Estimating City-wide Building Loss and Road Network Blockage for Tehran Expected Earthquake

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Special Session on
Strong earthquakes impact databases and expected loss estimations in emergency mode

Introduction

- Elements of Loss Estimation
- Loss Estimation Process and Basis Phases
- Crucial information in emergency response and disaster decision support systems
- Dedicated comprehensive GIS-based methodology
- Modeling multi-facet three-dimensional seismic risk maps
- Development of city geodatabase
- Development of building vulnerability functions
- Probabilistic method development: spatial distribution and severity of road network blockage following earthquake timely

Elements of Loss Estimation:

- Urban **Geodatabase** Development : Bbuilding inventory, road network, population, city infrastructure data, etc…)
- **Vulnerability** Studies:
  - Structural Loss
  - Road Network Loss
  - Human Loss
- **Risk** Algorithm Implementation (pre-event)
- Direct Damage Detection and **Loss Evaluation** (post-event)

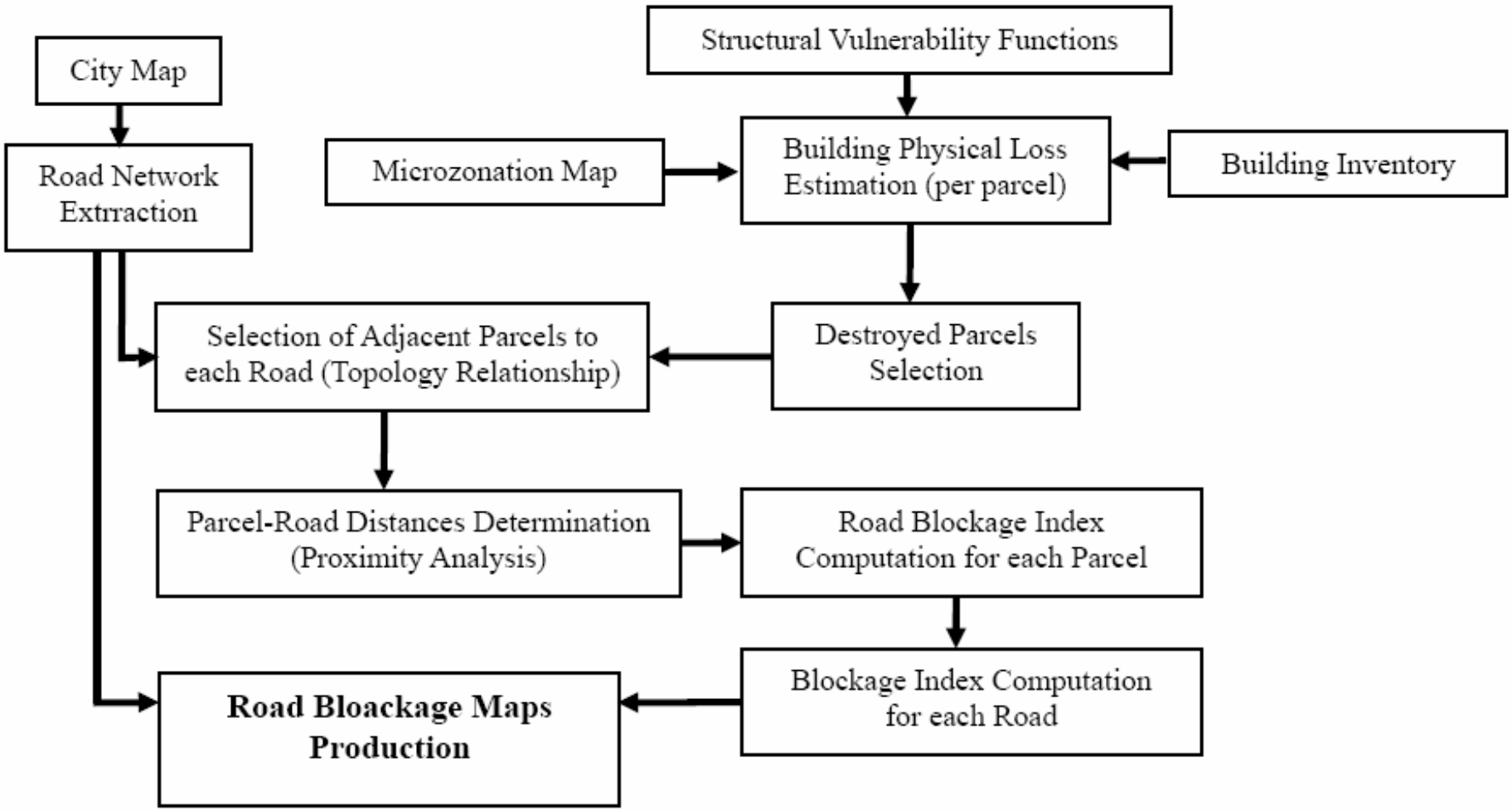
Methodology

- Phase 1- Creating city geodatabase & modeling in GIS:
  Topography, Building Inventory, Road Networks, Seismic Microzonation

- Phase 2- Modeling:
  - Structural vulnerability functions
  - Probabilistic/analytic road network blockage procedure

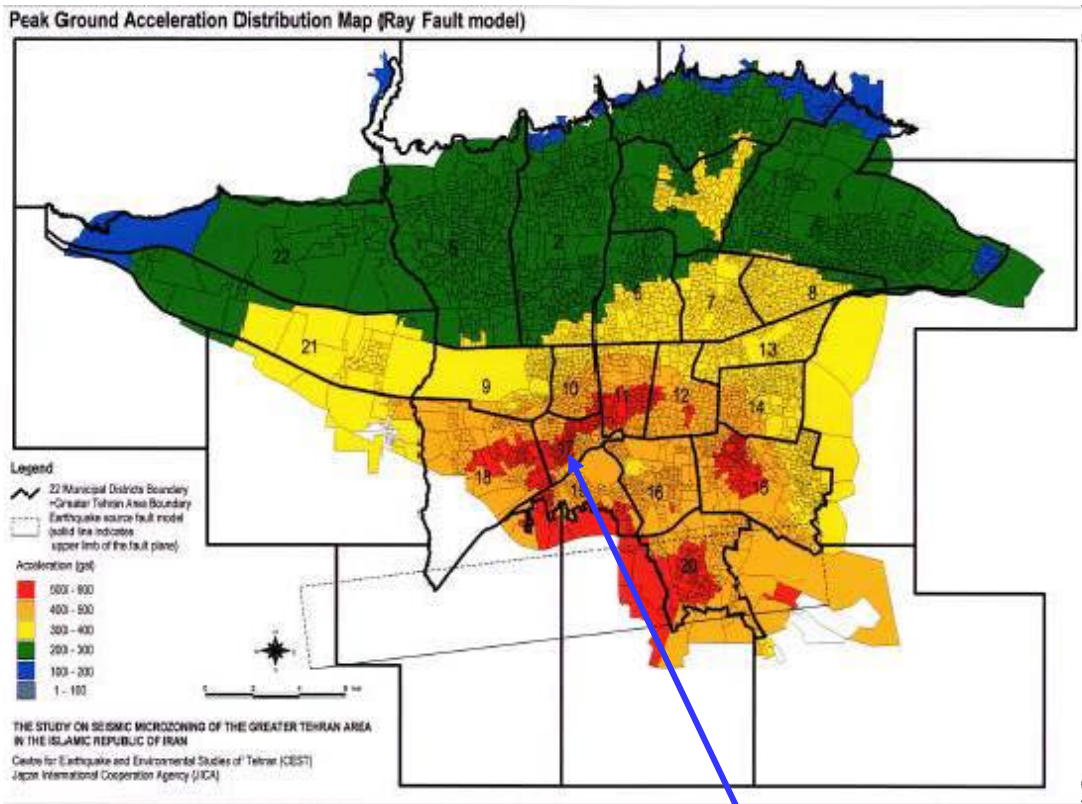
- Phase 3- Site specific loss estimation in GIS:
  - 3D mapping - building stock
  - Expected damages - building physical loss
  - Probabilistic road blockage index related spatial distribution within the road network

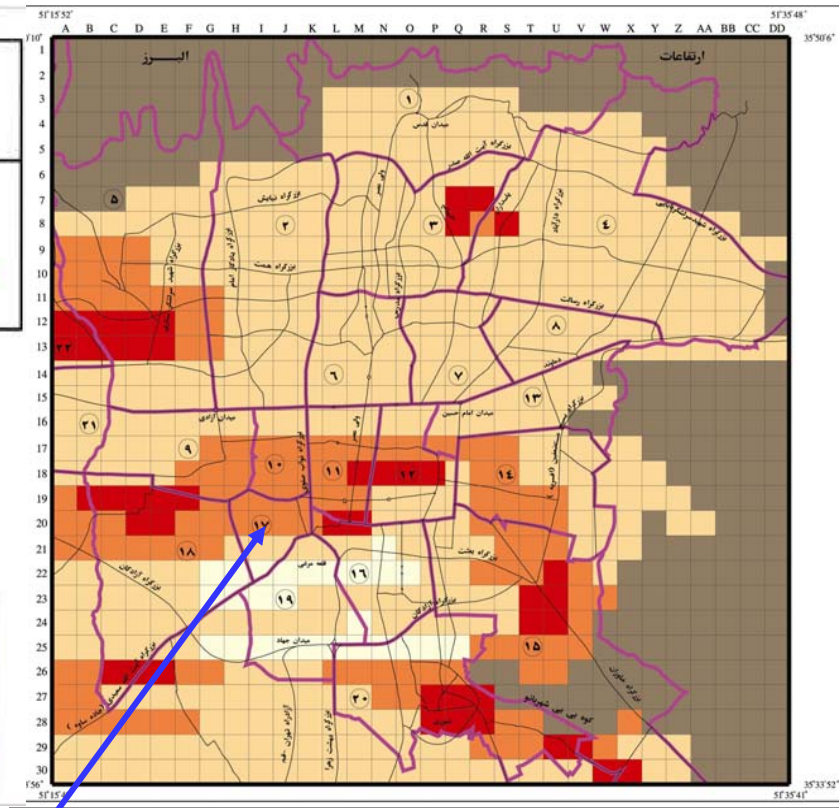
Methodology



Flow diagram corresponding to the steps involved and implemented in GIS

Seismic microzonation map





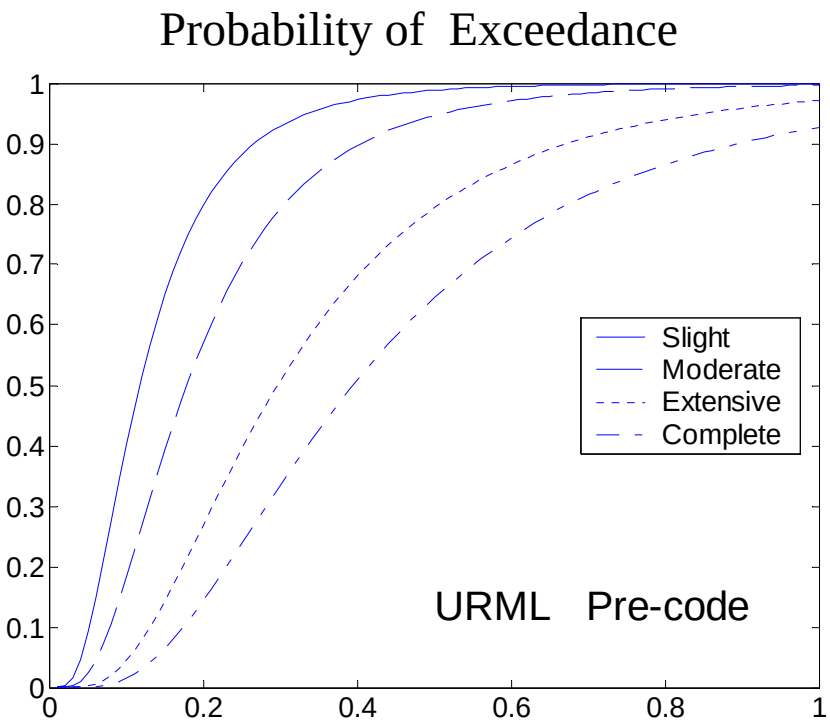
District 17

Geodatabase development

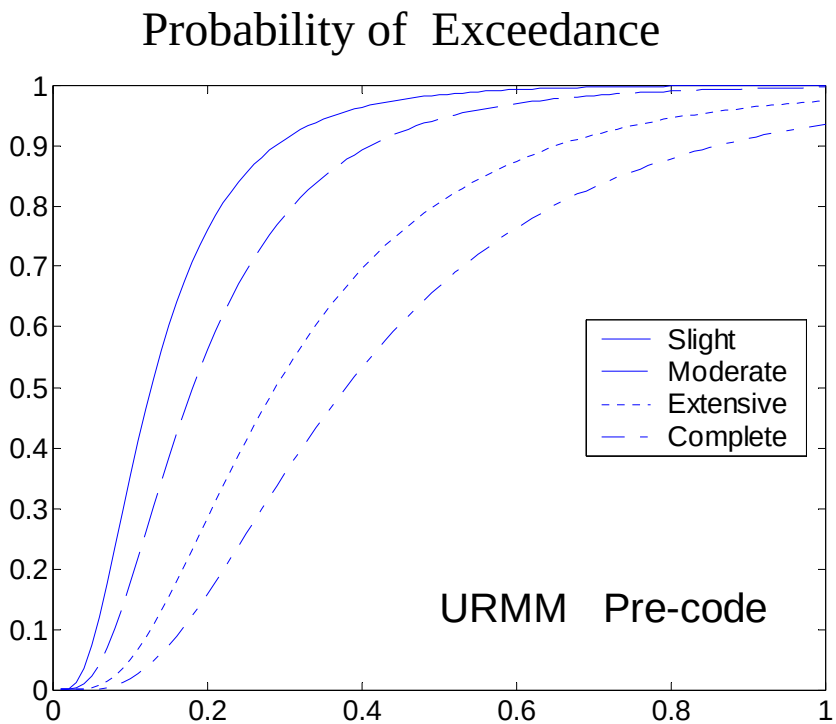
City Inventories (Buildings) – High resolution spatial and attribute from cartographic aerial photos (digitally 1:2000 scale stereo photos) and survey city databases developed based on field investigation

A portion of the 1:2000 urban digital map comprising of parcel data (original scene: 1.6 km by 1.2 km)

Structural vulnerability functions

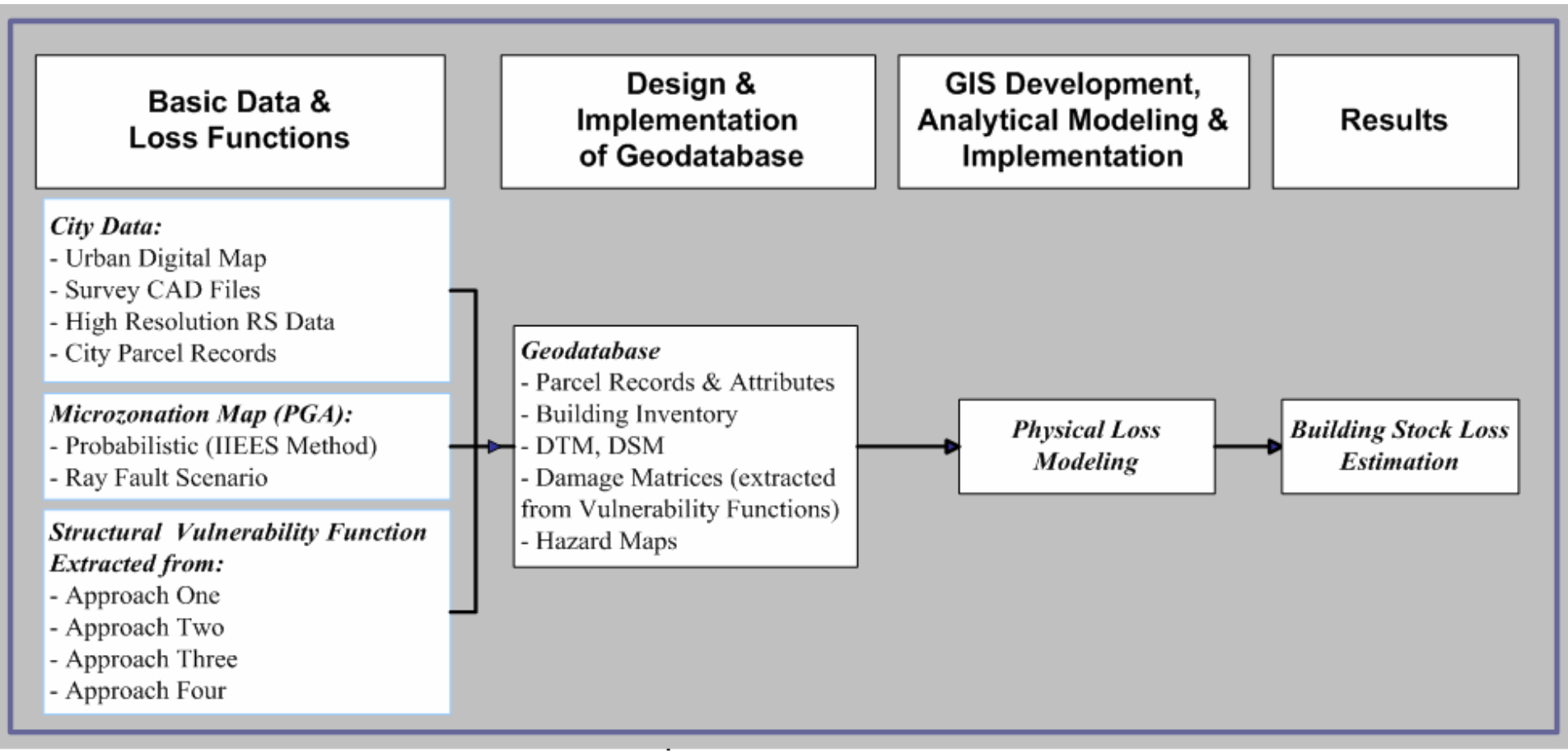


Fragility Curves for pre-code URML building class

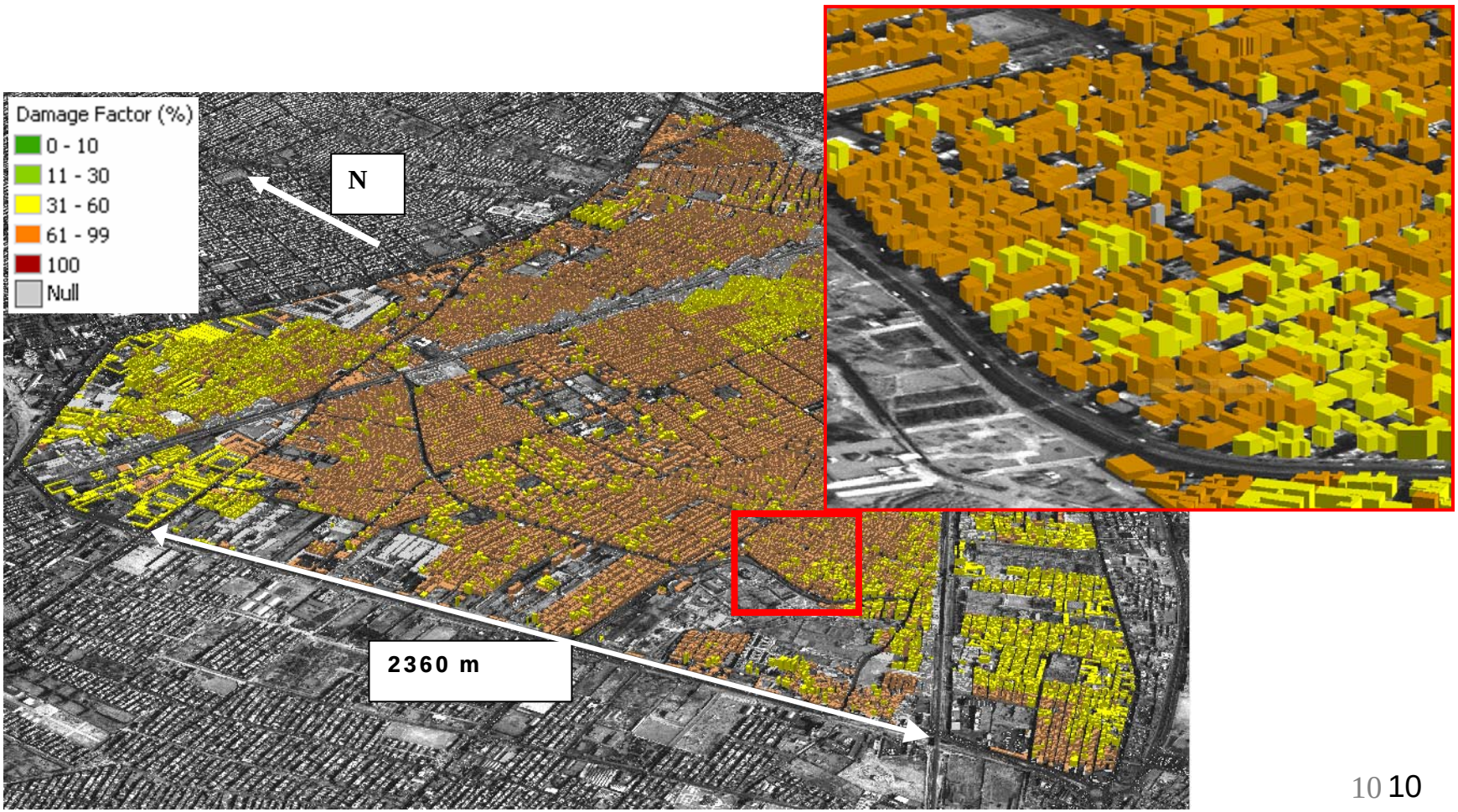


Fragility Curves for pre-code URMM building class

Building stock loss modeling



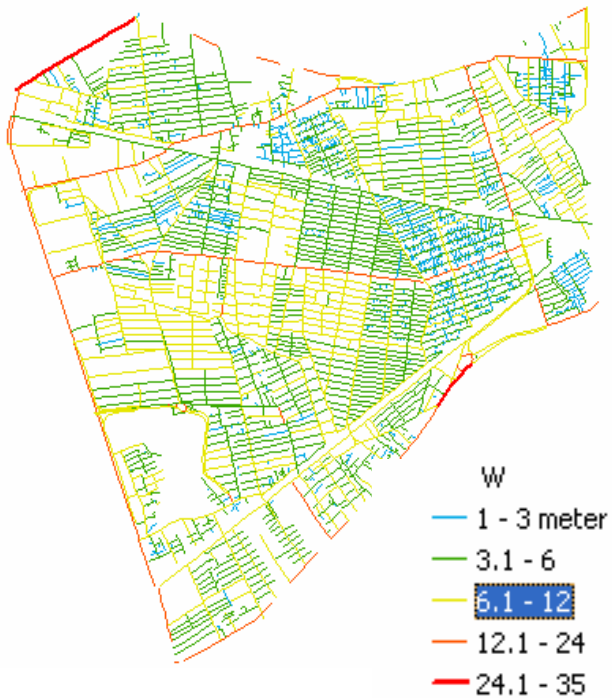
Building stock vulnerability modeling

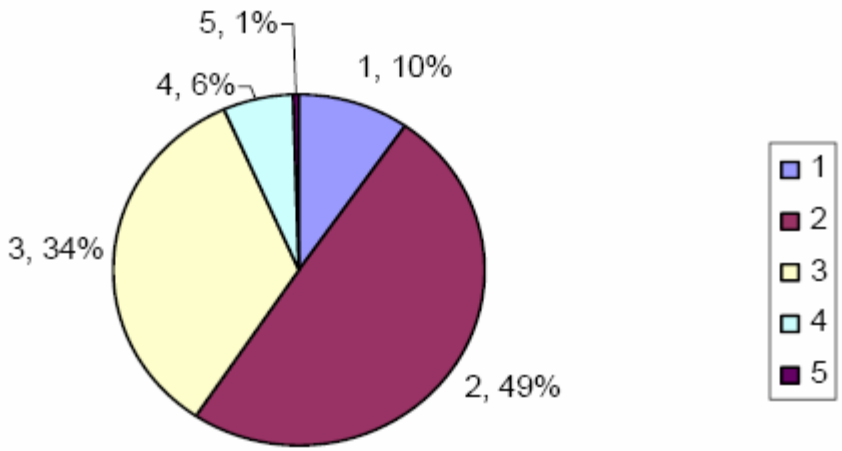


Road network

Classification of the study area roads based on the road width

Road classes	Road width (m)	Road length (m)
Class 1	1~3	21495
Class 2	3~6	110553
Class 3	6~12	75383
Class 4	12~24	13684
Class 5	24~35	1144
		Total: 222259





Pie chart of the road class distribution within district 17

Road network vulnerability modeling

Preliminary Road Blockage Index (Bahreini 1993)

RBI	Criteria
4	W/H < 0.5
3	0.5 < W/H < 1
2	1 <W/H < 2
1	2 < W/H

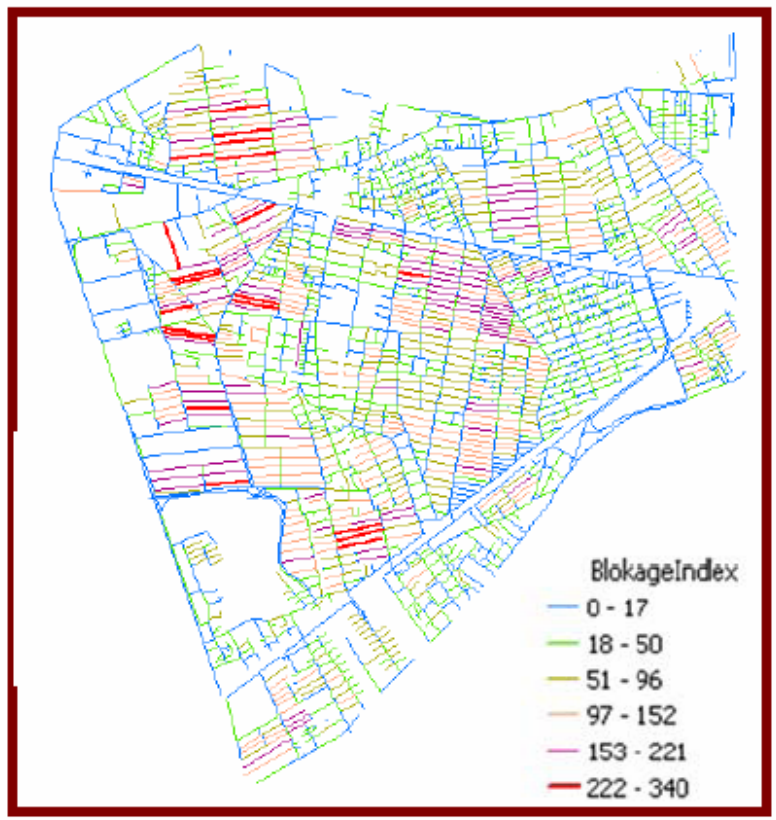
"H" is building height
"W" is adjacent road width

Building Height Specific Debris Modeling

Topological Distance to Road Network (m)	Number of story
3	1
4.5	2
6	3 and upper

Road network vulnerability modeling

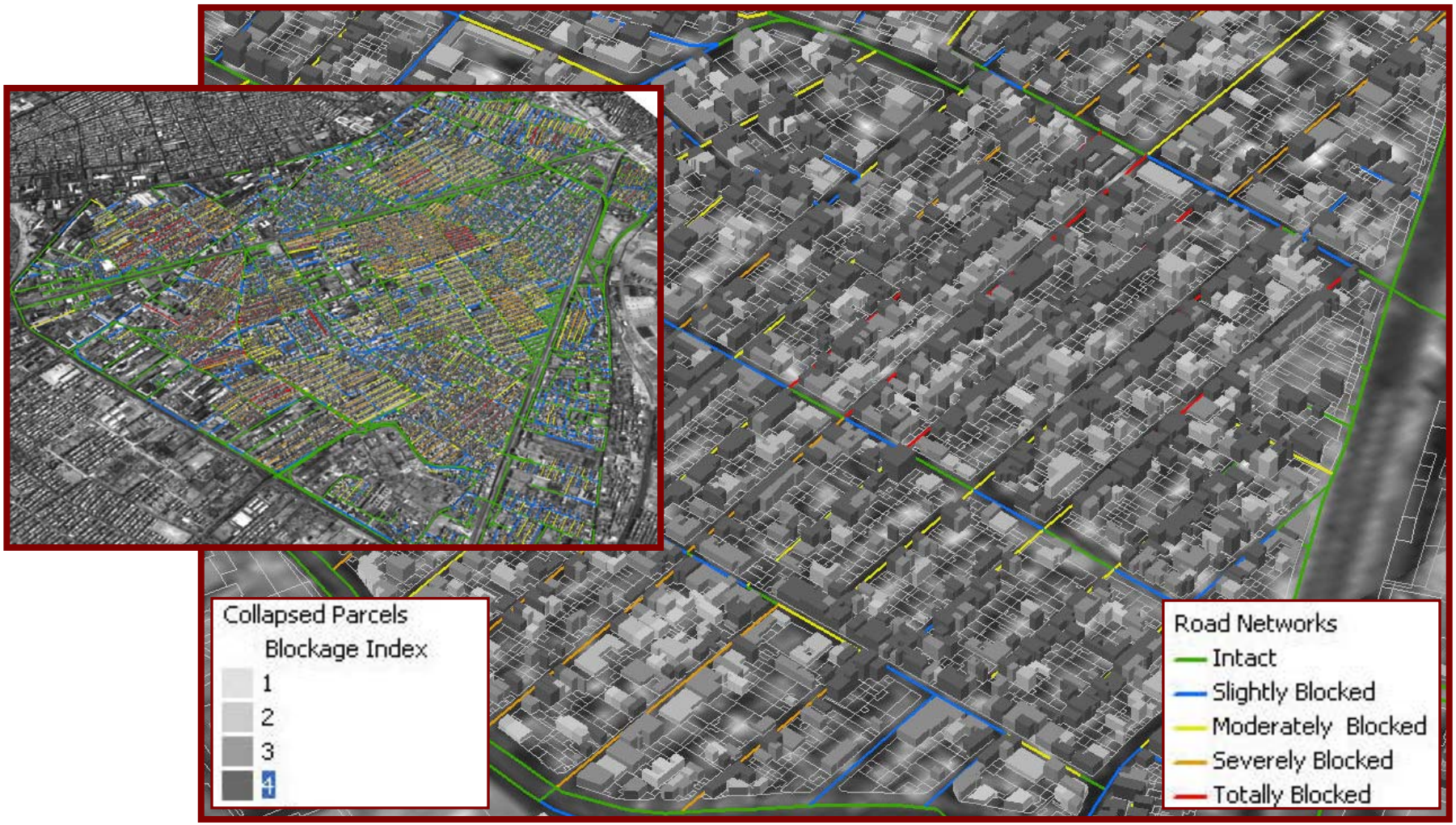
Contributing parcels for the road blockage are highlighted are



Aggregated RBI for individual roads

Result

Probabilistic Road Network Blockage Condition - part of Tehran



Conclusions

- Crucial optimal risk management plan considering all pre and post earthquake phases in disaster management cycles
- Feasibility in reducing the monetary loss and more importantly in reducing human loss
- High volume of data & processing:

  promote such vision, supportively ahead of time