Urban Vulnerability Assessment and Resilience

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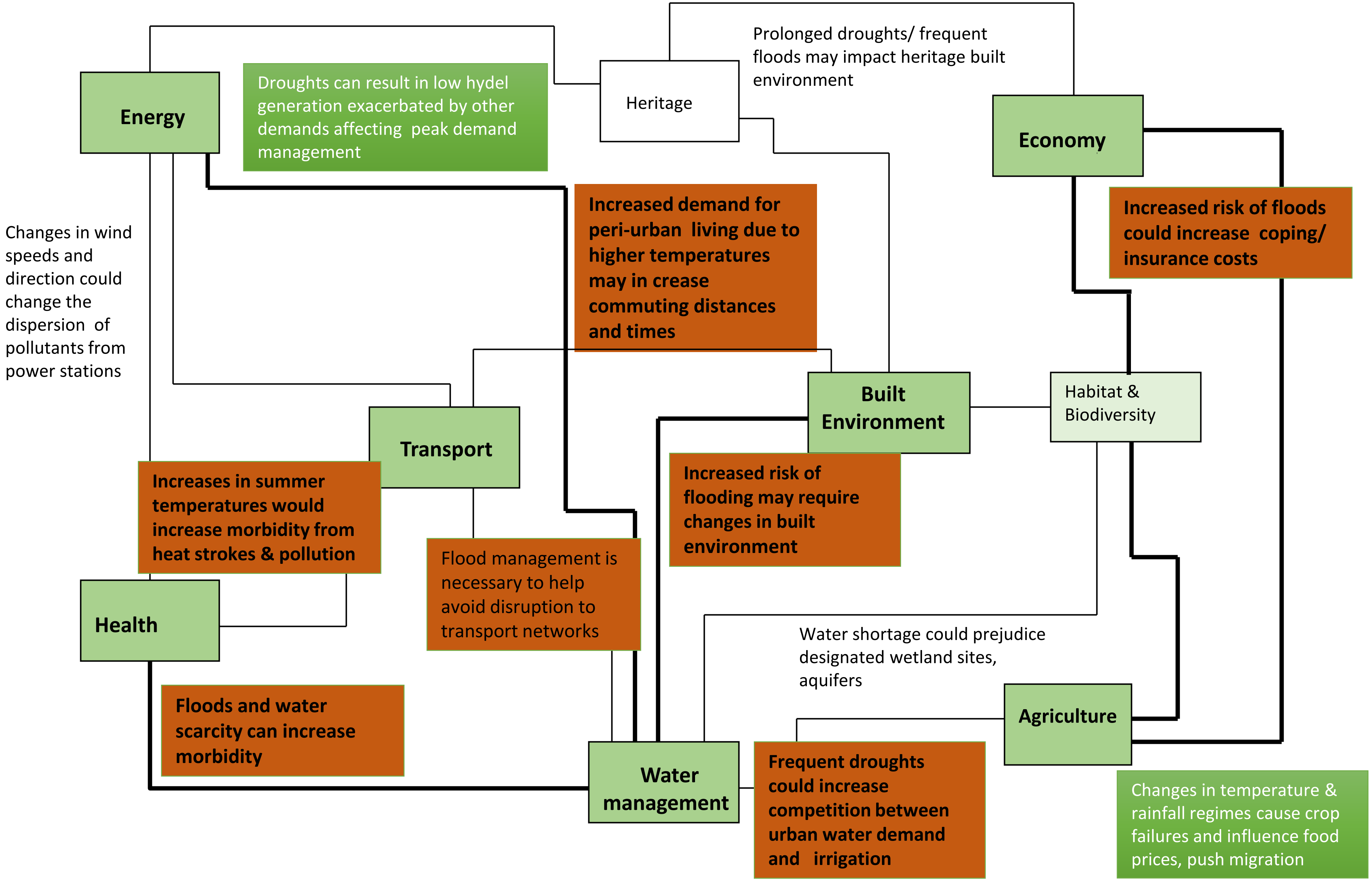
TARU

Climate variability and change

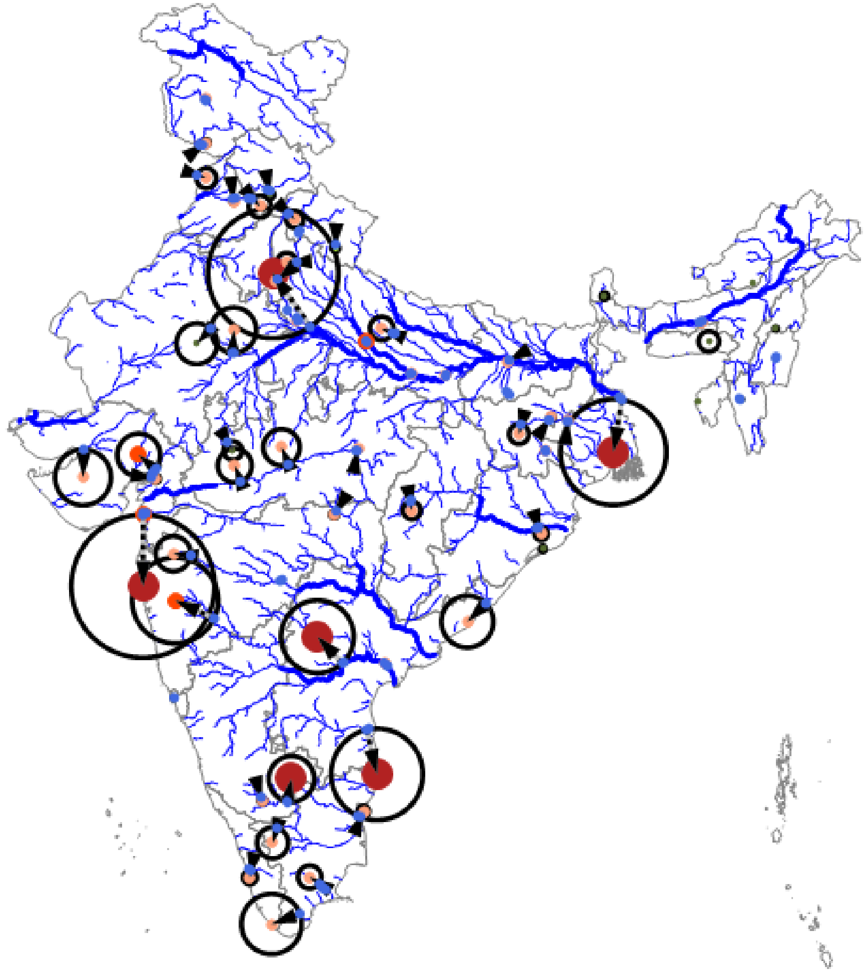
- Monsoons with extreme rains and long dry spells> water logging and floods
- Temperature increase and humidity increase>> discomfort periods increase>> In tropics, even small change can lead to increasing discomfort periods.
- Coastal erosion impacting coastal communities
- **Fisheries sector may see 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

Climate change impacts: Linkages across sectors



Business as Usual 2030 Indian Urban Water Scenario

- 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 wat 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

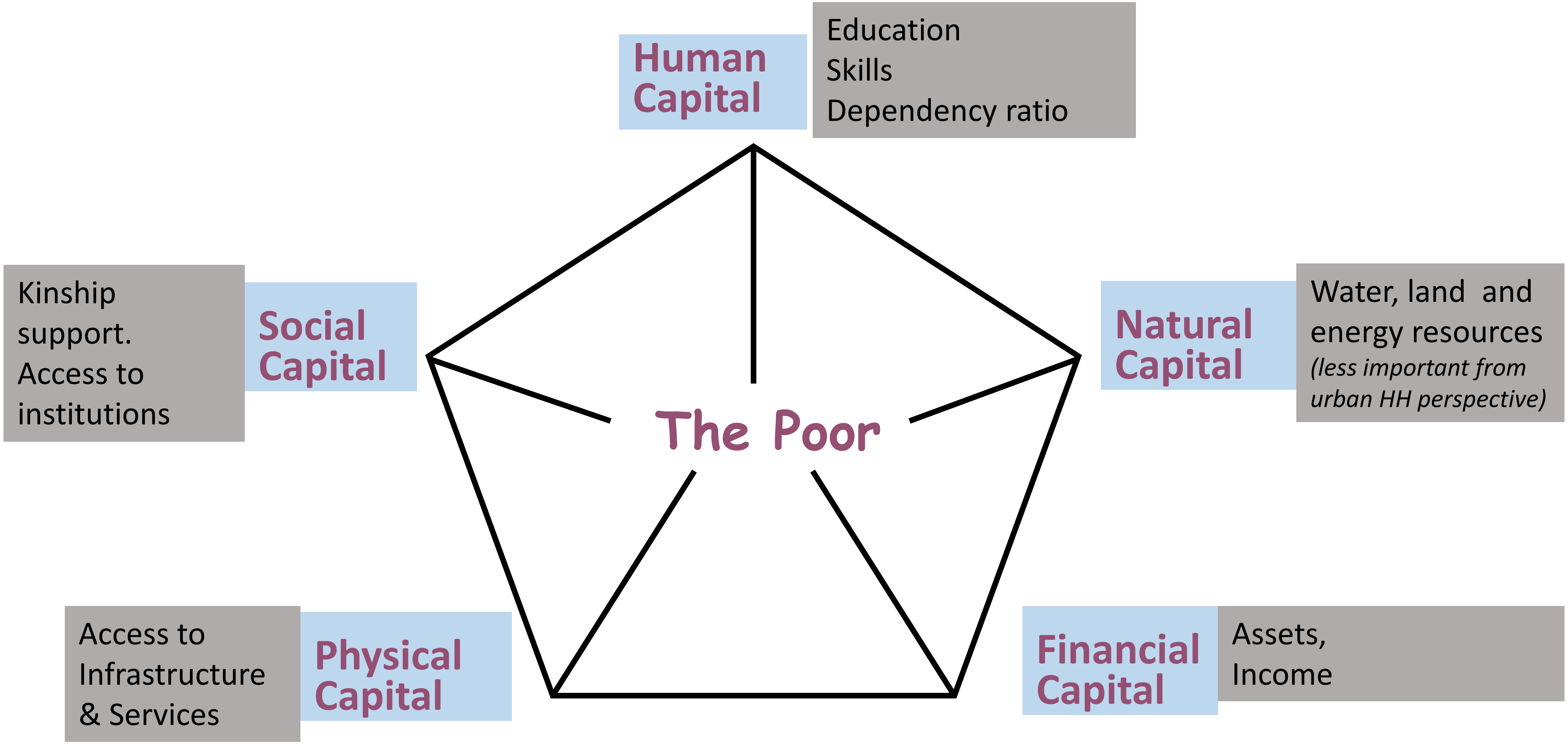
Context informed, adaptive approach needed to assess vulnerability

Challenges and opportunities to assess city level vulnerability

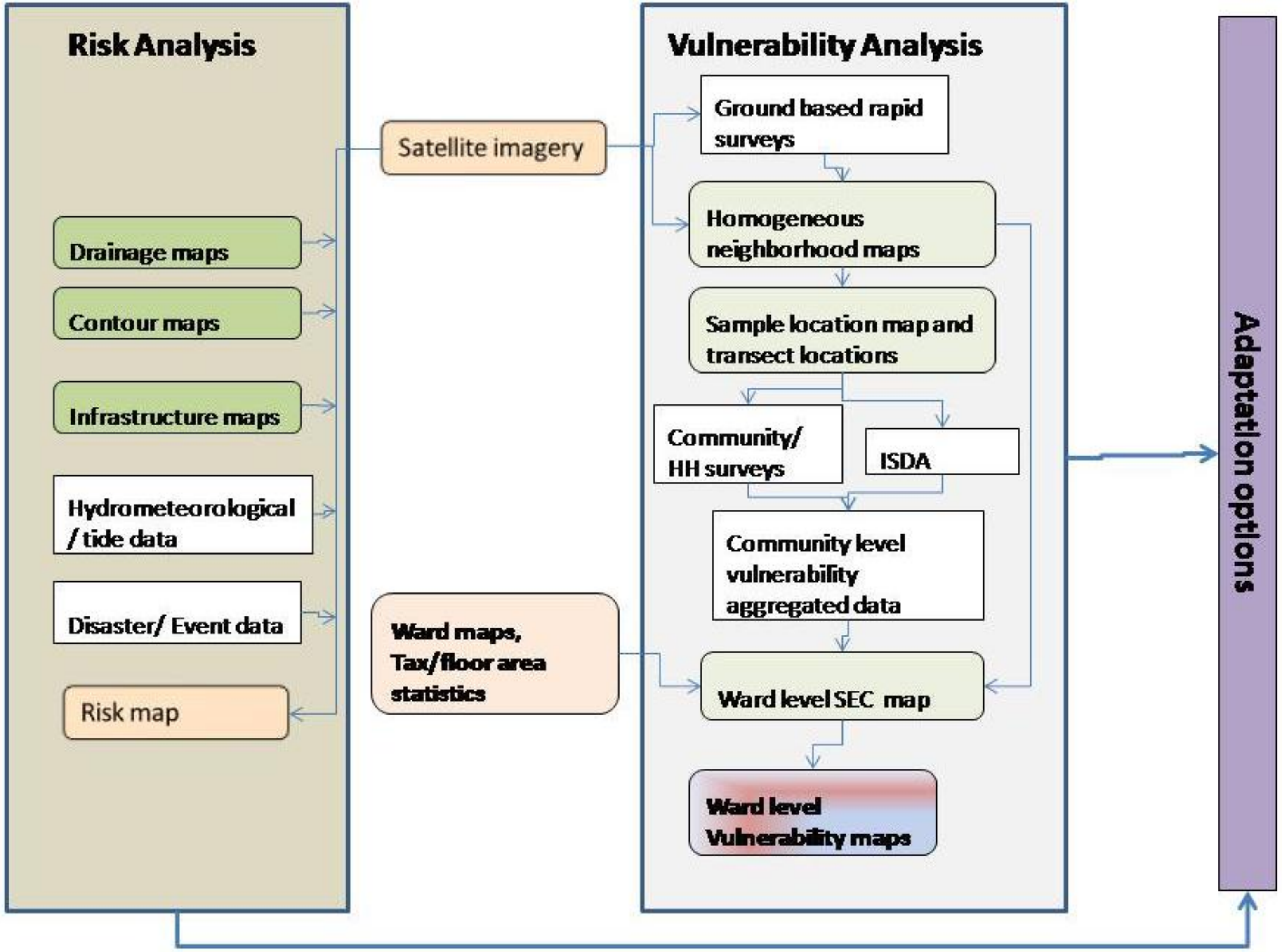
- Population Census data collected only once in a decade, extrapolation often not valid
- Very few mechanisms to collection of vulnerability/capacity data
- Municipalities do not have spatial data (GIS); updating paper maps a challenge
- Infrastructure access not mapped; knowledge in few hands - lost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

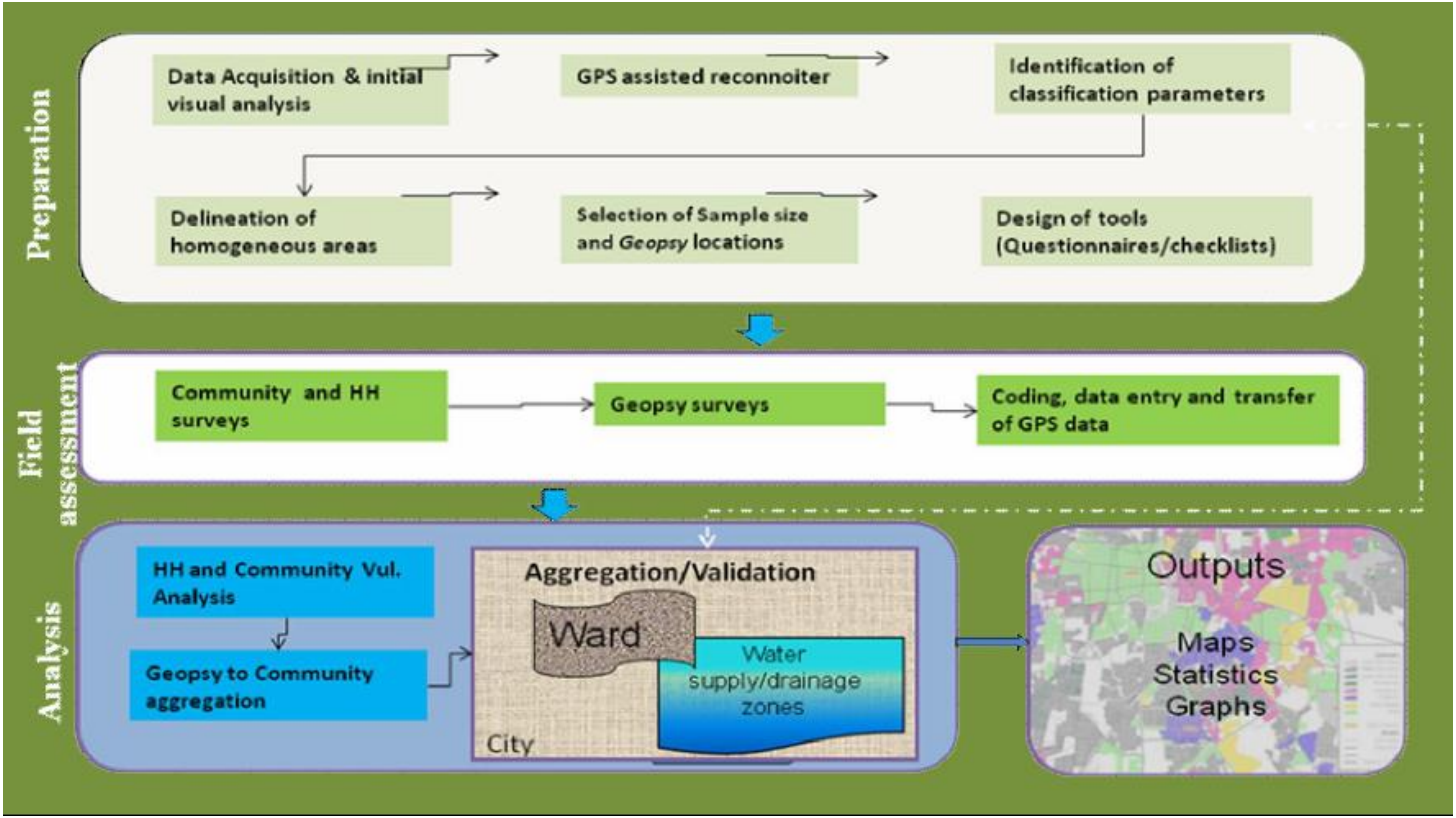
- Recent remote sensing/GIS data freely available- Google Earth, Open street maps often every year updated-Time series data often available
- Object oriented classification of socio economic classes can be done fairly accurately
- GPS has made mapping easy- e.g. Slum mapping with smartphones
- Ground 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



Spatial vulnerability Analysis Method: Urban community> City level analysis

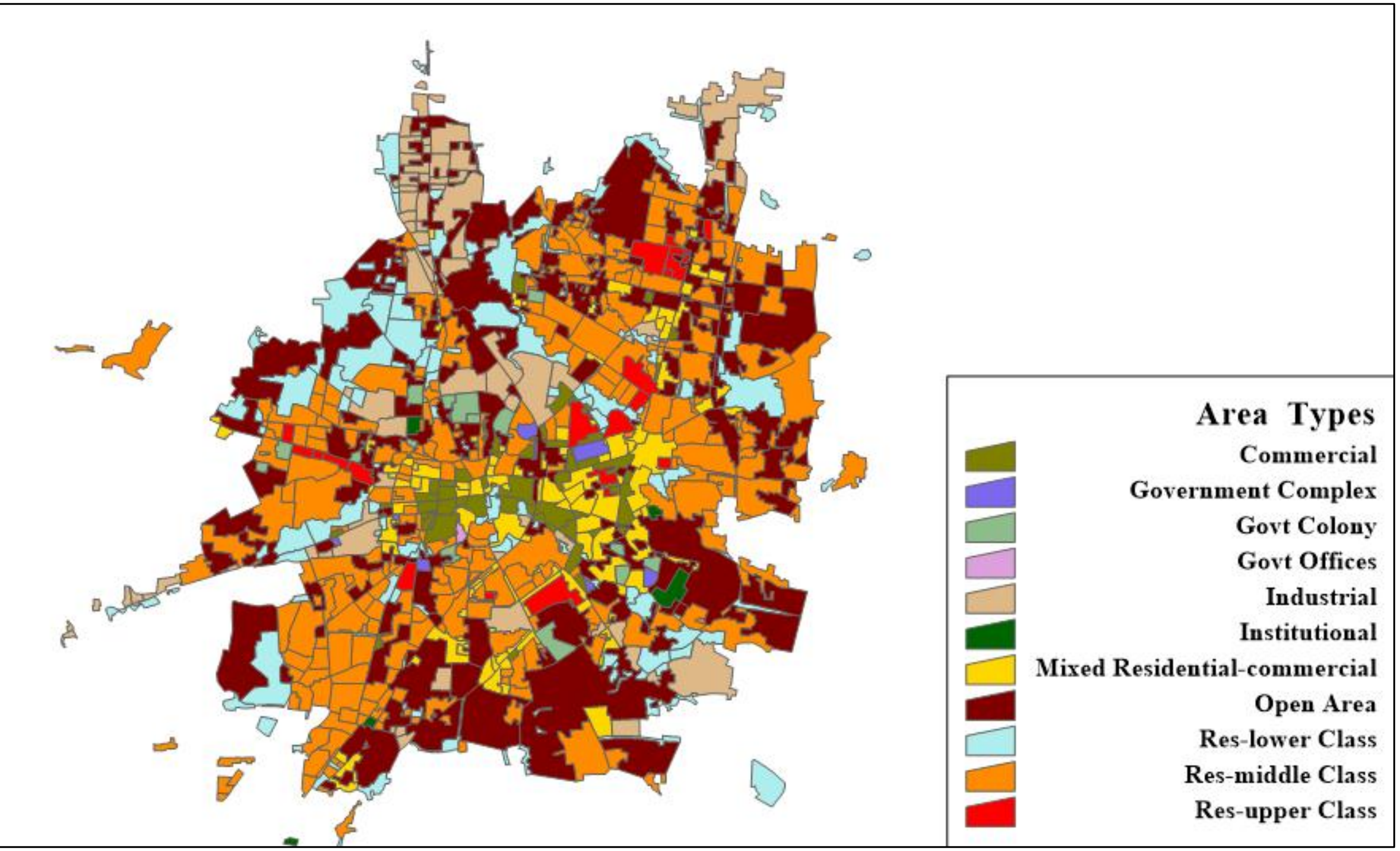



Preparation
Data Acquisition & initial visual analysis
GPS assisted reconnoiter
Identification of classification parameters
Delineation of homogeneous areas
Selection of Sample size and Geopsy locations
Design of tools (Questionnaires/checklists)
Field assessment
Community and HH surveys
Geopsy surveys
Coding, data entry and transfer of GPS data
Analysis
HH and Community Vul. Analysis
Geopsy to Community aggregation
Aggregation/Validation
Ward
Water supply/drainage zones
City
Outputs
Maps
Statistics
Graphs

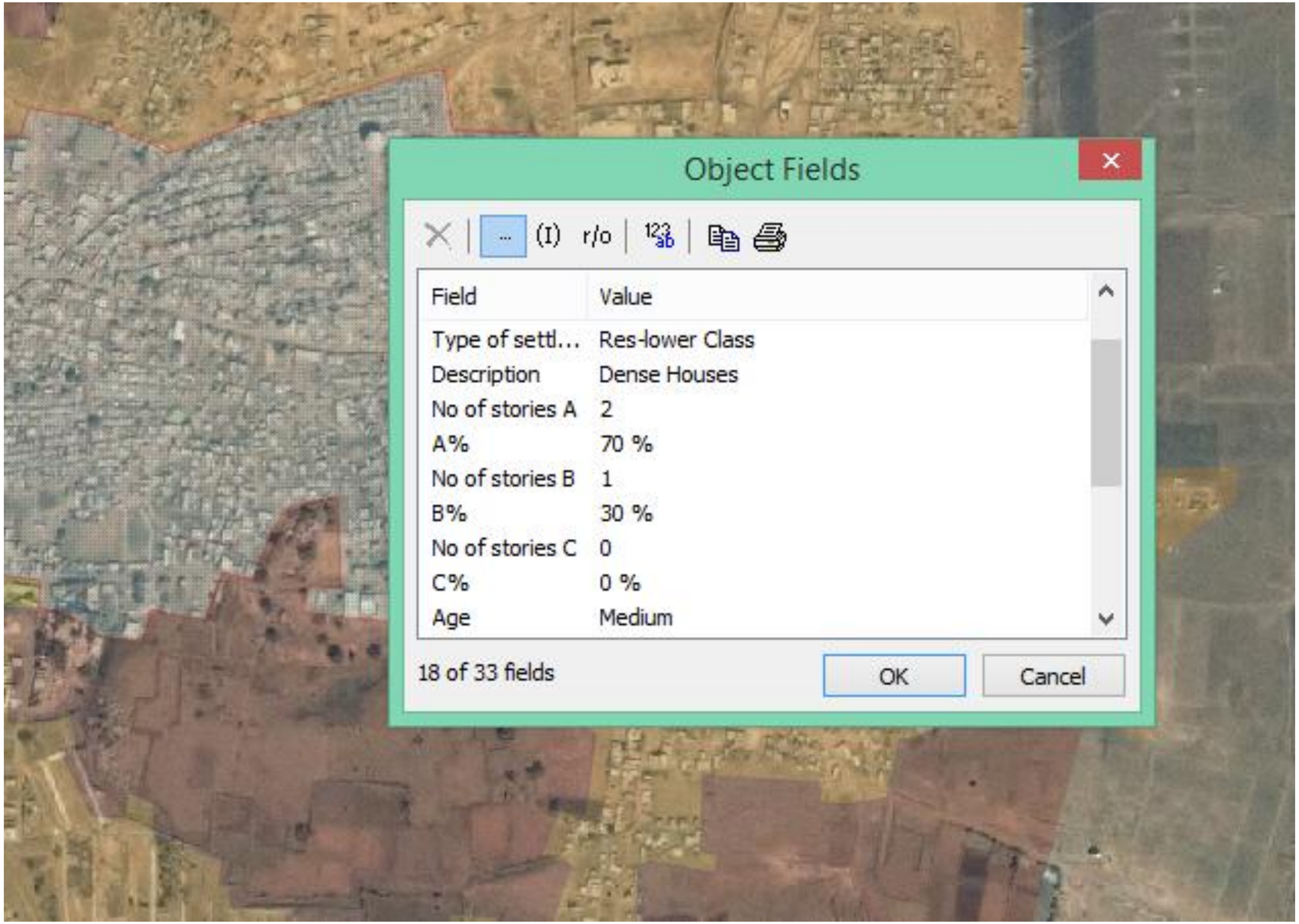
Area Typologies

Criteria	Upper	Mixed	Middle	Lower	Slum
Satellite Image					
Spatial distribution	Large bungalows / large flats with open spaces, fairly regular distribution, certain amount of planted vegetation / lawns / trees	Mainly in the core area, may be associated with industries, or commercial areas	Compact houses, row houses, Flats, regular distribution often as colonies or housing societies, uniform house sizes	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)	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.
House Size	Very big houses on larger Plot area	Big older houses but often unplanned	Medium sized houses. Plot area almost equal to the floor area	Small sized houses	Small mostly single room, with almost equal floor area and plot area
Housing density	Quite low	Average, Mix of commercial and residential use as evidenced by vehicles	Evenly spread out, medium density	High density	Very high density
Road width	Wide spacing	Narrow , winding roads	Optimal road width, free of congestion	Narrow lanes	Narrow winding lanes inside the settlement.

Area typologies & Geopsy samples



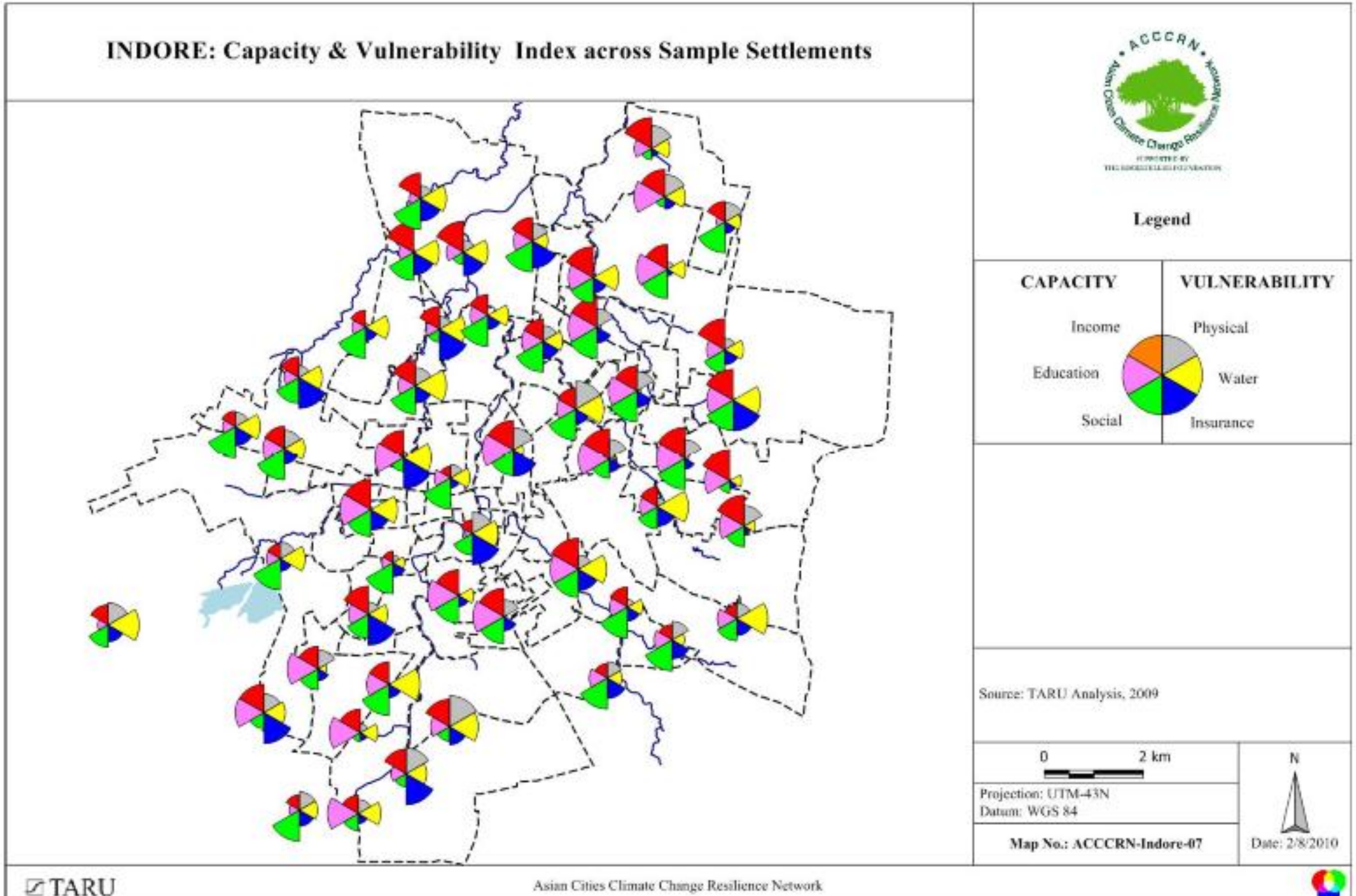
Area Attributes



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.

Capacity- Vulnerability Indices: Urban Households



City estimates from GIS analysis

Sl. No.	Social Capacity Index	Slum	Lower	Middle	Mixed	Upper	Grand Total
1	0-2	87%	33%	13%	7%	-	23%
2	2-4	12%	32%	50%	64%	7%	41%
3	4-6	1%	11%	37%	18%	31%	24%
4	6-8	-	23%	1%	12%	61%	11%
5	8-10	-	1%	-	-	-	0%
Grand Total		100%	100%	100%	100%	100%	100%

Table (34): **SURAT: Social capacity Index across the City**

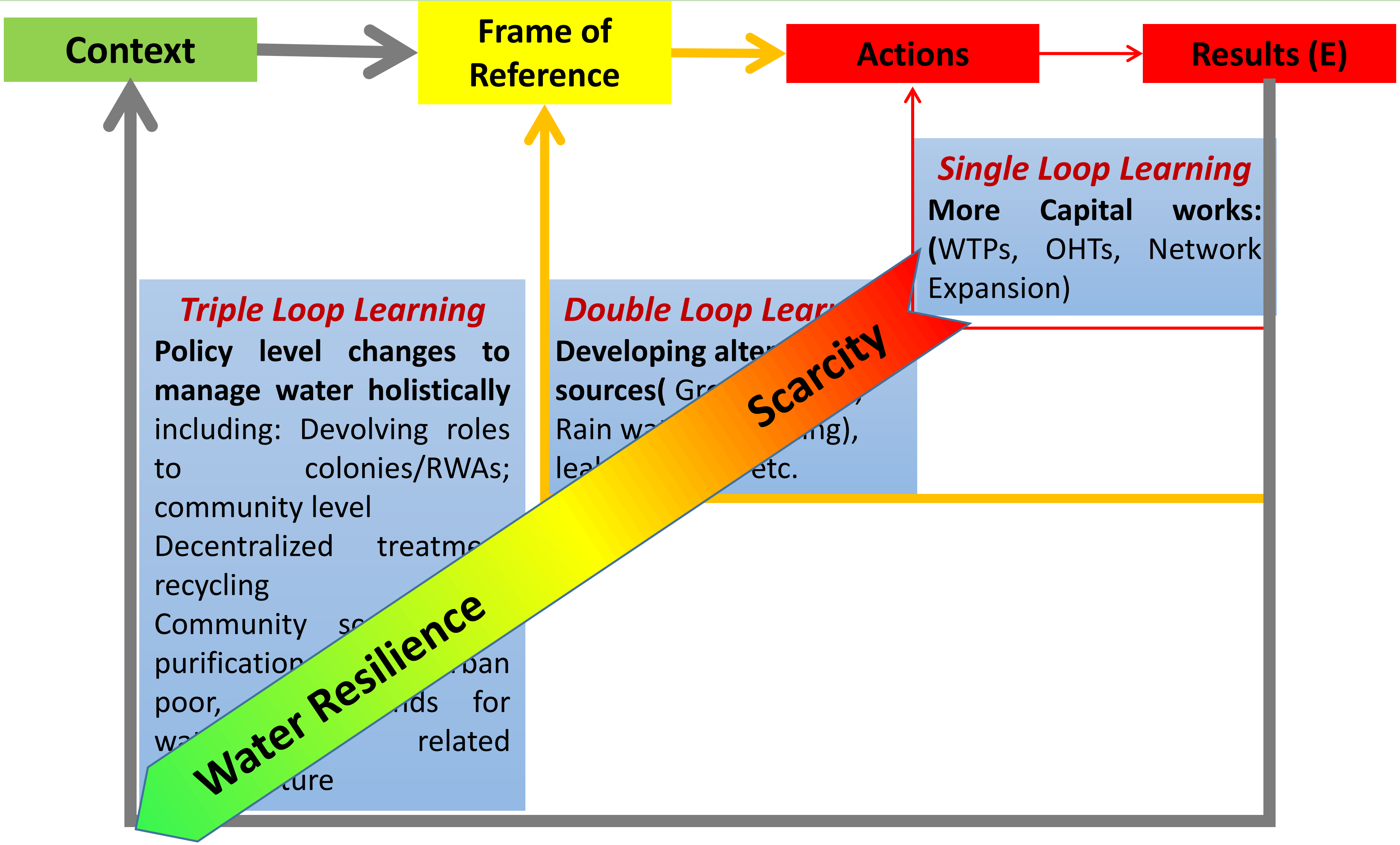
Table (13): **Estimates of Drainage and sewerage services vulnerability index range across Socio economic classes in Indore city**

Sl. No.	Drainage and sewerage vulnerability index	Slum	Lower	Middle	Mixed	Upper	Grand Total
1	0-1	3%	19%	26%	-	9%	18%
2	1-2	-	3%	-	-	-	1%
3	2-3	35%	52%	20%	53%	19%	32%
4	3-4	-	14%	1%	-	11%	4%
5	4-5	1%	4%	24%	34%	21%	20%
6	5-6	48%	7%	20%	13%	28%	20%
7	6-7	-	-	8%	-	5%	5%
8	7-8	13%	-	-	-	7%	1%
Grand Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

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)

Approach to Resilience: Triple Loop Learning



- Natural Resource Management
- Disaster Risk Management and Climate Change
- Urban Development
- Scenario Planning and Strategy Development
- Governance
- Water Supply and Sanitation
- Social Development
- Communications

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