management and Climate Change adaptation (60 minutes)
  • Global frameworks and policies (60 minutes)
  • Disaster Ethics and Humanitarian Actions (30 minutes)
• **Introduction to urban systems, their interdependencies and associated risks**
  • Risk profile of Gujarat in the urban context (60 Minutes)
  • Urban systems and associated risks (60 Minutes)
  • Case study/Group Exercise - Interdependencies of urban systems (60 minutes)
	• **Urban Resilience, Framework for Urban Resilience: Case Studies, Methodologies and Tools**
	  • Urban resilience and its components (30 minutes)
	  • Key instruments for urban resilience (60 minutes)
	  • Tools of Resilience Analysis/Assessment (60 minutes)
	  • Group exercise on resilience tool (60 minutes)
	• **Good Practices in Building Resilient Cities and towns**
	  • Case studies on building resilient towns and cities (60 minutes)
	  • Sectoral experience sharing and group discussion (60 minutes)
		• **Urban Resilience and Governance**
		  • Mainstreaming Disaster Risk Management and Climate Change Adaptation into Urban Development Planning (60 minutes)
		  • Multi-sectoral risk management (60 minutes)
		  • Group Exercise – Drafting institutional mechanism for urban risk governance (60 minutes)
		  • Field Visit (120 minutes)
		  • Group discussion (30 mins)

Specialized Course for Policymakers

Day 1	Day 2

• **Introduction**
  • Role of policymakers in disaster risk management (30 minutes)
  • Group activity- Gaps and challenges in urban policies and implementation from lens of DRR and resilience (60 minutes)
• **Mainstreaming Disaster Risk Management (DRM) and Climate Change Adaptation (CCA) into Urban Development Planning**
  • DRR and CCA frameworks in the urban context (45 minutes)
  • Case studies: integration of DRR & CCA through national and state schemes and policies (45minutes)
  • Group discussion (30 mins)
	• **Transboundary Governance** (30 minutes)
	• **Disaster Grievance Redressal Mechanism** (30 minutes)
	• **Disaster Risk Financing**
	  • Key concepts and existing instruments (30 minutes)
	  • Group exercise - Tabletop on strategy planning for integration of DRM and CCA (60 minutes)

Specialized Course for Practitioners



Guide to the Trainers

The training module was created with a framework that encourages participation. The trainer may take into account the following recommendations in addition to the knowledge and skill inputs described in the technical sessions to make the programme interactive, thorough, and exciting and ensure that trainees retain inputs after the course is over:

- Write a welcome note to the potential participants once the participant list has been finalised. The note should include a welcome message, information on the institute's location, directions to the site, the reporting time for training, the current weather, and the required attire.
- The participants should be required to complete an online registration form containing their name, address, and contact information, among other information.
- After the training has begun, the list of participants with their contact information should be passed around to check for any errors before being finalised.
- To start the conversation, a group activity involving all participants should be planned as guided in the module.
- Every day, short-duration discussions should be planned, especially for the post-lunch session (not more than 15 minutes).
- Reassign participants for group projects as often as you can to promote stronger peer interaction.

Specialized Course for Practitioners

Having completed the comprehensive Basic Course on Urban Risk Reduction and Resilience which introduced the learners to the key concepts, legislations, frameworks, tools and practices of disaster risk management, climate change adaptation, urban systems and associated risks, urban resilience and urban governance, the focus of the Specialized Course for Practitioners is to dive deeper into specific aspects where the engineers, architects, urban planners can play a crucial role.

For effective learning and take away from the current course, it is expected that the learners have duly completed the Basic Course before getting enrolled for this course. The current course is a fast-paced three days course dedicated for the practitioners from the Urban Local Bodies from varied Municipal Corporations, Municipalities, Urban Development Authorities of the state. The course comprises five training sessions with eleven learning units and group exercises with a total duration of eight and a half hours.

Technical Session 1: Introduction

Introduction, Overview & Perspectives

The technical session offers to introduce the learners to the key roles of practitioners (engineers, architects and urban planners) in disaster risk management and strengthening urban resilience. The session would take the learners through various case examples from around the world to highlight practitioners 'roles and approaches in resilience building.

- Learning Unit 1.1: Role of Practitioners in disaster risk management and resilient urban development

The primary objectives of the technical sessions are:

- To have a better understanding of the roles and responsibilities of practitioners in DRM
- To enhance knowledge on ways to engage in resilient urban development

Duration : 30 minutes

Methodology

- Lecture-based learning
- Discussion

Trainee's Note

This technical session consists of one learning unit followed by a discussion. It should be conducted to provide a basic conceptual clarity about the key roles and responsibilities of urban practitioners in DRM and resilience building using various tools and methods. The trainer should aim for an understanding through the active participation of learners through discussion and question & answer sessions. It is recommended that while explaining and using examples on the same, trainers strive to link the general concepts to the urban contexts of Gujarat.

Learning Unit 1.1: Role of Practitioners in Disaster Risk Reduction and Resilient Urban Development

Brief Description of the Learning Unit

This learning unit introduces learners to the roles they can play in disaster risk management and resilient development. It strives to guide the learners to best direct their efforts toward making their cities risk-informed and resilient. It develops an understanding of how cities can act in a resilient manner. This would also enable the learners to identify areas for integrating their learning within their spheres of work.

Learning Objectives

- To have a better understanding of the roles and responsibilities of practitioners in DRM and resilience building
- To enhance knowledge on ways to engage in resilient urban development practices

Duration: 30 mins

Methodology

- Lecture-based learning
- Discussion

Detailed Description

At the local level, DRR responsibilities are shared among several departments. The Ministry of Housing and Urban Affairs, GoI suggested ensuring the participation and commitments of various government departments, NGOs, and public representatives in the urban plan formation exercise thus increasing the scope for integration of practices for building urban resilience. The formulation of development interaction committees to advise on aims and objectives, priorities and major requirements of all sections of society for safe development of the community is encouraged by the ministry. Urban local bodies can play a major role in disaster risk reduction through activities like (MoHUA 2016):

- Preparation and updating of city DRR plans
- Strengthening of Techno-legal regime (updating of building bylaws and other departmental policies and guidelines regime)
- Participation and coordination in DRM activities
- Conducting simulation activities such as pre-, during post-disaster actions like risk assessment and relief distribution for recovery from the event
- Awareness of departments on DRM and CCA
- Establish a governance mechanism for monitoring and evolution.
- Use of technology and tools for DRM and CCA

City Disaster Management Plan

People anticipate elected politicians and local government representatives to act swiftly to address the issue when disasters threaten or occur in their area. The municipal government of the city is expected to mobilize its resources, coordinate, acquire, and direct the activities of stakeholders like nonprofits and for-profit businesses in the city, and if required, seek support from line departments and outside the area of control. All of these actions are organized into a City Disaster Management Plan (CDMP), which directs officials in making quick decisions for handling any disaster crisis.

A DM plan is essential for workouts and capacity building in particular. Emergency response professionals benefit from training to better understand their roles and develop the skills needed to complete assignments. Drills and exercises offer a way to validate plans, checklists, and response protocols as well as to assess the abilities of response personnel. An engineer or urban planning practitioner can support the plans using methods like:

- GIS
- Remote Sensing, Aerial photography, Drone monitoring
- GPS
- Databases (E.g., Big data, EMDAT, etc.)
- Crowdsourcing data
- Mobile-based services
- Geotagging of houses and other buildings

Kolkata Municipal Corporation developed an urban flood modeling and early warning system for housing a population of 4.6 million. The stormwater management model (SWMM) was used to analyze Kolkata city's whole stormwater system. The system was equipped with a real-time early warning system. Improvements to the gated outfall system were recommended. Development planning with disaster resilience considerations in municipal planning and budgeting was done with a set of 60 extreme event scenarios, including combinations of excessive rainfall, tide and fluvial floods, and drainage system failures. These were done through inundation maps (GIS) and videos. The identification of flood-prone locations, hydraulic modeling of the river and canals to inform prediction scenarios, and recommendations for enhancing a meteorological forecast system were all made.

Thiruvananthapuram Municipal Corporation prepared the City Disaster Management Plan document with support from KSDMA & UNDP. This document included inputs from a series of consultations and meetings and identifies disaster risk areas including scientifically prepared grid-based maps of critical infrastructures in the city.

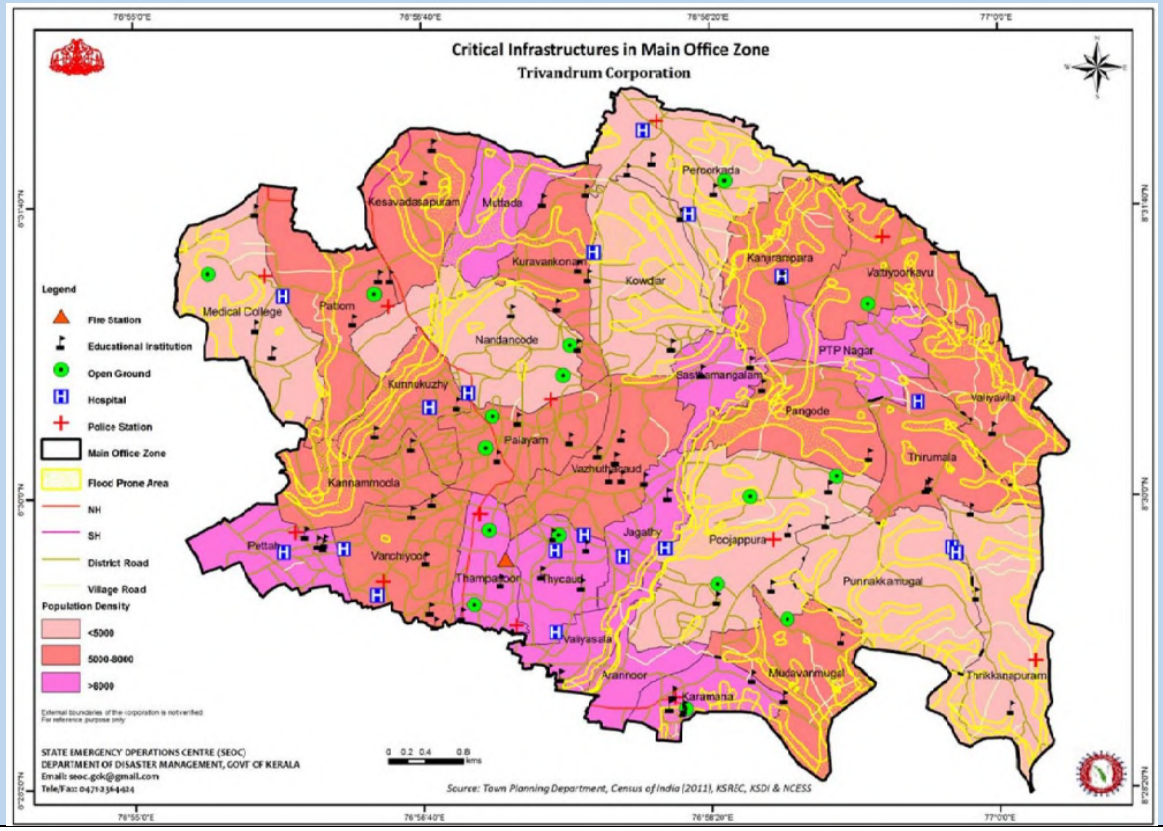


Fig 1. GIS-based Map (CDMP, Thiruvananthapuram)

Karnataka State Natural Disaster Monitoring Centre (KSNDMC) has a unique model that has installed a network of weather monitoring stations which comprises Solar Powered GPRS enabled Telemetric Weather Stations, Telemetric Rain Gauge Stations. The near-real-time data collection, reporting and dissemination have been helping the State Government in planning and executing disaster management and mitigation plans at the micro-level The data on Temperature, Relative Humidity, Wind Speed, Wind Direction, Rainfall Intensity, and amount of Rainfall is being collected at every 15minutes. The near-real-time data collected through the network is being analyzed, maps, and reports are generated in real-time. It is supported by a 24x7 interactive Help Desk "VARUNA MITRA" which is operational throughout the year.

The DM plan also makes it easier to respond and recover quickly. Rebuilding and the placement of temporary housing facilities are post-disaster mitigation issues that must be handled quickly. Planning well in advance facilitates this. Finally, a city's emergency management baseline is provided by a DM strategy that is adaptable enough to be used in all circumstances, even unanticipated ones. A city can therefore move on with long-term mitigation actions targeted at certain dangers with confidence. Or, it might invest more money in risk-based security measures. (e.g., specialized training, equipment, and planning). A city disaster management plan that integrates aspects of CCA is comprehensive in nature and includes identified climate risks and measures for mitigation.

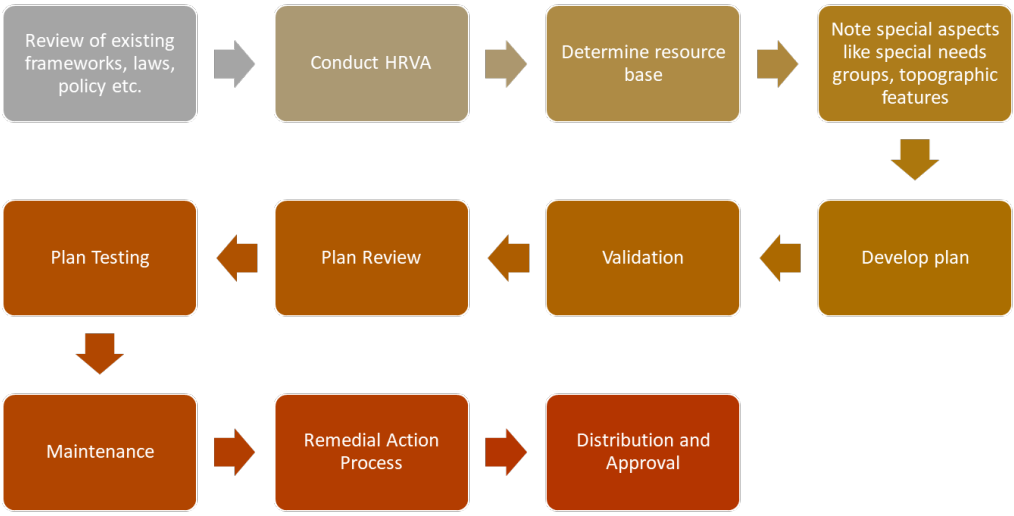


Fig 2. Steps for CDMP (adapted from NIUA, 2016)

a) Maximize development co-benefits

Activities to build resilience and address urban challenges usually lead to the development of co-benefits. Projects should be developed keeping in mind the impacts of shocks and stresses and how multi-sectoral approaches can be introduced. This can support addressing the cascading disasters. Eg. Paris has been converting its schools into "oasis," cooling islands as part of its resilience strategy to combat the urban heat island effect and the risk of storm water flooding. Although the majority of its residents live less than 200 meters from a school, it has 761 schools with 60,000 sq.m. of asphalt-paved schoolyards that are inaccessible to the public. It is predicted that the surface temperatures in Paris will decrease by 10% and that there will be an increase in water absorption of 4 to 16 mm if the impermeable surfaces of the schoolyards are replaced with permeable surfaces. By making the schoolyards accessible to the surrounding communities, the city has been able to maximize co-benefits. In times of heat waves, the oasis offers relief to those who need it most.

b) Pursue Resilient Urban Development and Design

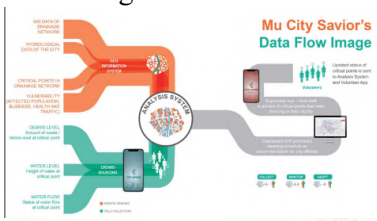
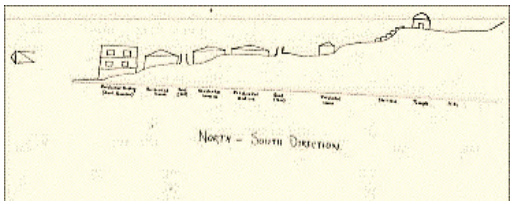
It is important to place urban planning and land-use management at the core of urban resilience. Practitioners can conduct systemic and specific vulnerability mapping and mainstream resilience into on-going urban master plan updates and sectoral strategies. Designs that can support safeguarding natural buffers should be promoted for better management of critical ecosystems. Eg. To interpret risk maps into risk scenarios for Patong Municipality in Thailand, landslide risk maps were evaluated. With the goals of preventing slope collapse and lowering landslide risk, city officials created risk management recommendations based on the level of exposure and risk of the various regions of the city. In addition to identifying high-risk areas and prohibiting housing development there, recommendations included applying protective cover like vetiver grass, other suitable vegetation, and synthetic geotextiles made specifically for protecting exposed slopes, as well as building rock cages (gabions), retaining walls, ditches, and other structures to prevent erosion. Local early warning capacity for rainfall-induced land slide was increased instead of existing settlements being relocated through training and the installation of extra rain gauges.

Discuss with learners: *What are the responsibilities that are undertaken by the learners in their jurisdiction to ensure minimum disaster damage and build resilience? Do the roles and responsibilities of each practitioner vary? If yes, how are they inter-linked to the goal of risk reduction? What are the key departments that work in coordination for activities to prevent disaster events?*

Urban local bodies and practitioners like engineers, architects, and planners can be effective in tackling disasters through developing mitigation measures, coordination with other stakeholders who are involved in disaster management, early warning system, relief distribution, providing shelter to the victims, medical assistance, etc.

Table 1. Few Key Roles of Practitioners In Building Resilience (adapted from NIUA, 2019)

Phases	Architect	Engineer	Planner
Risk and vulnerability assessment	Building design to conform to the hazard profile (cyclone, earthquake, etc.) Incorporate NBS/green building codes as part of the design	Periodically assess the stability of existing structures. Identify failure modes and consequences. E.g.: RVS, fire audit, structural audit Third-party audit for any new critical infrastructure Maintenance guidelines for different building typologies	Identify new and emerging risks along with known risk profile Estimate vulnerability caused by varied land use taking into account climate change impacts; assess potential access issues during a disaster; analyze the effectiveness of regulations and policies. Revision of building bylaws to incorporate hazard risks Integrate risk into land use planning and master plans Include industrial and other risks in land planning (cite Bhopal gas tragedy)
Disaster risk reduction and mitigation	Lead community surveys and plans of shelters for the poor. E.g., Through PMAY, smart city missions Make adequate provision for various safety measures in building and site plans (evacuation routes, evacuation points, fire escape, fire safety regulations, etc.)	Specify requirements and retrofitting measures to mitigate disaster impacts; Design and implement risk reduction training. E.g.: retrofitting training to masons (specific repairing and retrofitting of heritage buildings)  Stringent building permission linked structural design	Identify critical infrastructure and services. Identify risks associated with areas and advise for quality development in the right locations. Develop practical and cost-effective regulations. Promote stakeholder partnerships and community consultation. E.g., Gujarat land pooling scheme

Phases	Architect	Engineer	Planner
Disaster preparedness and pre-disaster planning	Advice on building use in the event of hazard. E.g., multipurpose cyclone shelter designing 	Give measures for strengthening of existing structures. Identify vulnerable structures and measures and develop emergency response plans to provide vital services. E.g., Citizen App for Urban Flood Management  	Locate settlements at risk and advise of relocation and transport planning for access in disaster situations. E.g., Relocation projects, evacuation maps Planning critical infrastructure to reduce service disruption 
Emergency relief	Sensitive designing of relief shelters with durable structure Training for rapid disaster appraisal Develop survey methods to facilitate the repair and reconstruction of dwellings E.g., Transect walk 	Plan and provide locally suitable technology to reestablish basic service. Assess damages to transport and undertake civil repair works 	Estimate the demand for basic services, shelter through liaison with community leaders and local authorities to plan the supply. E.g. participation through SJMMSVY, development of Ward Disaster Management Plan

Phases	Architect	Engineer	Planner
Early recovery/transition	Assess traditional patterns of use building materials and technology etc. 	Structural surveys of buildings and infrastructure and identification of site for facilities Specify safe construction methods. Identify constructions suitable for compensations	Assess potential locations for transitional dwellings and vital facilities in consultation with key stakeholders. Research and advise on strategic objectives for compensation packages. Carry out additional participatory surveys
Reconstruction	Designing of buildings based on hazard profile. Desing to culturally and environmentally sensitive Design and plan landscaping elements Provide designs with open and semi-open spaces and vegetation. Green building certifications 	Proper design and planning of drainage, water supply, safety features etc. Training of staff for safe installation of emergency water, electric supply etc. Segregated treatment of waste, operational STP etc. 	Integrate hazard and climate change impacts into long-term plan or policy development like RSLUP, Master plans. Ways to monitor and regulate development Amend local planning policies and guidelines to take account of new housing and site planning requirements. Create ownership of the reconstruction planning among the impacted community
Post reconstruction development and review	Review of designs based on people's needs and changing habits. Undertake lifecycle studies, regular surveillance to prevent major repairing Understand changing hazards and building needs Advice on minimizing costs	Periodically review the stability of key buildings. Advise on cost-effective retrofitting, extensions and safe new construction	Review preparedness plans, regulations, renewal strategies in consultation with local communities. Train professionals in local authorities for covering future risk assessment and reduction when planning developments/settlements.

Session Plan

Content	Trainer's Note	Time
Role of ULB and urban practitioners	Focus on explaining the role of urban practitioners with the support of examples.	20 min
Discussion	A brief discussion on how urban challenges is changing and actions to improve resilience.	10 min

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- ADPC (2013). Integrating disaster risk management into urban management. Disaster Risk Management Practitioner's Handbook Series
- https://www.adpc.net/igo/category/ID409/doc/2013-w06Evi-ADPC-ADPC_DRM_Practitioners_Handbook_-_Urban_Management.pdf

Additional Reading Material

- Urban Disaster Risk Mitigation through Community-Based Disaster Risk Management (CBDRM)https://www.preventionweb.net/globalplatform/2007/first-session/docs/side_events/June_7_Thu/09_Working_towards_Community_Resiliance_in_Asia-Pacific/ADPC_CDBRM_Presentation.pdf
- Towards a Disaster Resilient Community in Gujarat. GoI-UNDP Disaster Risk Management Programme

Notes

Summary

The Technical Session 1 will guide the learners on:

- Activities and interventions that can contribute to building resilience in the urban context
- Roles and responsibilities of urban practitioners, engineers, architects, and planners for improving resilience
- Relationships between various departments and inter-linkages that can support in minimizing urban challenges

Technical Session 2: Understanding Critical Infrastructure and the Systemic Risks

Introduction, Overview & Perspectives

This technical session aims to provide learners with an understanding of the critical infrastructures and their interdependencies in urban settings. Through a combination of critical infrastructure examples and actions that make them integral to disaster resilience, the session will introduce learners to risk assessment, and resilience assessment and guide them towards building resilience of critical infrastructure. It will help learners unravel the ways of performing rapid visual screening, and develop risk-sensitive plans. Overall, this technical session will equip learners with the knowledge needed to understand the critical infrastructures, risks associated, and ways to build resilience with the help of a case study.

- Learning Unit 2.1: Relevance of critical infrastructures for disaster resilience
- Learning Unit 2.2: Risk and resilience assessments of critical infrastructure and resilience building
- Learning Unit 2.3: Case study- Resilience building measures for critical infrastructure
- Learning Unit 2.4: Discussion

The primary objectives of this technical session are:

- To develop an understanding of the critical infrastructures and their relevance to disaster resilience
- To analyze the risks and resilience aspects of critical infrastructure
- To gather knowledge on building resilient critical infrastructures

Duration: 135 Minutes

Methodology

- Lecture-based learning
- Case study
- Discussion

Trainer's Note

While introducing the learners to the critical infrastructures, trainers can plan short participatory exercises seeking learners to list out the infrastructures they believe are critical in their cities. This will also help understand how well the learners have grasped the categories and terminologies. Further, the trainers should delve into the different activities of urban practitioners, to build resilience of critical infrastructure. Trainers can leverage the diverse experience of the learners in generating discussion.

Learning Unit 2.1: Relevance of Critical Infrastructures For Disaster Resilience

Brief Description of the Learning Unit

This learning unit will bring a renewed focus on critical infrastructures in a city and how it is integral to resilience. The unit will detail the complex nature of critical infrastructure and a wide range of actions that make them crucial to disaster resilience. It also delves into the ways of making critical infrastructure resilient.

Learning Objectives

- To familiarize with the critical infrastructures and relevance to disaster resilience
- To enhance knowledge of resilient infrastructure

Duration: 30 Minutes

Methodology

- Lecture-based learning
- Discussion

Detailed Description

According to UNDRR**, critical infrastructure (CI)** is the physical structures, facilities, networks and other assets which provide services that are essential to the social and economic functioning of a community or society. Each country defines the critical infrastructures based on national priorities. Strategies for protecting critical infrastructure from risks are common in many countries. **Coalition for Disaster Resilient Infrastructure (CDRI)** is a partnership of national governments, UN agencies, development banks, and financing mechanisms, the private sector, and knowledge institutions that promote the rapid development of resilient infrastructure to respond to the SDGs 'imperatives.

Delivering on the Paris Agreement, New Urban Agenda, and 2030 Agenda, cities can promote investment in areas of sustainable development, improved building conditions and disaster resilience. Initiatives such as these can help increase urban resilience through climate action and mitigation. The core idea of disaster risk management involves different societal actors and power holders in a society ranging from individuals to households to communities, governments, private sector, academia, civil society, military organizations, bilateral & multi-lateral donors and organizations, etc (Lassa, et al, 2018). This technical session shows how various stakeholders are responsible to build the resilience of critical infrastructures.

It is important to note that, the **Prime Minister's 10-point agenda for DRR** highlights the future growth of "infrastructure" and that development of infrastructures should be built on global standards of disaster safety. The U20 2023 prospects also align with mindful planning in the allocation of urban resources like critical infrastructure, basic services, e-governance, etc. Some recent infrastructure projects in India to improve resilience were providing temporary shelters to flood-affected people in Orissa, Cyclone Shelters in West Bengal, Kerala & Lakshadweep, and reconstruction of damaged houses in J&K.

Critical sectors in India have been defined under Section 2(e) of the Information Technology (National Critical Information Infrastructure Protection Centre and Manner of Performing Functions and Duties) Rules, 2013, as sectors that are critical to the country, and destruction of these will have a debilitating impact on security, economy, public health or safety.

Discuss with learners: *What in your opinion are considered the critical infrastructures in India? Then play the video for a better understanding.*

SCAN ME Video: What is the critical infrastructure that keeps society running? by UNDRR **https://www.youtube.com/watch?v=GAMzrlqlRis**

CIs are usually divided into **physical and socio-economic infrastructure** systems. Physical critical infrastructure encompasses basic services such as electricity and water supply, waste management, transport or information, and telecommunication technologies. Socio-economic infrastructures include hospitals, schools, public administration, disaster management services, and recreational areas. The critical infrastructures could be tangible in nature– hard assets or intangible in nature- soft assets. The soft assets bind the hard assets and are essential for managing, functioning, and maintaining critical infrastructure assets.

Hard Asset	Soft Asset
•Electricity and supply network •Water supply •Waste (water) management •Transport •Information and telecommunication technologies •Hospital •Schools •Recreational areas •Museums •Disaster management services – Emergency Shelter, DM center, Centres equipped with rescue	•Management •Maintenance •Finance, business, and regulatory environment •Education •Public administration •Policies and Operation •Health and well-being •Accessibility •Capacity Building and Community Engagement •Smart services- quality communication; security •Resilience

Fig 1. Some Hard and Soft Assets of Critical Infrastructure (adapted from Perez and Wilon 2012; Wataya and Shaw, 2022)

Natural hazards	Human-made & technological hazards	Security risks
•Geophysical (earthquake, landslides, tsunami etc.) •Hydrometeorological (floods, avalanches, drought, heatwaves etc) •Biological (epidemics) •Cosmic phenomena (asteriods, solar flare)	•Industrial accidents, chemical spills •Transport accidents •Large scale power outages •Environmental degradation and pollution • Dam failures	•Hostile governments •Terrorism and wars •Cybercrime •Climate change •Transnational crime •Untrusted investments •Population density •Supply chain attacks

Fig 2. Some Risks and Hazards To Critical Infrastructures

The network of CIs is **complex** in nature due to inherent inter-dependencies which is difficult to identify and quantify causal links between them and specific observed effects (failure/disruption) as shown in Fig 3. The complex network of CIs and their interconnectedness allow for systemic risks which are interdependent and cascading in nature causing failures in a network of interconnected systems. A recent example is the increased dependency on information and technology systems during COVID-19 for goods and services. The lockdown led to disruption of transportation services and that was a challenge for patients stuck at home, who rely on timely medication or electrical devices. The 2015 flood in the city of York in the United Kingdom disrupted police operations and hospitals over hundred kilometers away in Newcastle because the telecommunications system was damaged.

Fig 3. Interdependency Categories of Critical Infrastructure (adapted from UNDRR, 2020)

Inadequate critical infrastructures can amplify the effect of hazards. E.g., the World Health Organization noted that the "fecal droplet" originating from excreta in a building's drainage system re-entered into residents' apartments via sewage and drainage systems routes. Inadequate "traps" and non-functional water seals in the sewerage system were considered as one of several modes of transmission in Hong Kong during the SARS outbreak in early 2003. The disruption of critical infrastructure affects rural and urban areas differently. Rural areas are more prone to disruptions and restoring infrastructures may take longer due to lack of resources and access during disasters. Disruptions in urban areas, however, tend to impact more people and have the potential to cause higher economic losses.

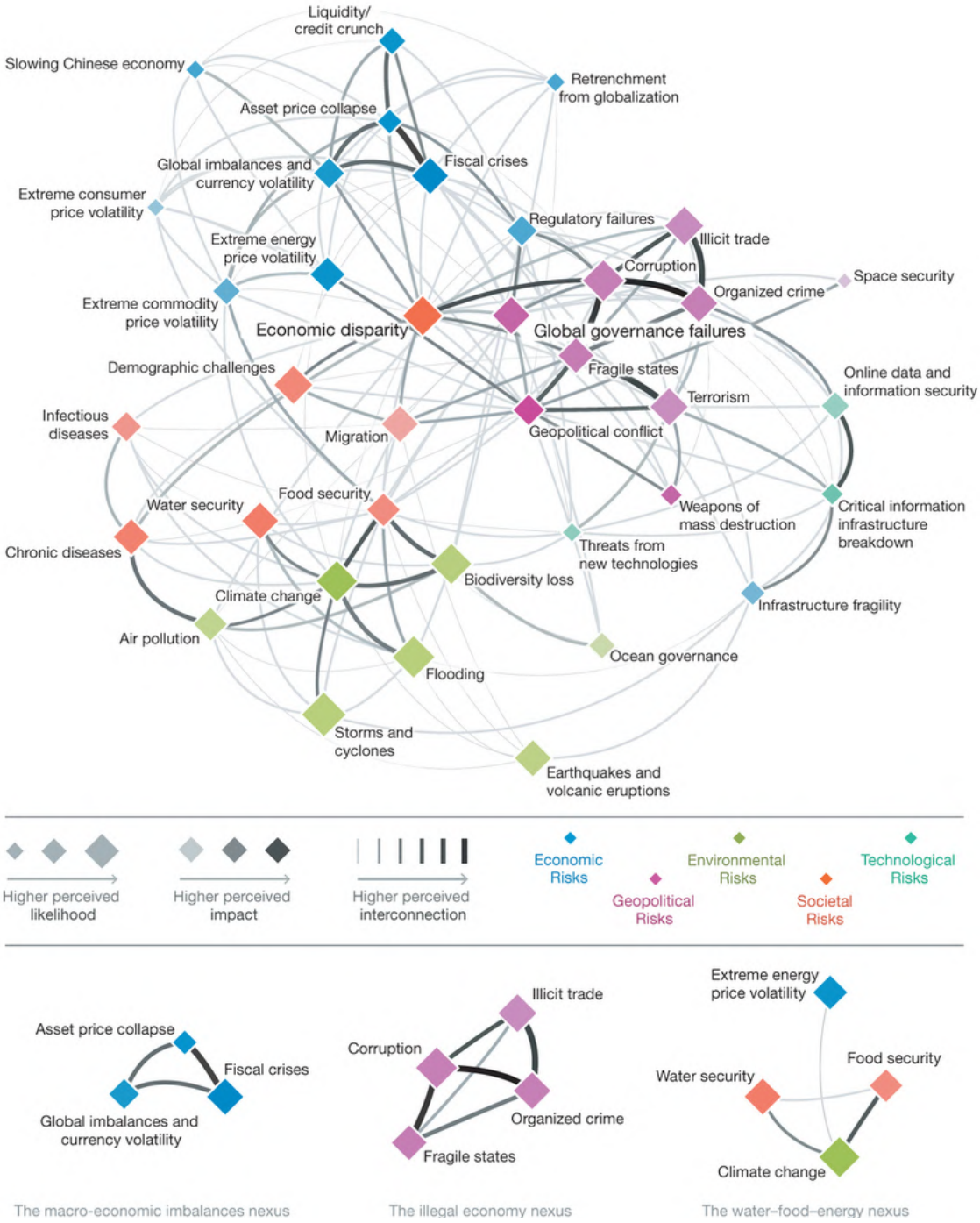

Fig 4. Systemic Interdependencies of Risks (World Economic Forum)

Critical infrastructures are important for quick recovery after a disaster. Quick restoration of access roads, drinking water supply, or healthcare can save lives and lessen losses. CI is evolving and the importance of certain infrastructures changes with time. Thus, it is necessary to consider the long-term changes, vulnerabilities that might result from pathway decisions, and cascading effects of a critical infrastructure failure.

Information and Communication technology has become a high-priority infrastructure in recent times after the COVID-19 pandemic. Cyber and information technology infrastructure is used to operate and monitor power systems, water/wastewater systems, transportation, networks, etc. According to Business Standards, India observed a 70 percent increase in ransomware activity in the fourth quarter (Q4) of 2021.

E.g., Following Cyclone Aila in the Sundarbans, the availability of safe drinking water was a major problem. At the end of May 2009, the Sundarbans region in West Bengal, India, reported an upsurge in the number of diarrhea cases following storm Aila. The Department of Health and Family Welfare, South 24 Parganas District, conducted a study to pinpoint the cause and agent of the outbreak as well as to suggest preventive measures. There were 14 fatalities and 1076 probable case patients in the outbreak which started in May and continued until August 2009, peaking in June. Villagers had to break water pipelines close to their homes to get easy access to water because supplies were insufficient. Both samples of piped water and containers of stored drinking water were found positive for fecal contamination. The cholera outbreak was probably caused by tainted drinking water. The outbreak was contained by repairing the pipelines, chlorinating water at the household level, and warning the residents about the dangers of broken water pipe connections. The DRR considerations were taken into account when building tube wells as part of the Aila recovery effort in the affected villages by installing wells with raised platforms. In the impacted area, these tube wells provide access to safe drinking water. (Bhunia and Ghosh, 2011)

SCAN ME Video: How Climate Change and Disasters are Forcing a Rethink on Infrastructure by Asian Development Bank **https://www.youtube.com/watch?v=Jc5XbKHqNBw**

Resilient critical infrastructures can lead to resilient cities through timely and efficient minimization of disruptions, improved resistance, knowledge of absorptive capacity, and so on as shown in the figure.

In May and June 2021, India was hit by two significant cyclones during the COVID-19 outbreak. Because managing the conflicting demands of a lockdown and an evacuation is very difficult when disasters with natural hazard origin and pandemics are involved, transportation and infrastructure designers should collaborate with epidemiologists to set more exits and revise the standard operating procedures for evacuation to ensure the efficient transfer of people. Meanwhile, to reduce the risk of cross-infection in the setting of pandemics, planners of the food and water infrastructure should proactively modify how people may access emergency supplies.

Fig 5. Principles of Resilient Infrastructure (UNDRR, 2022)

These principles assist urban practitioners in:

- setting a basic understanding of resilient infrastructure,
- planning and implementing infrastructure projects that take resilience as a core value
- developing architectural and engineering designs based on reliable data and consideration for safety and disaster risk mitigation
- assisting the public and private sectors in making risk-informed decisions

Session Plan

Content	Trainer's Note	Time
Critical Infrastructure	Focus on introduction, interdependencies, and role in disasters with examples.	20 min
Resilient infrastructure	A brief on the principles of resilient infrastructure and the role of practitioners in enhancing the resilience of CI through examples.	10 min

References

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- Portugal-Perez, A., Wilson, J.S. (2012) Export performance and trade facilitation reform: hard and soft infrastructure. World Dev, 40 (7), pp. 1295-1307, 10.1016/j.worlddev.2011.12.002
- Wataya, E. and Shaw R. (2022) Smart Cities Soft Assets Consideration in Smart and Resilient City Development, pp. 108-130

Additional Reading Material

- UNDRR (2020). Making Critical Infrastructure Resilient: Ensuring Continuity of Service https://www.undrr.org/media/48327/download
- UNDRR (2022). Principles for Resilient Infrastructure https://www.undrr.org/media/78694/download

Notes

Learning Unit 2.2: Risk and Resilience Assessments of Critical Infrastructure and Resilience Building

Brief Description of the Learning Unit

This learning unit explains how to conduct a risk assessment for Critical Infrastructure that can support disaster risk management (DRM) and climate change adaptation (CCA). It elaborates on rapid visual screening, remote sensing, and urban planning techniques that are supporting the cities in building the resilience of critical infrastructure. It discusses a guidance list on a variety of action items pre-, during, and post-disaster to ensure the resilience of critical infrastructure.

Learning Objectives

- To familiarize with the risk assessment of critical infrastructures
- To enhance knowledge of resilience-building methods for critical infrastructure

Duration: 60 Minutes

Methodology

- Lecture-based learning
- Discussion

Detailed Description

Risk Assessment

Critical infrastructure stakeholders use a variety of risk assessment approaches to identify the most probable and serious occurrences that could harm infrastructure assets, systems, and networks. In the risk assessment, data is gathered and values are assigned to risks in order to establish priorities, create and compare action plans, and inform decision-making. The assessment's information is used to support resource allocation and planning efforts.

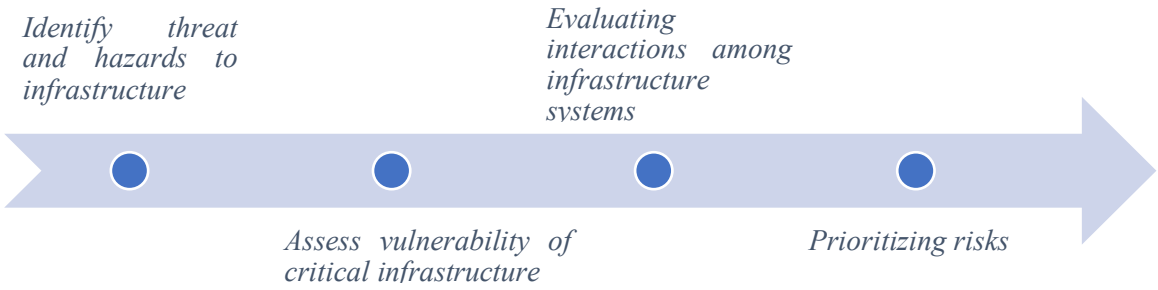


Fig 1. Stages of Risk Assessment of Critical Infrastructure

Critical infrastructure risk assessments use scenarios to divide identified risks into components that can be individually assessed. These situations consist of an identified hazard, an entity impacted by that hazard, and associated conditions including vulnerabilities and consequences. Resilience is integral to the risk equation as it can influence an entity's vulnerability to different hazards, as well as the consequences that might arise from it.

a) Identify threats and hazards

While all hazards can be taken into account, stakeholders could want to estimate the possibility that each one will materialize in order to pinpoint which ones need to have their risk levels further evaluated. The frequency of historical events, established hazard recurrence rates, and estimates can all be used to calculate risk likelihood. Some of the key agencies which provide information on hazards are the IPCC, Indian Meteorological Department, Geological Survey of India, Indian Space Research

Organization, newspaper, chamber of commerce, local historical society, etc.
The expertise and historical knowledge of planning participants and stakeholders is another important source of hazard data. All risks can be evaluated as time and resources permit, though it is wise to prioritize threats/hazards that are most realistic and likely to materialize.
Vulnerability Atlas of India (VAI) prepared by the Building Materials and Technology Council (BMTPC), presents the state and UT-specific hazard zones thus supporting in strengthening the existing and new infrastructure.

b) Assess the vulnerability of critical infrastructure
It is crucial to have a basic awareness of the city's building topology and its features. All the structures in a given city can be categorized into four categories: reinforced concrete structures, load-bearing stone or brick structures, timber structures, and structures constructed of temporary materials (like plastic, bamboo, cloth, etc.). The strength of these buildings can be evaluated without much technical expertise based on the construction methods utilised within the city or state. It is necessary to pinpoint the locations of buildings that are subpar or have structural weaknesses so that corrective action can be planned. The vulnerability of critical infrastructure depends on its accessibility to the public, its robustness, proximity to other vulnerable assets, etc. Hazard Risk Vulnerability Analysis (HRVA) is a highly technical process undertaken by specialist professionals.

Rapid visual screening: This assessment's primary goal is to comprehend the risk that a town, or city faces from the perspective of a building or other infrastructure collapsing due to disaster incidents like an earthquake that is predicted to shake the area around the site. An experienced team of assessors should typically spend 15 to 30 minutes per building, standing in front of it without having to enter it or perform any complicated computations. This evaluation technique is beneficial for scenario projection (with a preliminary level estimate of possible damage during an event like earthquake, cyclone, fire etc. of expected intensity in the region of the building site under consideration). This method is based on visual observations; hence, it provides a good overall idea of safety, but does not guarantee high accuracy. In India, RVS of masonry buildings is carried out as per the Bureau of Indian Standards format in the code document IS13935:2009

RVS can be very helpful in prioritising the buildings that need more investigation so that technical and other resources can be used to their fullest potential. It is suggested that qualified individuals with expertise in civil engineering or architecture should perform it as the method calls for technical judgement that can only be learned through formal education. RVS should not be performed by laypeople since this may result in false conclusions. Generally, RVS entails filling out templates where the surveyor records the location of the building under consideration in the seismic zone, creates a basic line drawing of the building plan, and records the existence or absence of earthquake-resistant elements.

BMTPC developed a methodology of RVS for seismic safety of typical housing typologies in India using five standpoints (a) Site and Soil Features, (b) Architectural Form and Material Choices, (c) Structural System, (d) Construction Details, and (e) Maintenance Quality.
The method provides Seismic Safety Index and Performance Rating for a particular house, with respect to an ideal house of the same typology. The Seismic Safety Index is defined for each vulnerable parameter for each housing typology. These index values for each parameter are based on the Delphi Method, which employs an expert's opinion, against empirical, analytical, or any other procedures. Experts based on previous study and their experiences assign score values to each factor. Further, the form divides all the parameters into two sets of factors, i.e., Life-Threatening Factors (L) and Economic Loss-Inducing Factors (E). Each of these two sets of factors is divided into two more factors Structural Elements-related Factors and Non-Structural Elements-related Factors. (NDMA, 2020)

c) Evaluating interactions among infrastructure systems

Stakeholders should prioritise vital infrastructure by taking into account the potential effects of the consequences once hazards have been identified. Security concerns (costs connected with the loss of infrastructure) and other elements that can lead localised occurrences to become more widespread disruptions are consequence considerations to take into account when evaluating threats to the city's infrastructure (dependencies). Estimating the consequent disruptions to key infrastructure can be done using historical events. The four broad aspects of evaluation are:

- Human: loss of life, illness, injury
- Economic: costs associated with damage to infrastructure
- Mission: the ability of an organization to meet objectives or perform a function
- Psychological: mental or emotional state of individuals or groups

d) Prioritizing risks

Information from the hazard and vulnerability assessment is overlaid with the interaction of infrastructure systems to identify regions of significant risks. Information on the potential risks posed to a facility can be gained by understanding which elements at risk are exposed to which types of hazards, how frequently (or how often) such hazards occur, their potential intensity in the given critical infrastructure, and the potential interactions with other hazards or other etc. The resulting risk will be higher whenever a higher vulnerable population and assets and a higher intensity hazard coexist. Prioritizing risk reduction strategies can be made easier with local knowledge and a grasp of the risk factors.

It is considered that a systemic approach improves the resilience of CIs and leads to more resilient communities. However, tools for the assessment of CI are being researched and implemented on a small scale. This necessitates practical tools for decision-making support. A dynamic assessment of individual CI's resilience by studying interdependencies is important for supporting infrastructures.

SCAN ME Video: How Singapore Uses Science to Stay Cool by Bloomberg Originals **https://www.youtube.com/watch?v=PM101DvvG4Q**

Resilience Assessment

CI resilience can be understood as the ability of these systems to anticipate, withstand or absorb shocks and stresses, while adapting to new conditions that would result in a quick recovery and transformation as a way to better cope with chronic stresses and acute shocks in the future (UNDP 2022). The failure of a CI system can lead to several effects cascading
on one or more additional CI systems. As the past learning units have guided that there are widely accepted interdependencies, one failure can be cascading and cause escalated impact on the city's functioning. Establishing the context, resilience analysis, resilience assessment, and, finally, resilience enhancement are key stages for the effective management of resilient infrastructure. There are many resilience assessment methodologies but they highly depend on the need and availability of dataset. The broad framework is shown in Fig 2.

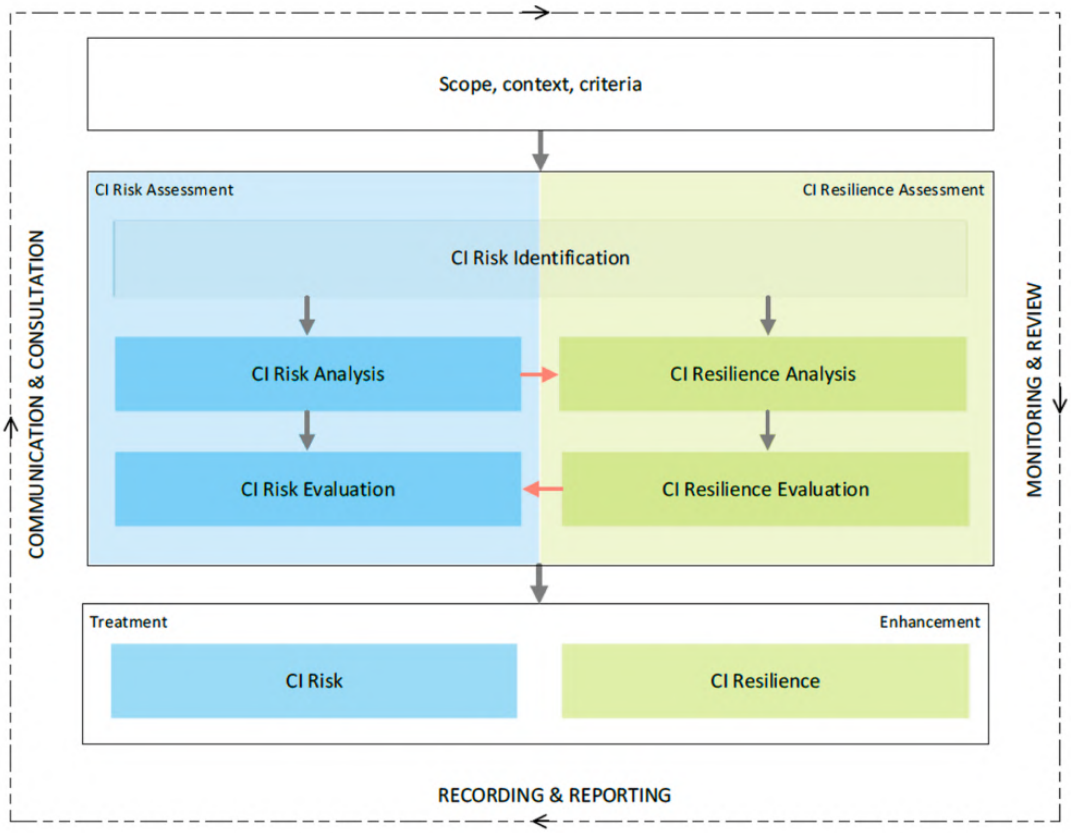


Fig 2. Framework for Resilience and Risk Management of Critical Infrastructures (Rod.B, 2020)

Assessment of the readiness of nations to report on the Sendai Framework targets showed that data related to target D on reducing damage to critical infrastructure was available for only 60 percent of nations and is rarely complete (UNDRR 2020). This makes resilience assessments and reporting more important. Based on past research common dimensions and key indicators of resilience assessment frameworks of CIs can be established as shown in Fig 3.

Technical dimension: Refers to the capability of the physical systems to perform to an acceptable level when subjected to a disaster/disruptive event

Organizational dimension: Refers to the capacity of organizations (govt., non-govt, private sector, other stakeholder organizations) to decide and take actions to prepare for and respond to a disaster /disruptive event

Social dimension: Refers to considering the capacity of social relationships and networks to lessen the negative effects of catastrophes on critical infrastructure while explaining society's response to disaster /disruptive event

Economic dimension: Refers to the capability to minimize direct and indirect financial losses resulting from a crisis

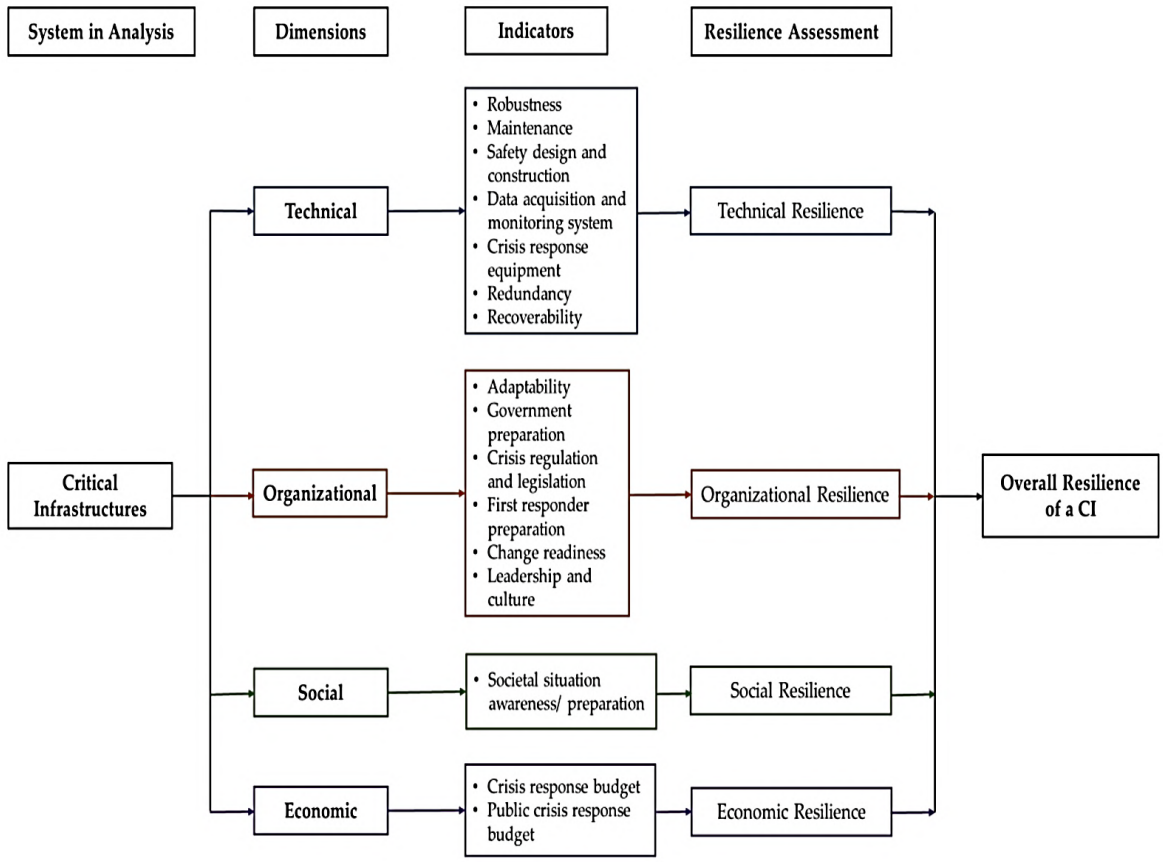


Fig 3. Framework for Measuring CI Resilience (Guo et.al, 2021)

Chief Resilience Officer in Surat Municipal Corporation:
Surat is a city with a fast-growing population and also one with the most migratory population. It is also one of the cities that are most adversely affected by climate change, according to the World Bank Sustainable Development Network. Throughout the previous century, Surat has seen an epidemic of the plague in 1994 and 23 floods, including a big one in 2013. Lessons from past calamities, community, and social resilience building for early flood response, preventing vector-borne diseases, increasing nutrition, water management, and the electric grid are the city's top goals for urban resilience.
In accordance with Surat's engagement with 100 Resilient Cities, an initiative started by the Rockefeller Foundation, the leadership of the Surat Municipal Corporation has selected a Chief Resilience Officer. To help Surat prepare for, endure, and recover from the "stresses"—slow-moving calamities including acute traffic, air pollution, water shortages, and social cohesion—that are increasingly a part of life in the 21st century, this new job was created to lead citywide resilience building activities.

Building resilience of Critical Infrastructure

The recent increase of infrastructure investments globally, changing risk landscape, and digitalization provide opportunities to rethink critical infrastructure policies across countries and beyond, and to integrate resilience in upfront planning and designs. In India, mainstreaming of climate resilient planning and design concepts, tools and local resilient standards have furthered critical infrastructure resilience.

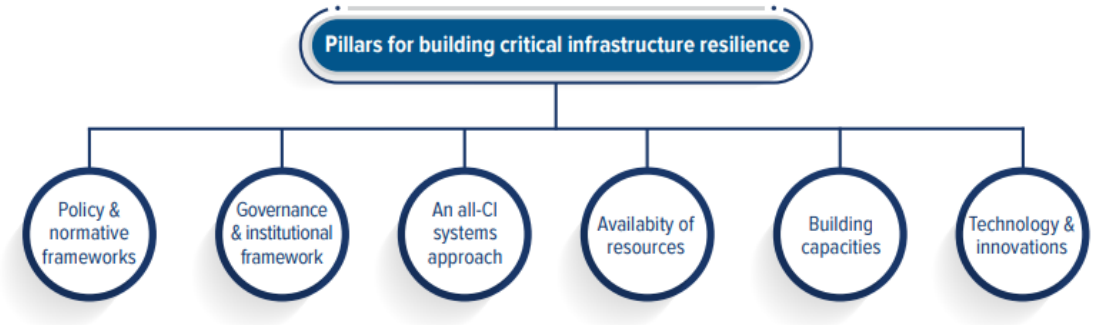
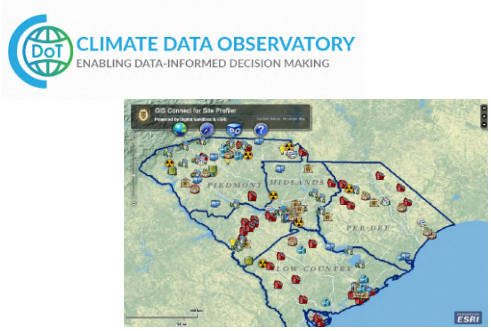
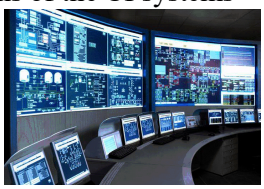


Fig 4. Pillars for Building CI Resilience (UNDP, 2022)

Table 1. Guidance Notes For Building Critical Infrastructure Resilience

Guidance for CI resilience building	Stage	Examples of actions by Practitioners
Create an enabling policy and environment for building CI resilience ("whole-of-government", "all-of-society" approaches, mainstreaming of critical infrastructure resilience into the DRM)	Pre-disaster	• Implement research studies on the resilience aspects of the CI systems • Sensitize key stakeholders on the CI and DRM • Develop guidelines for activities that the public and private sectors need to implement for building resilient critical infrastructure systems
Ensure all-hazard approach, risks, and security threats perspectives are assessed	Pre-disaster	• Collect reliable and quality disaggregated data on risks, vulnerabilities, demography, geography, etc. from different sources • Design and apply ICT solutions, GIS, and big data analysis • Develop disruptive event scenarios and conduct periodic assessments of CI resilience • Incorporate CI risk assessments in existing and new planning projects 
Achieving an all-CI system approach through partnerships	Pre-disaster	• Leverage the power of partnerships with stakeholders like the community, private partners, and other departments for building CI resilience through retrofitting, shelter designs, etc. • Engage in awareness-raising activities for CI resilience in city dwellers, responders, researchers, etc.

Guidance for CI resilience building	Stage	Examples of actions by Practitioners
		
Enhance human capacities for building CI resilience	Pre-disaster	Collect and share good practices and lessons learned for advancing resilience-building
Investments in building CI resilience	Pre-disaster	• Design and implement structural measures like construction of extreme weather event-proof facilities, retrofitting, gabion walls, etc. • And non-structural measures like the adoption of resilience-oriented codes and standards, mainstreaming of resilience-based design 
Strengthening preparedness	Pre-disaster	• Building and running early warning, alert, and emergency information systems • Developing future-proofing methodologies and tools for cities • Engage in inspections and performance evaluations of the CI systems 
Testing of recovery plans	Pre-disaster	Adhere to relevant policy guidance, legal solutions, and SOPs
Minimizing failures and disruption	During disaster	• Coordinate and cooperate for response measures • Prioritize actions to restore the essential functionality of the CI • Identify social infrastructure to support (Kerala floods case recalling retired power sector employees for repair)
Post-disaster damages and losses assessment	Post-disaster	• Adopt methodologies and SOPs to assess CI damages • Conduct rapid post-disaster damage, losses, and needs assessment
Resilient Recovery and Build Back Better	Post-disaster	• Identification and prioritization of CI to be reconstructed or rehabilitated

Guidance for CI resilience building	Stage	Examples of actions by Practitioners
		• Develop guidelines and good practices for building back better
Transformation	Post-disaster	• Update CI system designs to enhance the operation • Refine the approach of building resilience by revising risk and threats assessments, integrating new technologies

Risk-sensitive urban planning: Risk-sensitive urban planning entails integrating disaster risk reduction and climate change impacts into the management and administration of public and commercial organizations, notably in plans for physical and spatial development. By institutional and legal changes, plans, programmes, and initiatives that provide guidelines for land use, land management, and infrastructure development, it combines disaster risk management. The key challenge for planning institutions that are only accustomed to traditional planning is figuring out how to use risk information to assess its effects on development and spatial plans. Urban plans of all shapes and sizes, from territorial to land-use zoning, can aid in reducing susceptibility and catastrophe risk, enhancing resilience, and protecting environmentally sensitive areas.

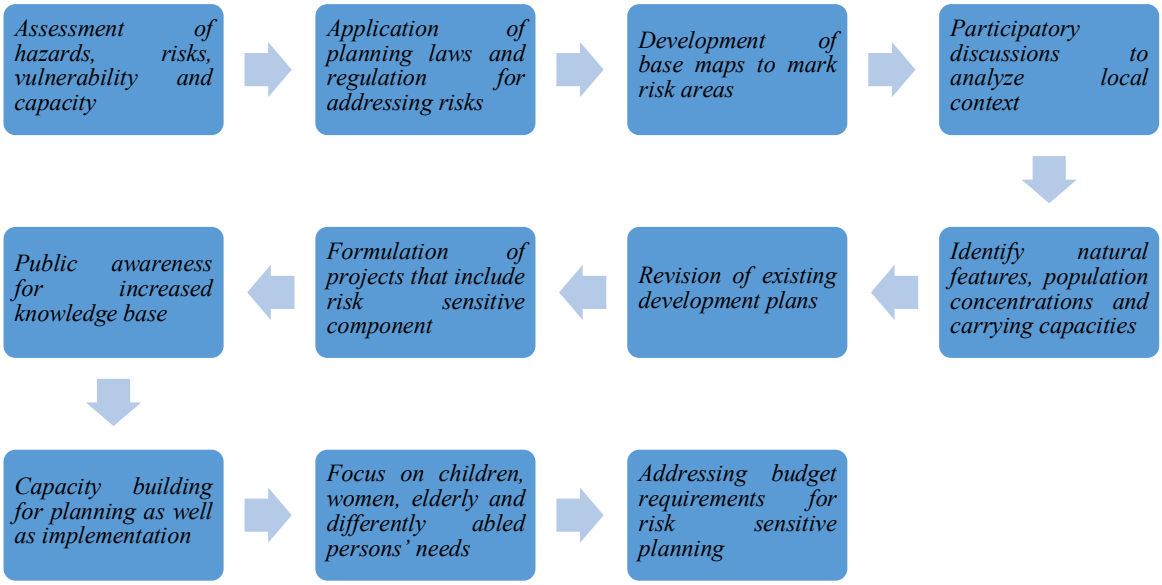


Fig 5. Steps for Risk-Sensitive Urban Planning (adapted from MoHUA 2016)

SCAN ME Video: Building Climate Resilient Cities | Google Earth Engine x WRI India And BMC by Google India **https://www.youtube.com/watch?v=7Ev8RJ9jNmU**

SCAN ME Video: Flood Risk Management in the City of Buenos Aires by World Bank **https://www.youtube.com/watch?v=5rpQ2TdGPs4**

Discuss with learners:

- *Can the existing framework and policies efficiently manage risk to CI and promote comprehensive resilience in India?*
- *Is there an update needed considering the advancement in technology and adoptions?*
- *What critical components need change?*
- *What actions have you taken in your city to build the resilience of critical infrastructures?*

Session Plan

Content	Trainer's Note	Time
Risk Assessment of CI	Focus on stages, stakeholders and resources that support risk assessment	20 min
Resilience building of CI	A brief on how resilience can be built for CI, global practices and actionable for practitioners.	20 min
Discussion	Engage with learners to elaborate the work they have been doing for building the resilience of CI in their cities.	10 min

References

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Additional Reading Material

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- UNDRR (2022). A holistic approach to assess the systemic resilience of critical infrastructure; insights from the Caribbean Island of Saint-Martin in the aftermath of Hurricane Irma https://www.undrr.org/media/80326/download
- Centre for Liveable Cities (2018). A Resilient Singapore https://smartnet.niua.org/sites/default/files/resources/a-resilient-singapore.pdf

Notes

Learning Unit 2.3: Case Study- Resilience Building Measures for Critical Infrastructure

Brief Description of the Learning Unit

Having understood the risk and resilience assessments for critical infrastructure and resilience-building the aim of the learning unit is to map the critical infrastructures and identify such resilience-building measures in varied urban systems of Gujarat with the help of a case study from another Indian city.

Learning Objectives

- To encourage learners to think critically about the existing initiative and the interconnectedness of CIs
- To enable the learners to map the potential risks associated and measures to build resilience.

Duration: 30 minutes

Methodology

- Reading
- Discussion

Detailed Description

The case study aims to promote an understanding of resilience-building measures for critical infrastructure with a basic understanding of global examples.

Case Study

Smart Traffic Infrastructure Bhubaneswar (2017 onwards)

The Smart Cities Mission for Bhubaneswar included integrating technologically enabled solutions into the current citywide infrastructure to utilise information and data analytics to enhance civic services. 2018 saw the establishment of the city's "Smart Bus and Traffic Infrastructure," which included smart parking management, emergency response & incidence management, smart traffic management, and enhancements to public transport operations through the implementation of a bus modernization plan. Under the Smart Cities Mission, the city had implemented a bus modernization plan backed by the establishment of a pan-city IoT network, paving the way for smart mobility.

Through participatory decision-making, responsible governance, and open access to information and technology (BPTS, 2017), the city took on the Smart City Challenge and adopted visions like a transit-oriented city, liveable city, child-friendly city, eco-city and regional economic centre. Bhubaneswar Puri Transport Services (BPTS) evolved into Capital Region Urban Transport (CRUT) on May 4, 2018, with the vision to reorganize the public transit services in the city and in its neighbouring cities of Cuttack and Puri. It received the award of excellence for “Innovation in Urban Transport during Covid-19” during the Summit on urban mobility organised by MoHUA, in 2021. The solutions that CRUT uses involved asking for the feedback of citizens which provided a platform for citizens to co-create and shape the city’s future.

Futuristic cities would require the development of smart mobility solutions and the "quality of life" indicator in India's Ease of Living Index Framework includes mobility as one of the key elements (IFC, 2020). The goal of the Smart Transportation System (STS) is to reduce traffic issues and create effective mobility by utilizing commuter’s prior knowledge of the current traffic situation, the availability of seats on public transportation systems, etc. This improves comfort, convenience, safety, and the overall transportation experience.

The project operated as a pan-city intervention with a city-wide IoT-based smart transport plan

established for Bhubaneswar, involving smart traffic management, transit operations (Mo Bus), parking management app, common payment cards, emergency response & incidence management, and a command-and-control centre (CCC). It supports in furthering the project costs approx. Rs. 442 crore and is being conducted in support of both private and public sector partners like Bhubaneswar Smart City Limited (BSCL), Bhubaneswar Development Authority (BDA), CRUT, HAIL.

The key objectives of the project were to:

- Increase the effectiveness of future mobility by offering the city centralized transportation services and facilities that enhance multi-modal connection and traffic flow while lowering congestion.
- Enable automated enforcement tools to increase discipline and the safety of vulnerable road users like walkers and bikers.
- Create low-impact, carbon-neutral development leveraging advancements in air quality protection and green infrastructure
- Provide stakeholders and residents with real-time access to the most recent traffic updates, including frequent and important travel advisories
- Incorporate the use of data analytics, technology, and information to assist city officials in comprehending citywide traffic patterns and making wise judgements for service-level improvements.
- The transportation infrastructure was hit majorly during the Cyclone Fani of 2019 when network connectivity, electricity and water supply disruptions halted the MoBus services. Bus services were restored by CRUT within ten days after cyclone Fani. In this study, the many elements and innovations involved in implementing public mobility in Bhubaneswar are examined and documented.

Public Transit Option

The Mo Bus system was introduced in 2018 with the aim of providing inhabitants with an economical, convenient, and environmentally friendly method of transportation. Mo E-Rickshaw introduced in 2022 ply on several routes providing feeder service to Mo Bus. The facility has seen a shift of public ridership of 32% from private vehicles to MoBus (CRUT, 2019). It saw a significant rise in users after the COVID-19 lockdown. During the lockdown, the bus queue shelters and bus fleet were repurposed as vending spots and grocery-on-wheels, respectively. When the lockdown had led to limited transportation options MoBus helped frontline workers (COVID Call Centre Executives & Emergency Health Workers, and Police during the pandemic through multiple trips 24/7). It took more than 200 trips in a month with seamless options for travel to routes to hospitals, stations and other emergency facilities. It introduced a no-standing passengers' norm and cashless payment options.
Some of the features integrated into the Mo Bus service at various stages are:

Pre-operation:	During operation:	Post-operation:
•Training and capacity building of staff •Vehicle planning schedule and dispatch •Bus staff allocation and electronic ticketing machine distribution •Regular vehicle fitness check •Regular staff training •Preparation of logsheets to keep track of bus operations •Depots with features of rainwater harvesting, solar lighting, STP	•Bus queue shelters involve provisions for Wi-fi, nearby accessible toilet booths, e-cycle (Mo cycle) stations, and bus route information map •Fuel monitoring •GPS based Automatic Vehicle Location System for tracking delays •Public Information System •Emergency call system •GPS based in-vehicle announcement •50% reservation for female MoBus guides •E-ticketing •Surveillance system •Intermittent cleaning	•Chip based fuel refilling •Maintenance every 10 days, cleaning •Wastewater reuse at depot for landscaping

Fig 1. Some Interventions During COVID-19 by CRUT

Smart Traffic Management

- Installation of security cameras using Automatic number-plate recognition ANPR technology to detect traffic violations. There are currently 12 Speed Violation Detection Systems (SVDS) at midblock and 13 Red Light Violation Detection Systems (RLVD) strategically placed at important signals.
- The e-challan technology makes it simple to issue tickets and pay for them via cashless transactions.
- At the city's main checkpoints, the Automated Traffic Counting and Classification System (ATCC) is installed to count the cars
- A Traffic Accident Recording System (TARS), run by the traffic police department, to record daily traffic accidents is installed across the city. Ten TARS devices are being used right now.
- Adaptive Traffic Signal Control (ATSC) systems have been installed in 50 squares throughout the city to reduce traffic congestion.
- Pelican crossings have been installed to give priority to pedestrian traffic crossing congested routes.
- 30 signalized crossings having 414 Public Address Systems (PAS) installed for quick notifications to the general public.
- 20 sites have Dynamic Message Signboards (DMS) installed to display warnings about the state of the road's traffic or to inform commuters of the posted speed limit and other traffic regulations.
- Installation of the Environmental Monitoring System (EVMS), which includes sensor stations for real-time monitoring and measurements of temperature, humidity, air quality index, noise level, and rain gauge as well as public viewing digital display systems, at ten identified problem areas throughout the city.

Fig 2. Some Features of The Transportation System in Bhubaneswar

Smart Parking Systems

On-street parking zones and multi-level car parks, respectively, have 5000 on-ground parking occupancy sensors and 1500 ultrasonic sensors installed. The Mo Parking app can detect occupied parking spaces and produce information about parking availability. Also, commuters can pre-book parking spaces through the app and make payments online. Cashless transactions have also been made possible by handheld POS operated by on-site employees.

Emergency Response & Incidence Management

A video management system at the command-and-control centre (CCC) and 450 fixed CCTVs and 150 PTZ cameras put throughout the city guarantee round-the-clock incident detection. With emergency call buttons and PTZ cameras, 50 integrated multi-services kiosks and 25 freestanding kiosks are strategically placed along roads and in other high-traffic areas. In multi-agency collaboration for quick and effective emergency response and occurrence management, ICCC serves as the facilitator. Computer-aided dispatch and tracking of first responders through radio communication are also done. There is a need to create awareness among citizens on available digital interfaces, such as digital kiosks that are developed for citizen-centric services

Other Practices

Intelligent City Operations & Management Centre (ICOMC) is a facility dedicated to the CCC. It is the centre of the pan-city IoT network, equipped with robust IT infrastructure, hosting multiple city subsystems on individual operator workstations integrated by a common smart city and GIS platform. The communication network that forms the backbone of the IoT is the 680 km city-wide subsurface fibre optic network. It operates in addition to a wireless network with 1800 Wi-Fi access points covering 518 locations. During the COVID-19 lockdown CRUT initiated the “Bus Pathshala”, a virtual training programme for its crew and staff on safe and eco-sensitive driving.

The Odyssey smart card is a common payment card used for transit in Bhubaneswar. The common city payment card was launched through a public-private partnership with a private bank, enabling cashless transactions for citizen services across multiple sectors, such as public transport, parking, utility payment, shopping, and recreation.

Advantages Of Interconnected Systems

Provisions of features such as surveillance cameras, and restrictions on overcrowding, provide safer commutes in the city. The ATSC enables understanding of the traffic capacity and creates green corridors. The Environmental Monitoring System with display boards provides an easy visualization of real-time environmental data and has increased transparency and awareness of environmental issues among citizens and decisionmakers. As the Mo Bus system incorporates demand-based replanning and scheduling it allows for efficient management of resources and makes bus rides convenient and affordable. The Traffic Violation Detection System has enabled efficient traffic management and

detection of violators while minimizing the load on traffic department staff. Mo E-Ride contributed to reducing pollution by 30-50% (India Times 2022).

The Intelligent City Operations and Management Centre's (ICOMC's) Command and Control Centre (CCC) provides a digital platform for integrating various city sub-systems. This platform runs on server computers at individual system operators' workstations and is managed by the relevant departments. The smart traffic components are disaster-resistant and failures are handled by the HAIL team within a stipulated period. Data acquired from ATCC is shared regularly with traffic police for further analysis and strategizing traffic operations. The sensor-based smart parking management system, special focus on assisting the specially-abled, senior citizens and female passengers have provided a better experience for the users. The smart parking system managed by the transgender community has enabled employment and efficient revenue collection.

The project further aligns with many **SDGs like 3.6**, which calls for action towards reducing deaths and injuries from traffic accidents which are supported through the implementation of solutions like pelican crossings along busy corridors prioritizing pedestrian movements. The project provides support to **SDG 5** through employment opportunities for women and transgender and promotes a safe and secure environment for women commuters. The project also promotes smarter mobility options **(SDG 7),** quick coordination with agencies for incidence response, a communication network for flexibility in the future expansion of smart infrastructure (**SDG 9**), and minimizing environmental impacts (**SDG 11**).

Discuss with learners: *After going through the case study learners should engage in a discussion to answer:*

- *Which pillars of building CI resilience contributed to this study?*
- *From this case study, what drives CI resilience, and who is responsible for it?*
- *If you were to develop a similar system in your city, what would you do differently for building the transport system more resilient?*

Session Plan

Content	Trainer's Note	Time
Case Study	Focus on understanding the features of the critical infrastructure and incorporated resilience-building measures	20 min
Discussion	Promote a discussion asking learners to elaborate on their understanding of resilience-building measures	10 min

Reference

- NIUA (2023). Smart Cities and Academia Towards Action and Research Part C: Urban Infrastructure https://niua.in/intranet/sites/default/files/2780.pdf

Additional Reading Material

- OECD (2018) Climate-resilient Infrastructure https://www.oecd.org/environment/cc/policy-perspectives-climate-resilient-infrastructure.pdf
- ADB (2022) Disaster-Resilient Infrastructure Unlocking Opportunities For Asia And The Pacific https://www.adb.org/sites/default/files/publication/791151/disaster-resilient-infrastructure-opportunities-asia-pacific.pdf

Learning Unit 2.4: Discussion

Brief Description of the Learning Unit

Having understood the importance of critical infrastructure and resilience building the learners should engage in a discussion to mutually learn about the Indian scenario and how to improve critical infrastructure resilience

Learning Objectives

- To encourage learners to share perspectives on improving CIs
- To recapitulate the knowledge gathered during the previous sessions

Duration: 15 minutes

Methodology

- Discussion

Guiding Questions

- How can governments and private sector organizations work together to identify and address systemic risks to critical infrastructure, such as cyberattacks?
- How do the interdependencies between critical infrastructure systems affect their resilience to systemic risks, and what can be done to improve these interdependencies?
- How can communities and individuals prepare for disruptions to critical infrastructure systems, and what role can practitioners play in improving resilience to systemic risks?
- In what ways can emerging technologies, such as artificial intelligence and the Internet of Things, help improve the resilience of critical infrastructure systems?

Notes

Summary

The Technical Session 2 guides the learners on:

- Types of assets, infrastructures that can be considered critical for a city and the interconnectedness
- Impact of disasters and climate change on critical infrastructure and related government agendas, schemes, etc.
- Methods to evaluate risk and resilience condition of critical infrastructures including rapid visual screening, resilience assessments, risk-sensitive planning, etc
- Existing cases of building infrastructure resilience and actions that contribute towards making resilient cities

Technical Session 3: Land Use Planning for Urban Resilience

Introduction, Overview & Perspectives

The third technical session, Land Use Planning for Urban Resilience, will look at key concepts and tools of land use planning and successful case studies from various towns and cities. It will delve into risk-sensitive land use planning concepts, participatory planning approach, and the principles of land use planning for disaster resilience. The session is intended to provide learners with practical tools and strategies for improving their own cities' resilience

- Learning Unit 3.1: Key Concepts and Tools
- Learning Unit 3.2: Case studies

The primary objectives of the session are:

- To understand the key land use planning concepts and tools in building resilience
- To explore case studies to understand the practice of land use planning for urban resilience

Duration: 90 minutes

Methodology

- Lecture-based learning
- Case studies
- Discussion

Trainer's Note

The trainer for the session should aim to provide learners with practical tools and strategies for improving their own cities' resilience and safety through land use planning. Showcasing successful case studies and good practices in land use planning that include emerging techniques, community-based initiatives, and regulatory instruments would be useful.

During the session, the trainer should encourage experience sharing among the learners, allowing them to gain insights from the experience of land use planning and development projects in their respective cities or towns. Overall, the trainer should create an engaging and interactive learning environment that encourages active participation and knowledge sharing among the learners.

Learning Unit 3.1: Key Concepts and Tools

Brief Description of the Learning Unit

The goal of the learning unit is to inform learners on the land use planning principles, concepts and tools that can support urban resilience. It shows how land use planning can integrate disaster risk management and climate change adaptation into urban development. The session will also cover the regulations, legislations and other instruments that support land use planning and their potential for integrating DRR and CCA into urban development.

Learning Objectives

- To understand the role of urban land use planning concepts in building resilience in the local and global context.
- To explain the uses of tools and technology and modern innovations for the same

Duration: 60 minutes

Methodology

- Lecture-based learning
- Discussion

Detailed Description

The urban population is continuously increasing across the globe. Urbanization increases productivity, and GDP per capita, and is considered to be a major source of economic strength, however, most urban dwellers are not equally benefitted. The UN expects that by 2050, 80% of the world's population to live in urban areas (Lall et.al. 2009). Rapid urbanization puts pressure on the available lands and services in urban areas where the incoming population tends to settle in hazard-prone areas like low-lying areas, steep slopes, floodplains, near industries, and railway tracks. As discussed in the previous technical sessions, the complexity of urban systems and uncertainty related to the impact of development and climate change affect and configure hazards in a city.

Urbanization in Gujarat and the majority of India has been an **ad hoc, unplanned process**. As a result, urban centers are made up of a variety of building types that are connected by a system of circulation components (roads, streets, etc.). High-rise buildings, mansions, shanties, and tenements are among the structures; avenues, highways, and lanes are among the means of transportation. Naturally, the city provides housing for both the wealthy and the destitute, each with particular requirements and vulnerabilities. As a result, the urban environment is a complicated amalgam of many structures and people.

Urban areas require attentive spatial design that takes disaster risks into account and ensures safer buildings. Strict disaster-sensitive urban planning strategies that include risk reduction and disaster safety are necessary for this. Critically evaluating the risks to a community and then planning for quick response facilities and additional risk reduction would be a smart place to start. Strict adherence to building bye-laws and structural safety elements based on risk assessment is necessary for individual buildings as well. The **SFDRR** placed a strong emphasis on addressing the root cause of disaster risk including, uncontrolled urbanization. The **New Urban Agenda**, which was established in October 2016, aims to encourage diversity in order to create cities and human settlements that are safe, healthy, accessible, affordable, resilient, and sustainable.

Land use is used to describe the human use of land. It can represent the economic and cultural activities practiced at a given place like agriculture, commercial, institutional, etc. Land ownership

commonly determines different land uses. For example, government lands are often used for parks, government offices, while privately owned lands are used for residential purposes.

Land use planning is the process of controlling how land is used by an authority like an urban local body, central planning agency etc. In most cases, this is carried out to encourage more desired social and environmental results as well as a more effective use of resources. More precisely, the objectives of land use planning frequently include environmental preservation, control of urban sprawl, reduction of transportation expenses, avoidance of land use disputes, and a decrease in pollution exposure. In order to achieve these objectives, practitioners believe that controlling land use will alter human behaviour patterns for the better.

Discuss with learners:

- *How does urban and land use planning function in their cities to address disaster risk reduction and climate change?*
- *What are the different spatial/land use plans deployed in your city?*
- *List some contrasting land uses present in your city leading to competition and conflict.*

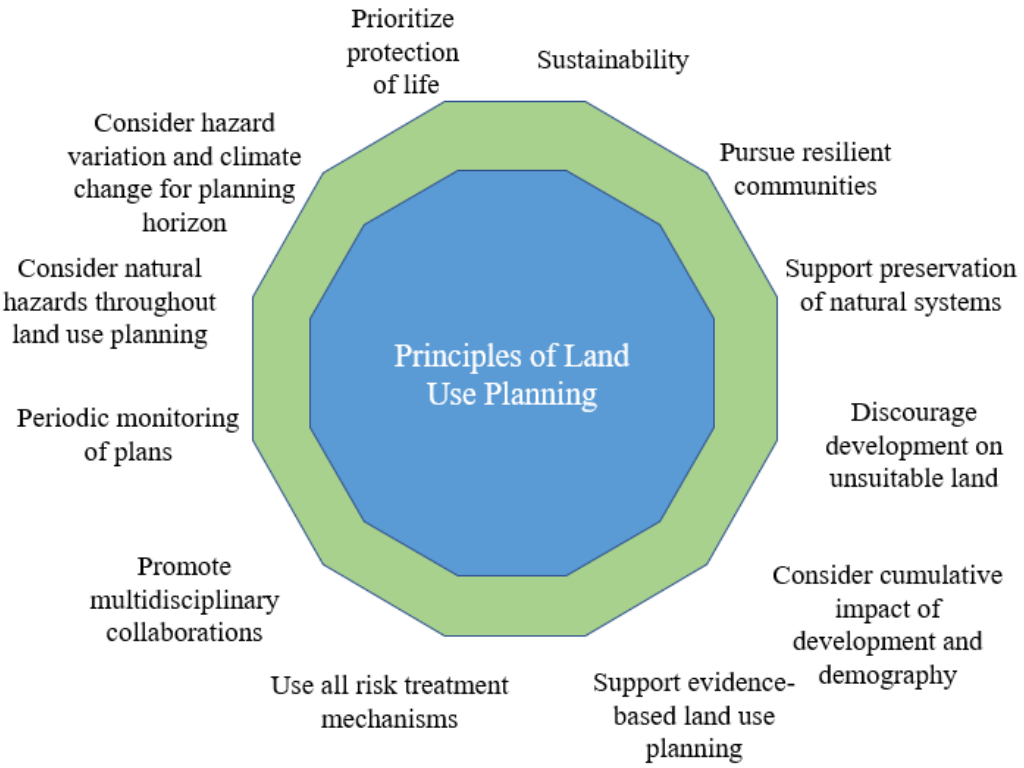

Fig 1. Principle of Land Use Planning for Resilience (adapted from Australian Institute for Disaster Resilience 2020)

Key Concepts

- **Risk-Sensitive Land Use Planning (RSLUP)**

The traditional method of land use planning is supplemented by two new factors by risk-sensitive land use planning (RSLUP):

- Parameters and goals for disaster risk reduction. The identification, collection, and integration of disaster/emergency management requirements with traditional land use planning data (such as socioeconomic profiles, demography, and transportation networks) results in the formulation of DRR goals and objectives.
- Inclusion via official government initiatives. There are steps made to ensure that the plan is understood, accepted, and supported; to increase planners' competency and knowledge

regarding risk-sensitive land use planning, and to increase the awareness and support of all stakeholders.

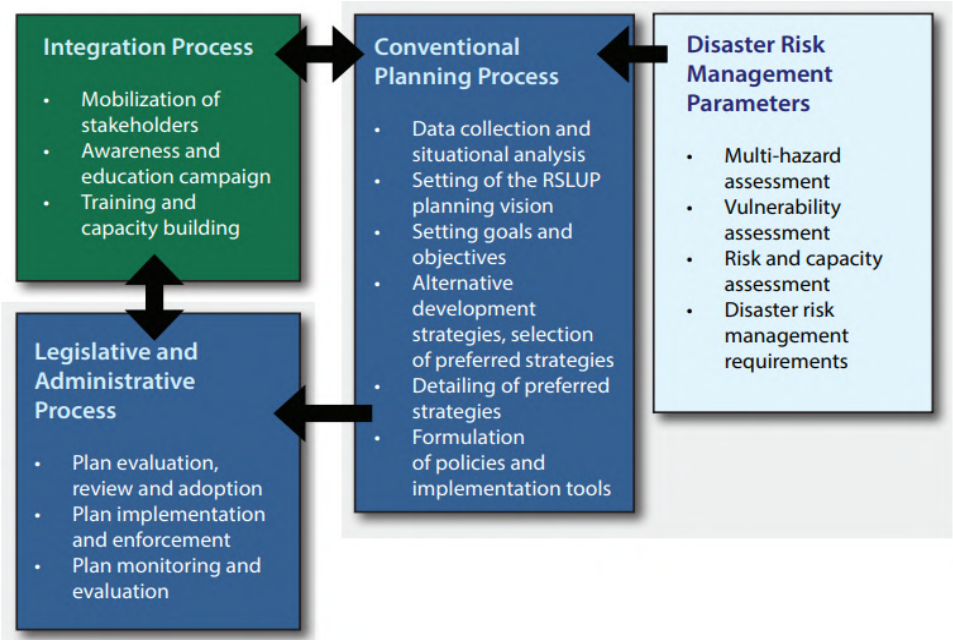

Fig 2. Risk-sensitive Land Use Planning Framework (EMI, 2010)

Risks to the population, productive assets, physical environment, and natural environment can be reduced by following RSLUP while undertaking urban planning and development. A set of descriptors are given to each element (i.e. words and phrases that signify the quality of the future and resilience desired). The RSLUP prepares city profiles and situational analyses of development sectors using the HVRA's findings (e.g., settlements, infrastructure, and natural environment) and describes how HVRA findings have affected the population, various industries, and spatial development. Some cities which have implemented Risk Sensitive Land Use Planning are Kathmandu, Can Tho City, Dhaka, Changunarayan

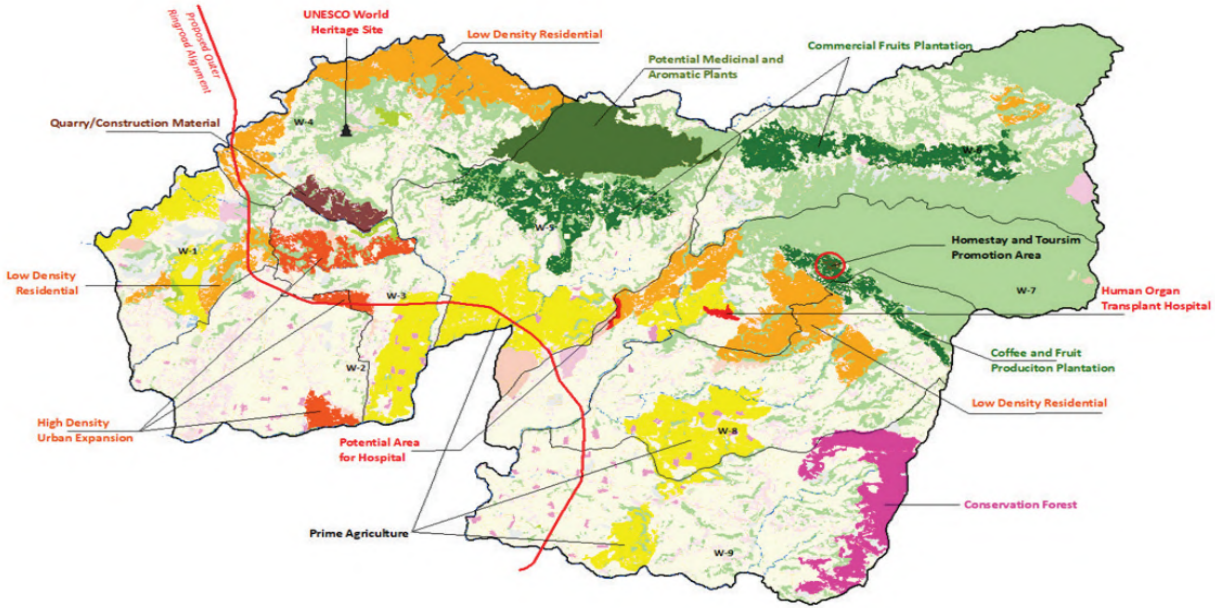

Fig 3. Risk-sensitive Land Use Map Changunarayan (DPNET, 2018)

- **Integrated Land Use Planning**

Integrated Land use planning assesses the use of resources, taking into account different uses, and

demands while balancing economic, social and environmental values including all sectors. It tends to avoid mismanagement and misuse of resources enhancing resilience to climate change and preserving the environment from degradation.

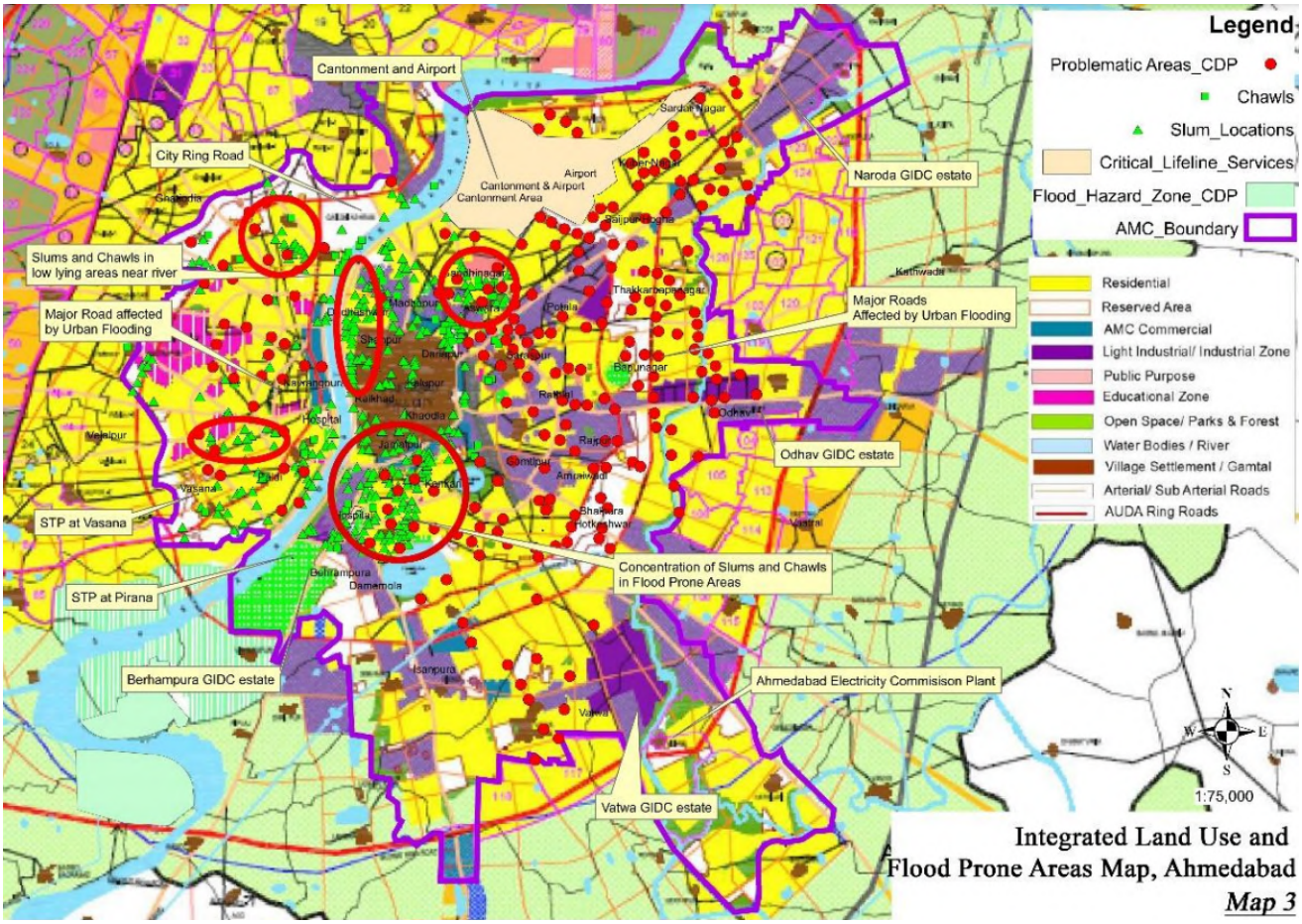

Fig 4. Integrated Land Use and flood map Ahmedabad (IRADE, 2019)

- **Participatory land use planning (PLUP)**

Important in many areas where community-owned lands (or settlements) are severely deteriorated and when conflicts over land use rights occur. Participatory land use planning is used for planning common property land, especially in the slums of a city. Negotiations between stakeholders and regulations for land management that are binding and based on planning units can control arrangements. It is possible to adopt land use for specific purposes based on the consensus of the community for social or geographical units. It is a people-centered, bottom-up strategy that acknowledges regional variations in socio-cultural, economic, technological, and environmental contexts.

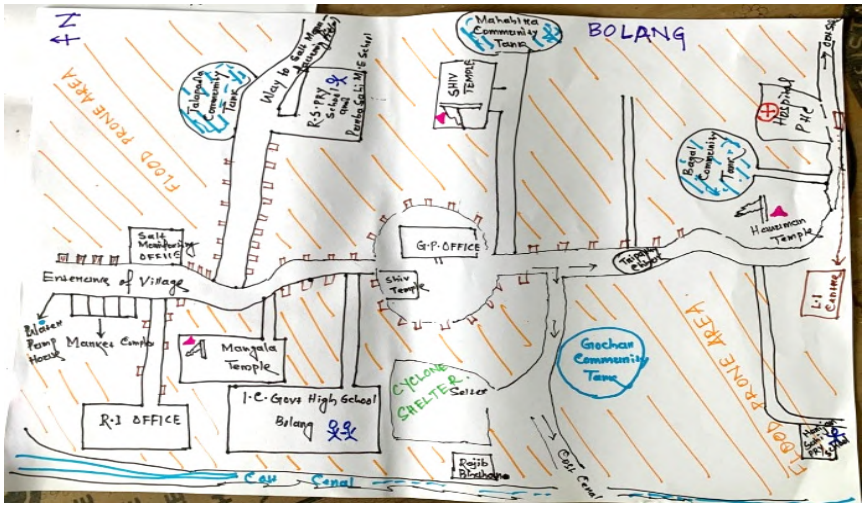

Fig 5. Participatory Mapping for Planning

Tools for Land Use Planning

- **Legislations and Regulations**

A national instrument offering standards for controlling building construction operations all over the nation is the **National Building Code of India (2005),** a thorough building code. All agencies involved in building construction, including Public Works Departments, other government construction departments, local bodies, and private construction agencies, are encouraged to adopt it as a model code. The Code primarily consists of administrative rules, development control guidelines, and general building requirements, as well as requirements for fire safety, material requirements, safety-related requirements for structural design and construction, and requirements for building and plumbing services. **Gujarat Comprehensive Development Control Regulations (2017)** apply to the land development and building construction in the State with restrictions for hazardous sites, industries, distance from natural resources, etc taken into consideration to ensure safety.

According to the **Land Acquisition Act, 1894**, the land needed for a public purpose might be notified for the proposed acquisition by the District Collector or any other officer particularly authorized by the government. The Collector has the authority to purchase land after the compensation or damages have been awarded. This supports the inclusion of consideration of disaster resilience of a site in land use planning.

The **Slum Areas (Improvement and Clearance) Act, 1956** gives the government the authority to remove slums by rehabilitating unsuitable homes and redeveloping crowded, derelict places to better the lives of slum dwellers. It guides the planners to clearly articulate how disasters may impact slums and consider information in land use planning and decision-making processes.

The **Urban Land (Ceiling and Regulation) Act, 1976** has the primary purpose to set a cap on the amount of land that any one person may own. The urban agglomeration limit for unoccupied land is 500 square metres. The Act's powers are governed by the competent authority, who will be chosen by the State Government. This helps in controlling the density of population in a land thus preventing pressure on resources.

Real Estate (Regulation & Development) Act, 2016 provides for the creation of the Real Estate Regulatory Authority to regulate and promote the real estate or sale of real estate projects, in an efficient manner to safeguard consumers' interests in the real estate industry, to create a framework for swift dispute resolution, and to create the Appellate Tribunal to hear appeals from the Real Estate Regulatory Authority's decisions, directives, and decrees. The act allows for the standardization of real

estate projects.

Guwahati Municipal Corporation introduced “resilience checks” as a part of the building permission process with integration of flood resilience principles as mentioned in the Building Construction Regulations (Byelaws) 2014.

Surat has formulated and implemented resilience action plans and SOPs for infrastructure development initiatives.

- **Spatial Data and Technology**

Land use changes occur constantly and at many scales, and can have specific and cumulative effects on the environment, extent and quality of biodiversity habitat, climate, and human health. Spatial datasets such as remotely sensed imagery, topographic data, vector data, administrative boundaries etc. can inform about temporal changes in land use. Spatial mapping of hazards, resources, and demography shows the potential locations of risks in relation to the surrounding natural and humanmade environments. Risk mapping takes into account the likely effects of an event on the neighborhood/city. They typically work in conjunction with "overlay mapping," though they are distinct from it. In order to determine the direction of new development and the specification of requirements for acceptable development, spatially portraying the risk and hazard while articulating risk tolerances could be beneficial. Technologies like AI and ML can support in bridging data gaps and identify the underlying presumptions and evaluation.

Video: Urban planners aim to eliminate slums—with a mathematical approach by Science Magazine **https://www.youtube.com/watch?v=YuRjeUkNf9o**

Video: Freetown The Treetown: Using EO & AI in Sierra Leone by GFDRR **https://www.youtube.com/watch?v=s0oLUJVjEj4**

- **Plans**

Numerous types of spatial plans are prepared in India with different purposes, strengths and weaknesses. The most predominant types are master plans, regional plans have ability to enhance or integrate DRR and CCA. The integration of urban nodes with semi-urban and rural areas requires a comprehensive plan at the proper scale (district/inter-district, investment region, or special area).

The **regional plans** ’strategy is based on knowledge about regional features such the movement of people, goods, knowledge, and money. It broadly describes the patterns of land use, infrastructure, and settlement in a given area. likely to include a variety of jurisdictions, area plans, governance systems, and area types, including urban, rural, peri-urban, and agricultural areas.

A **master plan** is a plan created within the parameters and goals of a perspective plan (long-term 20–25-year plan) that has been approved. This plan's goal is to provide additional information and intended actions in the form of strategies, land uses, and physical proposals for different strategies stated in the perspective plan and regional plan depending on the needs and aspirations of the people, the resources that are available, and other factors. a comprehensive long-term plan that takes into account infrastructure, housing, and the built environment. It tends to approach planning technically and may do the same with DRR as well. With a tendency to pursue huge initiatives rather than utilising local communities' adaptive capabilities on a smaller scale a master plan may approach DRR with a strong

regulatory focus. Town Planning Schemes are prepared at the micro level for an area of about 100 hectares particularly within the master plan area and are those pockets which are under pressure of urban development and need attention.

Examples of Plans:

The Regional Plan for Goa – 2021 facilitates land use regulation and direct state development. The Goa plan stands out for a number of reasons, including the digitisation and direct co-relationship of all data at the subregional level with the land survey records and revenue data, the identification of ecologically important areas that should not be touched, and the engagement with the communities for the preparation of a peoples' plan.

Smart City Plan for Coimbatore includes a project to create an Eco-restoration Master Plan for eight lakes and a connecting greenway, focusing on reviving the eight-lake network to redevelop environmentally sensitive areas and introduce sustainable and improved public realm along the lake edges.

Discuss with learners: *List a few example(s) where DRR has been fully integrated into an urban development or infrastructure project of your city. Share some DRR practices undertaken by poor communities in your city. Mention a few points to scale and support these actions.*

- **Zoning**

Zoning, overlays and other associated controls-related resource documents set limits on the type and extent of development that can occur in a given area. Hazard-prone areas should have resilience provisions in place. Zoning helps to describe risk tolerances in terms of permissible development criteria. It restricts construction or certain uses in areas that have been designated as not suitable for new development because of hazards or the effects of development on natural hazards. By taking build form issues into account, it can address acceptable/residual risk. Rezoning property helps to prevent construction in hazard-prone regions such that rebuilding enhances risk profiles and prevents the repetition of unnecessary hazards after an incident.

SCAN ME Video: Zoning Matters: How Land-Use Policies Shape Our Lives by Urban Institute **https://www.youtube.com/watch?v=aLMsI92crZw**

Session Plan

Content	Trainer's Note	Time
Key concepts	Focus on giving a brief on the land use planning in urban areas with a focus on principles, key concepts and drawing insights from the learners' experience. Through examples understand mainstreaming of DRR and CCA in land use planning	15 min
Tools for Land use planning	Focus on explaining about the tools, legislations and regulatory instruments for land use planning to build urban resilience	30 min
Discussion	Focus on promoting the knowledge on the land use planning interventions, tools and integration of DRR	15 min

References

- Australian Institute for Disaster Resilience (2020). Land Use Planning for Disaster Resilient Communities. Australian Disaster Resilience Handbook Collection

- DPNET (2018). Risk Sensitive Land Use Planning (RSLUP) for Urban Risk Mitigationhttps://www.dpnet.org.np/uploads/files/Learning%20Document%20Issue%207%20-%20Risk%20Sensitive%20Land%20Use%20Planning%20for%20Urban%20Risk%20Management%20%28002%29%202019-05-16%2010-15-42.pdf
- EMI (2010). Risk-Sensitive Land Use Plan: Kathmandu Metropolitan City, Nepal, Philippines: German Federal Foreign Affairs Office and EMI.
- Lall, Somik V, and U Deichmann (2009). Density & Disasters: Economics of Urban Hazard Risk. Policy Research Working Paper 5161, Washington DC: The World Bank.

Additional Reading Material

- Net Zero Carbon Cities https://www.nzcctoolbox.org/solution-database
- EMI (2014) Risk-Sensitive Land Use Planning Guidebook Bangladesh Urban Earthquake Resilience Project
- Implementation Guide for Land Use and Urban Planning: Words Into Action by UNDRR https://www.undrr.org/sites/default/files/2022-12/67430_landuseandurbanplanningforpublicrev.pdf

Notes

Learning Unit 3.2: Case Studies

Brief Description of the Learning Unit

The learning unit "Case Studies" focuses on exploring various tools and concepts relevant to land use planning for enhancing urban resilience. The unit includes cases on participatory initiatives, regulations, nature-based solutions, and infrastructure resilience. It highlights the importance of a participatory and engaged approach, the mainstreaming of DRR and CCA, and nature-based solutions in building resilient cities. Through case studies and good practices, learners will gain insights into the practical implementation of land use planning tools and concepts.

Learning Objectives

- To know about the recent practices that support land use planning efforts for urban resilience.
- To analyze varied case studies and to capture the key lessons and challenges

Duration: 30 minutes

Methodology

- Case studies
- Discussion

Detailed Description

Case Studies

1. Risk-sensitive land use planning in Kathmandu, Nepal

Nepal has experienced some of the major earthquakes of all time which have killed over 11,000 people in the past century. National Society for Earthquake Technology-Nepal studied that earthquakes with damage intensity greater than VI may recur every 21 years in Nepal. Kathmandu being a metropolitan area faces the challenges of high population density, the demand for services and land, heavy traffic, and load on built infrastructure. The present conditions contribute to the amplified vulnerability of communities, compounding the probable interruption of various functions and destruction of assets. The national plans regulate the growth of haphazard development, provide incentives for safe development to private sectors, and regulate local-level development through local governments.

Approach undertaken: Risk-sensitive land use planning has been piloted in the Kathmandu region. It undertakes the Disaster Risk Assessment (DRA) using information from historical data on seismo-tectonic and geological conditions around Kathmandu Valley, and the fault model of the 1934 Bihar-Nepal Earthquake. The DRA interpreted vulnerability from the concentration of settlements in various wards. The locations were mapped in the hazard maps to indicate the potentially affected sectors. Probability studies were referred to for seismic risk. Building materials used and their risk was assessed for the planning process. The plan recommended appropriate zones for various land uses, with risk reduction measures. It also aimed to enhance the capacity of the stakeholders and officials to reduce the loss of life and property.

Good practice: Kathmandu faces challenges with limited land and resources and high population density. The study highlights that if risk information is integrated into land-use planning the process of planning is strengthened. The pilot has undertaken a detailed risk analysis while taking into consideration the aspects of disasters and climate change. The proposed land use of the RSLUP Kathmandu aligned with the zoning standards and was developed into an implementation tool by drafting the Zoning Ordinance. The land-use plan aligns with other higher-level development plans like river basin development, heritage conservation, etc.

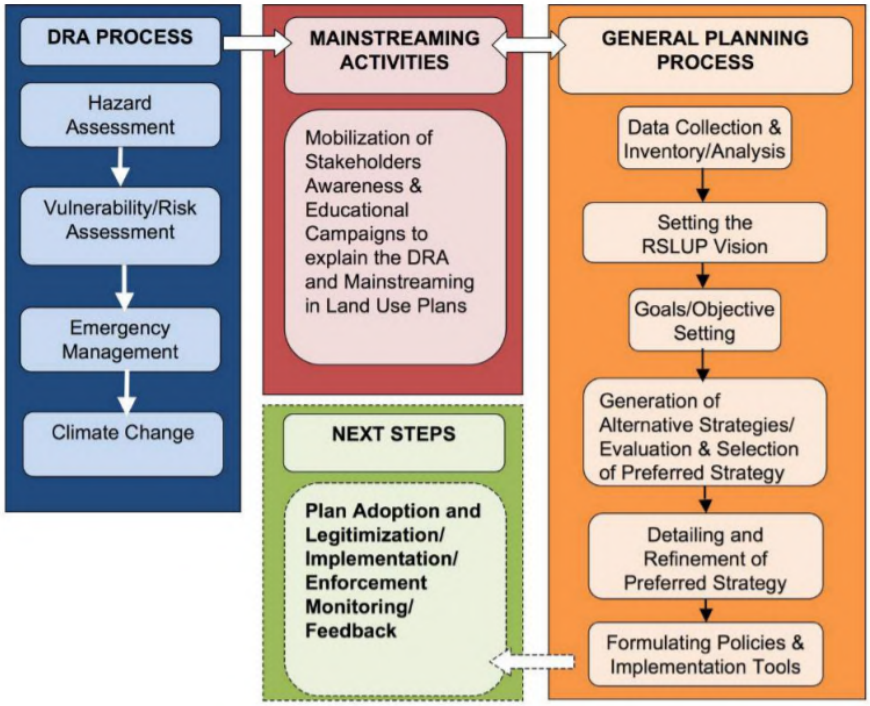

Fig1. Risk-sensitive Land Use Planning Framework KMC Source: (EMI, 2010)

2. Seveso directive- Technological Risk Prevention Plan France

The Seveso Directive covers establishments where hazardous substances may be present. The member states are expected to develop land-use plans considering establishments with toxic substances. Land use planning considers- quantitative risk analysis for the establishment, hazard zoning, and classification of development based on disaster management aspects. The technological Risk Prevention Plan (PPRT *in French*) is being implemented in La Rochelle, France for the protection of the current and future population around the industries. The planning departments observed industrial accidents can be severely aggravated because of the proximity of hazardous establishments to residential areas, transport hubs, commercial centers, public spaces, and services. Appropriate zoning and land-use change recommendations through stakeholder consultation was done for strengthening PPRT which was added as a component in urban planning plans. 7 levels of hazard zones are created depending on the intensity and the probability. Regulatory zones are formed which the citizens need to adhere to for development.

3. Kawaki Initiative- Kochi

In 2018, Kochi City became the first city in India to sign on and become a founding member of the Cities4Forests worldwide movement. With the aid of Kudumbashree, a community-based organization that is a part of the Local Self Government Department in Kerala, consultations were undertaken with local community members to ascertain their priorities. In addition, the Urban Community Resilience Assessment (UCRA) framework, an evaluation structure and bottom-up process developed with assistance from the Cities Alliance - Joint Work Program on Resilient Cities, was put into practise across four vulnerable neighbourhoods to evaluate the disparate coping capacities of the individual and community.

Approach undertaken: In 2020, local council members, Resident Welfare Association (RWA) members, and students participated in a comprehensive participatory "mapathon" activity through the Cities4Forests programme in India to evaluate the potential for green restoration in two important wards in Kochi. The project looked at changing the land use land cover of the city through several

critical spatial maps generated through this exercise to make an evidence-based analysis of the different environmental and social vulnerabilities. It led to the development of a guidance document on Nature-based solutions and community resilience to highlight the urban restoration plan for a greener future.

Good practice: The project created sustainable civil models to create and conserve green spaces. Spatial maps were gathered as part of a "Mapathon" event through a multi-stakeholder workshop to understand the potential places for urban greening.
Little urban grooves that resembled traditional grooves, or kavu, were created as part of the Kawaki Initiative in the available patches. 10,000 sq. m of space for the green cover was conserved through 15 kavus. With the assistance of government organisations, housing associations, Kudumbashree units, and even private partners, Kawaki Woods were built around the city by 2022.

4. Safety Authorities 'Contribution to land use planning Estonia

The prevention of industrial accidents and emergency preparedness are the responsibilities of the Estonian Rescue Board (crisis management department and regional and local rescue centres). The board has a range of binding authorities in this regard and is actively involved in siting and land use procedures as well as related environmental impact assessments, including screening and scoping. Comprehensive and detailed spatial plans and building design documentation must be submitted to the board for approval when:

- choosing the location of a new establishment,
- expanding the operations of an existing establishment, or increasing production, provided that a plan needs to be initiated or amended or a building permit needs to be granted, comprehensive, special, or detailed spatial plans and building design documentation must be submitted to the board for approval
- Planning an area located in the danger zone of a hazardous enterprise

The board determines whether the following factors are true:

- The plan or construction activities increase any major accident hazard or the severity of its effects;
- The planned accident-prevention measures are sufficient; and
- The operator of the establishment must provide additional information to the local authority and the board before the plan is adopted or the building permit is granted.

If a proposed activity in the plan or the building design documents raises the probability of a significant accident occurring or the severity of its effects and the planned accident prevention measures are insufficient, the board may reject the request (UNECE 2017)

Session Plan

Content	Trainer's Note	Time
Case Study 1 - Plans	Focus on explaining the planning good practices in detail	15 min
Case Study 2- Participatory Action	Focus on promoting the knowledge of the participatory and multi-stakeholder aspect and integration of DRR and CCA with land use planning	15 min

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Additional Reading Material

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Notes

Summary

The Technical Session 3 guides the learners on:

- The need of land use planning and its contribution for building resilient cities.
- Existing laws, regulations, mechanisms and tools that contribute to planning land use in urban areas
- Processes like risk-sensitive land use planning, participatory planning and integrated planning mechanisms for planning urban areas
- Existing cases of land use planning efforts from India and globally that have improved resilience

Technical Session 4: Grey and Blue-Green Infrastructures for Urban Resilience

Introduction, Overview & Perspectives

The technical session offers to introduce the learners to the key concepts of grey and blue-green infrastructure, nature-based solutions and activities that support building urban resilience. The session would take the learners through the environmental and social impact assessment (EIA and SIA), legal frameworks and various case examples from around the world where initiatives on resilient grey-blue-green infrastructure have contributed to better urban conditions.

- Learning Unit 4.1: Key Concepts
- Learning Unit 4.2: Introduction to SIA and EIA
- Learning Unit 4.3: Case Studies
- Learning Unit 4.4: Discussion

The primary objectives of this technical session are:

- To develop an understanding of the grey and blue-green infrastructures and their relevance to urban resilience
- To have a better perspective on the nature-based solutions
- To gather knowledge on the importance of SIA and EIA
- To enhance knowledge through cases where grey-blue-green infrastructure is promoting resilient urban development

Duration: 120 minutes

Methodology

- Lecture-based learning
- Discussion
- Case-study

Trainer's Note

This technical session consists of three lecture-based learning units followed by a case study-based learning unit. It should be conducted to provide a basic conceptual clarity about grey-blue-green infrastructure in the urban context, recent practices and related laws. The trainer should aim for an understanding through active participation of learners, various nature-based solutions relevant in the context of Gujarat and how EIA and SIA can improve planning projects through discussion and question and answer sessions. It is recommended that while explaining and using examples on the same, trainers strive to link the general concepts to the urban contexts of Gujarat.

Learning Unit 4.1: Key Concepts

Brief Description of the Learning Unit

This learning unit introduces learners to the grey-blue-green infrastructure, their role in resilient cities and ways to enhance grey and blue-green infrastructure. It strives to guide the learners to best direct their efforts toward designing and engaging in projects promoting the use of grey and blue-green infrastructure. Further, it delves into the umbrella concept of Nature-based Solutions (NbS) and the different approaches encompassed under it. It will discuss key principles of NbS, the existing NbS practices. It lays down the key gaps and enablers of NbS. This would also enable the learners to identify areas for integrating their learning within their spheres of work.

Learning Objectives

- To have a better perspective on grey and blue-green infrastructure
- To enhance knowledge on ways to strengthen urban resilience through examples
- To familiarize with the concept of NbS and its principles
- To enhance knowledge of existing practices and enablers of NbS

Duration: 45 mins

Methodology

- Lecture-based learning
- Discussion

Detailed Description

SDG 11, Sustainable Cities and Communities has as its principal objective "making cities inclusive, safe, resilient, and sustainable." It encourages inclusive and sustainable urbanisation. It includes making investments in public transportation, enhancing urban planning and resource management, and putting into practice policies for disaster preparedness and climate change adaptation. **Targets 11.6 and 11.7** in particular seek to provide universal access to secure, inclusive, and accessible green and public places and to lessen the negative environmental effect of cities on a per-capita basis.

Urban areas are increasingly at risk from disaster risks, climate change, as well as from threats to environmental justice and human comfort. Key **global risks** identified are extreme weather, biodiversity loss, climate action failure, natural hazards and human-induced environmental disasters- these are essentially environmental in nature and are anticipated to have a negative decadal impact on countries as a result of temperature increases (WEF, 2020). Ahmedabad is projected to see an approximate 50 percent loss in vegetation between 2010 and 2030 (Ramachandra et. al. 2016). Attention needs to be given to the potential role of green (such as trees, parks, playgrounds, and forests) and blue (such as seas, rivers, lakes, wetlands, and water utilities) spaces in efforts to address these challenges; this attention is frequently approached through the concept of green and blue infrastructure. **Green infrastructure** can be defined as a strategically planned network of natural and semi-natural areas with other environmental features, designed and managed to deliver a wide range of ecosystem services (air, water quality, climate mitigation, green spaces, etc.), while also enhancing biodiversity and provides many community benefits (UNDRR 2017).

However, in India, green infrastructure stands for trees, lawns, hedgerows, parks, fields, and forests and **blue infrastructure** refers to water bodies like rivers, canals, ponds, wetlands, floodplains, and water treatment facilities. This refers to an urban planning context where water bodies and land are considered interdependent and grow with the help of each other while offering environmental and social benefits.

There is agreement among practitioners that **blue-green infrastructure** is an approach to sustainable urban planning and effective use of urban space. It is important to understand that green infrastructure depends on "blue" processes even if it frequently refers to projects that incorporate elements like parks, green roofs, and vertical and horizontal gardens. On the other hand, blue infrastructure refers to elements of urban development that are intended to benefit both the quality and quantity of resilient water service including devices installed and retrofitted within existing water collection systems. Hence, the phrase "blue-green infrastructure" refers to a combination of the two types of infrastructure mentioned above.

Vancouver Board of Parks and Recreation adopted the 'Rain City Strategy' 2019 aimed at protecting urban water bodies and improving urban water quality, increasing urban resilience through sustainable water management, and enhancing livability by improving natural and urban ecosystems. It used features like rain gardens, green roofs, permeable pavements, engineered wetlands, modular systems, and absorbent landscapes for water conservation and management.

SCAN ME Video: Vancouver Rain City Strategy by City of Vancouver **https://www.youtube.com/watch?v=3BqQ_KvMeGM**

Discuss with learners: *Does the city they work in face issues with water management? What are the practices that they undertake to prevent these issues? List some retrofitting suggestions.*

Grey infrastructure involves assets that provide services required by society, such as transportation or wastewater treatment. They are human-engineered assets like pipes, buildings, roads, etc. In order to reduce costs and boost resilience, green, blue, and grey infrastructure can be strategically combined. This will assist in addressing the impending financial and environmental catastrophe that is affecting the world's infrastructure systems. E.g. For coastal flood protection, mangrove forests to decrease wave energy and storm surges can be more cost-efficient than grey components like embankments, and sluice gates, also both features can work together.

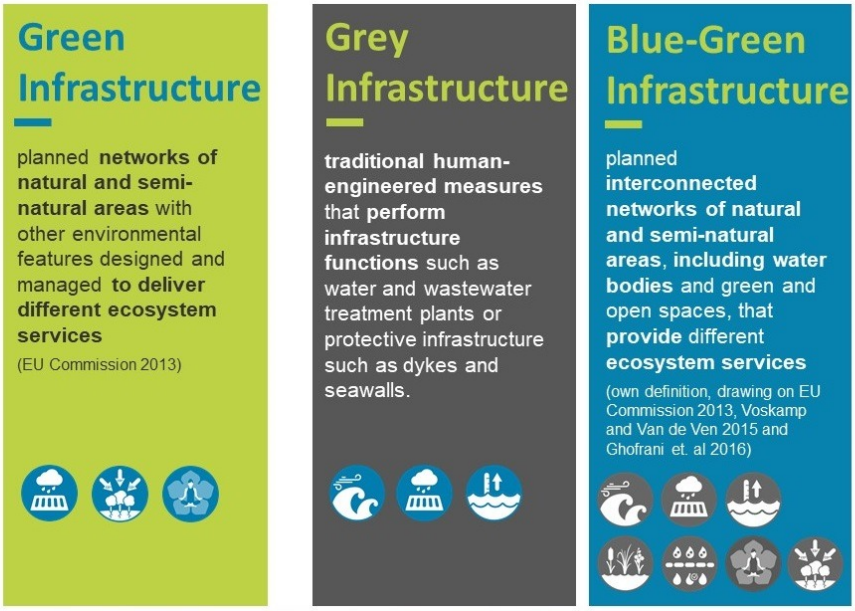

Fig 1. Blue, Green, And Grey Infrastructure (Wetlands International, 2019)

SCAN ME Video: How do we build climate-resilient cities? By WELL Labs **https://www.youtube.com/watch?v=zb96gyJn-LA&t=299s**

Ministry of Environment, Forest, and Climate Change, GoI is the central point for planning, monitoring and implementing policies pertaining to environment and climate, while the Ministry of Water Resources and Ganga Development oversees India's blue infrastructure, the national water resources. Under the **National Action Plan on Climate Change (NAPCC**), the **Smart Cities Mission** and the **Atal Mission for Rejuvenation and Urban Transformation (AMRUT)** focus is on improving urban living and that includes blue, green and grey components as part of the mission intention. Initiatives are undertaken in different cities in a decentralized manner. E.g. Udaipur Smart City programme involves preventing sewage discharge, de-weeding lakes and cleaning up the water and creating more habitable waterfronts and spaces.

SCAN ME Video: Eco India: How the pattern of a beehive inspired the design for an affordable, natural air cooler by Scroll.in **https://www.youtube.com/watch?v=nt2oyaP2m6Q**

The **Delhi Development Authority** was among the first to include a Blue-Green policy for Master Plan 2041 in which it has adopted a pragmatic method by developing a multifaceted plan to guarantee that the policy is incorporated into the masterplan. It is now creating a 60-layer digital map of the city (Roy, 2019) that will show the various organisations responsible for the different bodies of water and land. The large drains (nullahs), which are currently under the control of several agencies, will then be cleaned up; pollutants will be treated, and garbage disposal and untreated outfalls will be halted. The cleaning of sewers will be helpful because Delhi produces over 3,800 million litres of sewage every day, of which half enters water bodies without being treated. It is proposed that buffer zones and green corridors will be created along drains and used as walking and cycling paths.

Discuss with learners: *What steps do they propose to bring on board multiple stakeholders to support grey and blue-green infrastructure, and address underlying concerns? What could be the possible economic benefits on the cities?*

The actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits are called **Nature-based Solutions** (IUCN, 2016). NbS that conserve or restore nature to support built infrastructure systems (grey infrastructure) can reduce disaster risk and produce more resilient and lower-cost services in developing countries. In the disaster risk reduction and climate change fields, NbS can be the green and blue infrastructure strategies that work to support community well-being, generate benefits for the local environment, and make progress on the Sustainable Development Goals (SDGs)

SCAN ME Video: Urban Nature-based Solutions: What are they and why are they so important? By WWF International **https://www.youtube.com/watch?v=SRXx0QyxBFo**

NbS is an umbrella concept covering a range of ecosystem-based approaches for environmental management, restoration and conservation, ecosystem-based DRR, ecosystem-based adaptation etc. **Ecosystem-based DRR** (Eco-DRR) is the sustainable management, conservation and restoration of ecosystems to reduce disaster risk, with the aim to achieve sustainable and resilient development (Estrella and Saalismaa, 2013). E.g. Reforestation and sustainable vetiver cultivation in drought-prone areas, conservation actions such as the cleaning of wetland channels, removal of invasive water hyacinth etc. **Ecosystem-based Adaptation** (EbA) is the use of biodiversity and ecosystem services as an adaptation strategy against the adverse effects of climate change (CBD, 2009) E.g. Plantation of mangroves for preventing cyclone impact on coastal cities, mixed farming techniques to retain soil fertility, regreening of urban infrastructures with more open spaces, green roofs, urban forests etc. The approaches that aim to manage land, water, sea and living resources in a way that promotes conservation and sustainable use of resources in a holistic and equitable way is referred to as ecosystem-based approach.

SCAN ME Video: Urban Nature-based Solutions: Vegetation, agriculture, and forestry by WWF International **https://www.youtube.com/watch?v=PutoHFs1EDs**

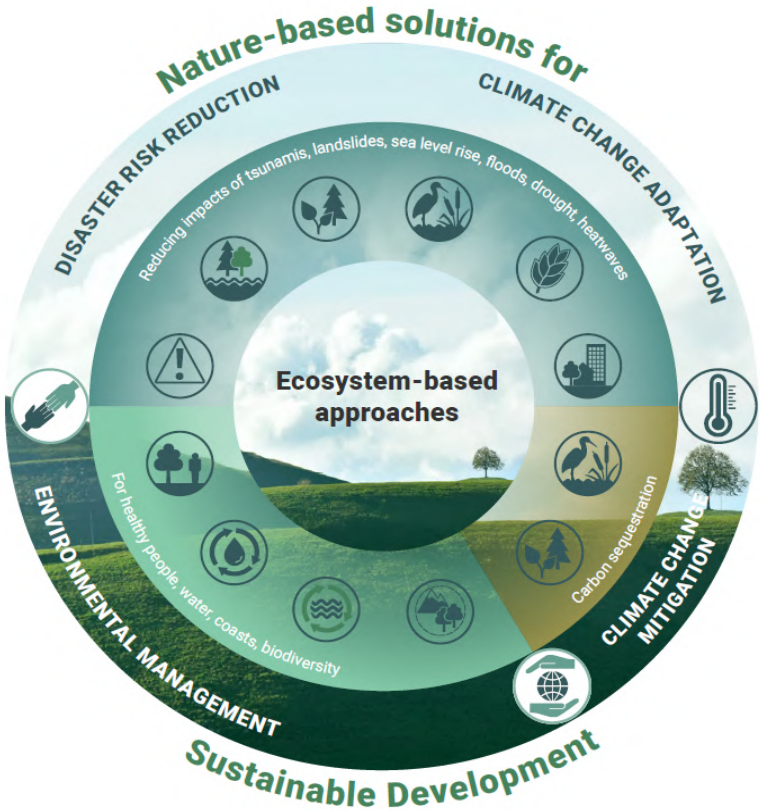

Fig 2. Nature-based Solutions Types (UNDRR, 2021)

Principles of NbS (IUCN, 2016):

- Can embrace nature conservation norms
- Can be implemented alone or integrated with other solutions
- Are site-specific and vary with contexts
- Can produce societal benefits in a fair and equitable way which promotes transparency and broad participation

- Maintain biological and cultural diversity and the ability of ecosystems to evolve over time
- Are applied at a landscape scale
- Can recognise and address the tradeoffs between the present and future benefits
- Are an integral part of the overall design of policies, and measures

The considered **enabling factors** for NbS are relevant policies and regulations, stakeholder consultation and participation, creation of knowledge and evidence base, multi-disciplinary public-private partnerships, inclusion in curricula and training courses and availability of standards for NbS. Some of the internationally implemented NbS solutions are greening interventions like public parks, green corridors, arboretums, green roofs, vertical greening, bioswales, riparian buffers etc.

SCAN ME Video: Roofing solution in Amsterdam by World Economic Forum **https://www.linkedin.com/posts/world-economic-forum_water-watersecurity-innovation-activity-7048247698612772864-_NCs?utm_source=share&utm_medium=member_desktop**

Practitioners like urban planners, architects and engineers should be open to collaborative governance mechanisms when planning and implementing NbS in cities. It should involve ways and processes to include different actors in the design, development and implementation, but also considerations of leveraging new institutions, networks or societies for operationalizing and enabling NbS in the long term. E.g. Asian Cities Climate Change Resilience Network (ACCRN), in Surat, Gujarat, has designed improved management of water bodies and prevented construction on the floodplains within the city. The regular monitoring by climate watch groups helps in engaging the community with the project.

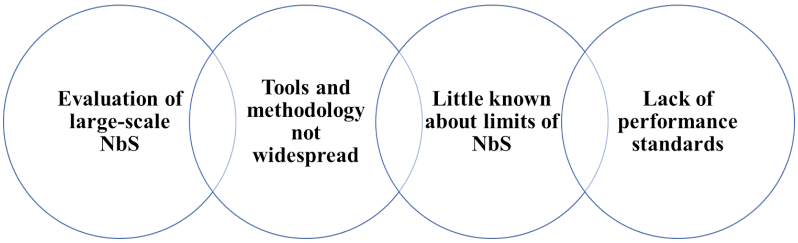

Fig 3. Key challenges in NbS (adapted from UNDRR, 2021)

The scaling up of NbS to large-scale is still largely unfamiliar because small-scale NbS interventions are reviewed more frequently than large-scale NbS interventions. For large-scale NbS, a suitable assessment framework is required. Site- and context-specific tools and procedures are used to plan and implement NbS. Compared to traditional engineering, they are less advanced and common. Research on the limitations of NbS are yet to be explored and practitioners can play an important part in systematic research on various elements of performance criteria and establishing the efficiency of NbS. Awareness of local knowledge and the dominant ecosystem-targeting factors can support NbS.

National Institute of Urban Affairs (NIUA) Climate Centre for Cities (NIUA C-Cube) and World Resources Institute India (WRI India) launched India's first national coalition platform for urban nature-based solutions (NbS) at the 11th World Urban Forum in Poland in 2022. As Nature-Based Solutions are fast emerging as cost-effective and sustainable ways to address climate change induced challenges such as urban flooding, air and water pollution, and heat and storm surges it holds potential in the state of Gujarat. It can be included in Gujarat's resilience and adaptation strategy through initiatives like Cities4Forests.

India's National Disaster Management Plan 2019 has parts that promote Ecosystem-based services for Disaster Risk Reduction. The strategy includes developing research, maps, and assessments that include an ecological component for many of the hazards listed. With a recommendation for creating detailed maps that outline coastal wetlands, mangroves, shelterbelts, and tracts for coastal bio-shields utilising the best techniques, field research, and satellite data.

With regard to cyclones/wind, tsunamis, flooding, and drought, nature-based features, in particular, are promoted in the strategy like encouraging the inclusion of coastal shelterbelts as a required element under national afforestation programmes. It also promotes appropriate green and blue infrastructure. Wetland conservation and restoration, as well as catchment area treatment and afforestation, are encouraged. It also asks to encourage water conservation, harvesting, effective irrigation, and afforestation.

Discuss with learners: *List a few activities that can be considered Nature-based Solutions in a city. Recollect some examples from past training sessions which can be considered as NbS. What can be the benefits of NbS over conventional engineering interventions?*

Identify and discuss some of the enabling policies and government actions and financing options for NbS in Gujarat.

Fig 4. Benefits of NbS (IUCN, 2020)

Among other policies, **National Urban Policy Framework (NUPF), 2020** is a key policy that supports NbS implementation in India. It shares an integrated and unambiguous strategy for India's urban planning in the future. Built on 12 principles that map 10 functional areas of managing urban space, the policy places a strong emphasis on achieving sustainable urbanisation through environmental sustainability. It guides for an "integrated approach across urban sectors to plan

proactive measures to prevent, avoid and minimize adverse impacts on the natural systems upon which our communities, businesses and infrastructure systems depend"

Fig 5. National Urban Policy Framework Principles and Functional Areas (MoHUA 2020)

Session Plan

Content	Trainer's Note	Time
Grey and Blue-Green Infrastructure	Focus on explaining the types, their integration, relevance to SDGs, existing policies, and interventions by urban practitioners through supporting examples.	15 min
Nature-based Solutions	Focus on introduction, principle, key enablers, its benefits, and examples	20 min
Discussion	With case examples lead a brief discussion on how infrastructures catalyze and improve resilience of a city and the ongoing NbS practices in the world and what can be implemented in Gujarat	10 min

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Notes

Learning Unit 4.2: Introduction to SIA and EIA

Brief Description of the Learning Unit

This learning unit explains why Environmental Impact Assessment (EIA) and Social Impact Assessment (SIA) are important for urban development projects and how to conduct them. It elaborates on various laws that are supporting the cities in conducting EIA and SIA. It will allow learners to understand the EIA and SIA from their local context and envision their integration into ongoing projects.

Learning Objectives

- To familiarize with the concept of EIA and SIA
- To enhance knowledge on how to conduct EIA and SIA

Duration: 30 Minutes

Methodology

- Lecture-based learning
- Discussion

Detailed Description

Environmental Impact Assessment is a structured approach for obtaining and evaluating environmental information prior to its use in decision-making in the planning and development process (UNDESA). A project's possible environmental implications are identified and evaluated using this ex-ante analytical process. EIA ideally applies to all projects, especially those that could have major negative environmental effects and informs the procedure for obtaining development consent. It systematically examines both the valuable and adverse consequences of the project and ensures that these are taken into account during project design. EIA comprises an **environmental management plan** (EMP) outlining how such measures should be put into practice and tracked in order to avoid and/or mitigate negative consequences and maximize good ones.

EIA as a mandatory procedure originated in the early 1970s, with the implementation of the National Environment Policy Act (NEPA) 1969 in the US. In India, EIA was first implemented in 1976-77 when the Planning Commission asked the Department of Science and Technology to examine the river-valley projects from an environmental angle. Environment (Protection) Act 1986 made EIA a statutory requirement in India. The other main laws in this regard are the Indian Wildlife (Protection) Act (1972), the Water Act (1974), the Air (Prevention and Control of Pollution) Act (1981), and the Biological Diversity Act (2002). Amendments were made to include mining, thermal power plants, river valley, infrastructure (roads, highways, ports, harbors and airports), and industries including very small electroplating or foundry units to get environment clearance.

Recently, the Supreme Court of India quoted the example of rampant development leading to urban flooding in Bengaluru and highlighted the importance of environmental impact assessment for urban development. It said “make necessary provisions for carrying out Environmental Impact Assessment studies before permitting urban development.” (LiveLaw, 2023)

Discuss with learners: *What are some of the significant environmental impacts caused by urban development in their cities over the past decade? How it has affected the local population? What are the key projects where they have undertaken EIA and how was it beneficial in safeguarding the environment and in the prevention of creation of new risks?*

The EIA process has the following steps:

- **Project identification:** Consideration of alternatives and selection of chosen approach
- **Screening:** It determines whether the proposed project, requires an EIA, if yes, then the level of assessment. Town and Country Planning department is responsible for the screening.
- **Scoping:** This identifies the key issues and impacts that should be assessed and also defines the scope and time limit of the study. It typically involves public engagement.
- **Impact analysis:** This is done after collecting relevant data and it identifies the likely impact on the physical, and social environment of the proposed project
- **Mitigation:** It recommends actions to reduce adverse environmental consequences of development activities
- **Reporting**: In this stage, the EIA report is shared with the decision-making body and other interested parties. EIA report is usually developed by consulting experts.
- **Review of EIA:** It examines the effectiveness of the EIA report and provides the information necessary for decision-making. Conducted by practitioners and government officials after the completion of EIA to check the adequacy and effectiveness of EIA This stage involves inputs from the public, NGOs, etc.
- **Decision-making:** It decides whether the project is approved or needs more changes. Impact Assessment Authority along with the experts consult the project-in-charge for making decisions.
- **Post monitoring:** This stage is relevant only if the project is implemented. It checks to ensure that the impacts of the project follow legal standards and that implementation is done according to the EIA report.

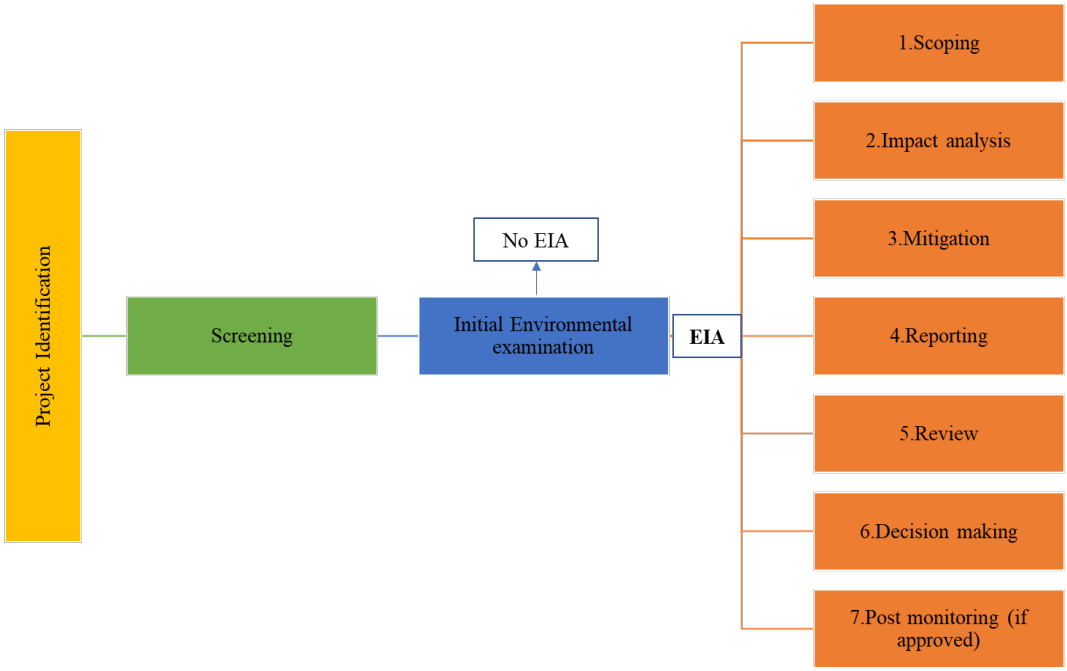

Fig 1. Stages of EIA (ENVIS, 2018)

Strategic Environmental Assessment is the thorough process of assessing the environmental effects of a policy, plan, or programme and its alternatives at the earliest feasible stage. SEAs may only concentrate on a specific policy or programme and are not explicitly required to include the requirement for routine reporting. It is different from EIA with the focus being on issues of sustainable development, considers a broader range of alternatives, pro-active approach to development projects and gets to the root cause of environmental degradation instead of symptoms of degradation.

Social Impact Assessment is a process of research, planning and the management of social change or consequences (positive and negative, intended and unintended) arising from policies, plans, developments and projects (UNEP, 2007). It provides a framework for gathering, analyzing, prioritizing, and incorporating social information and participation into the design and delivery of developmental interventions. SIA are usually conducted by governments before any development project that requires acquiring land. E.g., the construction of a factory will have both environmental impacts depending on the site selection and social and economic impacts through the creation of jobs or the displacement of traditional commerce. SIA usually includes the analysis of impacts on livelihoods, culture, lifestyle, human health, etc. The key stages of SIA are:

i. Identify stakeholders' groups and communities and areas of influence
ii. Describe the baseline conditions with an overview of legislation related to land use, human rights etc.
iii. Develop an effective public plan to involve all potentially affected members of the public
iv. Describe the proposed action or policy change and reasonable alternatives
v. Scoping to identify the full range of probable social impacts
vi. Screening to determine the prospects and limitations of the SIA
vii. Predicting responses to impacts
viii. Develop a monitoring plan & mitigation measure

The SIA is not devoid of environmental considerations. E.g., if the planned housing complex project impacts the availability of land for local food production it will lead to impacts such as less yield and increases in food prices.

The National Resettlement & Rehabilitation Policy 2007 covers components related to the rehabilitation and resettlement of people impacted by the purchase of land for public projects or involuntary displacement for any other reason. It also acknowledges the hardship of individuals who do not have legitimate or acknowledged claims to the land upon which their survival depends so heavily. A participatory and open assessment of the negative effects on the affected families' economic, environmental, social, and cultural well-being is required. Section 4 of The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 mandates the conduct of Social Impact Assessment (SIA), as a precursor to land acquisition.

Discuss with learners: *Consider a slum in your city that has to be rehabilitated to a different site due to an upcoming highway development project. What will be the broad social impacts? Discuss the steps for SIA and some mitigation measures for mitigating the identified impacts*

Environmental and Social Impact Assessment (ESIA) identifies and assesses the potential social and environmental impacts of a proposed project in its area of influence, evaluates alternatives, and designs appropriate mitigation, management, and monitoring measures. Generally, an ESIA is required for Substantial Risk and High-Risk projects with a physical footprint (UNDP, 2020). It follows stages similar to the EIA and SIA with conducting Social and Environmental Screening to identify potential risks and their significance, issues to be addressed, spatial and temporal focus and consultations with stakeholders, partners, and project-affected communities on the scope of assessment. This is followed by baseline environmental and social information, legal frameworks, examination of project alternatives and analysis of impact. Mitigation measures are identified and incorporated in the environmental and social management plan and capacities are built to implement same. It engages with

stakeholders at the appraisal stage and for communicating mitigation measures. This is helpful for an accurate and complete evaluation from the social and environmental lenses.

The EIA and SIA can be performed by many methods out of which a few popular ones are cost-benefit analysis, checklist, matrix, network etc. We will briefly discuss the cost-benefit analysis method. **Cost-benefit analysis** can be explained as an attempt to calculate the societal benefits and drawbacks of various action plans in terms of a single unit of money. There should also be a description of the intangible, frequently unquantifiable effects. E.g., People might not pay the full cost of the water they use, for instance, increasing the necessity for a water supply project. Installing metres and charging the actual cost, or just requesting that people conserve water, would be an alternate idea. The decision-maker alone can determine if an option is politically viable, but it may have economic decisions influenced by the alternatives' relative costs. It is important to study when a project is benefiting some people and harming others. Steps of a cost-benefit analysis:

- Identification of alternative techniques to achieve the goals and alternative projects that can be undertaken. E.g., For water conservation projects, the installation of water meters can be an alternative option, in-situ redevelopment instead of resettlement of slums depending on the condition.
- Establishing a framework for the analysis of the project
- Identification of costs (direct costs, indirect, intangible costs) and benefits of the proposed project (Direct like revenue, indirect like increased customer interest due to proper clearances etc.). These should be guided by the understanding of exactly how the project affects different people as gains and losses may vary for stakeholders, where to limit the assessment (national, sub-national etc.)
- Assigning amount or value to each cost and benefit, which includes quantification of the costs and benefits. E.g., For the redevelopment of a historical building compensation considerations, market price and shadow prices etc. have to be considered. Tallying the total value of benefits and costs and comparison will lead to the decision of viability

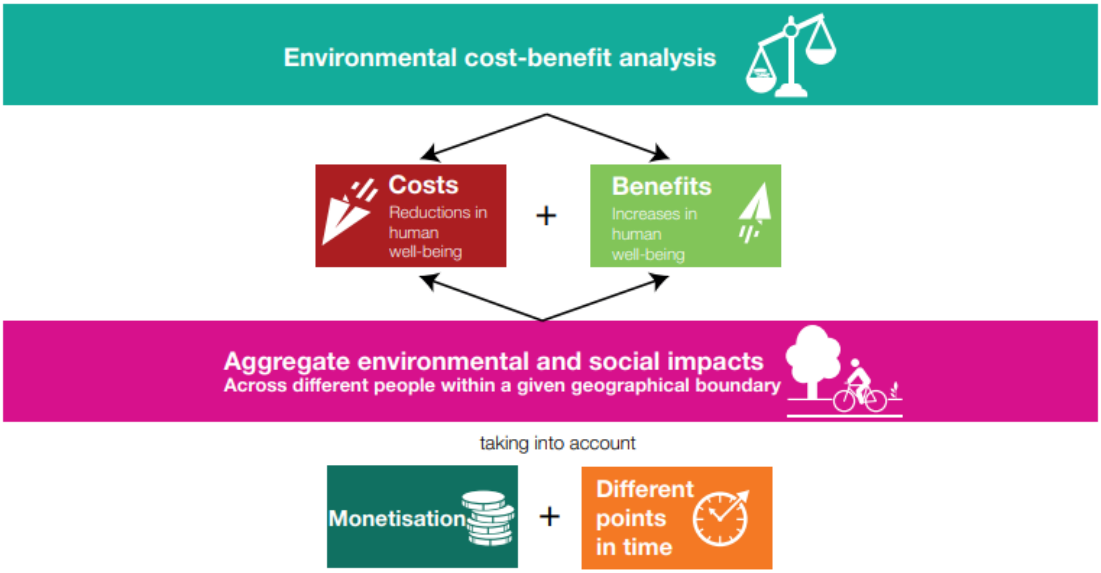

Fig 2. Cost-benefit Analysis (OECD, 2018)

Maintaining the overall quality of life, ensuring continued access to natural resources, and preventing long-term environmental and social damage is some of sustainable development's defining traits. Hence, institutional and stakeholder responses to sustainable development is needed at several levels, which EIA and SIA may help with.

Session Plan

Content	Trainer's Note	Time
EIA	Focus on the concept, stages and history of EIA	10 min
SIA & ESIA	A brief on the SIA and ESIA, the stages and CBA as one of the methods of analysis.	10 min
Discussion	Engage with learners to elaborate on how EIA, SIA can be useful in cities	10 min

References

- LiveLaw (2023). Make Environmental Impact Assessment Mandatory For Urban Development, Recommends Supreme Court; Cites Condition Of Bengaluru As Warning https://www.livelaw.in/top-stories/make-environmental-impact-assessment-mandatory-for-urban-development-recommends-supreme-court-cites-condition-of-bengaluru-as-warning-218641
- ENVIS (2018). http://spaenvis.nic.in/index1.aspx?lid=2887&mid=1&langid=1&linkid=577
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- Ministry of Finance. PPP TOOLKIT for Improving PPP Decision-Making Processes https://www.pppinindia.gov.in/toolkit/ports/module2-fgost-oosiaassr.php?links=fgost4
- UNDP (2020). Guidance Note UNDP Social and Environmental Standards Social and Environmental Assessment and Management https://info.undp.org/sites/bpps/SES_Toolkit/SES%20Document%20Library/Uploaded%20October%202016/UNDP%20SES%20Assessment%20and%20Management%20GN%20-%20FInal%20Nov2020.pdf

Additional Reading Material

- Chris Joseph, Thomas Gunton, Duncan Knowler & Sean Broadbent (2020) The Role of Cost-benefit Analysis and Economic Impact Analysis in Environmental Assessment: The Case for Reform, Impact Assessment and Project Appraisal, 38:6, 491-501, DOI: 10.1080/14615517.2020.1767954
- WHO. Environmental Impact Assessment: Operational Cost Benefit Analysis https://wedocs.unep.org/bitstream/handle/20.500.11822/28857/EIA_Operational_CBA.pdf?sequence=1&isAllowed=y

Notes

Learning Unit 4.3: Case Studies

Brief Description of the Learning Unit

Having understood the grey-blue-green infrastructures and nature-based solutions the aim of the learning unit is to map the importance of interventions that use resilience-building measures in varied urban systems with the help of case studies from another Indian city.

Learning Objectives

- To encourage learners to think critically about the existing initiatives of nature-based solutions for urban resilience
- To enable the learners to map the importance of grey-blue-green infrastructure for urban resilience

Duration: 30 minutes

Methodology

- Reading
- Discussion

Detailed Description

The case studies aim to promote an understanding of the opportunities for improved urban resilience opened through practices that promote nature-based solutions and adaptations.

Case Studies

1. Blue Green Action Plan- Madurai

Due to the extreme water stress circumstances that the city and the larger Vaigai Basin were experiencing, the Madurai Municipal Corporation teamed up with an international academic institution, a local NGO, and citizen groups in December 2014 to develop a blue-green action plan. By bottom-up stakeholder involvement, this plan was created with actions like "water walks" which were held close to water sources, bringing together people of the local community and officials from local government and organisations. They talked about the deteriorated river corridor and associated issues. Through such conversations, the top priorities for the blue-green plan were identified, which gave rise to the projects like managing the drainage and sewerage network, cleaning up the lakes, and developing green space that was part of the blue-green plan. The blue-green plan has been merged with ongoing work under the Smart Cities Mission to enhance economic growth via climate compatible development projects as funded by the Smart Cities Mission.

Project document: Future-proofing of an Indian city: Lessons from Madurai (2014) **https://cdkn.org/sites/default/files/files/FPIC_Madurai-Action-Plan_12141.pdf**

2. Wetland Conservation to Enhance Urban Flood Control Systems in Colombo, Sri Lanka

Colombo Metropolitan Region the urban belt that encircles Colombo, is rapidly growing and accounts for almost half of the national GDP. Rapid urbanisation in the region has resulted in decades-long degradation and modification of the area's wetlands which are crucial for storing water during torrential downpours. As a result, the water-holding capacity of the local wetlands has dropped by around 40%, directly aggravating the risk of flooding. The repercussions of the area's flooding vulnerability are also being exacerbated by climate change and sea-level rise. The city's traditional stormwater management solutions have been engineering-based, ignoring the significant flood-mitigation advantages provided by wetlands.

Metro Colombo Urban Development Project was approved by the World Bank in 2012. Wetlands are used as green infrastructure as part of the Metro Colombo Urban Development Project, which also includes investments in grey infrastructure. In order to accomplish the targeted results, the project makes use of infrastructure restoration, flood and drainage management, and implementation assistance. Grey infrastructure initiatives address the ability of canals, lakes, and the Colombo Municipal Council's numerous micro-drainage improvements to drain water. These parts are intended to increase the systems' limited outflow capacity, which has been further restricted by solid waste, floating debris, and a lack of routine maintenance. The project established Colombo's first urban wetland park in Beddegana. It is predicted that the flood control and drainage management programme, including the project's green infrastructure components, will directly or indirectly benefit around 2.5 million people.

The green and grey components for flood and drainage management were selected on basis of technical grounds for short- and long-term flood-risk mitigation abilities, including diverting water in the upper catchment area, creating additional retention reservoirs in the project area; removing bottlenecks to maximize conveyance capacity; improving capacity of system outflows; improving overall water quality to reduce health hazards, etc. The lakes often provide the same flood protection as the wetland region, but the majority of the services that wetlands provided, such as biodiversity, wastewater treatment, and carbon sequestration, are not there. Although it is obvious that these co-benefits are economically valuable, the measurement may be hampered by ambiguity surrounding climate change variables, co-benefit values in the present, and development trends. Notwithstanding these uncertainties, a World Bank study used cutting-edge Decision-Making under Uncertainty technique with participative and quantitative approaches to evaluate the economic desirability of wetland conservation. While weighing the pros and cons of scenarios including urban expansion and wetland protection, it was discovered that wetland conservation is the most desired option from a welfare economic standpoint.

3. 

Video: Urban Nature-based Solutions: Living Rivers by WWF International **https://www.youtube.com/watch?v=K62GkMxPuWA&t=58s**

4. 

Video: Aravalli Biodiversity Park: How a sand mine was restored to a 350-acre forest by DownTo Earth **https://www.youtube.com/watch?v=3MNWGbxbZTM**

5. 

Video: Eco India Shorts: Gujarat's green schools is helping its students understand the environment better by Scroll.in **https://www.youtube.com/watch?v=3jMBQM-r-Yw**

Discuss with learners:

- *Which are the key components for successful blue-green interventions?*
- *From the case study, who form the key stakeholders in interventions?*
- *If you were to develop a similar project in your city, how would you ensure it is sustainable?*
- *Divide the learners into 4-5 groups, namely: Housing, water supply, environment, infrastructure, and transportation. Based on their experience from their cities discuss which NbS, and BGI alternatives can support their cities.*

Session Plan

Content	Trainer's Note	Time
Case Study	Focus on understanding the features of the various projects in India and globally	20 min
Discussion	Promote a discussion asking learners to elaborate on the understanding of Grey-blue-green infrastructure and their relevance to the local context	10 min

References

- World Bank and WRI (2019). Integrating green and gray: Creating Next Generation Infrastructure. https://openknowledge.worldbank.org/entities/publication/ddda3ed0-096e-59dd-a25d-3de884254eba
- ICLEI (2022). Nature-based Solutions for urban climate resilience in South Asia: Cases from Bangladesh, India and Nepal https://cdkn.org/sites/default/files/2022-11/NbS%20Compendium_Nov%202022_final_web.pdf

Learning Unit 4.4: Discussion

Brief Description of the Learning Unit

Having understood the importance of grey and blue-green infrastructure to build resilience and impact assessments the learners should engage in a discussion to mutually learn about the present scenario and how to improve the use of NbS and grey and blue-green infrastructure.

Learning Objectives

- To recapitulate the knowledge gathered during the previous sessions
- To encourage learners to share perspectives on grey and blue-green infrastructure for resilience

Duration: 15 minutes

Methodology

- Discussion

Guiding Questions

- How can blue-green infrastructure help cities adapt to the impacts of climate change, such as increased flooding, heat waves, and droughts?
- How can nature-based solutions, and blue-green infrastructure be used to promote economic development and create new opportunities for livelihoods in urban areas?
- What are some of the potential conflicts that can arise between environmental and social concerns in cities, and how can these conflicts be resolved?
- How can EIA and SIA be used to ensure that development projects?
- What is the role of technology in the EIA and SIA processes, and how can it be used to improve the accuracy and effectiveness of these assessments?

Notes

Summary

The Technical Session 4 guides the learners on:

- The grey and blue-green infrastructure and its contribution to building resilient cities.
- Nature-based Solutions, principles, ecosystem-based disaster risk reduction and ecosystem-based adaptation for changing climatic conditions.
- Commonly used nature-based practices and the prevalent knowledge gaps in scaling these
- Existing EIA and SIA practices in India, steps and laws involved, regulations, and tools
- Existing cases on NbS and grey and blue-green infrastructure from India and globally that have improved resilience

Technical Session 5: Technologies for Urban Resilience

Introduction, Overview & Perspectives

The fifth technical session will look at key geospatial technologies and tools of urban planning and successful examples from various towns and cities. It will delve into the use of technology for urban resilience using open-source data. Briefly, it will let learners know about upcoming technologies, relevant policies and regulations. The session is intended to provide learners with practical tools and strategies for improving their own cities' resilience.

- Learning Unit 5.1: Technologies and Application in Urban Planning
- Learning Unit 5.2: Open Data for Urban Resilience

The primary objectives of the session are:

- To understand the key spatial technologies and emerging tools in urban planning
- To explore various datasets and their use in urban resilience projects

Duration: 90 minutes

Methodology

- Lecture-based learning
- Discussion

Trainer's Note

The trainer for the session should aim to provide learners with an overview of spatial technologies and tools for urban planning that can support data analysis for improving their own cities' resilience and safety. Showcasing successful studies and good practices would be useful. During the session, the trainer should encourage experience sharing among the learners, allowing them to gain insights from development projects in their respective cities or towns. Overall, the trainer should create an engaging and interactive learning environment that encourages active participation and knowledge sharing among the learners.

Learning Unit 5.1: Technologies and Application in Urban Planning

Brief Description of the Learning Unit

The goal of the learning unit is to inform learners about technologies for geographic mapping and analysis of the land and services for urban planning. It discusses the emerging tools and techniques, data, and software that can be used by practitioners for better decision-making.

Learning Objectives

- To understand the common technologies and tools used in urban planning
- To familiarize with how to use these tools and technologies

Duration: 60 minutes

Methodology

- Lecture-based learning
- Discussion

Detailed Description

Geospatial technology refers to the variety of contemporary tools that help map and analyse the Earth's geography and human settlements. The earliest maps were created in the prehistoric era and these technologies have been developing ever since. With the least amount of error imaginable, precise measurements at extremely small scales are now achievable thanks to geospatial technology. For the benefit of humanity and to effectively address current and future challenges, geospatial technology and its numerous applications generate a vast amount of data and information that must be handled and used. Planning at the local level can now incorporate geospatial technologies as the 73rd Constitutional Amendment allows for decentralized local-level decisions. The **National Geospatial Policy 2021**, and the Draft Space Bill are leveraging use of the technology for growth across various sectors of the economy.

The technology uses **geospatial data** which is information that describes objects, events or other features with a location on the earth. E.g., the location of a piece of land, an earthquake event, a squatter settlement in a city etc. Data visualizations are created using geospatial analytics, which also add timing and location to conventional sorts of data. Maps, graphs, statistics, and cartograms that depict recent and historical developments can be included in these visualizations. This added background enables a fuller understanding of the locations or events. Easy-to-identify visual patterns and graphics are used to convey insights that might be missed in a large spreadsheet. This could lead to quicker, simpler, and more accurate forecasts. E.g., change in land use patterns, reducing green spaces over years etc. Some of the geospatial technologies used in urban planning include:

1. **Remote sensing** utilizes data and photos from airborne or space-based camera and sensor systems and geospatial technology is used to examine distant objects or surfaces. It is the process of detecting and monitoring the physical characteristics of an area by measuring its reflected and emitted radiation at a distance (using satellites, airplanes, UAVs). By measuring and examining the information gathered by the sensor platforms, experts may evaluate the target's characteristics and draw the necessary conclusions. Satellites orbiting our planet have been used to create photographs using a variety of source options and geospatial technology techniques. E.g., satellites like LANDSAT Sentinnel, drones, camera traps etc.

Satellite datasets can be found at Bhuvan (https://bhuvan.nrsc.gov.in/), Bhoonidhi (https://bhoonidhi.nrsc.gov.in/), USGS etc.

Fig 1. Satellite vs Drone data (Matrix-geo)

The Town and Country Planning Organization of India has developed the standards for the application of drone/ UAV technology for the mapping of towns in India. The document called Formulation of GIS-based Master Plans for Small and Medium Towns is accessible at http://tcpo.gov.in/sites/default/files/newfile/dron-min.pdf

Bhuvan is a web-based portal that allows viewing the surface of the Earth in 2D/3D representation along with thematic information that can be downloaded for use by practitioners. This versatile visualization system helps users with navigation, satellite imagery with overlays of information like land use, natural resources, roads, and location specific features. It is richly populated with datasets on disasters (cyclones, droughts, earthquakes, floods, forest fire, landslides etc.).

The instructor can navigate through the Bhuvan portal to show various aspects of the portal.

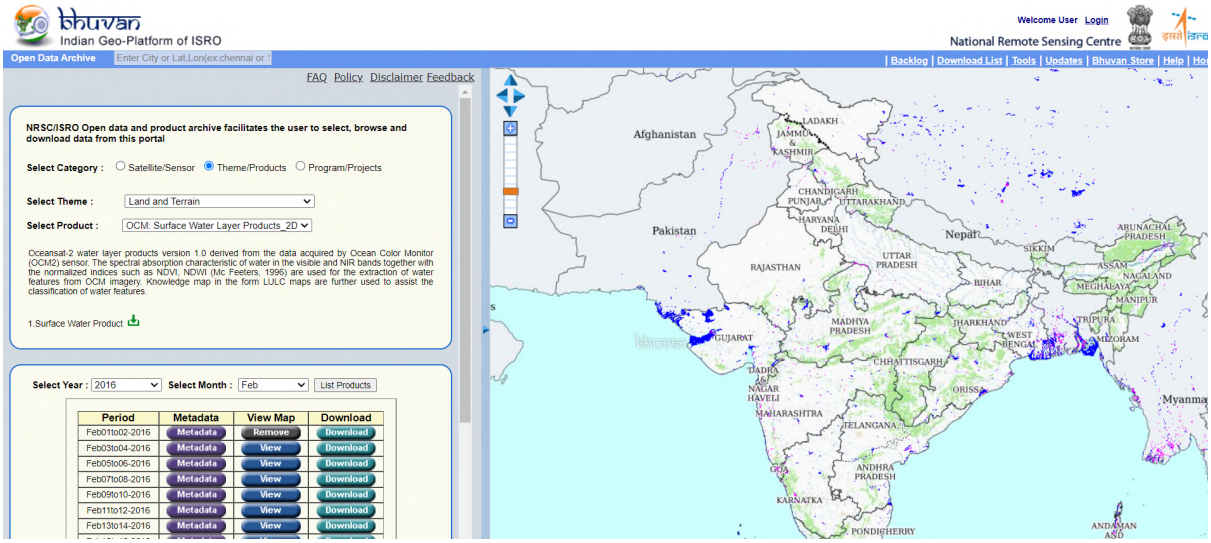


Fig 2. Bhuvan Portal Data View

2. **Geographical Positioning System (GPS)** is a navigation system that synchronizes location, velocity, and time data for travel by air, sea, and land using satellites, a receiver, and algorithms. Trilateration is a mathematical method that underlies how GPS operates. According to the method, GPS units need three satellites to calculate a position accurately. Here, information from a single satellite gives an approximate location of a point on the surface of the Earth within a sizable circular

area. The GPS can pinpoint the precise location of that point with the help of an additional satellite. Additionally, the precise location of that location on the surface of the Earth is provided by a third satellite. Three segments in a GPS are the satellite, ground control point, and user device. E.g., Pollution monitoring devices have inbuilt GPS, waste collection GPS trackers etc.

SCAN ME Video: GPS Based Monitoring of Solid Waste Management - Case of East Delhi Municipal Corporation by Urban Management Centre **https://www.youtube.com/watch?v=leN45d4LS4k**

3. **Geospatial information systems (GIS)** relate to the physical mapping of data by creating geographical analyses, derived maps, and three-dimensional scenarios using layers of geographic data. GIS makes more informed judgements possible for users by providing deeper insights into data, such as patterns, relationships, and situations. E.g., Map of flood prone areas overlaid on map of critical infrastructure shows information of exposed infrastructure, planning bicycle parking zones using green corridor and theft data, service area analysis, etc.

Key Platforms for GIS Service Delivery

Visualization services are available for Government as well as citizens of all states:

- Bharat Maps: https://bharatmaps.gov.in/
- State portal: https://stategisportal.nic.in/stategisportal/Home/Map/24

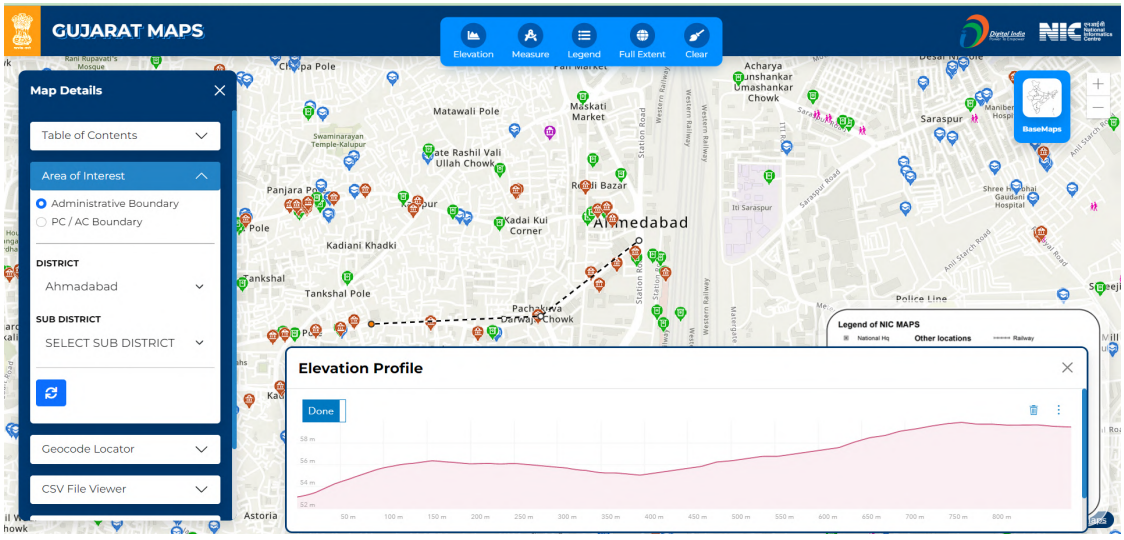


Fig 3. Gujarat Maps Portal View

Map services: https://mapservice.gov.in/

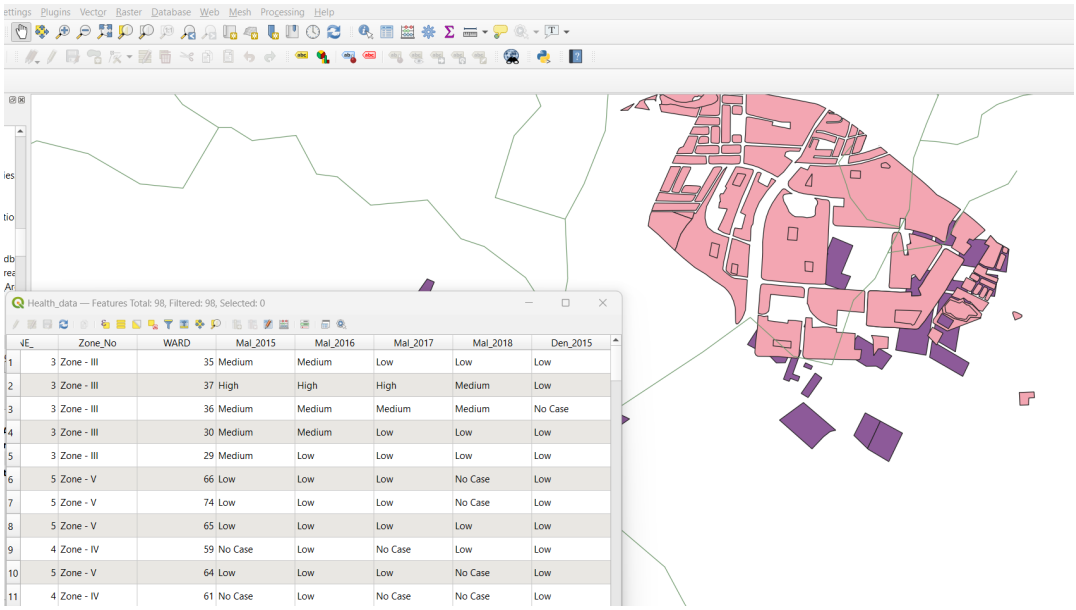
NIC has developed an automated map service dissemination application that allows the officers of the Ministry of Urban Development and local bodies to integrate in their e-governance portals. It consists of about 32 layers.

Software like ArcGIS, and QGIS support practitioners in using spatial technology for decision-making.

The trainer can guide learners to download QGIS 3.30 or QGIS 3.28 for Windows, MacOS, Linux, or Android and walk through the QGIS platform. If possible, perform a few exercises for a better understanding of the software.
Show the following to the learners:

- Opening a new project
- Toolbars, table of contents, display windows
- Open a vector layer and familiarize learners with various point, polygon, and line features
- Show the attribute tables and the type of information in these tables
- Display how to add a feature to the existing layer

Exercises can be shared from: Basic GIS Training https://www.preventionweb.net/files/13932_ACF2.pdf



	id_	Zone_No	WARD	Mal_2015	Mal_2016	Mal_2017	Mal_2018	Den_2015
1	3	Zone - III	35	Medium	Medium	Low	Low	Low
2	3	Zone - III	37	High	High	High	Medium	Low
3	3	Zone - III	36	Medium	Medium	Medium	Medium	No Case
4	3	Zone - III	30	Medium	Medium	Low	Low	Low
5	3	Zone - III	29	Medium	Low	Low	Low	Low
6	5	Zone - V	66	Low	Low	Low	No Case	Low
7	5	Zone - V	74	Low	Low	Low	No Case	Low
8	5	Zone - V	65	Low	Low	Low	Low	Low
9	4	Zone - IV	59	No Case	Low	No Case	Low	Low
10	5	Zone - V	64	Low	Low	Low	No Case	Low
11	4	Zone - IV	61	No Case	Low	No Case	No Case	Low

Fig 4. Sample GIS Project on QGIS platform

Nothing could be more challenging in terms of city planning for the future than moving the capital. This is what Indonesia plans to "future proof" its capital. In order to prevent a recurrence of Jakarta's existing issues, the location of the new capital has been chosen based on soil suitability and coastal modification. The government utilises GIS technologies to not only build a blueprint for their new city to make sure it includes the required 70% green space as claimed, but also to analyse the suitability of land depending on their criteria.

SCAN ME Story maps Lessons Learned from Jakarta, for the Better Capital **https://storymaps.arcgis.com/stories/91dc4418335b4a3caf3a369e6710374b**

Discuss with learners: *What are the geospatial technologies used by them in urban planning projects? How has these technologies strengthened analysis and decision-making?*

4. **Internet mapping technologies** are transforming how geospatial data is seen and shared. Programs like Google Earth and web features like Microsoft Virtual Earth are just two examples. A wider audience can now access these technologies thanks to improvements in user interface, whereas traditional GIS was previously only available to specialists and those who had the time to devote to mastering difficult software.

SCAN ME Video: ArcGIS Urban - Transforming Urban Planning and Design **https://www.youtube.com/watch?v=ScuSibogDpA**

Other Emerging Technologies

1. The robotic device **Bandicoot** was designed to clean any kind of sewer manhole. It was developed to provide a safe and efficient alternative to manual scavenging. The device was piloted in urban local bodies of Kerala. Currently, Bandicoot Robots are being used in 16 states by smart cities, Urban Local Bodies (ULBs), refineries, multinational corporations, townships, and housing complexes. The stand unit and the robotic drone unit are the two main components of the robot. The drone unit is the one that descends into manholes to do cleaning or unclogging tasks.

Fig 5. Bandicoot Robotic Device (Source: Google Images)

SCAN ME Video: Meet Bandicoot India's new robot that can end manual scavenging by Down To Earth **https://www.youtube.com/watch?v=VChT60sTZSU**

2. **Realtime Landslide Monitoring** and early warning system can emulate biological systems, where the proximity of inexpensive sensors allows for optimal interaction, resulting in excellent accuracy and dependability across the board for the entire sensor network. In the event of any nodal failure, the sensor network can dynamically reconfigure itself, creating a self-healing and self-organizing network. Third, the signals from the landslip detection system are accessible online, allowing researchers to examine the signal changes and patterns in real time. Fourth, the system can make globally optimal judgements without having to transfer all of the data it has gathered to a fusion centre. It has been installed in the Munnar in Kerala

SCAN ME Video: Realtime Landslide Monitoring And Early Warning System by India Science **https://www.youtube.com/watch?v=exGlU1ubMMk**

3. **Wind Solar Hybrid System (WISH)** offers greater advantages as compared to single-powered systems, such as wind and solar lighting. Hybrid systems are often referred to as solar wind hybrid systems. They use a method where renewable electricity is created by combining solar and wind energy. To produce electricity in the summer and winter, solar-wind hybrid systems are useful. The operation of hybrid solar wind systems remains unaffected by seasonal variations with changes in sunshine intensity and wind speed. It can generate power at any time of the year.

SCAN ME Video: Wind Solar Hybrid System (WISH) by CSIR INDIA **https://www.youtube.com/watch?v=l52XtsY4Igw**

4. **Digital Twin Cities** is an upcoming concept that gives a paradigm of urban planning and construction for long-term sustainable development. It successfully integrates digital technology advancements with urban operational systems and offers a workable strategy for urban renewal. It encourages safer, more efficient urban activities, more convenient and inclusive daily services, and more low-carbon, sustainable environments through precise mapping, virtual-real integration, and intelligent feedback of physical and digital cities.

   The technology has already been put to the test in creating a virtual Singapore. The island nation's model includes more than 3 million street-level images, 160,000 aerial photos, billions of data points plotted in 3-D, and more than 100 terabytes of raw data. Together, these images and the other components total more than 100 terabytes (Bloomberg, 2022). The model is to be built upon 14 basic datasets that span a range of topics, including land use, tree cover, and subterranean utilities.

   SCAN ME Video: Special Report: Digital Twin Cities by Mechanical Engineering Magazine **https://www.youtube.com/watch?v=HftDI09LVI0**

5. **COB: building with clay, sand and straw** the mixture's ability to absorb both high and low temperatures helps in controlling the internal temperature. As the walls are comparitively thicker, interior room temperatures are extremely constant, lacking the significant variations found in typical buildings. Some cob dwellings that were constructed hundreds of years ago still exist today. Many of them are protected from the elements by straw bales buried up to half a metre deep, which helps. Lime plaster is used to coat the exterior and add an additional protective layer in order to prevent long-term humidity.

Fig 6. COB Building (Tomorrow City)

SCAN ME Video: Building with Cob - A Natural & Affordable Way to Build a House by Exploring Alternatives **https://www.youtube.com/watch?v=CWuHQOvNRDw&t=18s**

6. Use of **Big Data** for mobility insights support to urban planning in Colombo, Sri Lanka
   In order to pseudonymize call detail records (calls, SMS, internet access), airtime recharge records, and visitor location records (VLR), LIRNE Asia worked with Sri Lankan mobile network operators. In a typical 24-hour period, including weekdays and weekends, the investigation revealed distinct mobility patterns and hotspots. This gave the city authorities many recommendations, including changing administrative boundaries and addressing transport demand. Additionally, the analysis discovered various mobility patterns near and during the Avarudu festival, offering information on how people move throughout the entire nation. Principal component analysis (PCA), a machine learning approach, was used to supplement census data and provide insight into Colombo's population size and distribution.

7. 

Video: The Trio - Underground Stormwater Storage Scheme by Institution of Civil Engineers **https://www.youtube.com/watch?v=GsBDpp08kwE**

Session Plan

Content	Trainer's Note	Time
Geospatial technologies	Focus on giving a brief on the types of technologies and tools. Through examples make the learners understand their relevance to urban planning	20 min
Other emerging technologies	Focus on giving a brief on the emerging technologies that can help in building resilience	10 min
Discussion and walkthrough	Focus on showing the learners how to use some web services and software relevant to urban planning	30 min

References

- Tomorrow city website https://tomorrow.city/welcome
- Genrobotics https://www.genrobotics.org/bandicoot2
- Abesinghe S, Kankanamge N, Yigitcanlar T, Pancholi S. (2023) Image of a City through Big Data Analytics: Colombo from the Lens of Geo-Coded Social Media Data. *Future Internet*.; 15(1):32. https://doi.org/10.3390/fi15010032
- Hong Kong Underground Stormwater Storage Scheme https://infrastructuredelivery models.gihub.org/case-studies/hong-kong-underground-stormwater-storage-scheme/

Additional Reading Material

- Scholarary Community Encyclopedia (2021) https://encyclopedia.pub/entry/16672#:~:text=Urban%20big%20data%2C%20also%20called,policies%2C%20plans%2C%20and%20projects.
- WEF (2023) Top 10 Emerging Technologies of 2023 https://www.weforum.org/reports/top-10-emerging-technologies-of-2023?gclid=Cj0KCQjwkqSlBhDaARIsAFJANkjpKB1GPK7cPh3Cy_3f-KEcmldDjf0m644108JMUcEb544xcRSoNAMaAiMlEALw_wcB

Notes

Learning Unit 5.2: Open Data for Urban Resilience

Brief Description of the Learning Unit

The learning unit "Open Data for Urban Resilience" focuses on exploring various datasets available for use in order to enhance urban resilience. The unit includes ways and resources for relevant data collection and analysis. These data could be used to address issues related to changing land use, disaster management etc. Through examples, learners will gain insights into how to utilize reliable open data.

Learning Objectives

- To know about the recent progress in use of open data with examples
- To analyze the varied benefits and challenges of open data

Duration: 30 minutes

Methodology

- Lecture-based learning
- Discussion

Detailed Description

When anyone can freely access, reuse, and redistribute data for any purpose without limitations, it is said to be **open data**. Even though there is a lot of information published on government websites, most of it is only meant to be viewed as standalone papers and not used for other reasons. The data must be re-usable, which means that users have the legal right to re-use it and it can be downloaded in **open formats** and can be read by software, in order to be deemed "open." The **Open Data for Resilience Initiative (OpenDRI)** aims to reduce the impact of disasters by empowering decision-makers with quality information and tools to support their responsibilities. Indian government has directories of open data that can be used by academia, professionals, and civil society in research and development fields at https://data.gov.in/

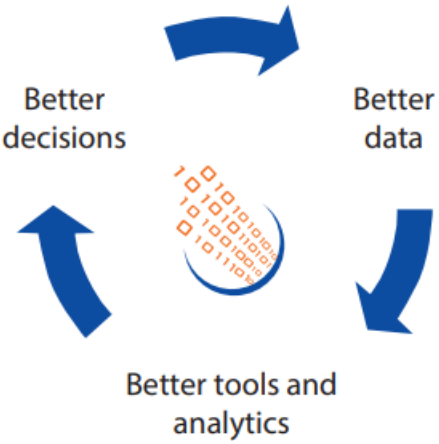


Fig 1. Open Data For Resilience Cycle (World Bank 2013)

Collecting data that is pertinent to urban planning and management like producing reliable data on hazard risk and making it widely accessible to all stakeholders—is a key responsibility of the urban public sector. Although complete openness of data has many advantages, it should be seen as an ongoing process that develops through dialogue between government stakeholders and their constituents. More stakeholders, academic institutions, ordinary citizens, and the private sector can incorporate risk reduction strategies into their decision-making thanks to the opening of information. This boosts community resilience and helps local government agencies produce and then spread risk information.

SCAN ME Video: mWater Introduction **https://www.youtube.com/watch?v=_3IjjlbAYNo**

OpenEEW is an initiative by Grillo to enable Earthquake Early Warning (EEW) systems for millions of people who live in areas with earthquake risks. It is a low-cost EEW system using sensors and cloud computing. This system uses off-the-shelf sensors that are placed in buildings near seismically active zones. This includes features like the sensor hardware schematics, firmware, dashboard, and other elements of the system as open source, with a permissive license for anyone to use freely.

In India, the **DRR Track of the G20** India Presidency will conduct discussions on the identified five priorities:

- Global Coverage of Early Warning Systems
- Increased commitment towards making infrastructure systems – disaster resilient
- Stronger national financial frameworks for DRR
- Strengthened national and global disaster response system
- Increased application of ecosystems-based approaches to DRR

SACHET app has been developed in India, based on the first priority, to publish official warnings for all disasters from authorized sources. It is implemented by NDMA (National Disaster Management Authority), and is part of CAP (Common Alerting Protocol) project implemented in India. The application acts as alert dissemination media for the common people before, during & after any disaster. It disseminates area-specific alerts to Indian Citizens from various Alert generating agencies and all 36 states/UTs Disaster Management Authorities.

Discuss with learners: *Let learners navigate the SACHET platform (https://sachet.ndma.gov.in) and answer what can be the benefits of using open data during different phases of disaster.*

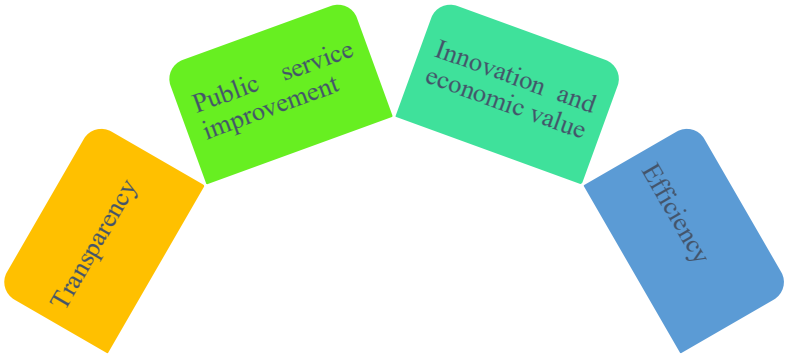


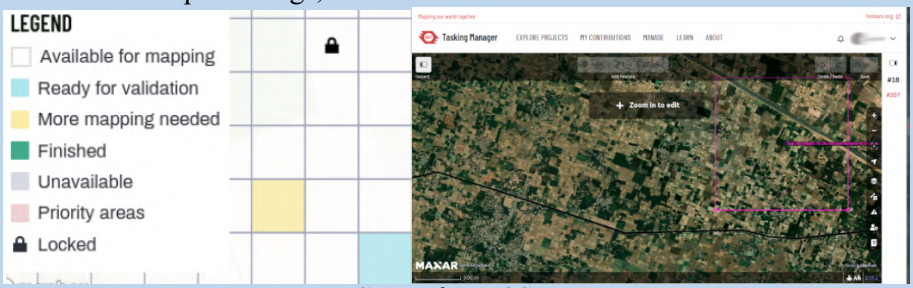
Fig 2. Benefits of Open Data (World Bank)

Volunteer mapmakers are helping humanitarian **OpenStreetMap** provide current maps for organisations working for managing disasters and climate change. Since its original application in Haiti after the 2010 earthquake, it has also been utilised for mapping earthquakes in Nepal, Eastern Afghanistan, Ecuador, and West Africa. These maps aid in locating the world's poorest population and most vulnerable areas, allowing cities and humanitarian organisations to more effectively focus their assistance efforts during times of disaster.

Give a walkthrough of the Humanitarian Open Street Map to the learners.

- Sign up at https://tasks.hotosm.org/
- Register with name and email address OpenStreetMap.org
- Explore projects in the main navigation to find a project to help map
- Navigate and show various components

- Show the learners how to map buildings, roads



Snaps from OSM

According to the **National Data Sharing and Accessibility Policy** datasets should be published in formats specified under NDSAP, i.e., open format which can be accessed without the need for a software license. Open data helps monitor government activities, such as tracking public budget expenditures and encourages greater citizen participation in government affairs, provides feedback on work quality, provides data to businesses to check market viability or empower the citizen to identify data gaps and inform the government. E.g., Karnataka and Punjab government open data portals have datasets related to urban services that can be used by the public.

Open data should have the following characteristics (Sunlight Foundation):

- Completeness, Machine-readable, Timeliness
- Permanence, Non-discrimination, Minimal usage cost
- From a primary source
- Easy to access, Commonly-owned, License to use

Smart City Ahmedabad inaugurated its Integrated Command and Control Centre under the **Safe and Secure Amdavad (SASA) Project** which provides access to data from the city. It allows Ahmedabad Municipal Corporation to monitor and control departments under it through the Command Centre. It includes a Comprehensive Complaint Redressal system where cumulative data on complaints and the status of work done to resolve them can also be viewed through the Command Centre.

Discuss with learners: *Have they used open data in any past projects or put collected data for use by the public. If yes, how it has been useful?*

City officials and planners can incorporate urban resilience using open data for nature-based solutions for land use planning, urban design, and other investment initiatives. The use of open data enables all stakeholders to have access to and participate in these efforts of gathering and analysing data. Local authorities can conduct this planning process in an open, collaborative manner. When deciding on policies and planning, local authorities can be aware of and study susceptibility issues by mapping urban-ecosystem interactions, trends, and predictions using open data.

Session Plan

Content	Trainer's Note	Time
Open data basics	Focus on explaining the definition, benefits and use case of open data	15 min
Walk through exercise	Elaborate about the various open-source platforms like HotOSM, mWater, KoboToolbox etc. and give a walkthrough of mapping on HotOSM	15 mins

References

- Open data infrastructure for city resilience a roadmap showcase and guide http://resurgence.io/Downloads/ODIR%20Publication%20Final%2016042018.pdf
- ODI (2017) Improving the resilience of cities using open data https://theodi.org/article/improving-the-resilience-of-cities-using-open-data/

Additional Reading Material

- Open Government Data (OGD) Platform India – An Overview https://www.meity.gov.in/writereaddata/files/OGD_Overview%20v_2.pdf
- Open Government Data (OGD) Platform India Do's and Don'ts https://dsc.smartcities.gov.in/uploads/resource/resourceDoc/Resource_Doc_1574977454_OGD_DOs_Donts_V23.pdf

Notes

Summary

The Technical Session 5 guides the learners on:

- Types of spatial technologies like GIS, GPS etc that can support practitioners in spatial data analysis and visualization
- Ways to utilize open data and datasets for disaster risk reduction and climate change adaptation
- How to use various technologies and resources for strengthening urban resilience

Technical Session 6: Group Exercise

Brief Description of the Learning Unit

The group exercise of creating plan using the tools and concepts learned during the course brings together learners to identify various types of risks and challenges in urban areas in Gujarat and address them. Using the insights of different sectors and stakeholders, the exercise tries to address the challenges in various disaster and emergency preparedness, response, and recovery. The overall goal is to plan an area to be more resilient from future changes in climate and risk landscape of Gujarat

Learning Objectives

- To develop an understanding, in advance, of the many needs of an urban area
- To provide a guide for drafting area-based plans using spatial information to manage and mitigate urban risks in Gujarat.

Duration: 60 minutes

Methodology

- Group exercise
- Discussion

Materials Needed

- Flip chart paper for each group
- Coloured markers

Detailed Description

Split the learners into two groups for the exercise.

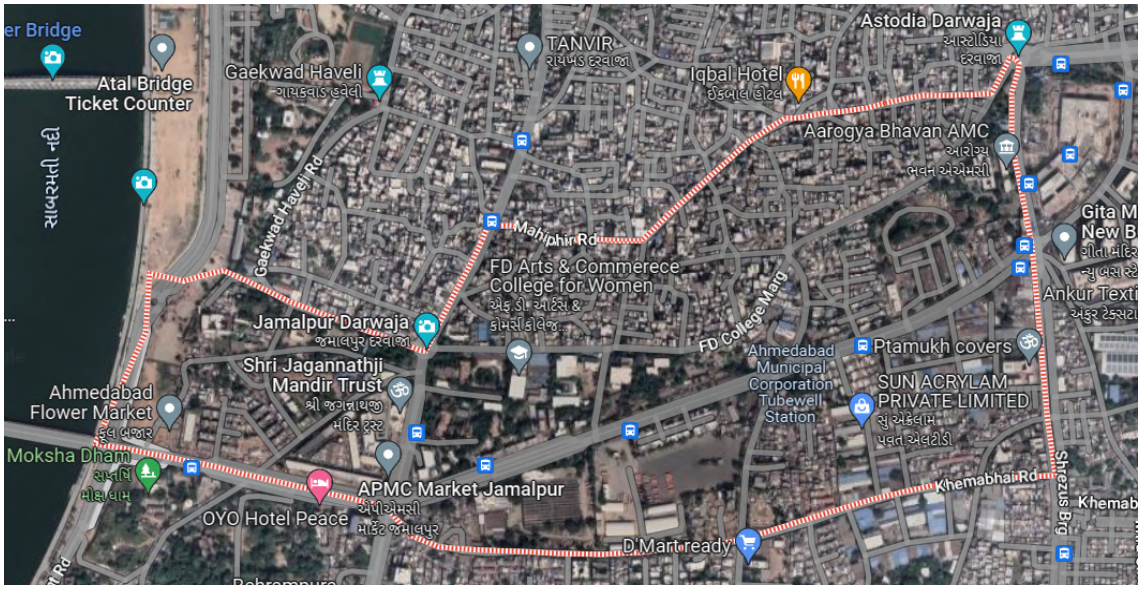
Background

The city of Ahmedabad was impacted by COVID-19 in 2020. The wards with higher population density saw higher containment zones during the pandemic. A study conducted by community health professionals including the AMC health department found that Jamalpur, Khadia were among the wards with high disease incidence cases of typhoid, viral hepatitis and diarrhoea. The factors for the condition are poor literacy rate, aging water supply infrastructure, and informal settlements with a lack of access to basic amenities (Times of India, 2022). Both the wards lie near the Sabarmati River and have occasional water logging issues. Both wards lie in the older part of the city with Jamalpur having heritage sites and densely populated old buildings and Khadia having residential areas surrounded by commercial areas. Solid waste management and slum settlements with poor basic facilities are some of the prominent challenges.

With the increase in temperatures globally, the temperature in Ahmedabad is also expected to rise with frequent heat waves. This would impact health and well-being leading the urban local bodies to develop initiatives to curb the effects. Considering this develop recommendations for the wards.

- Brainstorm risks and future critical events in the ward (10 minutes)
- List interventions for the ward (10 minutes)
- Identify the enabling and inhibiting factors for any intervention (10 minutes)
- Prioritize actions (*could be based on the duration of short-term, mid-term, long-term, environmental impact, economic constraints, etc.)* (10 minutes)
- Class discussion and debriefing (20 minutes)

Group 1: Jamalpur Satellite Image (Google Maps)



Group 2: Khadia Satellite Image (Google Maps)

Notes

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