



Building typologies for empirical and analytical risk assessment: Case Study Antakya

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*** Antakya, Hatay (Turkey) ***

SERAMAR-Project



Seismic Risk Assessment and Mitigation in the Antakya-Maras Region on the basis of Microzonation, Vulnerability and Preparedness Studies

Contributions (Weimar only):

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Seismic Risk Assessment

General questions and demands

SERAMAR-Project



Question:

**How could we ensure a high reliability of
Risk assessment and Damage Prognosis?**





Answer (I): Reliability of data

- **Antakya: ~27.800 buildings (2006)**

Which informations are available?

Which parameters are required?

Which parameters can be related to Earthquake Resistance?

Which buildings are designed according to Earthquake Resistant Regulations & which codes have been applied?

What is the real level of Earthquake Resistant Design (ERD)?

Mostly all buldings should be surveyed!



Building stock survey



- **Training and capacity building: a common effort**









Building stock survey

- All buildings are surveyed ...

Reinforced-concrete buildings without ERD:

RC

RC frames	RC	A	B	C	D	E	F
				-----○-----			
		very seriously pre-damaged (before-collapse-state)					A
		predamaged/weathered state and irregular plan or elevation shape (soft story)					B
		predamaged/weathered state or irregular plan or elevation shape (soft story)					BC
		without earthquake-resistant design (ERD)					C
		with moderate level of ERD					CD
		with high level of ERD					D

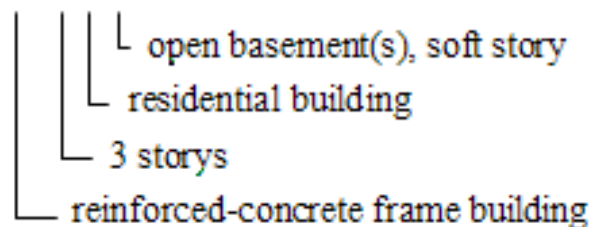


Building stock survey

Database ... considering particularities

Indexing of a structure:

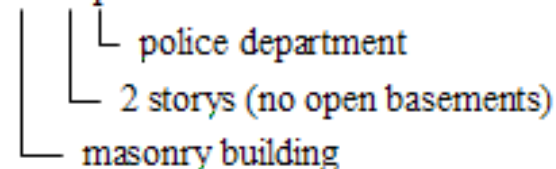
e.g. RC 3 r n



Number of stories

→ Story classes

e.g. MS 2 p



Vulnerability affecting factors

→

Peculiarities (*süreksizlikler/düzensizlikler*):

soft story	yumuşak kat	n
cantilevering upper story	çıkma kat	Γ
wildly/rampant built	kaçak yapı/gece konu	§
situated on (the top) of a steep slope ($> 30^\circ$)	tepe-yamaç etkisi	/



Answer (II): Reliability of Scenarios

• Historical (Ancient) Earthquakes

Date	Coordinates	Intensity	Location
69 BC	36.25 N -36.10 E	IX	Antakya, Syria
245	36.25 N -36.10 E	X	Antakya
334	36.25 N -36.10 E	IX	Antakya, Beirut, Cyprus
14.09.458	36.25 N -36.10 E	IX	Antakya and North of Syria
10.09.506	36.25 N -36.10 E	IX	Antakya, Samandag
29.05.526	36.25 N -36.10 E	IX	Antakya, Samandag
29.11.529	36.25 N -36.10 E	IX	Antakya
561	37.20 N -35.90 E	VIII+	Anazarba, Ceyhan-Adana, Antakya
30.09.587	36.25 N -36.10 E	IX	Antakya (60.000 dead)
08.04.859	36.25 N -36.10 E	IX	Antakya, Lazkiye
867	36.25 N -36.10 E	IX	Antakya
10.08.1114	36.25 N -36.10 E	IX	Ceyhan, Antakya, K.Maras (Tsunami)
13.08.1822	37.35 N -35.80 E	X	Antakya, Iskenderun (20.000 dead)
02.04.1872	36.40 N -36.20 E	IX	Antakya, Samandag (1.800 dead)



Answer (II): Reliability of Scenarios

• Recent Earthquakes

Date	Coordin. Lat. Long.	Location	Magnitude
14.06.1936	36.5 36.0	Iskenderun bay	5.5
08.04.1951	36.6 36.1	Iskenderun	5.7
22.10.1952	36.5 35.3	Ceyhan	5.0
24.03.1953	37.0 37.0	Gaziantep	5.1
07.04.1967	37.4 36.1	Yumurtalik-Ceyhan	5.0
15.07.1976	37.5 35.9	Yumurtalik-Ceyhan	5.0
29.06.1971	37.1 36.8	Aslantas-Berke	5.0
11.07.1971	37.2 36.8	Aslantas-Berke	5.0
24.06.1989	36.2 36.1	Antakya	5.1
10.04.1991	37.5 35.7	Yumurtalik-Ceyhan	5.4
03.01.1994	36.9 35.8	Yumurtalik-Ceyhan	5.3
22.01.1997	36.1 36.1	Antakya	5.5
22.01.1997	36.2 36.0	Samandag	5.2
27.06.1998	36.8 35.5	Ceyhan	6.3
04.07.1998	36.8 35.4	Ceyhan	5.4
25.06.2001	37.2 36.1	Osmaniye	5.4

Kalafat D, Bagci G (2001)
Adana ve Dogu Anadolu fay zonunun
deprensellik ozellikleri. TMMOB,
Jeofizik
Muhendisleri toplantisi-Adana, 36-43

Answer (III): Quality of Developers (Experts) Chance of Model Calibration



• Task Force Missions to Turkey:

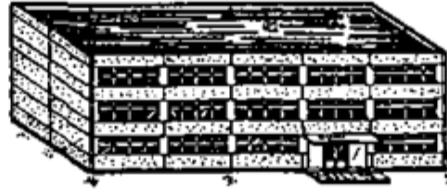
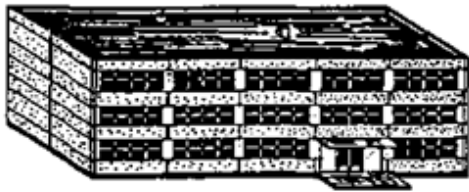


• Post Task Force Mission



Answer (IV): Simple damage description

• Observed Damage Grades: RC frame school buildings






Damage Grades **D1** to **D5**





Damage classification

• EMS Damage Grades

	<p>Grade 3: Substantial to heavy damage (moderate structural damage, heavy non-structural damage)</p> <p>Cracks in columns and beam column joints of frames at the base and at joints of coupled walls. Spalling of concrete cover, buckling of reinforced rods.</p> <p>Large cracks in partition and infill walls, failure of individual infill panels.</p>
	<p>Grade 4: Very heavy damage (heavy structural damage, very heavy non-structural damage)</p> <p>Large cracks in structural elements with compression failure of concrete and fracture of rebars; bond failure of beam reinforced bars; tilting of columns.</p> <p>Collapse of a few columns or of a single upper floor.</p>
	<p>Grade 5: Destruction (very heavy structural damage)</p> <p>Collapse of ground floor or parts (e. g. wings) of buildings.</p>



Casualties



Survey and Evaluation of Buildings for Empirical Risk Assessment



Empirical Approach

- **European Macroseismic Scale 1998 (EMS 98)**

Intensity (EMS 98):

„... is here considered a classification of the severity of the ground shaking on the basis of observed effects in a limited area.“

„ ... It allows the compression of a verbose description of earthquake (shaking) effects into a single symbol (usually a number, here in a range from **I. Not felt** to **XII. Completely devastating**). “



Damage prognosis

- **European Macroseismic Scale 1998 (EMS 98)**

Intensity X. Very destructive

Damage Grade D5:

Most buildings of Vulnerability Class (VC) A

Many buildings of VC B

a few of VC C

Damage Grade D4:

Many buildings of VC C





a few of VC D





Building stock survey

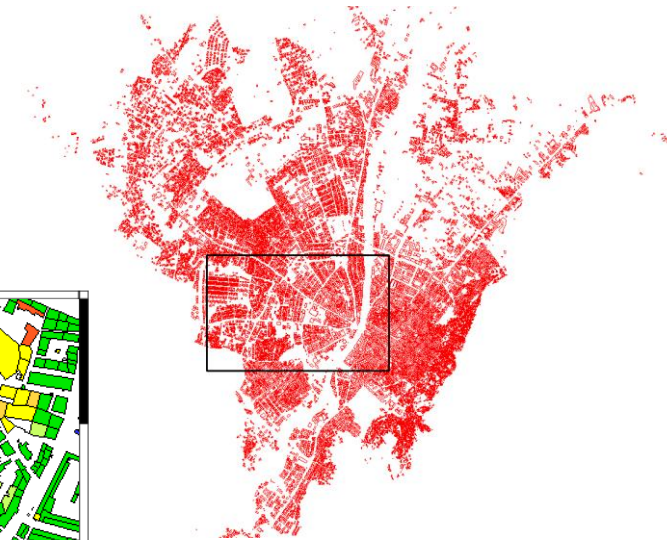
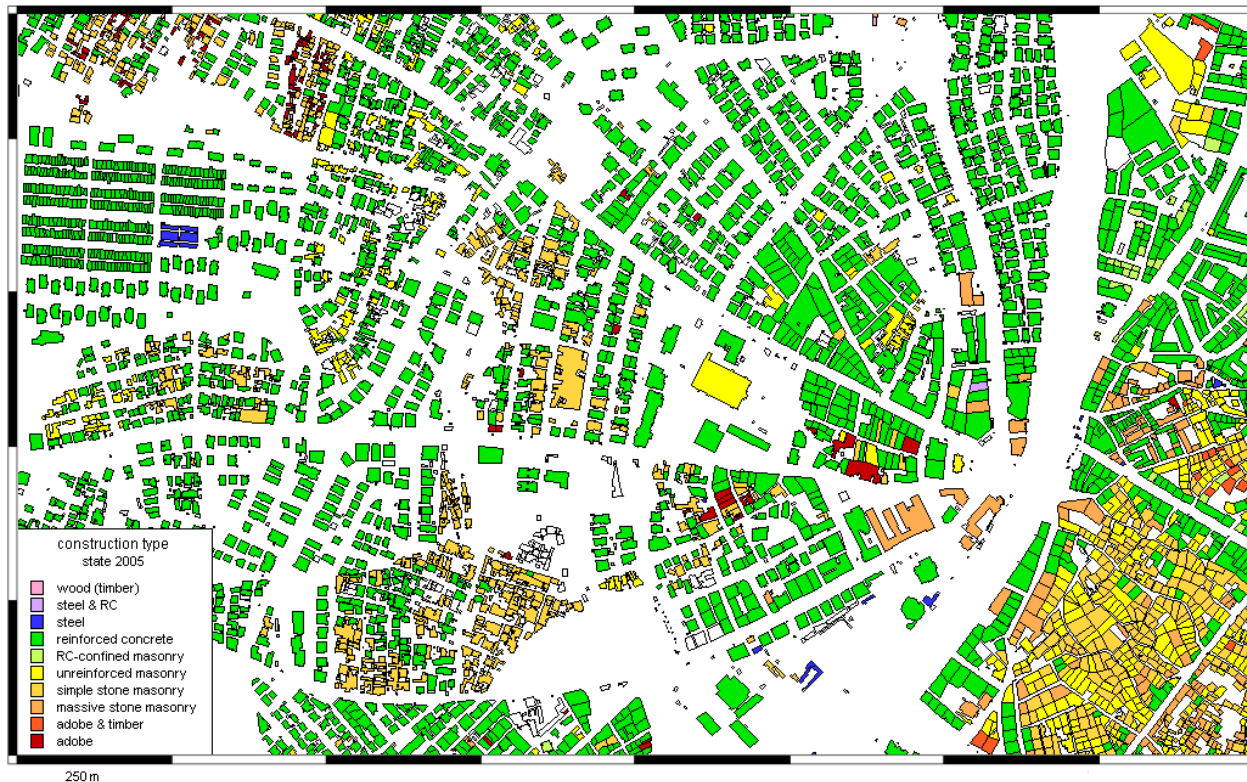
- All building are surveyed ...

RC frames with open basements		RCπ	A	B	C	D	E	F
						○		
			and additional irregular layout or structural deficiencies (e.g. too small column dimensions)					B
			irrespective of the number of open basement storys					BC
wildly/rampant built (e.g. eastern city district)		RC§	A	B	C	D	E	F
						○		
			- not regarding any building provisions or land-use planning regulations					
			- each building is erected and attached to the adjacent ones					

Building stock survey



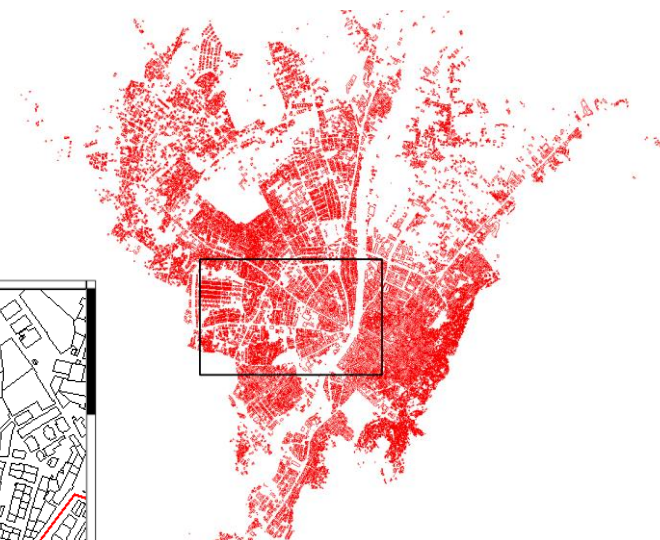
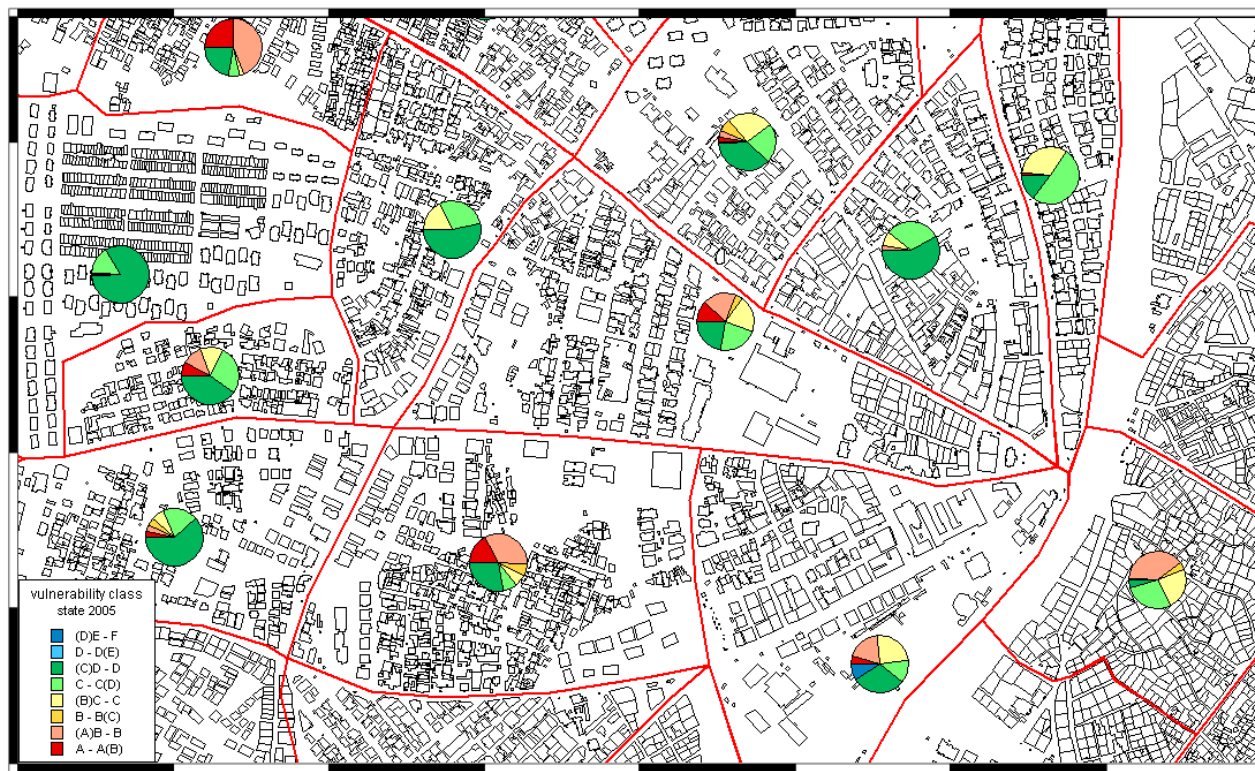
• Building types



Building stock survey



• Vulnerability classes



250m

250m



Survey and Evaluation of Buildings for Analytical Risk Assessment

Analytical Approach



Simplifications are required:

Concentration on the predominant building types?

Identification of typical buildings types and sub-classification

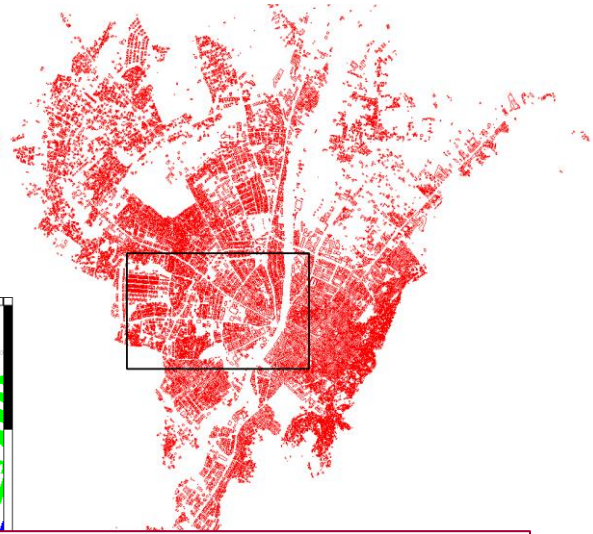
Detailed description and investigation of representatives





Sub-classification (I)

• RC frame type and Story Classes (SC i)



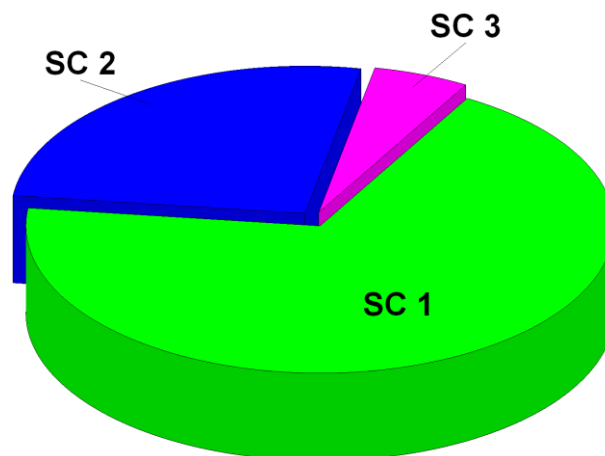
→ Presentation Lars Abrahamczyk

Conclusion:
80 % the buildings
are of RC frame type



Typical types and representatives

• RC frame Type and Story Classes





Sub-classification (II)

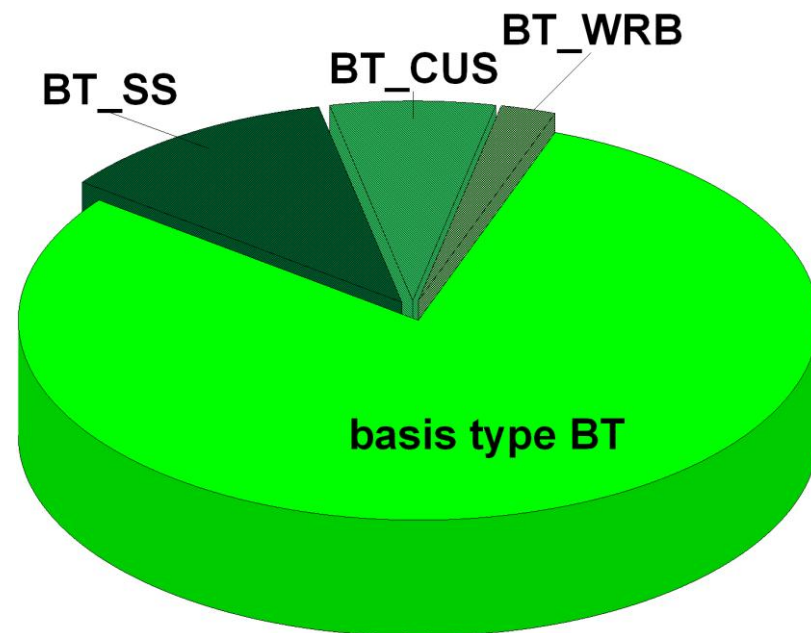
• Damage enforcing factors



SS
Soft Story



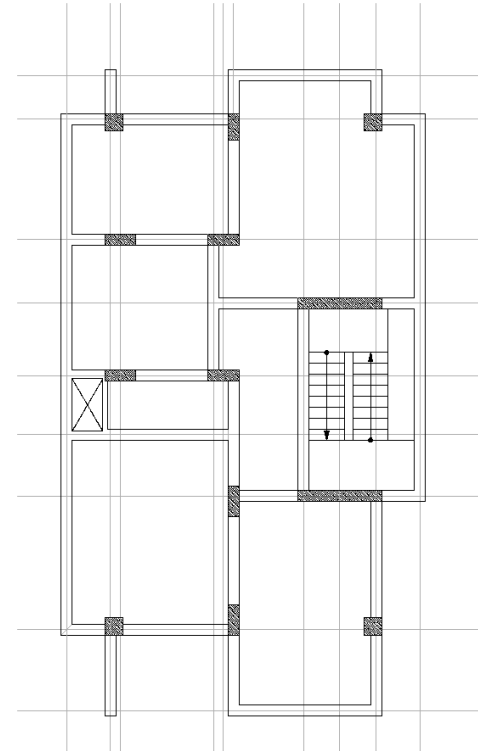
CUS
Cantilevering
Upper Story



Nonlinear Analysis



• RC frame Type building model

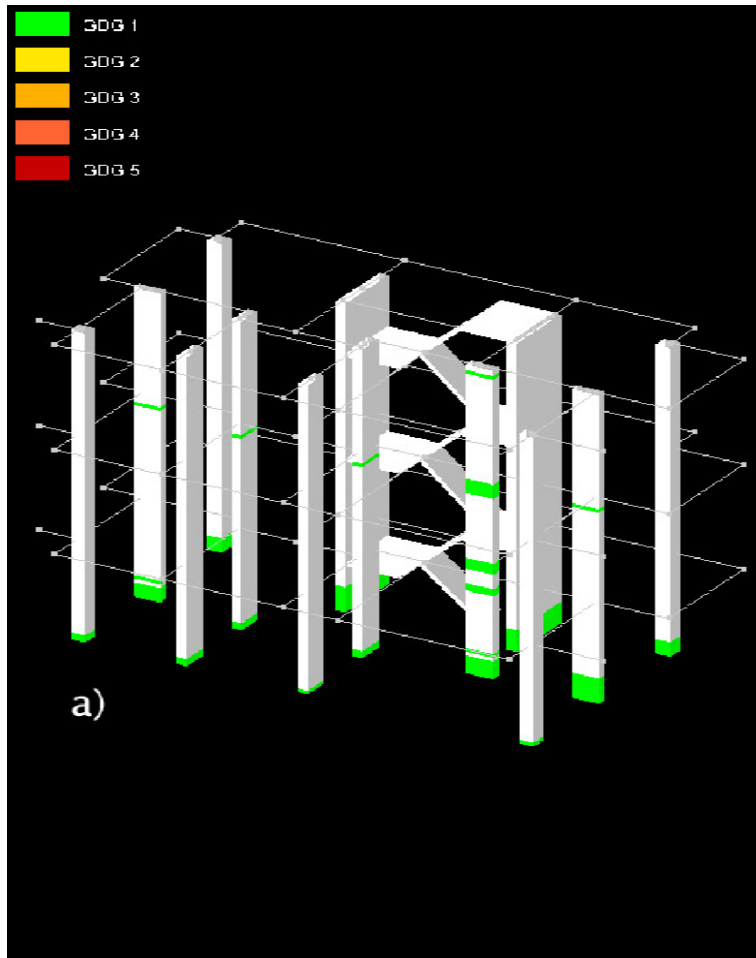


Simulation_D2_0.4g_DUB_50fps.avi

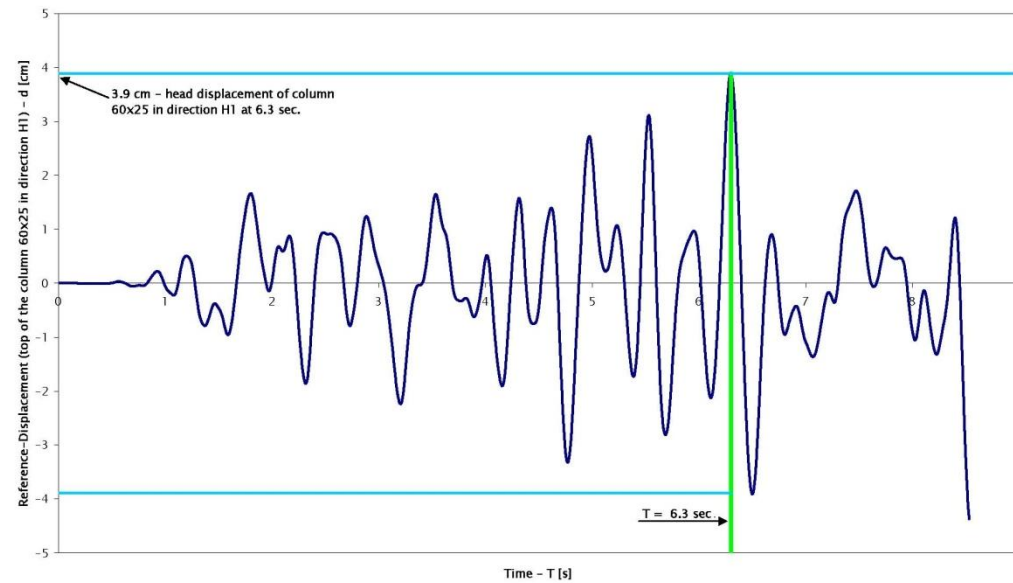


Nonlinear Analysis

• RC frame Type building model



Response of the column 60x25 during the earthquake Time-History-Simulation

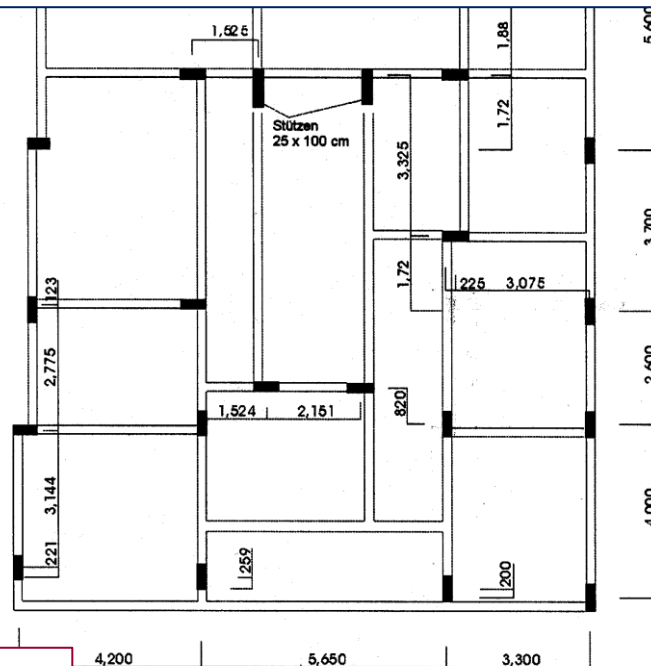


Sub-classification (III)



• Particularities of structural layout

Which buildings are designed according to Earthquake Resistant Regulations & which codes have been applied?
What is the real level of Earthquake Resistant Design (ERD)?



→ Presentation Alper Kirikaya

Sub-classification for detailed elaboration



GZ	RC-Tragwerke [RC]							
	Privat [P]				Gewerbe [G]			
	Basistyp [BT]	soft storey [BT_SS]	cand.u. st. [BT_CUS]	widly ram.b. [BT_WRB]	Basistyp [BT]	soft storey [BT_SS]	cand.u. st. [BT_CUS]	widly ram.b. [BT_WRB]
1	13	0	0	0	24	5	0	1
2	29	1	2	1	15	18	1	0
3	13	2	3	0	11	16	0	2
4	9	3	3	0	2	2	0	0
5	7	2	3	0	1	1	0	0
6	2	1	1	0	0	0	0	0
7	1	2	1	0	0	0	0	0
8	1	1	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0

					
RC-P-BT-2 Typ 1	RC-P-BT_WRB-2 Typ 2	RC-P-BT-5 Typ 3	RC-P-BT_SS-6 Typ 4	RC-P-BT_SS-8 Typ 5	RC-G-BT_SS-2 Typ 6

Codierung Stahlbetontragwerke Antakya (fein)



Scenarios

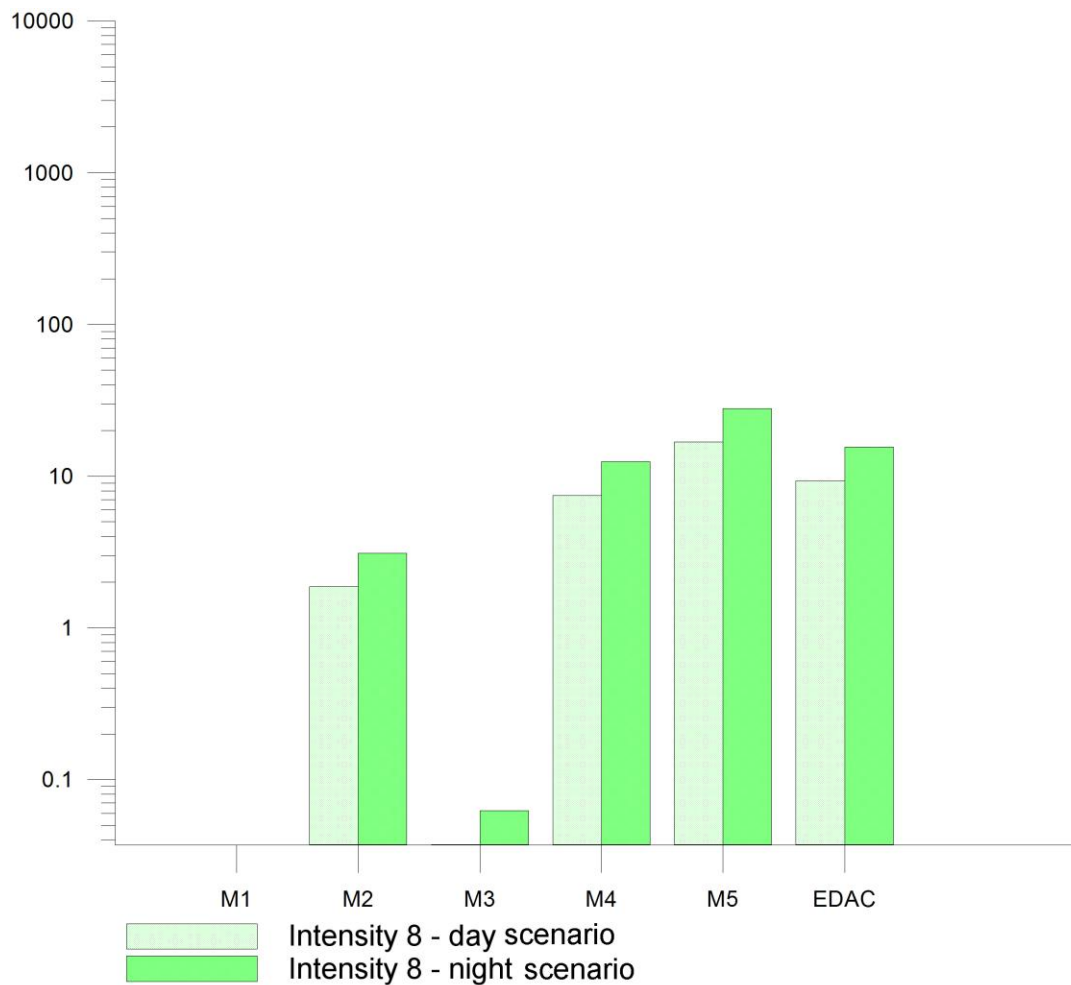
Damage + Loss

from Engineering to Economic & Social Aspects

Scenarios : Intensity VIII



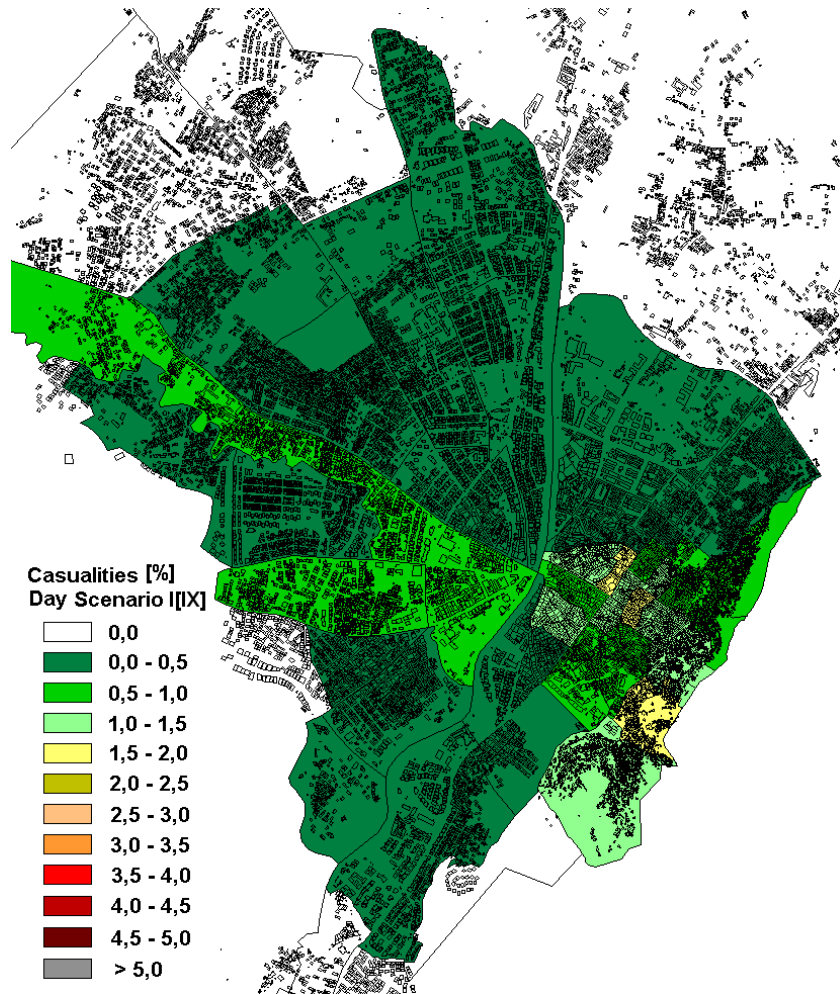
Casualties:
5 - 20



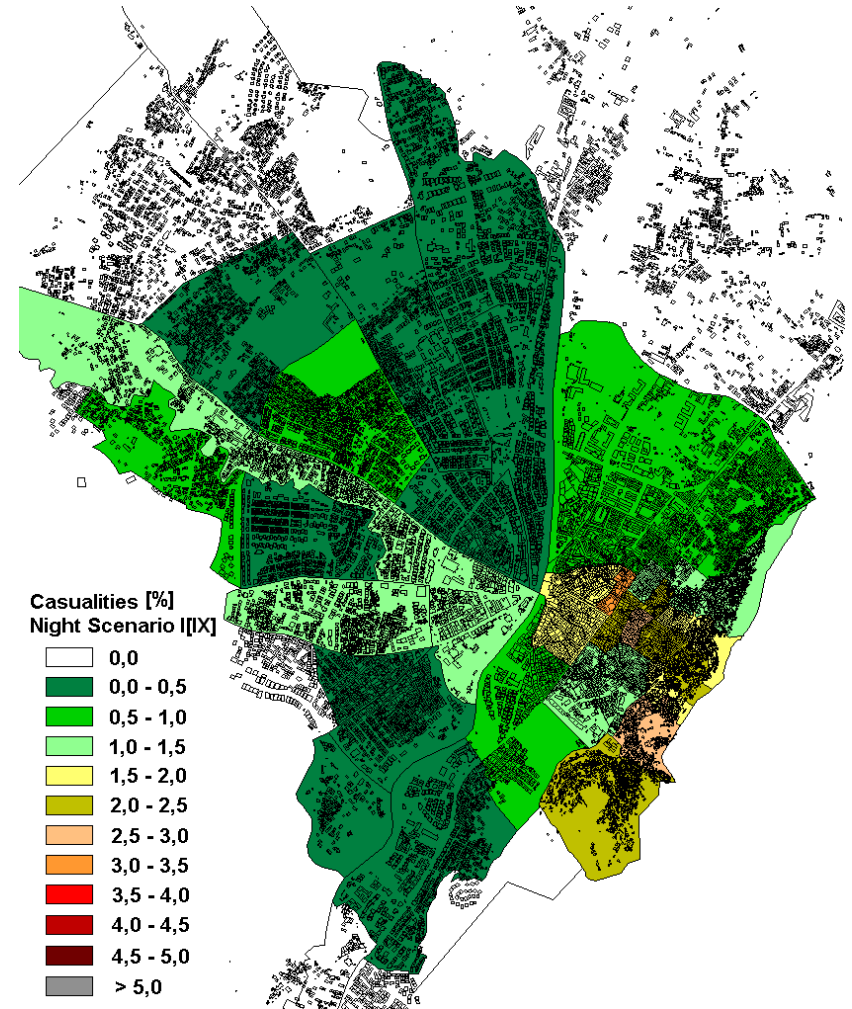
Scenarios: Intensity IX



EQ during day-time



EQ during night-time

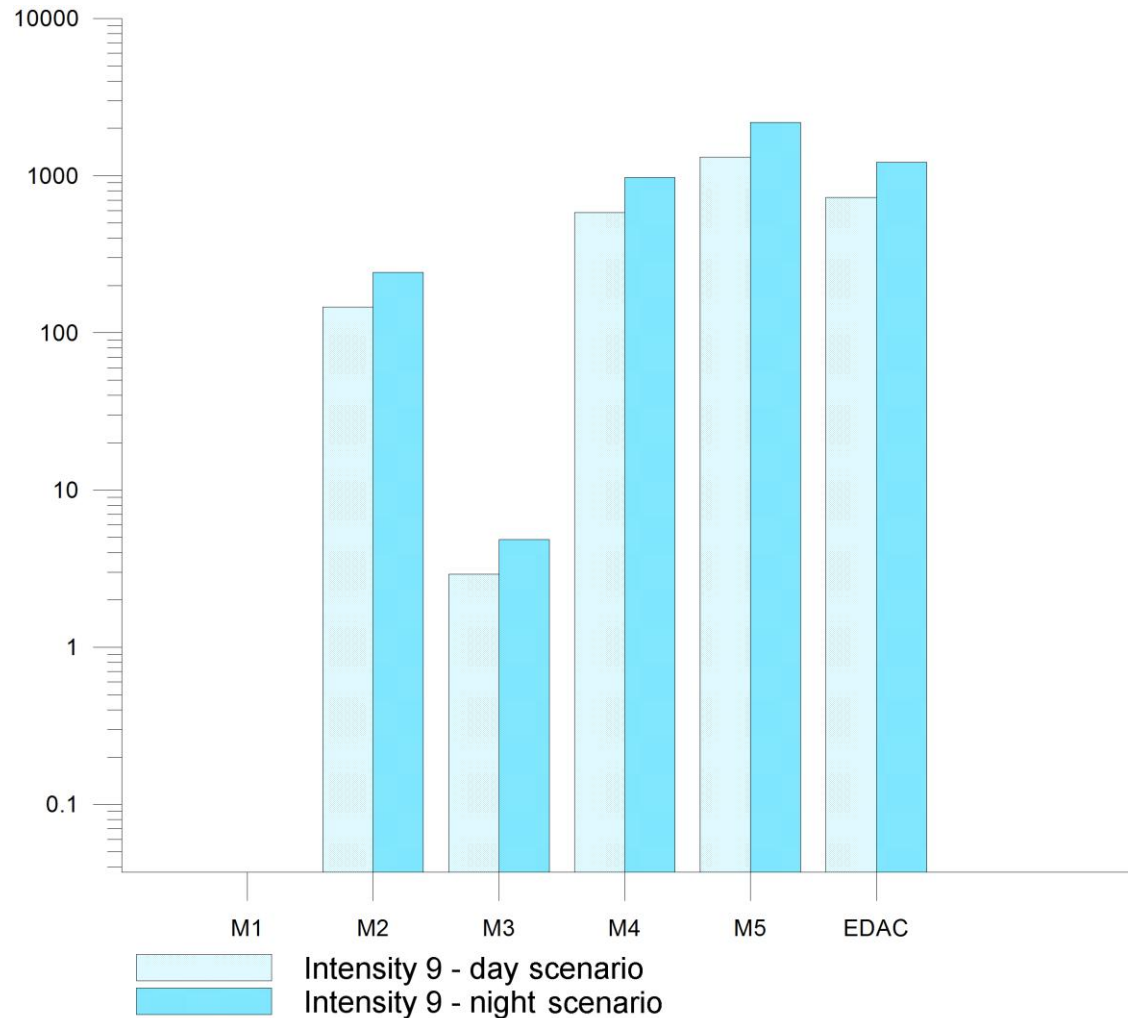


Scenarios: Intensity IX



**Casualties:
500 - 1500**

**02.04.1872:
Antakya,
Samandag:
1.800 dead**



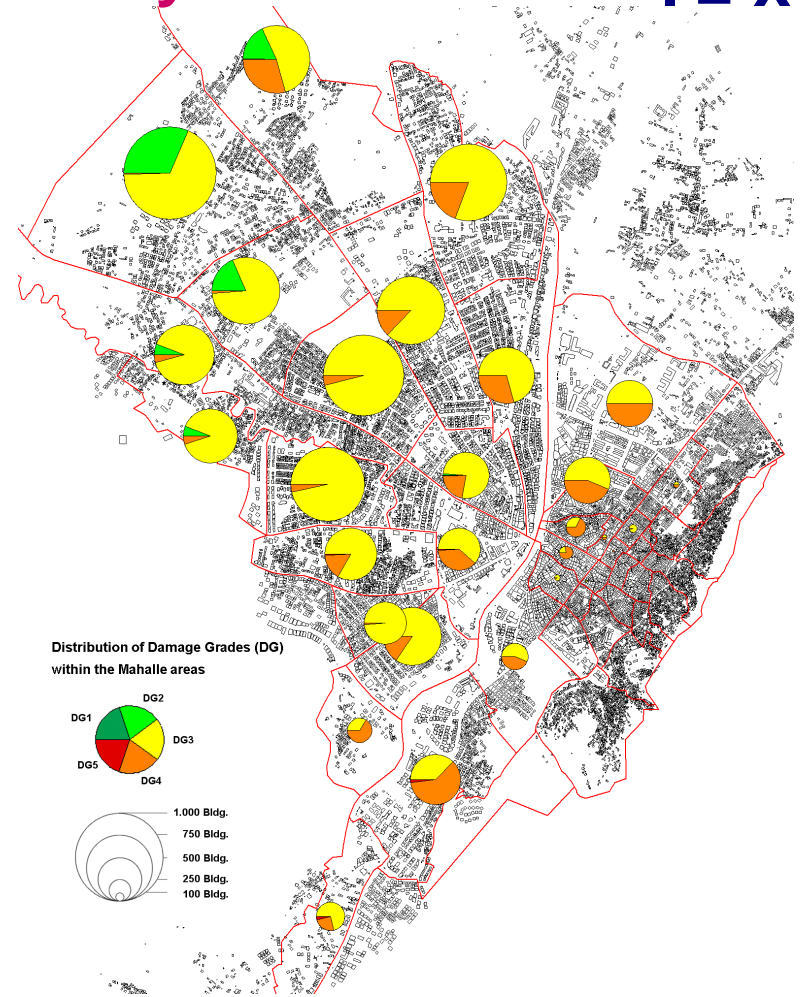
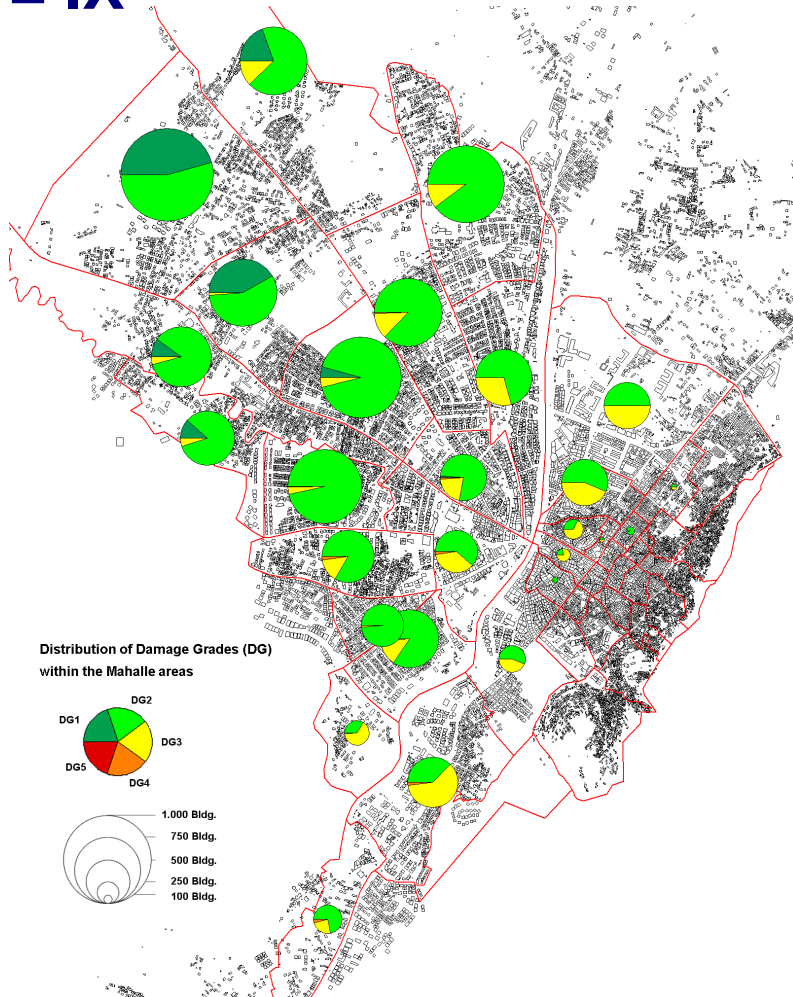


Scenarios: Empirical Approach*

I = IX

* RC structures only

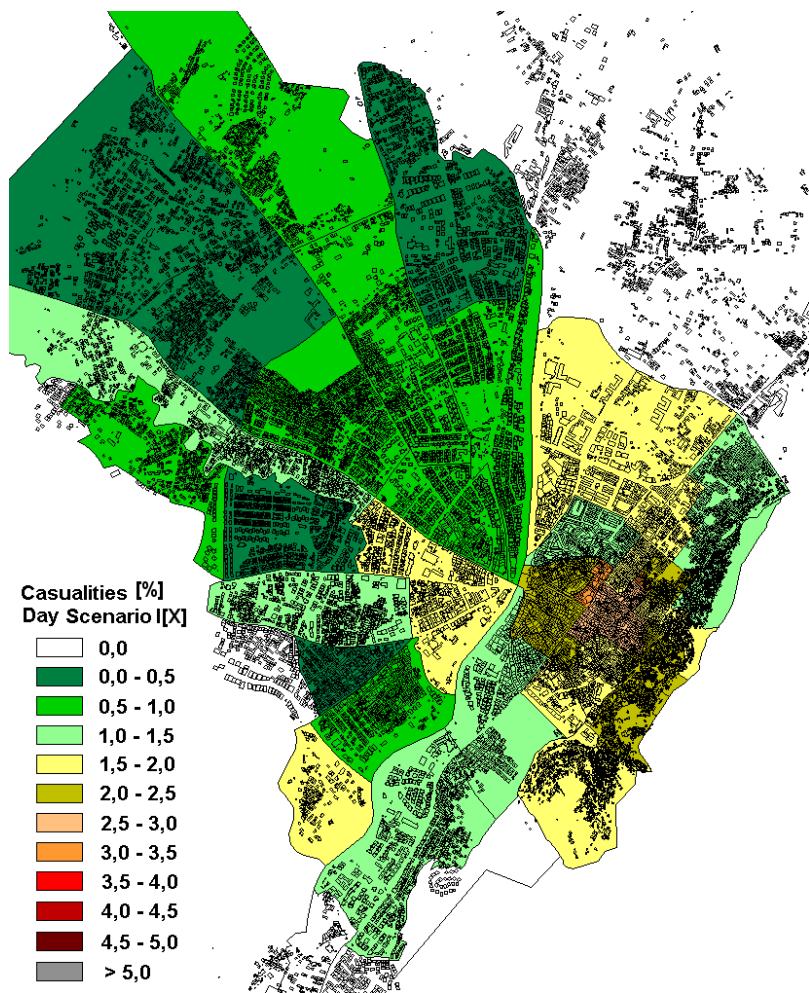
I = X



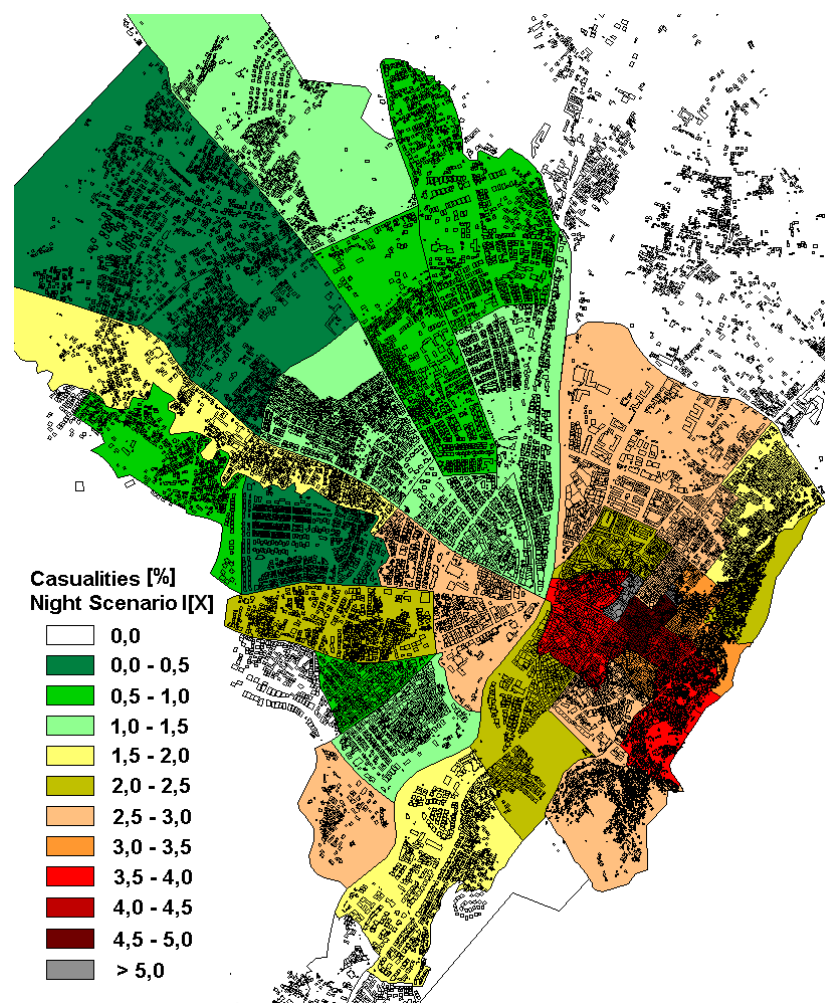
Scenarios: Intensity X



EQ during day-time



EQ during night-time

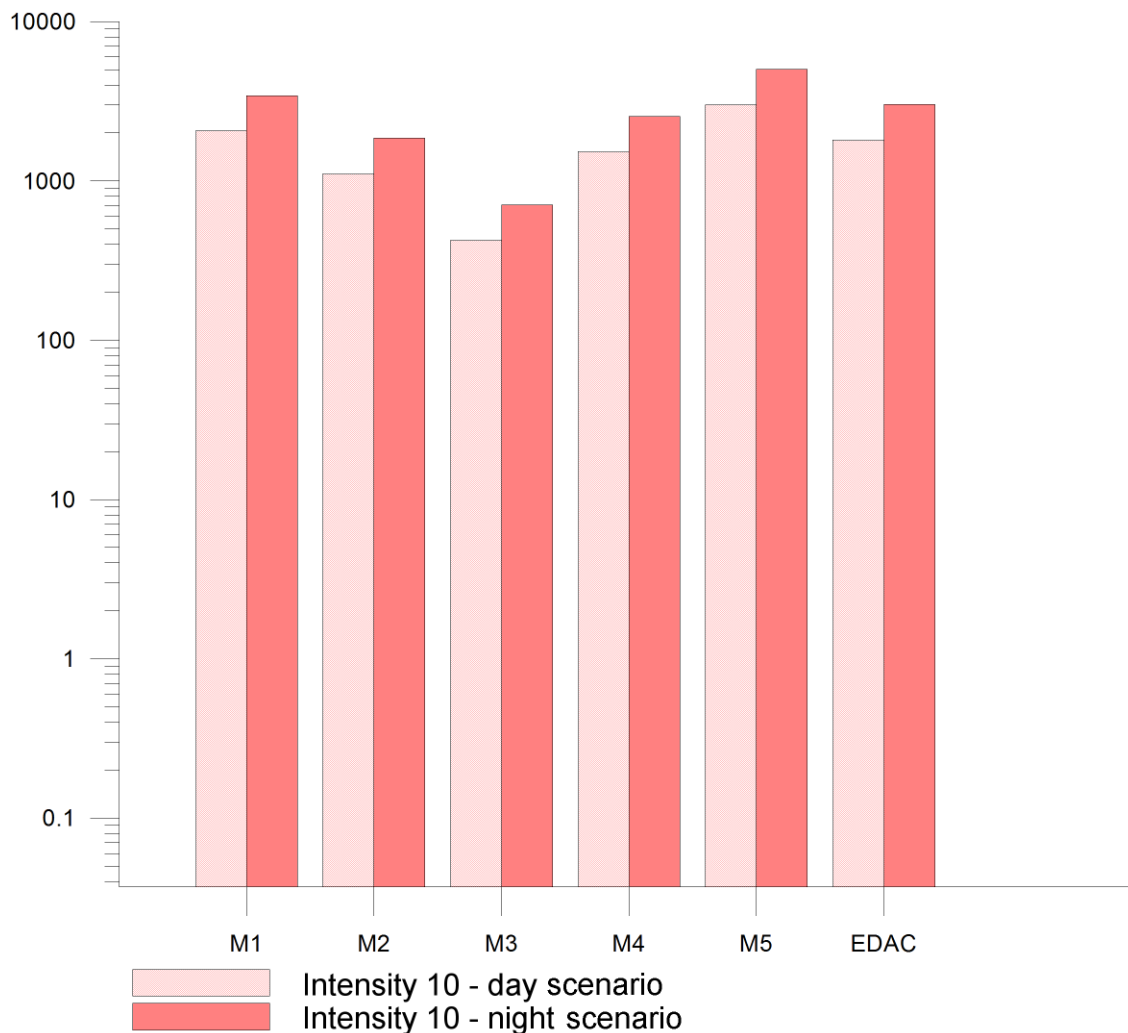


Scenarios: **Intensity X**



**Casualties:
2000 - 3000**

**13.08.1822
Antakya,
Iskenderun:
20.000 dead**



Need for further Action



... Waiting for answers and wise decisions



Questions?

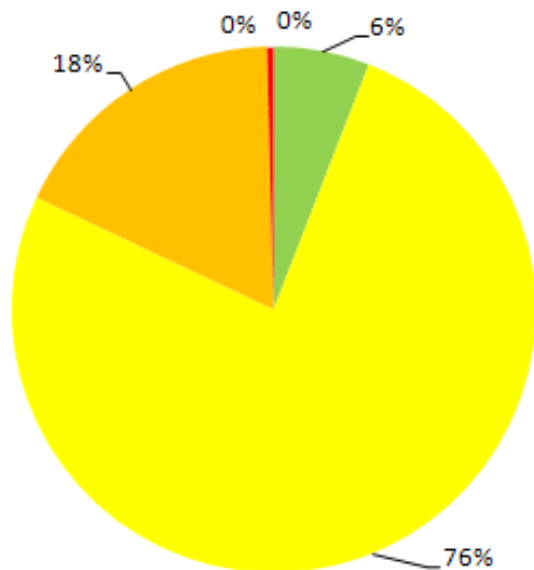


Thank you for your attention!

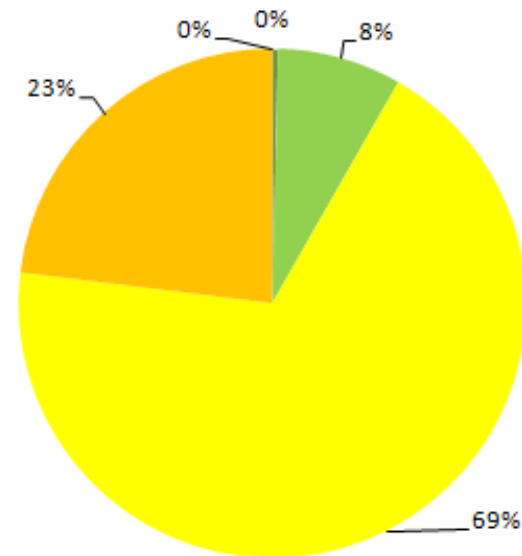


Scenarios: Last results*

Empirical approach I = X



*** RC structures only**



Analytical approach: ground motion according to Turkish Zoning map

■ SG1 ■ SG2 ■ SG3 ■ SG4 ■ SG5