Urban Vulnerability Assessment and Resilience

G.K. Bhat
TARU
Climate variability and change

- Monsoons with extreme rains and long dry spells > water logging and floods
- Temperature increase and humidity increase >> discomfort periods increase >> In tropics, even small change can lead to increasing discomfort periods.
- Coastal erosion impacting coastal communities
- **Fisheries sector may see migration towards colder waters**, virtual extinction of some species from their traditional areas *E.g. Sardines shifting towards Gujarat Coast*
- Vector borne diseases a major risk in riverine and high humid tropical cities
- Saline water ingress in to inland river sections, Khajan lands at risk
Changes in wind speeds and direction could change the dispersion of pollutants from power stations.

Droughts can result in low hydel generation exacerbated by other demands affecting peak demand management.

Changes in temperature & rainfall regimes cause crop failures and influence food prices, push migration.

Increases in summer temperatures would increase morbidity from heat strokes & pollution.

Floods and water scarcity can increase morbidity.

Flood management is necessary to help avoid disruption to transport networks.

Frequent droughts could increase competition between urban water demand and irrigation.

Water shortage could prejudice designated wetland sites, aquifers.

Changes in temperature & rainfall regimes cause crop failures and influence food prices, push migration.

Water management

Increased demand for peri-urban living due to higher temperatures may increase commuting distances and times.

Increased risk of flooding may require changes in built environment.

Flood management is necessary to help avoid disruption to transport networks.

Increased risk of floods could increase coping/insurance costs.

Prolonged droughts/frequent floods may impact heritage built environment.

Heritage

Economy

Habitat & Biodiversity

Agriculture

Built Environment

Health

Transport

Energy

Climate change impacts: Linkages across sectors
• Urban population to reach to at least 45%- (At least 500 million)
• Per capita water resources(<1700 cum/yr) already low, likely to worsen further
• Point water demands from cities-many in arid and semi-arid and upper catchments - Water supply would be a challenge to large cities
• Water and sanitation coverage to increase, **creating water conflicts** over limited perennial sources.
• Floods and water logging in urban areas amplified by increasing built up areas- (Flash floods, water logging)
• **Recycling and reuse may not catch up** leading to high differential availability across SECs, Core vs Periphery
• Low per capita land >> migration to cities>>informal livelihoods already high

Climate variability and change going to roll out over these human induced changes
Climate Hazard types

• **Category 1: Discrete recurrent hazards**, as in the case of transient phenomena such as storms, droughts and extreme rainfall events.

• **Category 2: Continuous hazards**, for example increases in mean temperatures or decreases in mean rainfall occurring over many years or decades

• **Category 3: Discrete singular hazards**, Abrupt shifts in climatic regimes; Major shifts in monsoon

  Speed of onset, duration and spatial extent and frequency of events would matter
Dimensions of urban vulnerability

• Location: Most cities started near water courses, coastal areas but located on low risk cores, inherent risks of expansion

• Access to Infrastructure and lifeline services
  • Especially- housing, water, electricity, transport, communication

• Water Resources, especially for cities relying on distant sources, quality and extent of local sources

• Legacy human interventions (embankments, dams, Roads)

• Livelihood patterns (Formal vs Informal sector)

• Health: Waterborne and vector borne diseases

• Ownership and access to Climate control assets (Fans, HVAC)
Understanding urban vulnerability

• Exposure to risks is highly diverse across the city (e.g. Flood and water logging may be occurring only in some parts)

• Several elements including livelihoods, incomes, assets at household level and resource characteristics, infrastructure status determine the urban vulnerability

• **Scale dependant** (households>colonies> City>Region)

• Interlinkages between different elements often not evident( e.g. Malaria and water logging)

• **Uncertainties about future trends** in demography, economy and Climate variability/change often unknown- Surprises common

• Often nonlinear- **Tipping points** (Poverty only “one illness away”) may need to be explored especially among the poor with low capital base

• **Social vulnerability difficult to assess: Proxy indicators necessary**

• **Indicators need to be contextualised**, but it can result in non-comparability

• **Scenario based approaches** to understand vulnerability may be necessary
Indicators for vulnerability assessment: Few pointers

- **Livelihood framework** (Natural, Physical, Human, Financial, Social capitals)-
  - Good proxies for vulnerability assessment
  - May not offer full picture of vulnerability
  - Externalities need to be understood (e.g. migration incomes can often stabilise local income uncertainties)

- **“Technology capital”/”Knowledge capital”** is increasingly becoming important in defining vulnerability/adaptability
  - Access to technology/knowledge base can reduce vulnerability (e.g. “Mobile phone” poverty)
  - Quantum jump in vulnerability reduction possible with access to knowledge base

- Past vulnerability has led to current poverty

Context informed, adaptive approach needed to assess vulnerability
Challenges and opportunities to assess city level vulnerability

- Population Census data collected only once in a decade, extrapolation often not valid
- Very few mechanisms to collection of vulnerability/capacity data
- Municipalities do not have spatial data (GIS); updating paper maps a challenge
- Infrastructure access not mapped; knowledge in few hands - lost with retirement
- Large changes happening beyond municipal boundaries-Peri-urban growth challenge
- Continued expansion and contested domains

- Recent remote sensing/GIS data freely available- Google Earth, Open street maps often every year updated-Time series data often available
- Object oriented classification of socio economic classes can be done fairly accurately
- GPS has made mapping easy- e.g. Slum mapping with smartphones
- Ground penetration radars: underground infrastructure mapping
- Crowd sourcing data possible to reduce costs; google traffic
- GIS techniques can be used with small samples to get city wide picture
Livelihood Framework for assessing Socio-economic vulnerability

- **Human Capital**: Education, Skills, Dependency ratio
- **Social Capital**: Kinship support, Access to institutions
- **Natural Capital**: Water, land and energy resources (less important from urban HH perspective)
- **Physical Capital**: Access to Infrastructure & Services
- **Financial Capital**: Assets, Income
Spatial vulnerability Analysis Method:
Urban community→ City level analysis

Risk Analysis
- Drainage maps
- Contour maps
- Infrastructure maps
- Hydrometeorological/tide data
- Disaster/Event data
- Risk map

Vulnerability Analysis
- Ground based rapid surveys
- Homogeneous neighborhood maps
- Sample location map and transect locations
- Community/HH surveys
- ISDA
- Community level vulnerability aggregated data
- Ward level SEC map
- Ward level Vulnerability maps

Adaptation options
# Area Typologies

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Upper</th>
<th>Mixed</th>
<th>Middle</th>
<th>Lower</th>
<th>Slum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spatial distribution</td>
<td>Large bungalows / large flats with open spaces, fairly regular distribution, certain amount of planted vegetation / lawns / trees</td>
<td>Mainly in the core area, may be associated with industries, or commercial areas</td>
<td>Compact houses, row houses, Flats, regular distribution often as colonies or housing societies, uniform house sizes</td>
<td>Small houses, irregular pattern, Mostly progression from slums, dense pockets, lack of open areas, some times as closely spaced colonies with small units (LIG housing)</td>
<td>Totally irregular, no open areas, cluttered along periphery or risk prone areas, railway lines, streams / rivers, drainage line / water bodies, industrial units, Wild vegetation is in the neighbourhood if located near streams.</td>
</tr>
<tr>
<td>House Size</td>
<td>Very big houses on larger Plot area</td>
<td>Big older houses but often unplanned</td>
<td>Medium sized houses, Plot area almost equal to the floor area</td>
<td>Small sized houses</td>
<td>Small mostly single room, with almost equal floor area and plot area</td>
</tr>
<tr>
<td>Housing density</td>
<td>Quite low</td>
<td>Average, Mix of commercial and residential use as evidenced by vehicles</td>
<td>Evenly spread out, medium density</td>
<td>High density</td>
<td>Very high density</td>
</tr>
<tr>
<td>Road width</td>
<td>Wide spacing</td>
<td>Narrow, winding roads</td>
<td>Optimal road width, free of congestion</td>
<td>Narrow lanes</td>
<td>Narrow winding lanes inside the settlement.</td>
</tr>
</tbody>
</table>
Area typologies & Geopsy samples

Area Types
- Commercial
- Government Complex
- Govt Colony
- Govt Offices
- Industrial
- Institutional
- Mixed Residential-commercial
- Open Area
- Res-lower Class
- Res-middle Class
- Res-upper Class
## Area Attributes

![Object Fields](image)

<table>
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<tr>
<th>Field</th>
<th>Value</th>
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<tr>
<td>Type of settl...</td>
<td>Res-lower Class</td>
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<tr>
<td>Description</td>
<td>Dense Houses</td>
</tr>
<tr>
<td>No of stories A</td>
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</tr>
<tr>
<td>A%</td>
<td>70 %</td>
</tr>
<tr>
<td>No of stories B</td>
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<td>30 %</td>
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<tr>
<td>C%</td>
<td>0 %</td>
</tr>
<tr>
<td>Age</td>
<td>Medium</td>
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18 of 33 fields
GIS based spatial extrapolation process

• Reconnoiter to identify broad typologies
• Area categorization based on density, roof type, texture etc. to extract objects of similar characters as proxy to SECs.
• Homogeneous Polygons delineated.
• Ground-truthing and collection of details of use, number of stories, SECs, % open area etc.
• Build attribute table of polygons
• Geopsy (small street level areas) used as samples to probe further.
• Spatial extrapolation from geopsy to polygon based on area
• Multi-parameter Spatial Sql will be used for aggregation based on typologies of objects.
INDORE: Capacity & Vulnerability Index across Sample Settlements

Legend

CAPACITY
- Income
- Education
- Social

VULNERABILITY
- Physical
- Water
- Insurance

Source: TARU Analysis, 2009

Projection: UTM-43N
Datum: WGS 84
Map No.: ACCCRN-Indore-07
Date: 2/8/2010
### Table (34): SURAT: Social capacity Index across the City

<table>
<thead>
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<th>Sl. No</th>
<th>Social Capacity Index</th>
<th>Slum</th>
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<th>Middle</th>
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<td>23%</td>
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<tr>
<td>2</td>
<td>2-4</td>
<td>12%</td>
<td>32%</td>
<td>50%</td>
<td>64%</td>
<td>7%</td>
<td>41%</td>
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<tr>
<td>3</td>
<td>4-6</td>
<td>1%</td>
<td>11%</td>
<td>37%</td>
<td>18%</td>
<td>31%</td>
<td>24%</td>
</tr>
<tr>
<td>4</td>
<td>6-8</td>
<td>-</td>
<td>23%</td>
<td>1%</td>
<td>12%</td>
<td>61%</td>
<td>11%</td>
</tr>
<tr>
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<td>8-10</td>
<td>-</td>
<td>1%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Grand Total</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
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### Table (13): Estimates of Drainage and sewerage services vulnerability index range across Socio economic classes in Indore city

<table>
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<tr>
<th>Sl. No</th>
<th>Drainage and sewerage vulnerability index</th>
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<td>6-7</td>
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<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>8</td>
<td>7-8</td>
<td>13%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>7%</td>
<td>1%</td>
</tr>
<tr>
<td></td>
<td>Grand Total</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
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</tbody>
</table>
Possible options to build Urban Resilience

• Incorporating lessons from disasters (Surat vs Delhi)
• Anticipatory culture necessary especially at ULB level
  • What population? What risks?
  • What needs to be done?
• Taking control over resources (local and distant)
  • when grids fail, it is local resources that can save us (Water, energy micro grids)
• Building synergy across sectors and scales
  • Households>Colonies> Wards>City;
  • Water, waste, Storm water, energy, transport etc..
• Planned redundancy across scales (not household level mini-utilities alone to manage water/energy crisis)
  • Mutually reinforcing systems starting from household>colony>city levels (Rainwater, sewage recycling): subsidiarity principle for managing services
• Paradigm shift to address emerging issues: From Landuse to Network planning
• Waste not want not: Urban metabolism as framework for management of resources and wastes
• Access to Knowledge, Real time Information, forecasting networks (Early warning systems)
**Single Loop Learning**
More Capital Works:
(WTPs, OHTs, Network Expansion)

**Double Loop Learning**
Developing alternate sources:
Ground water, Rain water harvesting,
leak reduction, etc.

**Triple Loop Learning**
Policy level changes to manage water holistically
including:
- Devolving roles to colonies/RWAs;
- community level
- Decentralized treatment,
- recycling
- Community scale water purification and urban poor,
- Public lands for water related infrastructure

**Frame of Reference**

**Actions**

**Results (E)**

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DSDS: Lessons from Indore and Surat
Natural Resource Management
Disaster Risk Management and Climate Change
Urban Development
Scenario Planning and Strategy Development

Governance
Water Supply and Sanitation
Social Development
Communications

Gurgaon
424 Qutab Plaza
DLF City Phase I
Gurgaon 122 002
India
Phone + 91 124 2560 424
Fax + 91 124 2560 421

Gandhinagar
Plot No. 541/2
Sector 8
Gandhinagar 382 008
India
Phone + 91 79 2324 0479
Fax + 91 79 2324 9882

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www.taru.co.in  e-mail: info@taru.org