The New Zoning Approach for Earthquake Risk Assessment

Fatmagül BATUK
Betül ŞENGEZER, Ozan EMEM

Yıldız Technical University, Turkey
Geodesy and Photogrammetry & City and Regional Planning

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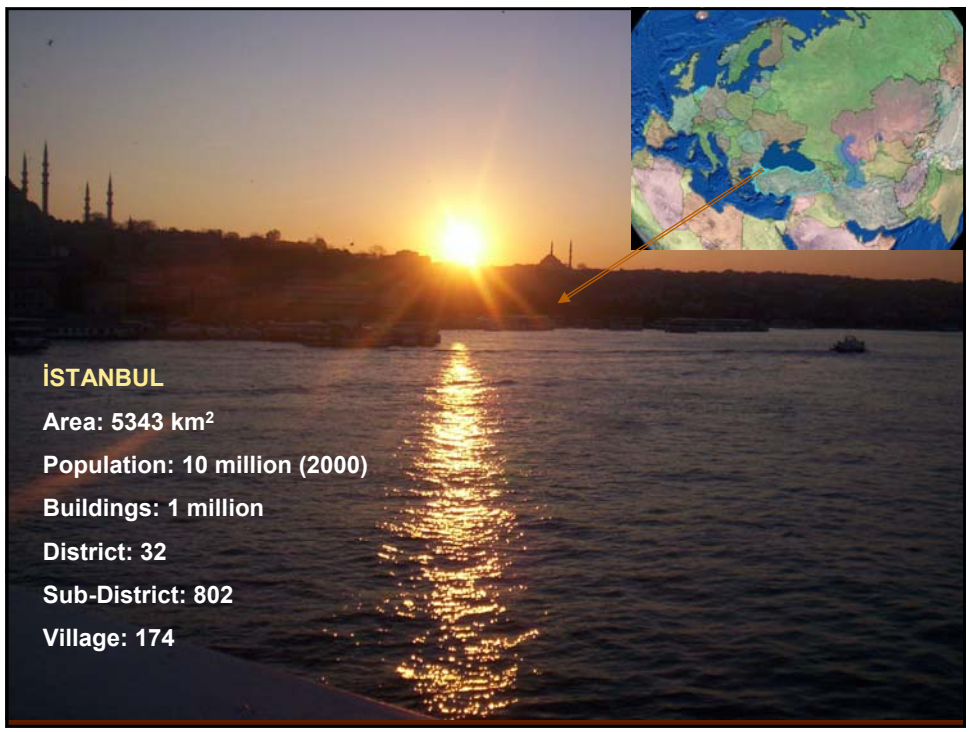


İstanbul

- Largest, most crowded and beautiful city
- Large-scaled earthquake is almost certain to take place, in 30 years
- Scenario of Earthquake (7.5 Mag)
  - 7% of all buildings (51.000) will either collapse or suffer from major damage
  - 73.000 deaths
  - 50 billion $ economical lost

Why?

- Problems
  - poor quality or depreciation of the buildings
  - poor urban environment generated by social, economic and physical deterioration as well as uncontrolled urban growth
  - inflexible planning system which remains incompatible with the dynamics of the city
  - inefficient control

Mitigation

- “sustained action that reduces or eliminates long-term risk to people and property from natural hazards and their effects”

Mitigation Phases

- Risks, Losses
  - Basic data (earthquake)
    - Disasters and their effects
    - Topography
    - Underground facts and their possible outer effects
    - Artificial elements such as buildings, roads, bridges, utilities, ...
    - Population, economy, ...
  - Scientific methods
- Alternatives and planning
  - Priority areas and reality (risks, potentials)
  - Benefit-cost analysis
  - Plans; macro, mezzo and micro levels
- Plans application and sustainability

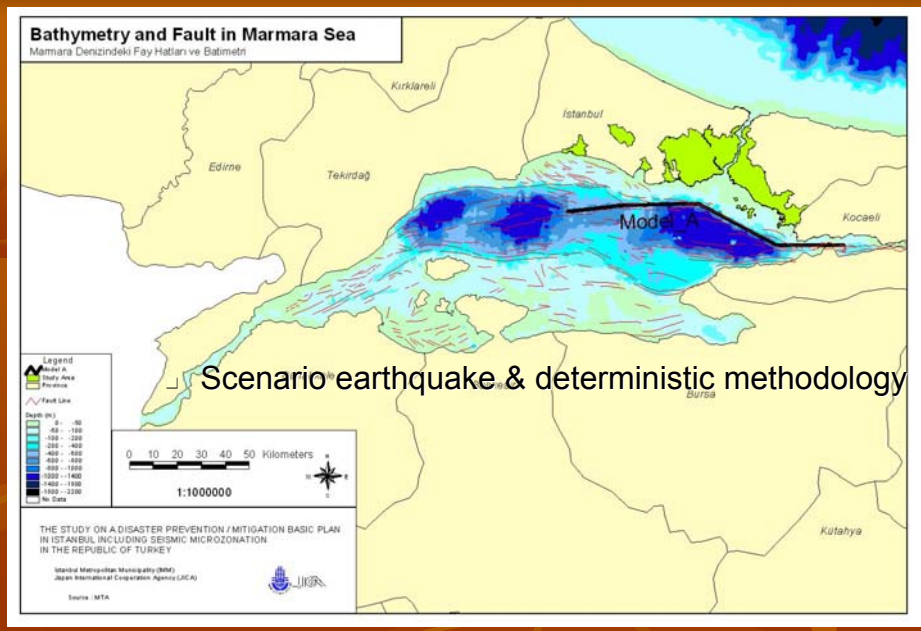
Mitigation

- Nowadays hazard assessment and mitigation planning has become easier & effective by using GIS
- But we need to get
  - complete & accurate data
  - reliable & programmable methods

İstanbul & Earthquake Risk

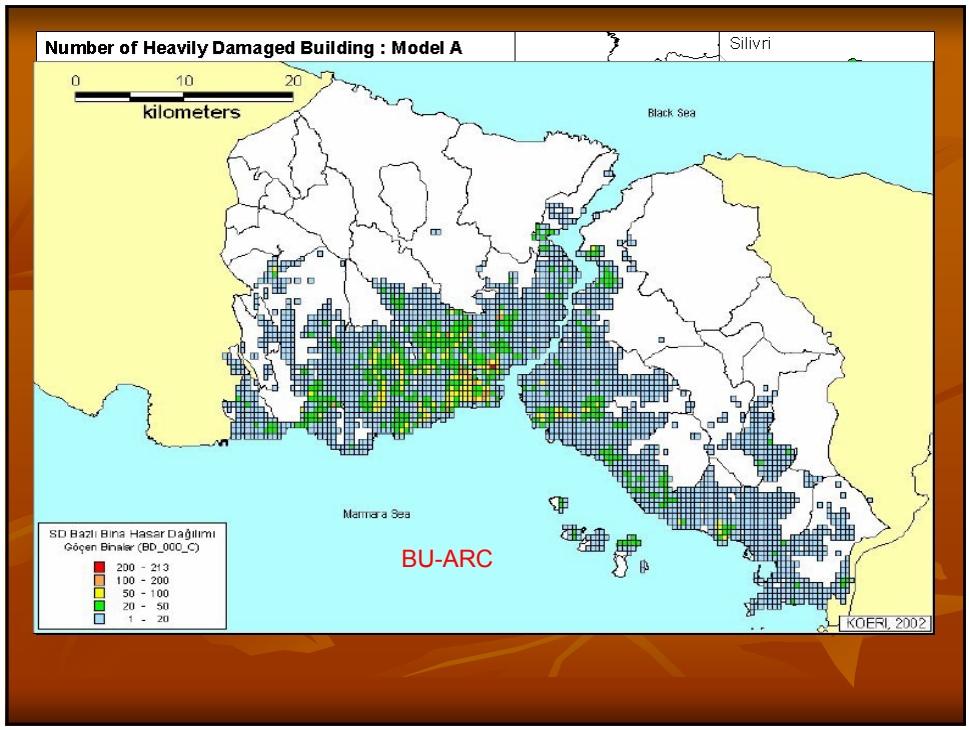
- The Study on a Disaster Prevention / Mitigation Basic Plan in Istanbul

  (JICA-IMM 2002)
- Earthquake Risk Assessment for Istanbul Metropolitan Area (BU-ARC 2002)



Scenario earthquake & deterministic methodology

- Social and physical losses based on
  - sub-district - JICA-IMM
  - cell (400 m x 600 m) - BU-ARC



Istanbul Earthquake Master Plan Project (IEMP) 2002-2003

- In order to mitigate heavy losses in the event of a large-scaled earthquake, Istanbul Metropolitan Municipality (IMM) has undertaken a variety of precautions since 1999
- Academic staff and students from the four universities in Turkey have taken part in the project for the purpose of defining road maps that could reduce risks dramatically
  - Bosphorus University (BU), Istanbul Technical University, Middle East Technical University and Yıldız Technical University (YTU)
    - 200 scientists

IEMP

- Scope
  - assessment of current situation
  - seismic assessment and rehabilitation of existing buildings
  - issues about urban planning, legal, financial, educational, social, risk and disaster management
  - planning of the activities in these fields, preparation of implementation programs
  - identification of the responsibilities and responsible authorities for earthquake disaster mitigation works

YTU Settlement and Urban Planning Group

- Team
  - Urban and Regional Planning
  - Geodesy and Photogrammetric Engineering
  - BU- Earthquake Engineering (Consultant)
- Goals
  - diminishing the hazardous effects of a possible earthquake
  - improving the quality of the natural and urban environment
- Focuses
  - conceptualisation of strategic planning
  - problems and potentials of the Istanbul Metropolitan Area
  - a roadmap including strategies, planning instruments, and priorities at various levels
  - some institutional and legal considerations

YTU Settlement and Urban Planning Group

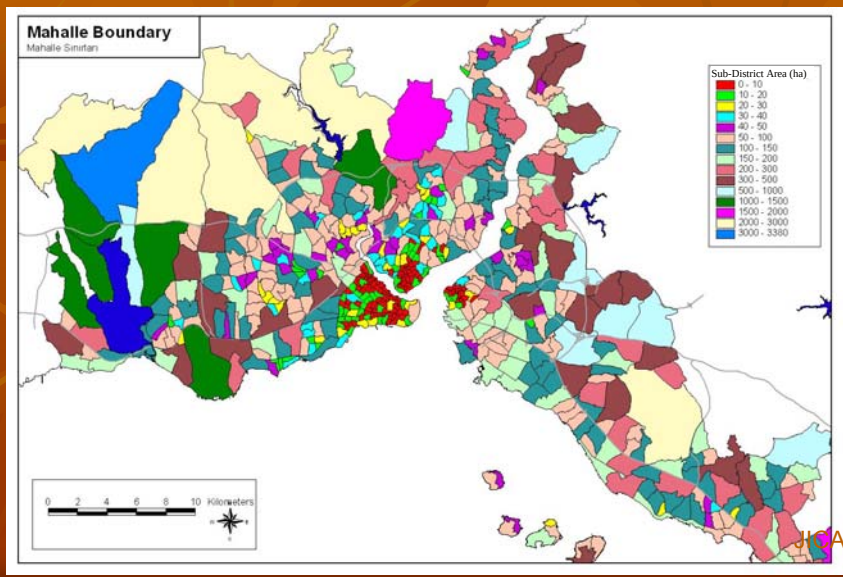
- Zones
  - problems
  - potentials
  - suggestions
- Data/Information
  - JICA-IMM
  - BU-ARC
  - IMM GIS & CAD data

Data Problems

- Social and physical losses have been determined on the sub-district bases
- In defining risks on this level there emerged two fundamental problems
  - Relative comparison of risks
  - Uncertainity

JICA-IMM

- Different Area Sizes, Intensity, Functions, Large Public Facilities

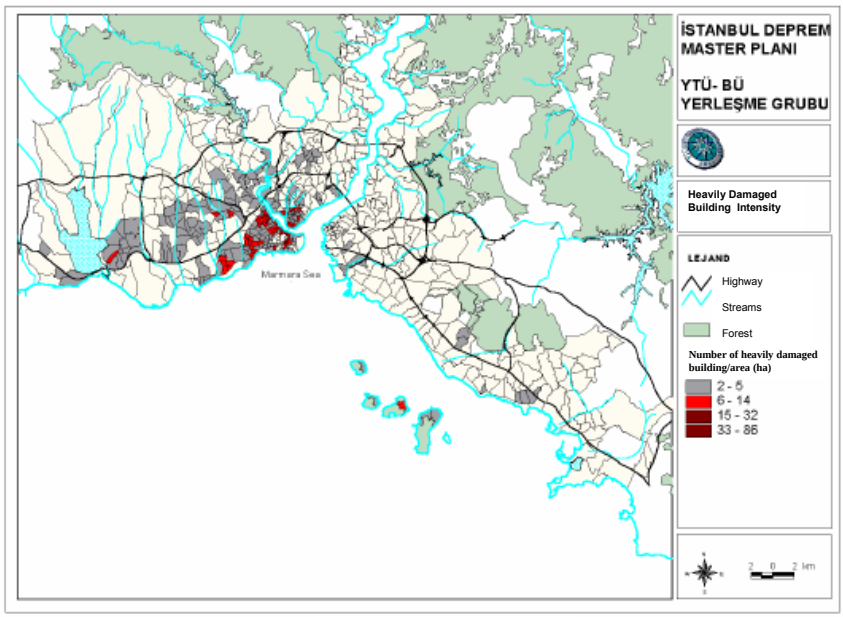


JICA-IMM

Solution

- A location quotient has been calculated for the rate of buildings expected to be heavily damaged (BEHD) in each sub-district
- JICA data showing the density of the BEHD in each sub-district has further been analysed and reproduced in the form of standard units of hectares
- The data obtained by the above method for each hectare has been multiplied by building density and population density of its unit for achieving a more realistic picture of the areas which will experience greatest loss of lives and economic value due to a possible earthquake in Istanbul respectively
  - Area of large public centers (public institutions, industrial sites etc.) are excluded
  - High density sub-districts with relatively small lands seem to suffer a heavier volume of damage

JICA-IMM



Data Problems
Risks-Cells

- Hard to comment about the reliability of data and information-different sources
- Cells contain different formations, functions and densities
  - affect the loss from different directions

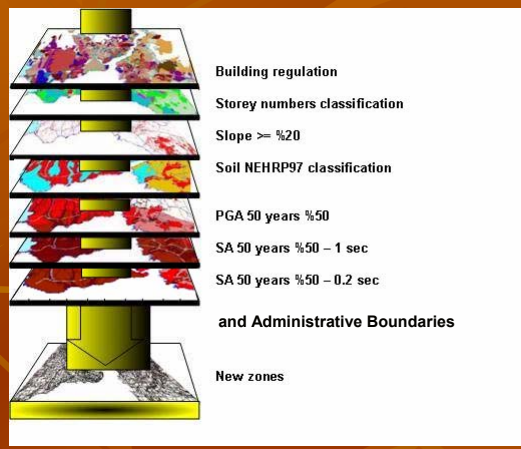
Proposed Zoning Design

- During the IEMP project, some difficulties have been appeared for risk assessment
- Some processes related to spatial decisions such as definition of priority areas were applied just for macro level
- It was required to define sub-areas which were changed in macro level, estimate the loss in respect of possible damage models which was found according to different structure characteristics and computational methods, and prepare cost-benefit analyses
- YTU team has developed a new zoning approach for risk zoning based on density, pattern and other properties according to the requirements of previous projects with the contribution of BU project team

- In Istanbul metropolitan area, different patterns of society, income groups, functions and different building groups are at some point in close proximity and at other they are interwoven
- An indication to be benefited from in order to classify those groups is density and the other is pattern
- The determiners of density are land use and heights
- Other characteristics to be classified are geological differences and slope
- Earthquake characteristics have been determined in classifications according to the velocity reaction values obtained over the probability method

- It is possible to make correct loss estimations by determining zones featuring different characteristics on macro level and by applying a variety of damage estimation models prepared in line with different structure characteristics
- Assessing the loss estimations of differing zones on unit basis, it will be possible to determine the risk priority areas
- In the IEMP, based on the current risk analyses, strategies have been devised at metropolitan city level or macro level, by putting forth a general risk-zoning process

Data Design



Building regulation

Storey numbers classification

Slope >= %20

Soil NEHRP97 classification

PGA 50 years %50

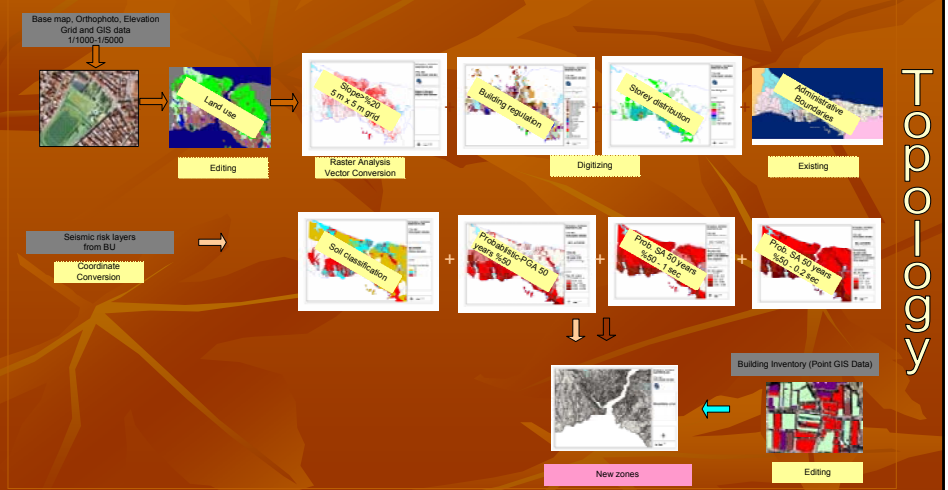
SA 50 years %50 – 1 sec

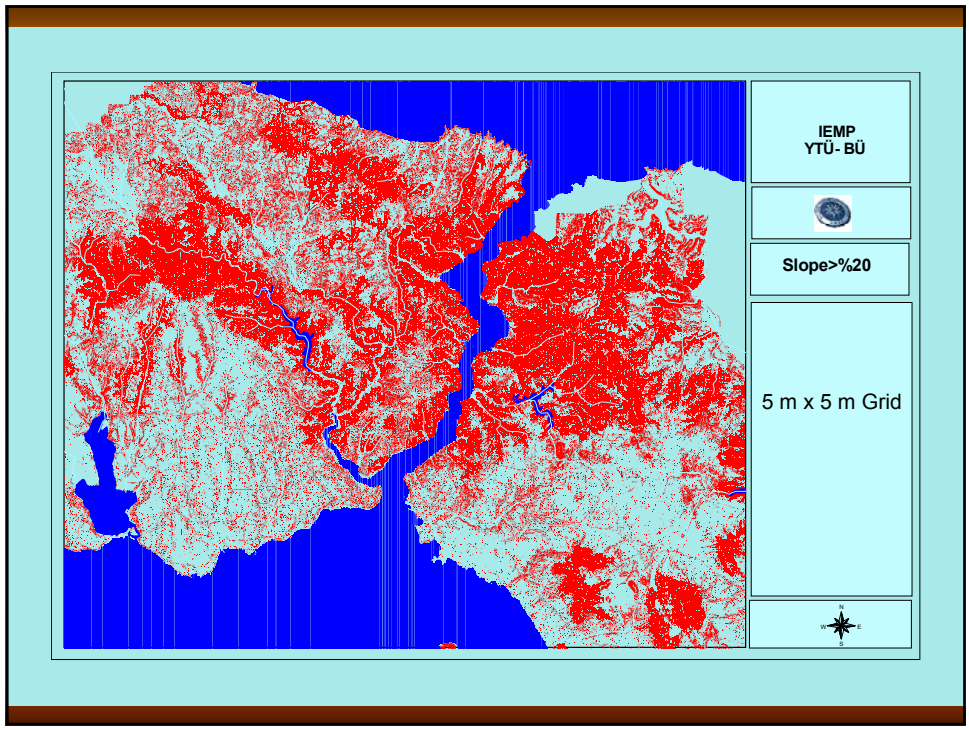
SA 50 years %50 – 0.2 sec

and Administrative Boundaries

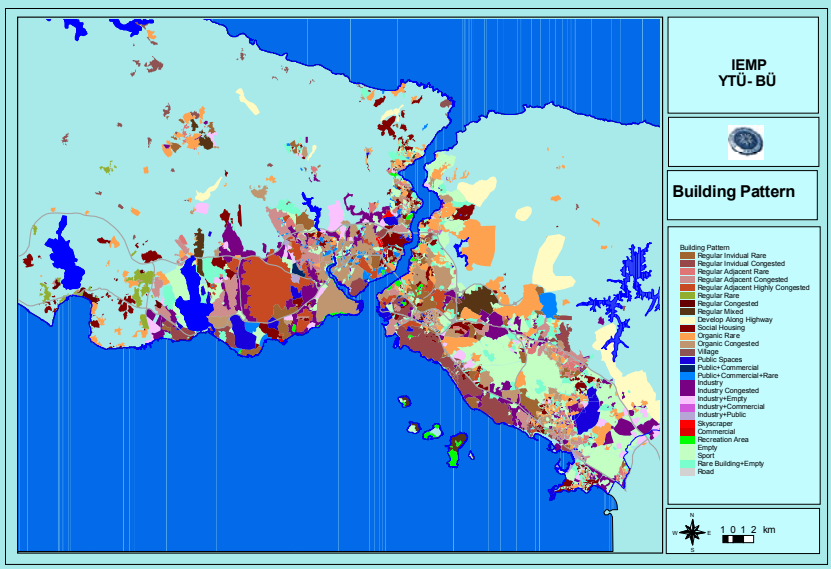
New zones

Data Process Flow

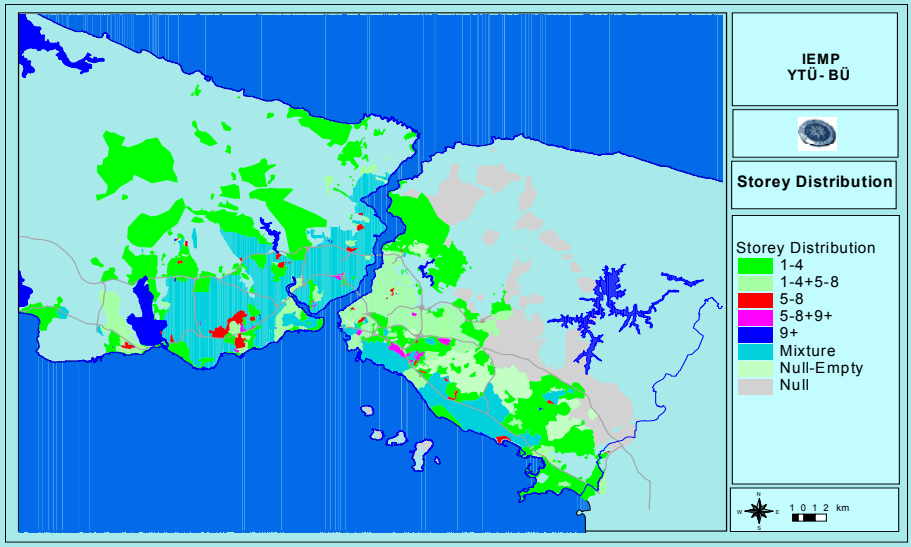


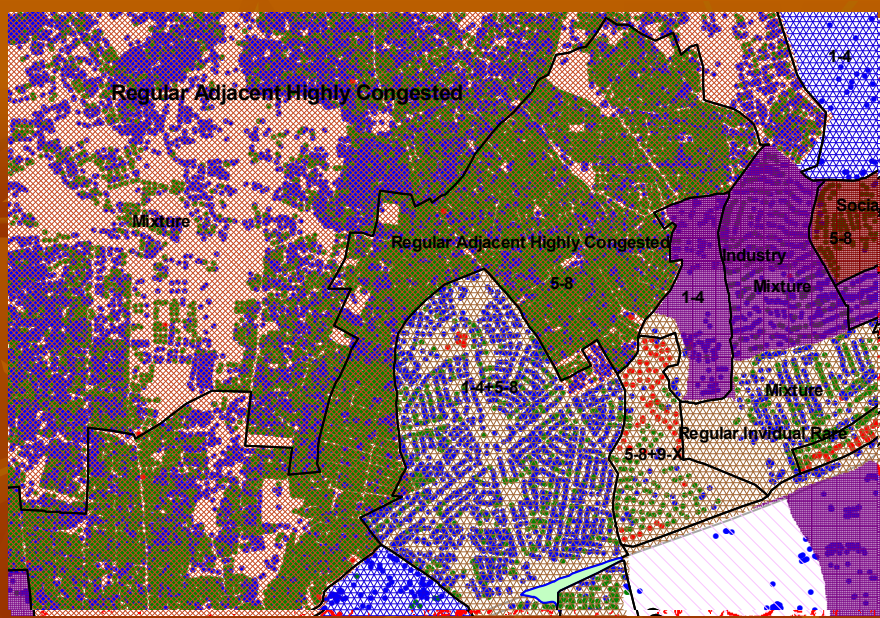


Building Regulation/Pattern

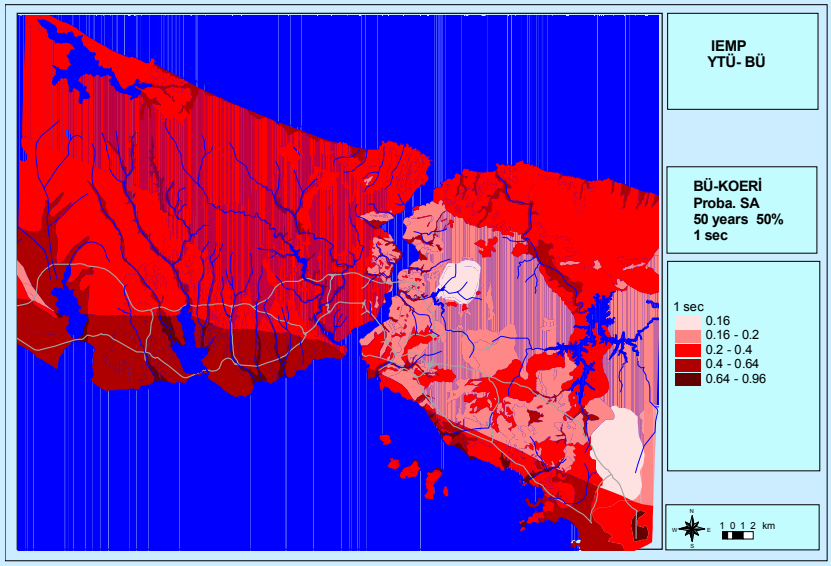


Storey Distribution





BU Team

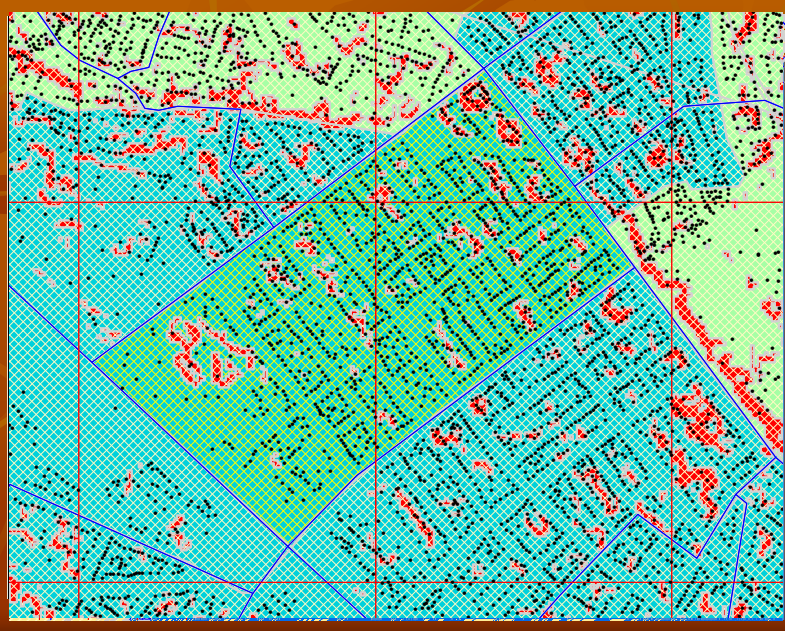


Inventory Data

Point Data

- Point building data - building counts
  - construction type & area & floor number
  - daily and night population
  - main function
- Building construction dates could not be obtained
- If they were added to the study, then it would be necessary to state the buildings as those constructed in 1979 and before, those constructed between 1980-1998 and those constructed in 1998 and after, along with the number of floors and construction type. In the mentioned years some alterations were made at the Earthquake Regulations, which, of course, affected the construction of buildings
- However, in the damage analyses after the earthquake, it was observed that no significant damage occurred between buildings constructed before 1975 and after the year

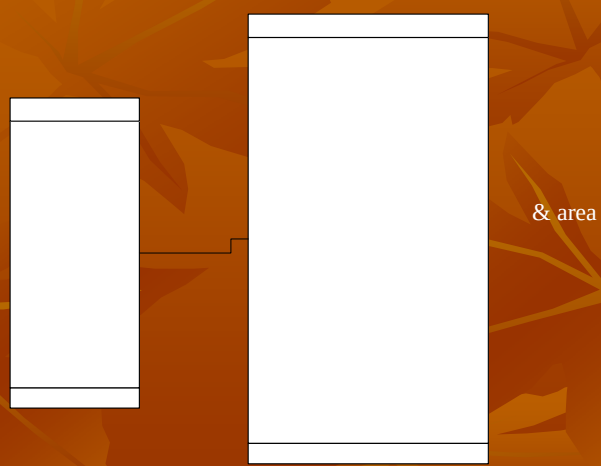
Overlay



Database Operations

- Calculations (each zone)
  - Combinations
    - Construction Type & Storey Groups & Area
  - Construction area
  - Construction base area
  - Taks (construction base area/zone area)
  - Kaks (construction area/zone area)
  - Population density

Database



Risk Assesment (Next)

- New attributes for each zone
  - Damage grades & the number of building & construction area
  - The number of death
  - The number of injury

Spatial Analysis Scenarios

- With the obtained results, a more accurate and realistic estimation regarding the risk reduction in priority areas could be made, and thanks to the cost-benefit analyses a variety of solutions could be brought about
- The number of damaged buildings = the number of heavily and more damaged buildings / zone area
- Risk = the number of heavily and more damaged buildings / total number of buildings = A

Spatial Analysis Scenarios

- If A > 50% (approximate rate, a certain value is not clear for our country)
  - It could be a priority area
  - Other factors need to be studied closer
    - If A > 50% and TAKS > 0.75, KAKS > 2.5
      - the rate of density is high with no good environmental conditions
      - they have the priority for studies
      - detailed microzoning and urban transformation researchers must be done as well as cost-benefit studies

Spatial Analysis Scenarios

- It may be decided to retrofit or reconstruct the building in question
- Instead of individually retrofiting buildings, it may be preferred to increase the total quality of the environment by tearing down all buildings and reconstructing them
- Instead of increasing the level of security one by one with a new plan, many benefits may be obtained over the total increase of environmental quality
- If the risk is high and the income and education levels are low, some incentives may be provided with the help of government
- In order to achieve urban transformation, it is possible to elevate the amount of synergy by combining the constructional aims with social development projects
- For regions emerging with peculiar patterns and function characteristics, different project methods and reinforcement techniques, for example not to spoil their historical pattern, should be thought of

Conclusion

- The rapid growth rate in metropolitan cities like Istanbul doubled with problems regarding city planning as well as problems with construction techniques, which as a result dramatically increased the risk of vulnerability in the event of a major earthquake
- Projects launched with the pioneering local administrations in cooperation with universities have proved to be initial step taken in the direction of eliminating the factors that may cost may lives, and disaster management mitigation efforts have been put into action

Conclusion

- YTU settlement and urban planning team has applied indicators defining the problems of Istanbul on macro level, harmonizing them with risk indicators, thus, obtaining general priority areas
- As a result, according to their typologies, offers and strategies for solution have been brought about
- With the help of aforementioned approaches, the priority areas have been determined but the amount of land equals almost one-third of the city, which necessitates the urgency to narrow and specify the risky areas in order to immediately start to apply solutions
- For the purpose of using the time the best way possible way until a probable earthquake, a method to be developed by using the present data has been suggested, and the fundamentals that may operate the risk model have been prepared at GIS environment

Conclusion

- Zones have been produced by overlapping vector data that includes administrative borders and other data regarding the pattern, floor count, slope and earthquake
- Building inventory, functions, and population data to each zone transferred
- Areas will be assessed with the BU KOERILoss software and on new areas basis physical, economic and social losses may be calculated. Results will be assessed and risk priority areas will be determined, rendering the strategies clearer for more detailed studies

Conclusion

- In researched studies and current projects, it is not possible to check the correctness of the information obtained as a result of earthquake loss estimation and vulnerability methodology
- According to our point of view, the underlying reason of the above situation stems from various data collected from different sources each of which have different scales, reliability and belong to various time periods, at some points the lack of proper and necessary information and the insufficiency of information produced at sub-district, census tract, zip code or various cell levels
- The only solution seems to develop NDSI applications which include multi hazard analysis and loss estimation data, and the subject should also be given more priority in e-government applications as is the case in developed countries


Thanks