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SEISMIC ASSESSMENT OF THE ARCHITECTURAL HERITAGE IN THE FATIH DISTRICT OF ISTANBUL

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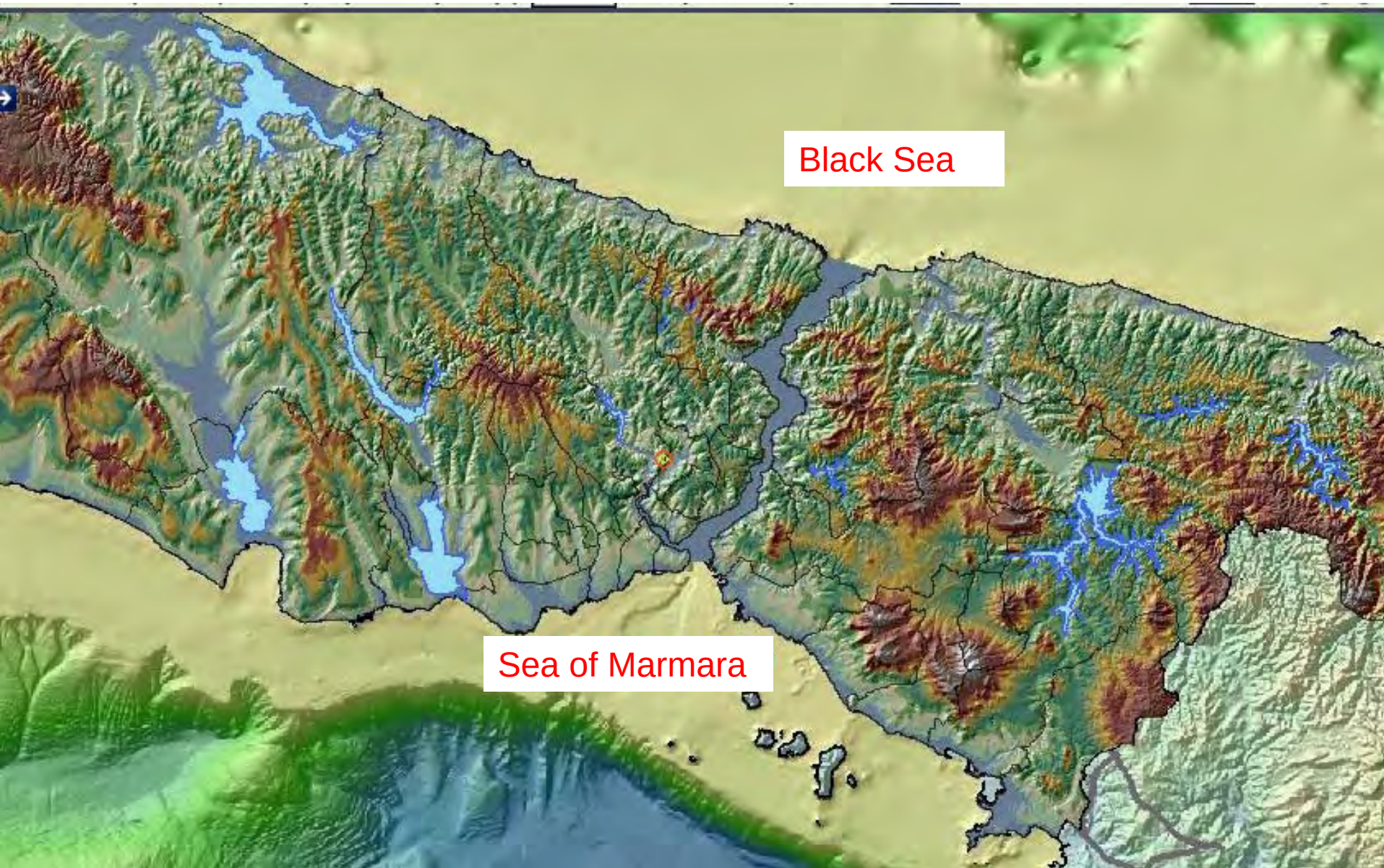
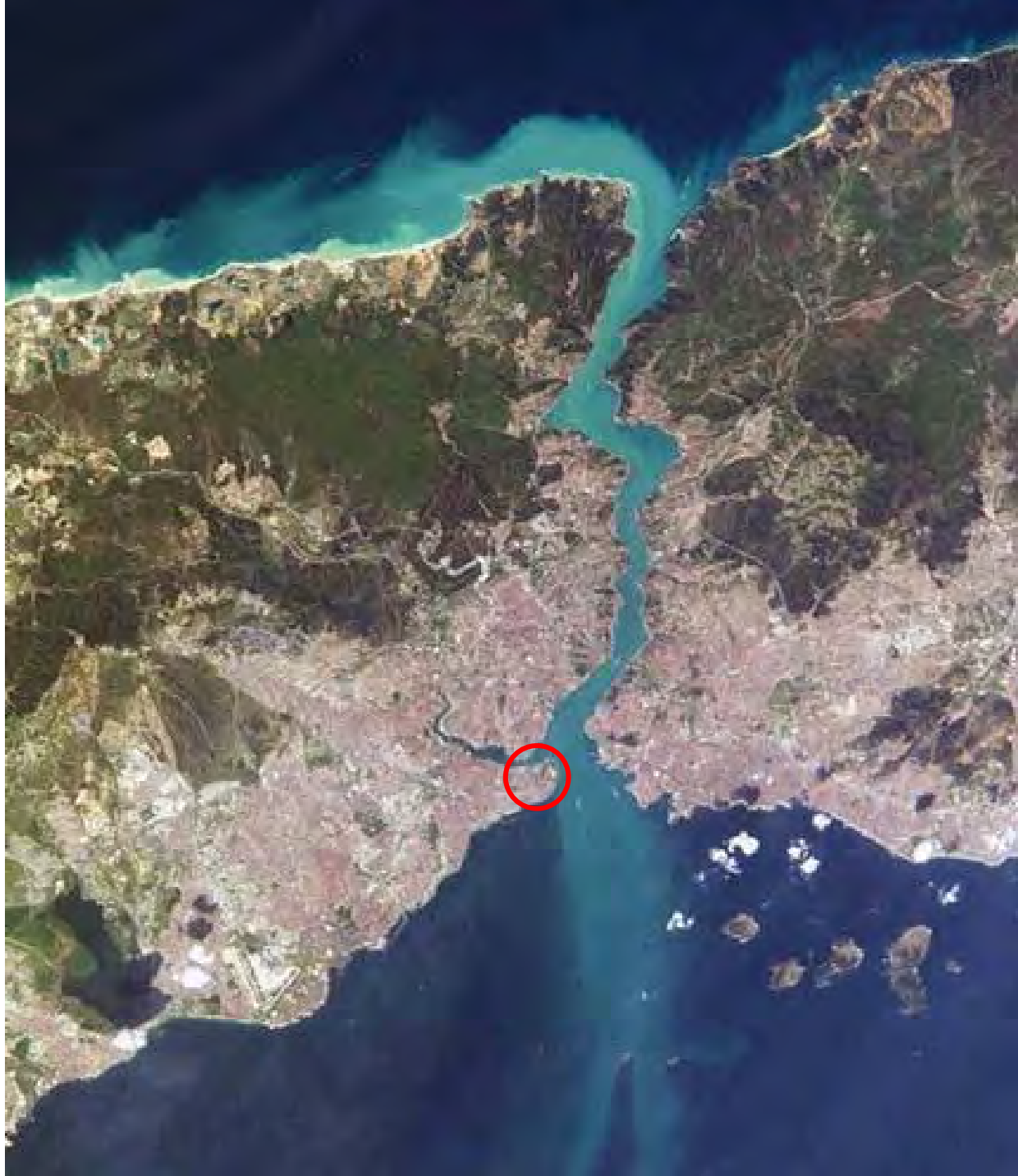
Geographic relief



Current urban sprawl: 1,200 km^2, 39 sub-districts, 12.6M residents.

Historic peninsula is the ancient heart of the 2,500-year old city.

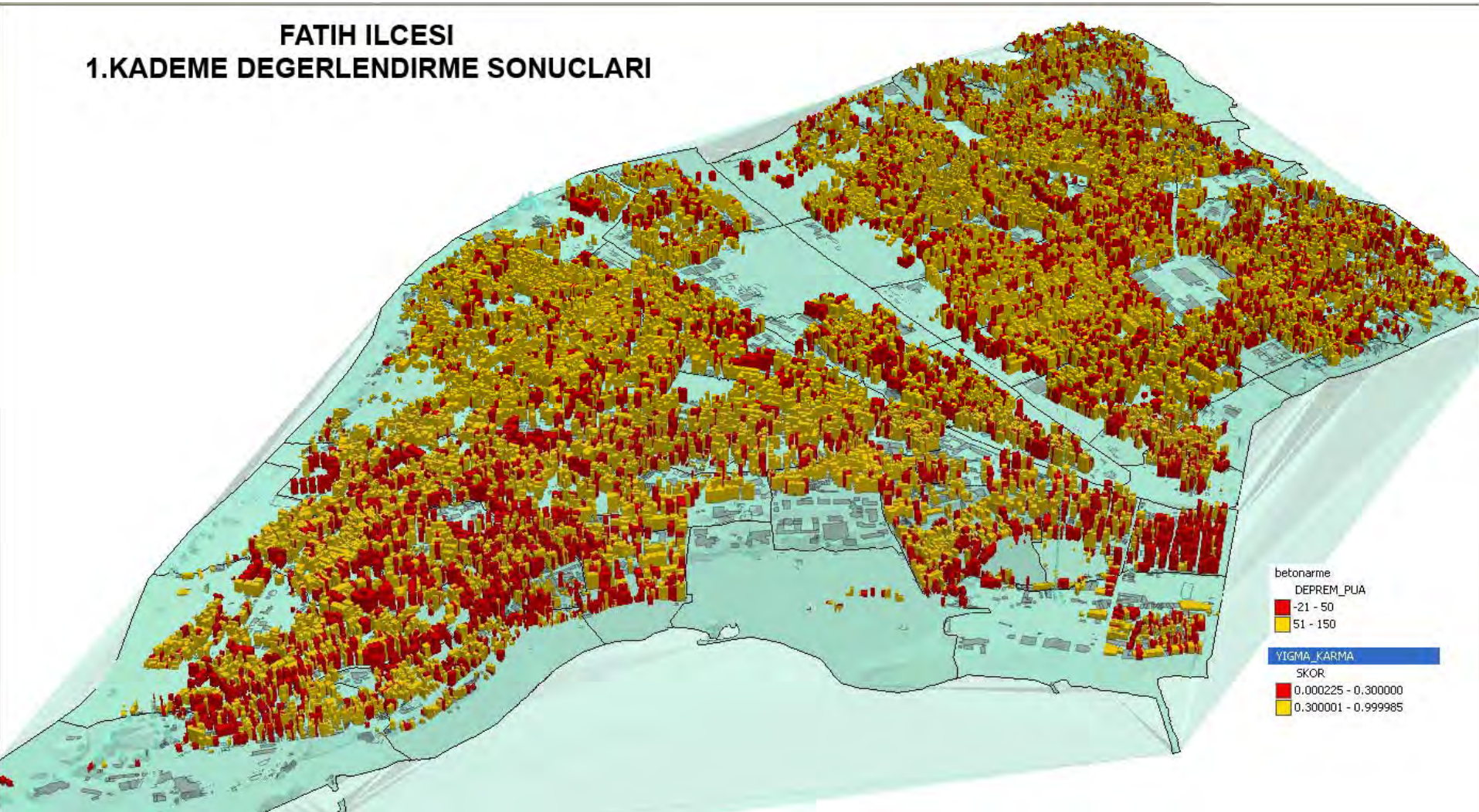



Sea of Marmara
Sea walls
Land walls
Golden Horn
Istanbul Strait

THE 2500-YEAR OLD CITY


BEYOĞLU
D.100
EMİNÖNÜ
ZEYTİNBURNU

Housing stock in Fatih: 30,000 buildings. Current population: 500,000. Size: 13 km^2.



Current urban view

Fatih boasts 4000+ registered historic buildings or sites under protection. These fall into many types: mosques, churches, fountains, walls, tombs, cisterns, lodges for religious orders, cemeteries, public baths, welfare facilities, schools and many others.

These date from Roman, Byzantine and Ottoman periods. They represent diverse building and architectural styles, materials and sizes. They are all under some form of protection.

It was judged that even simplified seismic assessment of these would require many years to complete, using many teams of experts.

Successive short listing reduced the final number of buildings to be considered to 221. These were surveyed by a first-tier procedure.

Of these 20 were subjected to detailed analyses.

Breakdown of the buildings included in the survey

Mosque	**91**	**School**	**15**	**Lodge**	**18**	**Church**	**32**
Tomb	**23**	**Seminary**	**14**	**Mortmain**	**5**	**Public Bath**	**3**
Unity Room	**1**	**Koran School**	**3**	**Private House**	**8**	**Institutional**	**1**
Museum	**1**	**Hospital**	**2**	**Public Kitchen**	**1**	**Fountain**	**1**
Library	**1**	**Timing House**	**1**	**Oil Press**	**1**	**Cistern**	**1**

Mosque

Mosque

Mosque

Public bath

Church

Oil press

Church

Koran school

Seminary

Lodge

Tomb

Remains of cistern

In keeping with the **Law on Preservation of Natural and Cultural Heritage Assets**, detailed registers were created for each building listing information on:

- Identification details (date built, builder, purpose, current owner, address, GPS coordinates)
- Site and vicinity information (neighboring/adjacent buildings, site geology)
- Building/conservation information (architectural style, dates of previous interventions, contents, heights of levels, floor details)
- Load carrying system
- Previous significant damages, if any, from earthquakes of 1509, 1766, 1894 and 1999
- Extensive photographic records

Stages of survey:

- 3-D laser scan measurements
- Inspection of current state (materials, signs of previous interventions, damages, settlements, etc.)
- Creation of point cloud for digital representation of building; wall thicknesses, openings, plan and elevation views drawn via CAD
- Taking of photographs using high-resolution cameras, create photogrammetric views using ortho-photo techniques
- Transferring photogrammetric views to CAD data

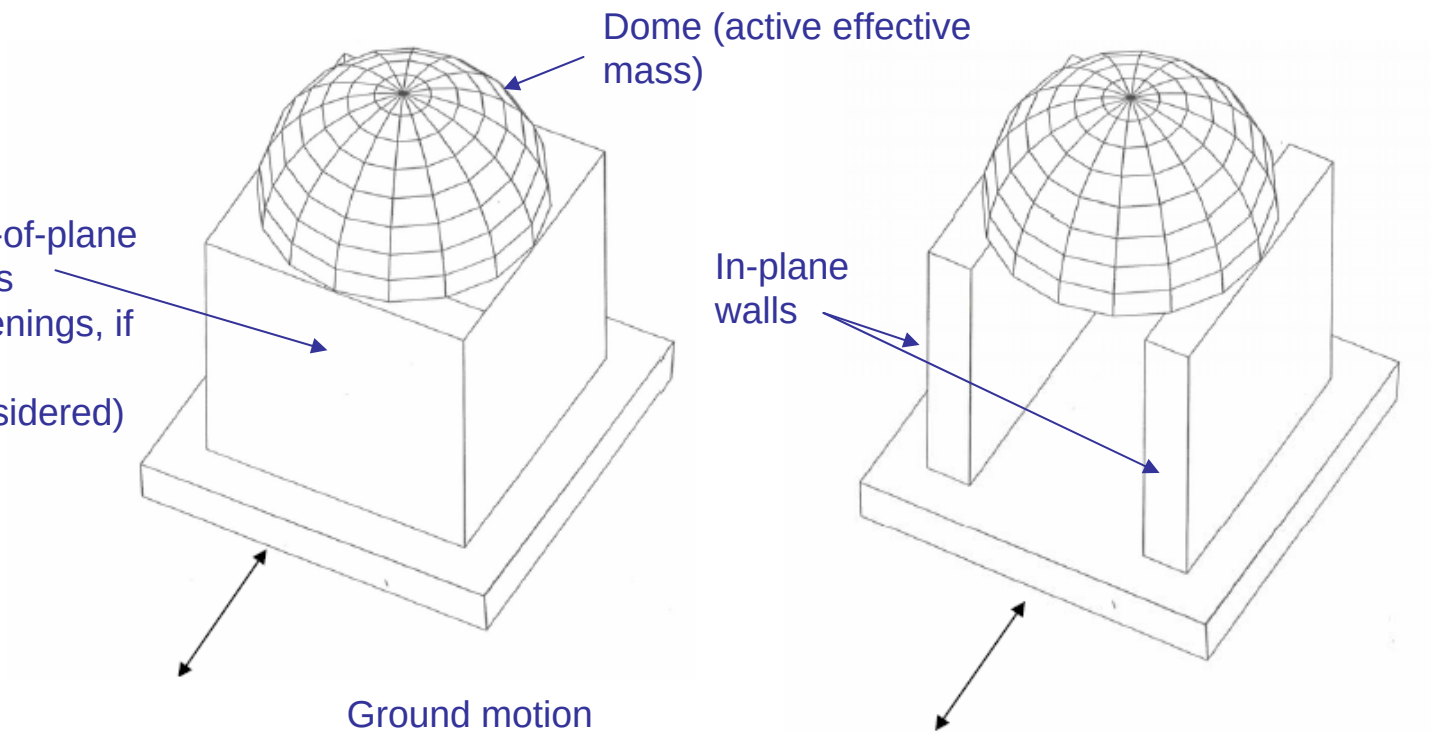
Laser scanning in progress

Exact coordinates noted on urban site plan

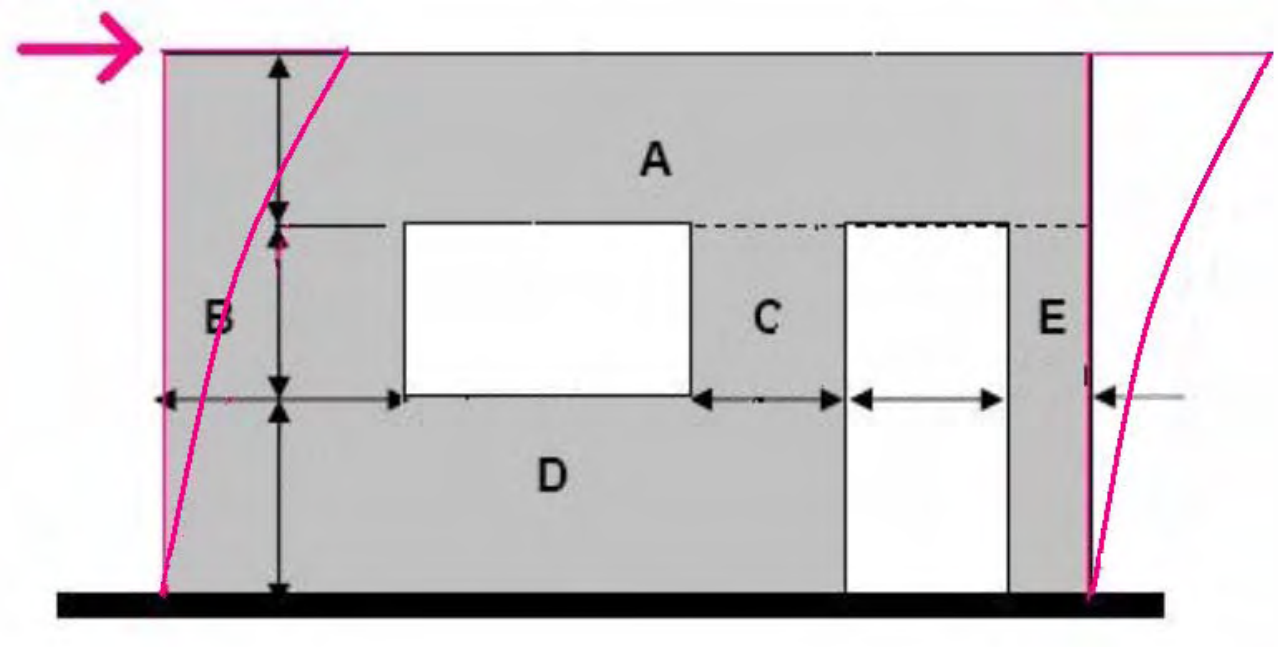
Two different levels of building assessment were conducted:

- Preliminary or simplified assessment (for all buildings in the survey)
- Detailed assessment (for 20 selected buildings)

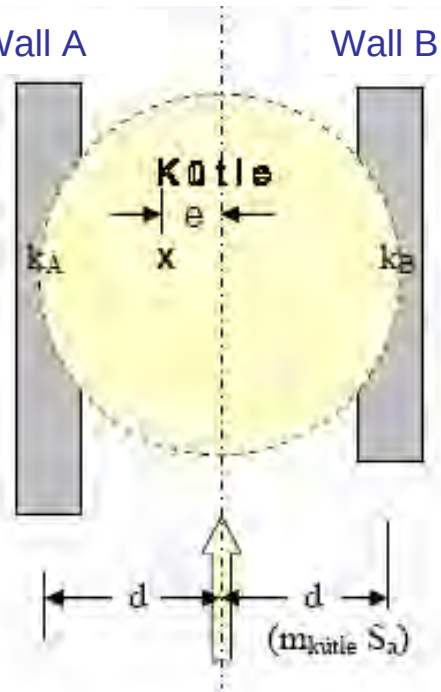
Idealized historic building for simplified assessment



Consider the effect of reduction in stiffness on account of openings



Estimate inertia forces on in-plane walls and calculate corresponding shear stresses



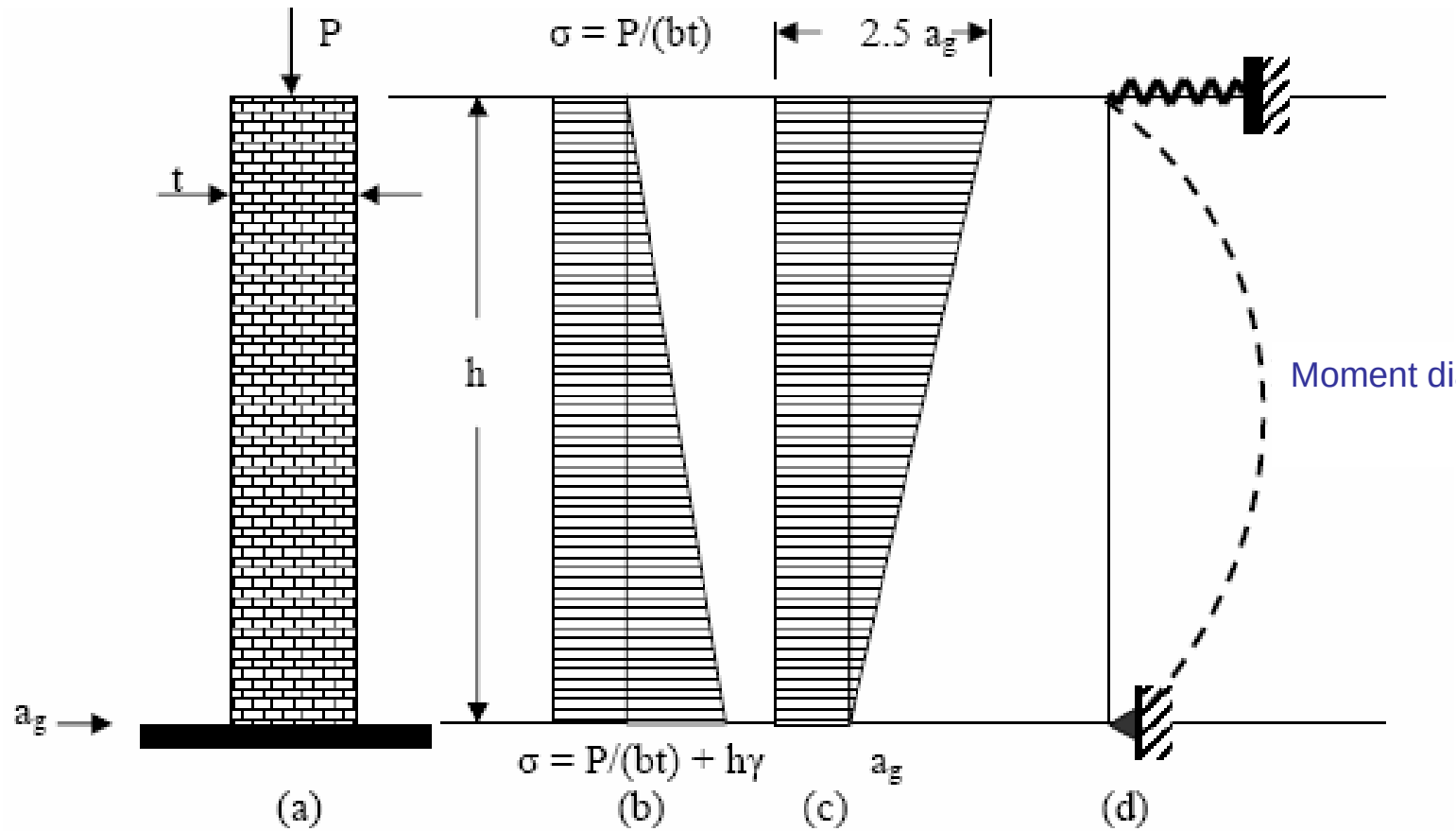
$k_A > k_B$

e = eccentricity

$$e = \frac{(k_A - k_B)d}{k_A + k_B}$$

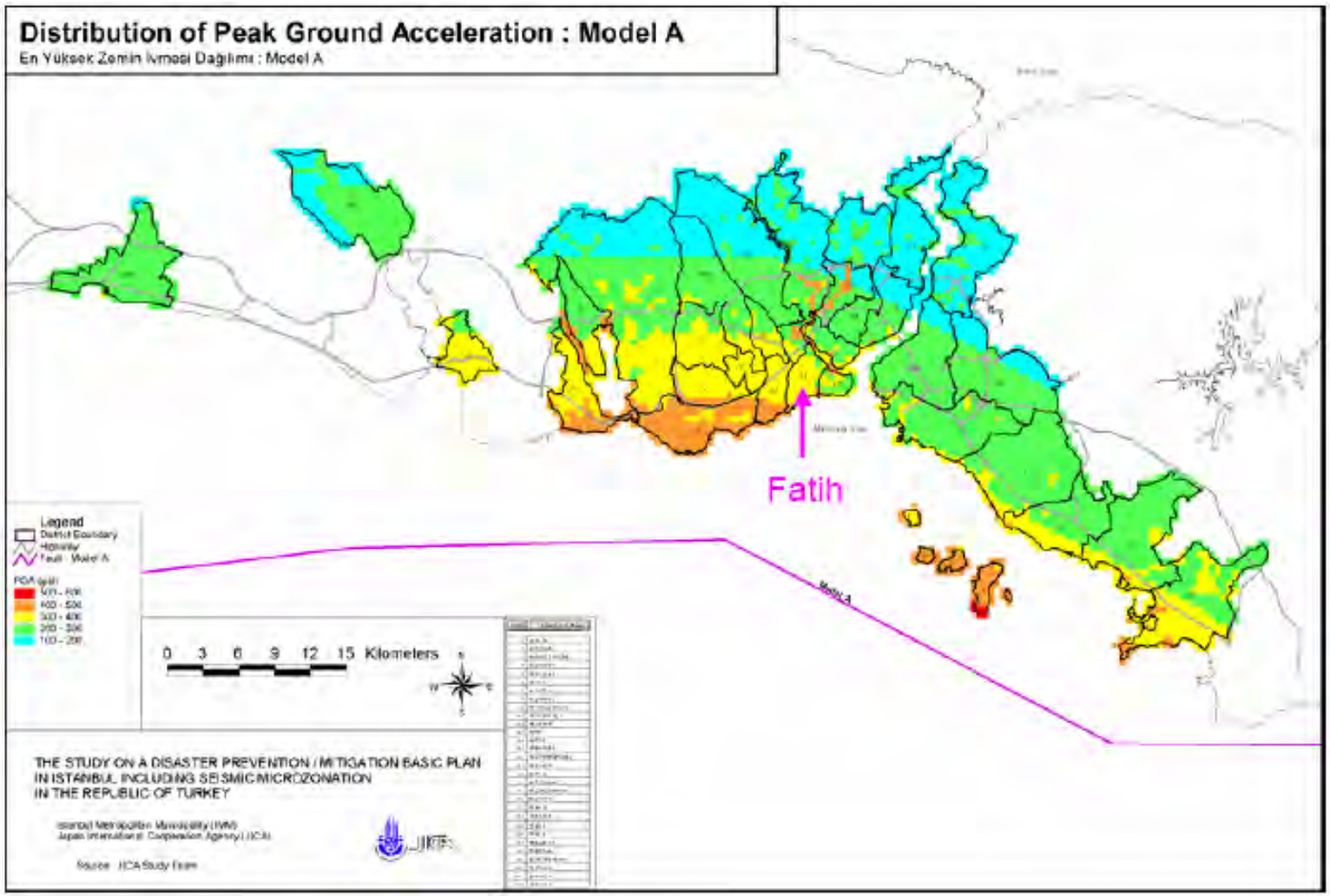
$$F_i = m_{kütle} S_a \frac{k_i}{\Sigma k_i} - m_{kütle} S_a e \frac{x_i k_i}{\Sigma x_i^2 k_i} \quad (1)$$

Estimate inertia forces on out-of-plane walls and calculate corresponding bending stresses

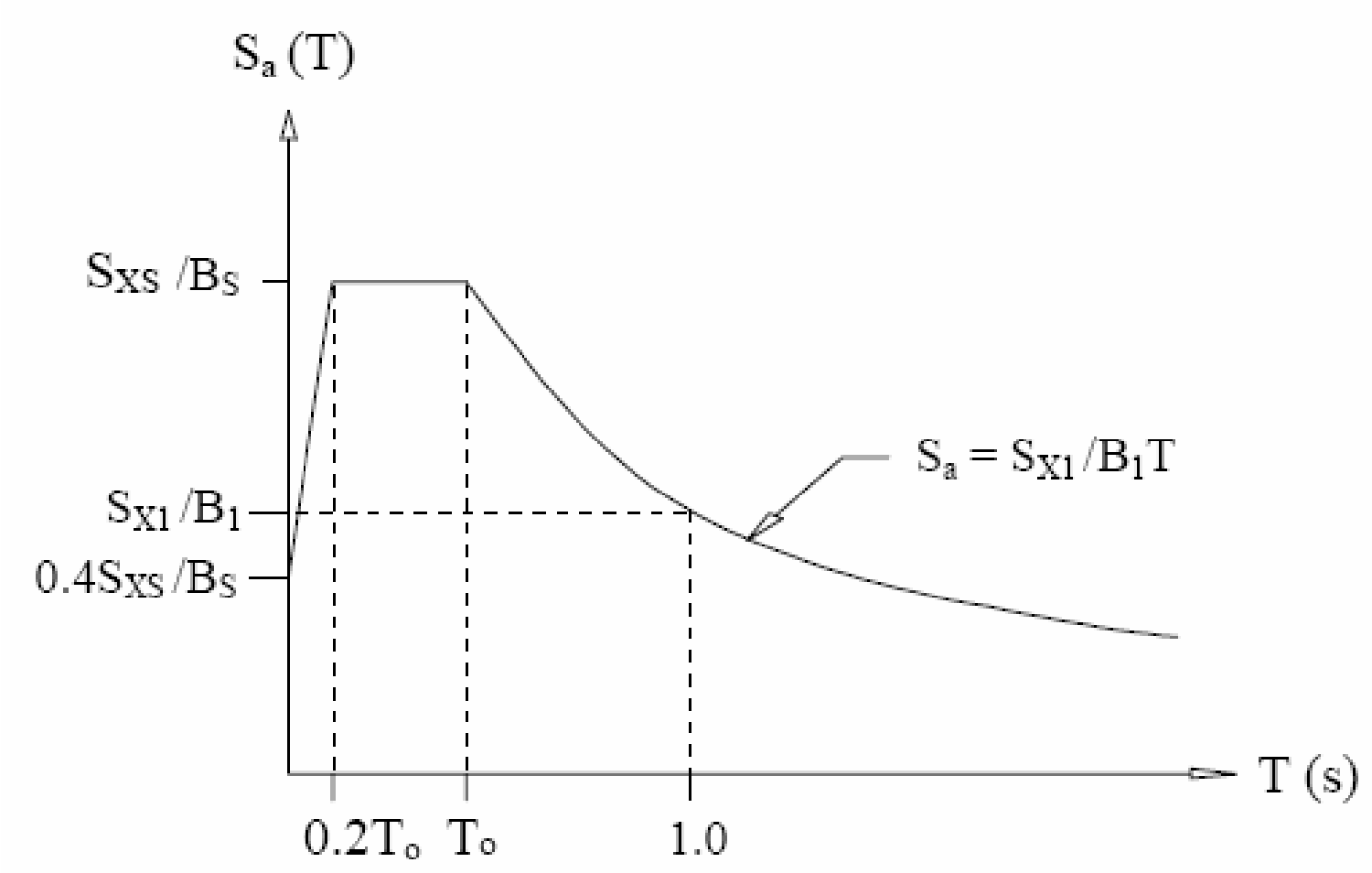


Moment diagram

Assumed seismic event: M7.2 earthquake on North Anatolian Earthquake shown as red line. Distance to each building calculated for ground motion prediction.



NEHRP-style site specific response spectrum derived for each building site



Calculation of in-plane shear stresses and out-of-plane bending moments were programmed as a spread sheet procedure. This way, calculated stresses were calculated and compared with limiting stresses for masonry walls to reach a judgment about probable performance during assumed earthquake.

- Most buildings appear to survive the scenario earthquake without collapse.
- Most vulnerable parts of mosques are the slender and tall minarets. Many of these are likely to collapse.

Detailed assessment was done on 20 selected buildings. Linear response history analyses were run on these because of many unknowns that are involved in historic buildings.