

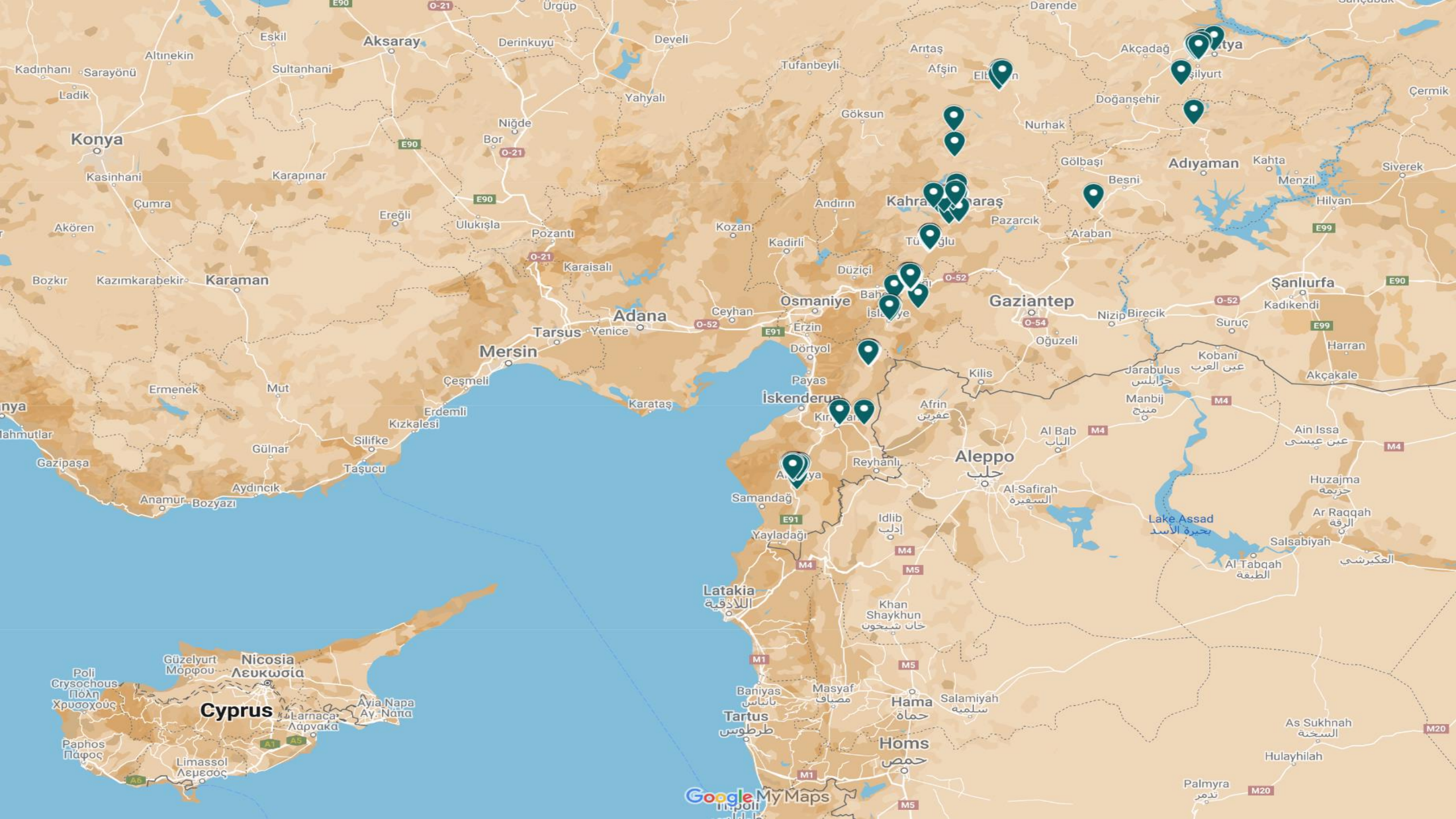
Observations on Proportions of the Reinforced Concrete Buildings in Turkey



Santiago Pujol, Ayhan Irfanoglu, Mario Rodriguez,
Remy Lequesne, and
Chungwook Sim (University of Nebraska-Lincoln)

Deployed by ACI Committee 133 – Disaster Reconnaissance

SURVEY AREA



Konya

Aksaray

Karaman

Adana

Mersin

İskenderun

Gaziantep

Kahramanmaraş

Adıyaman

Şanlıurfa

Aleppo

Cyprus

Nicosia

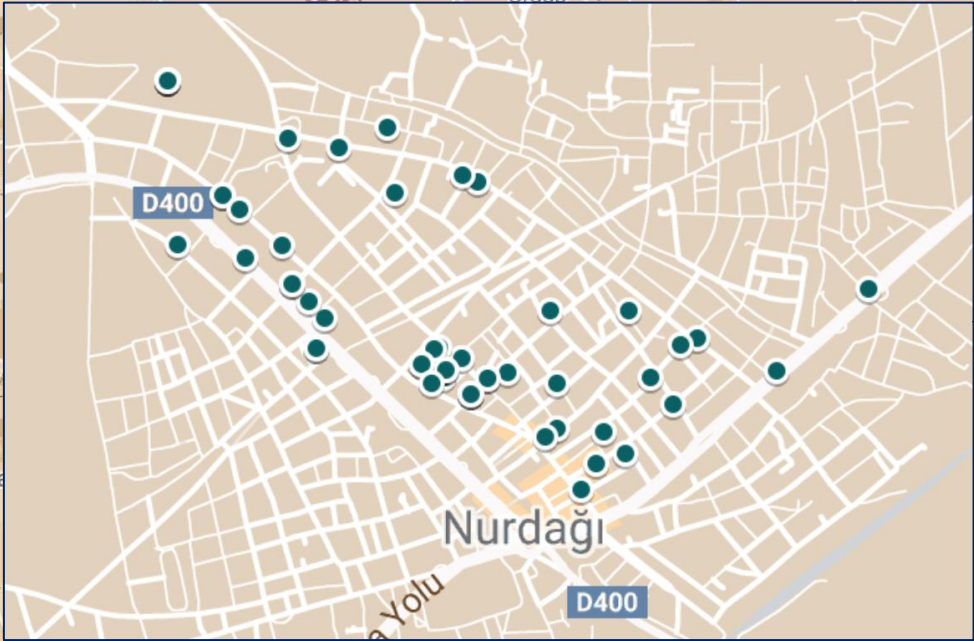
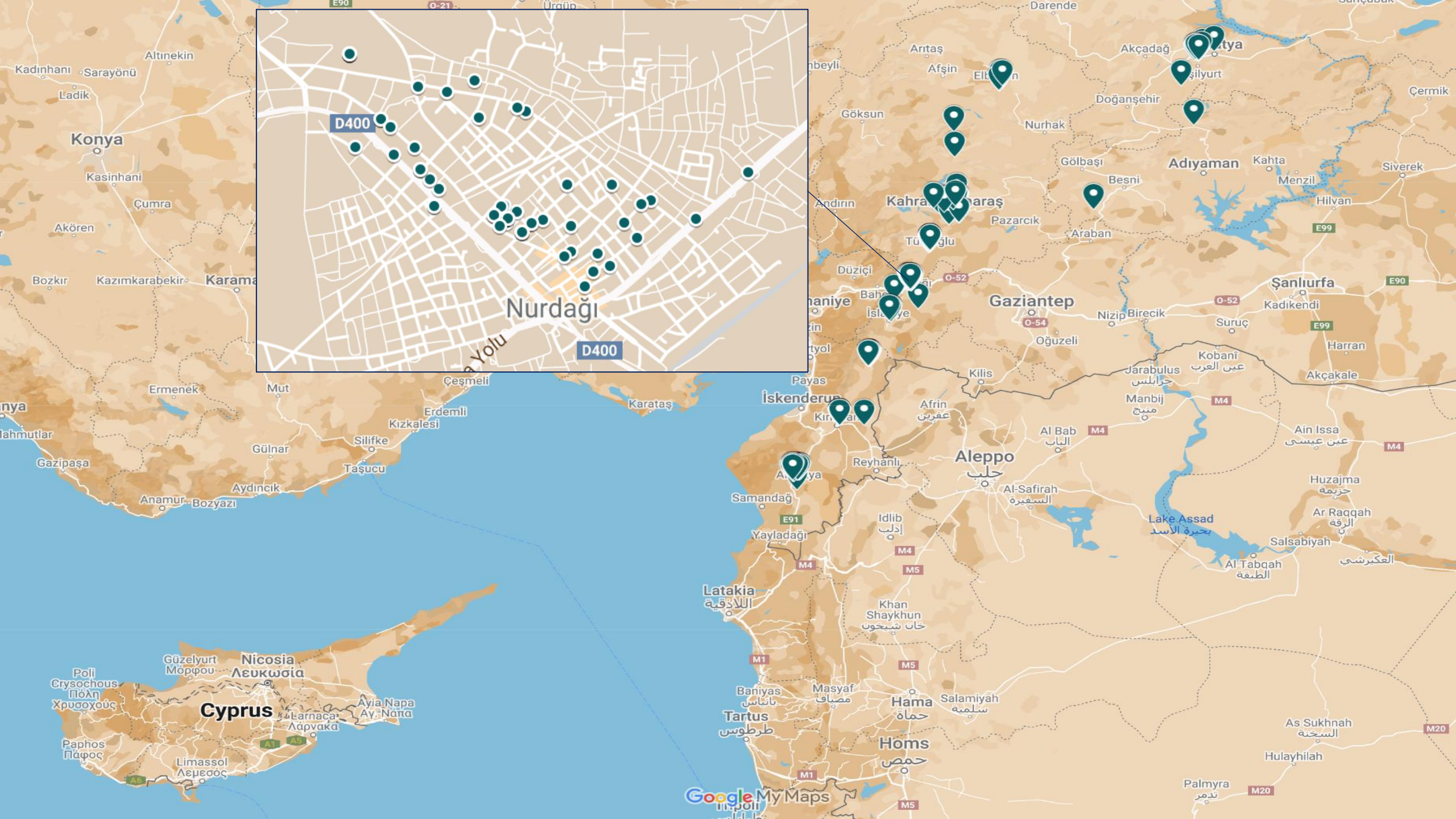
Latakia

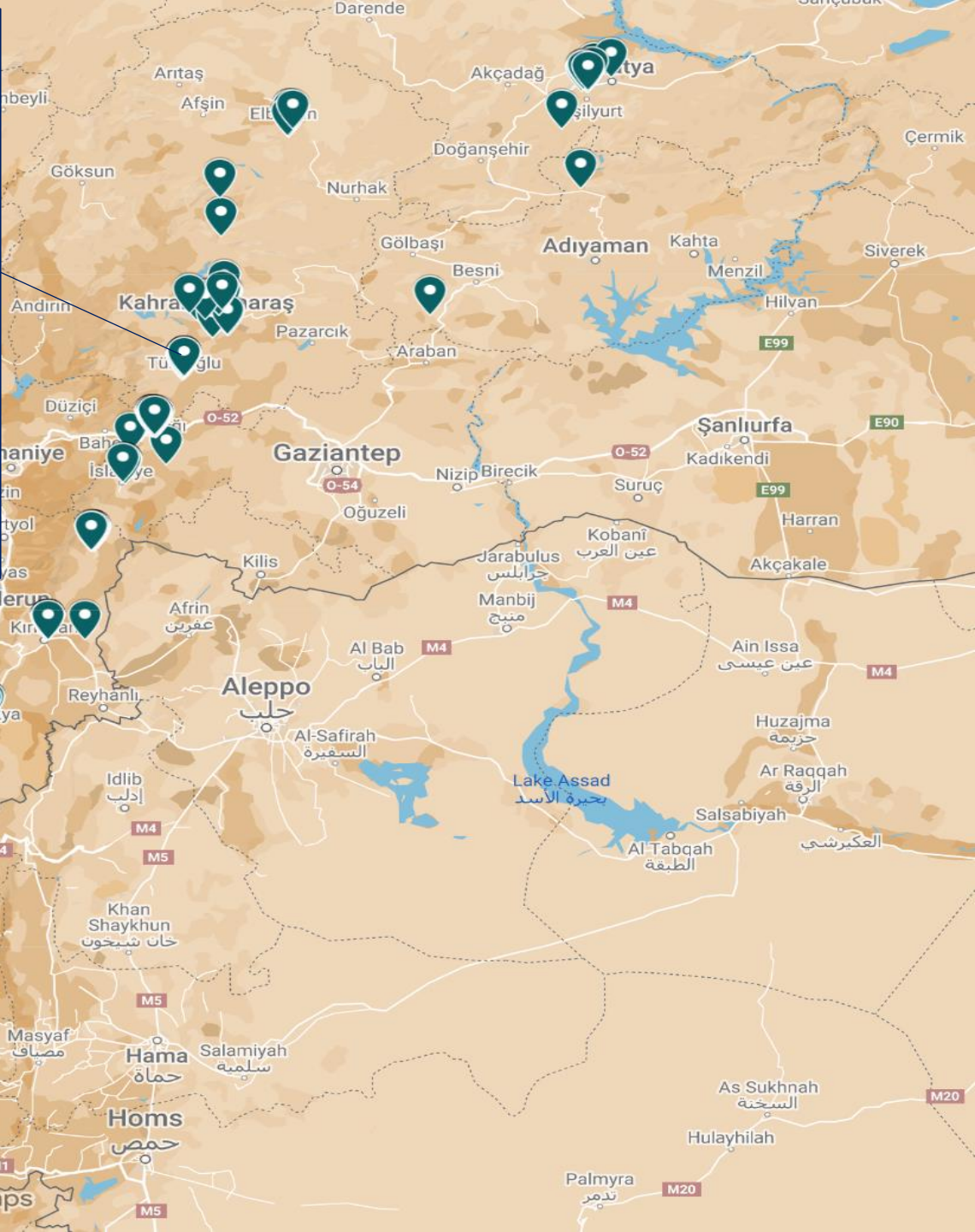
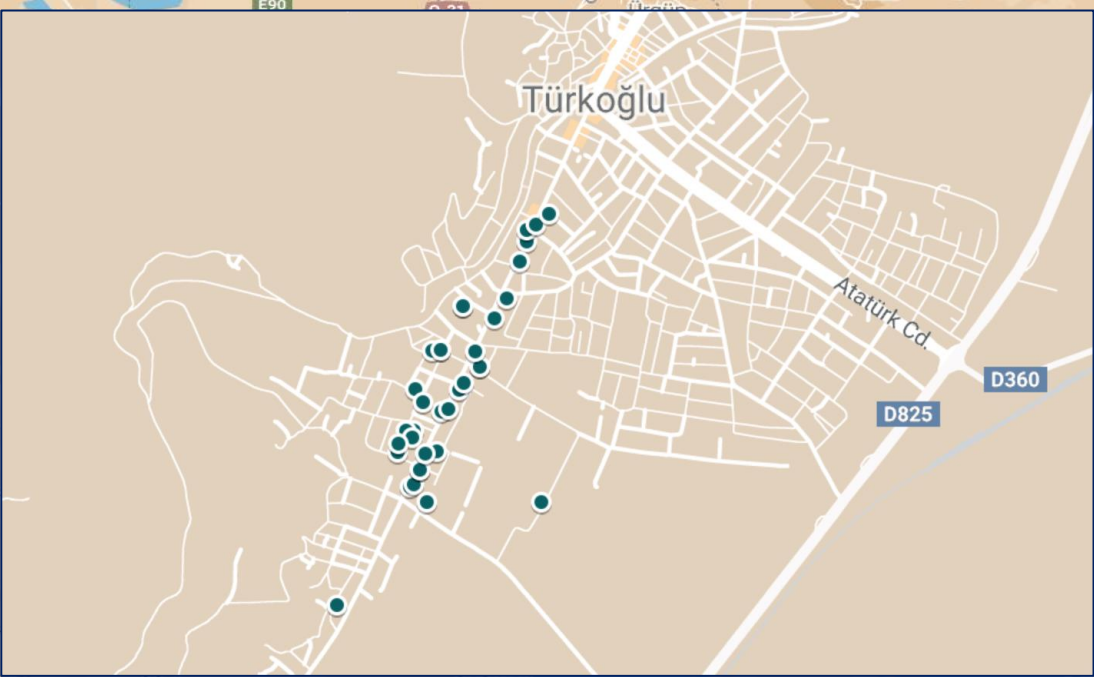
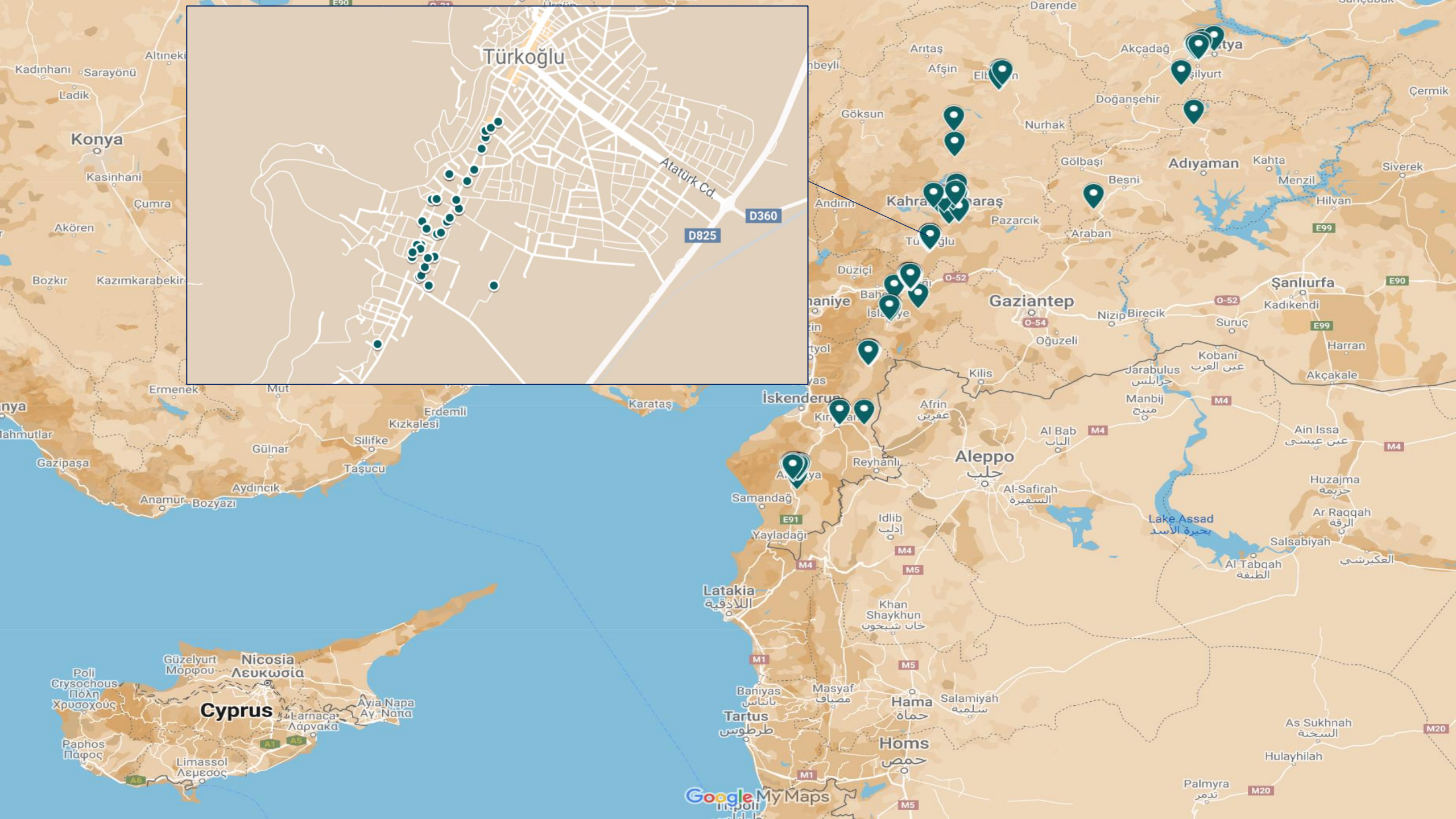
Tartus

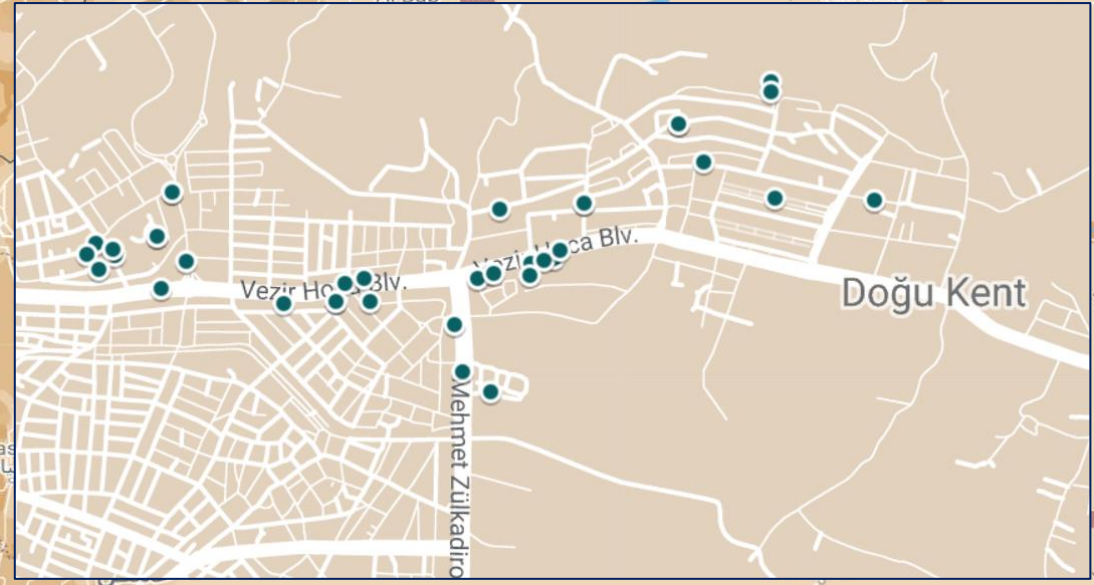
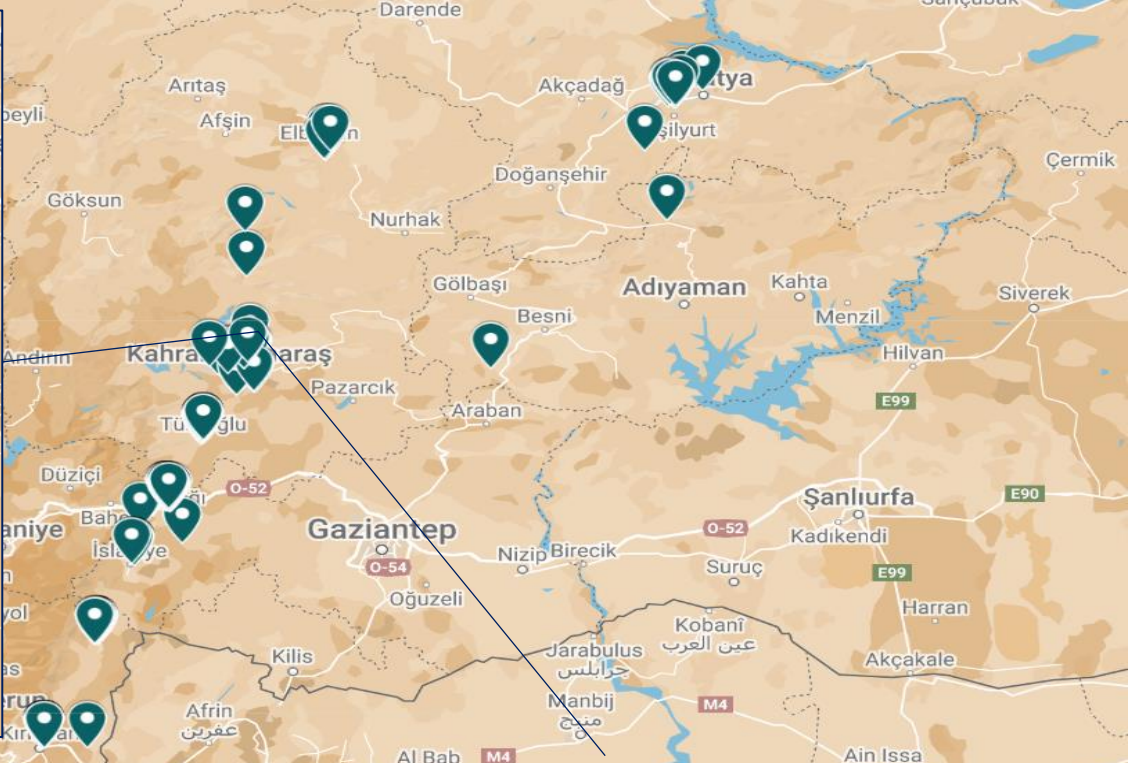
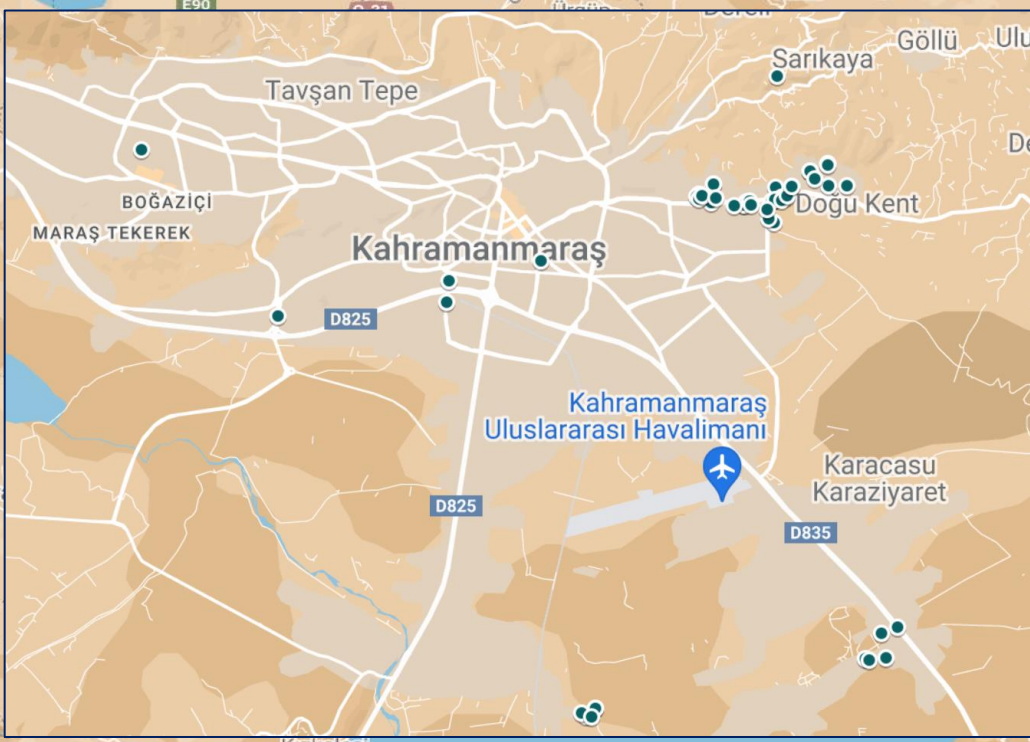
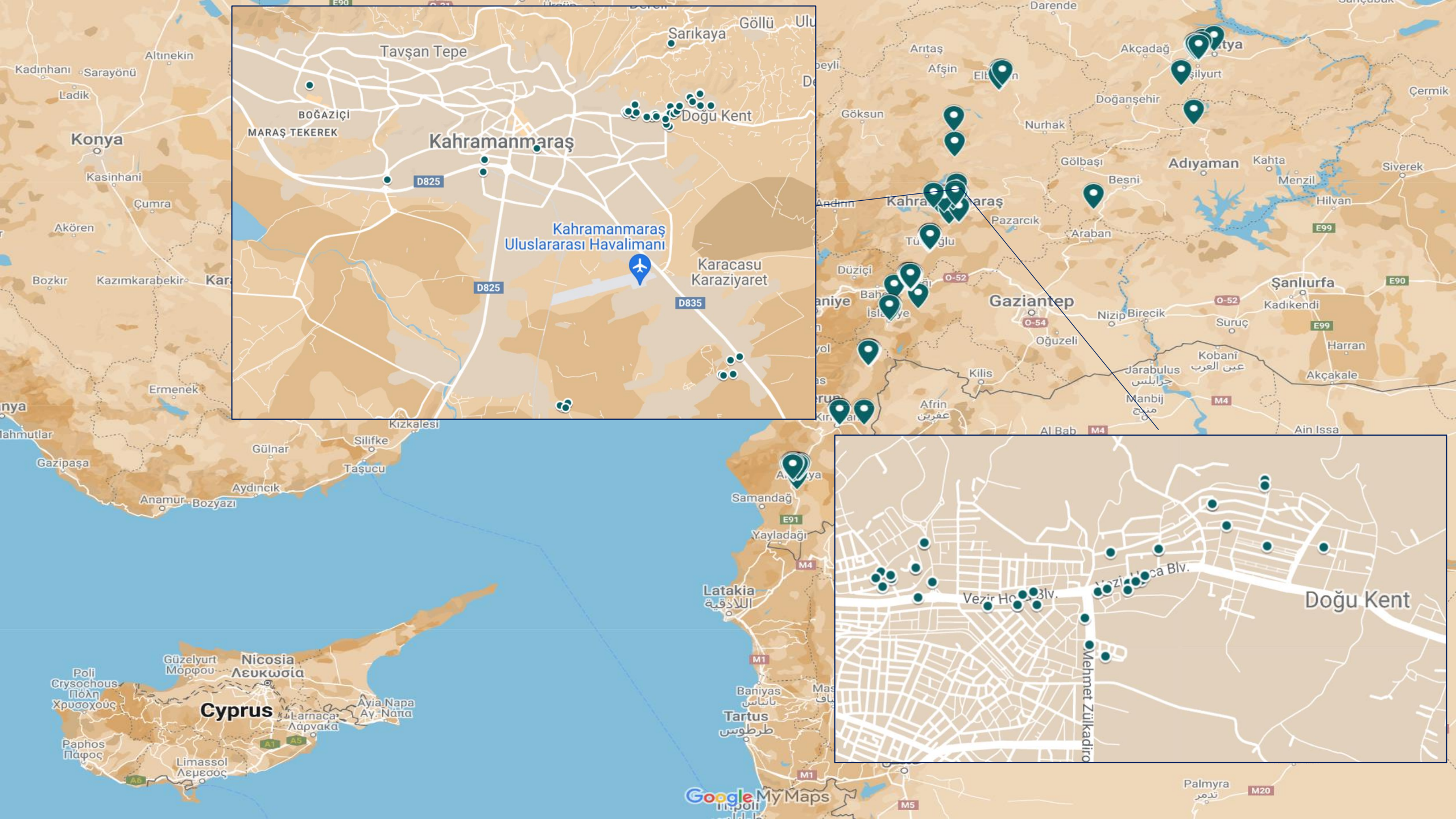
Hama

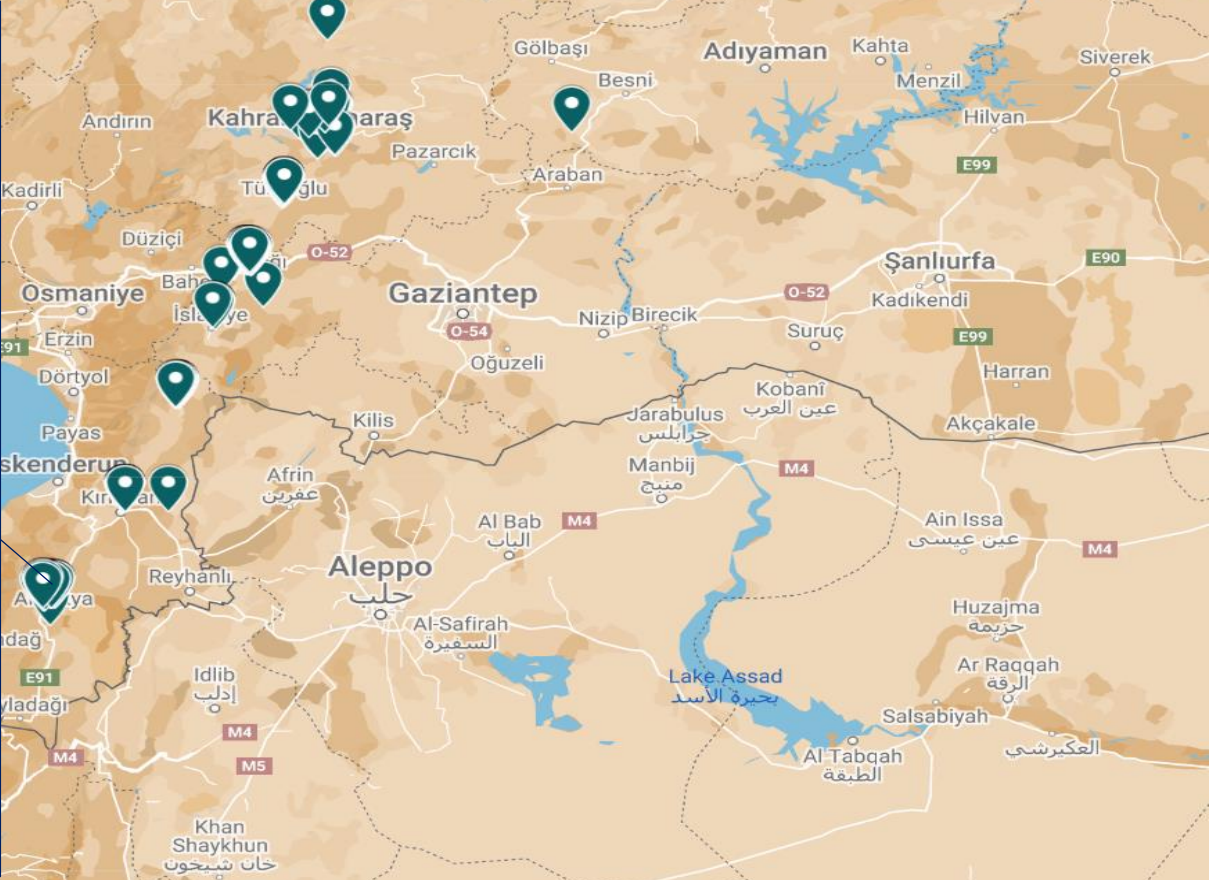
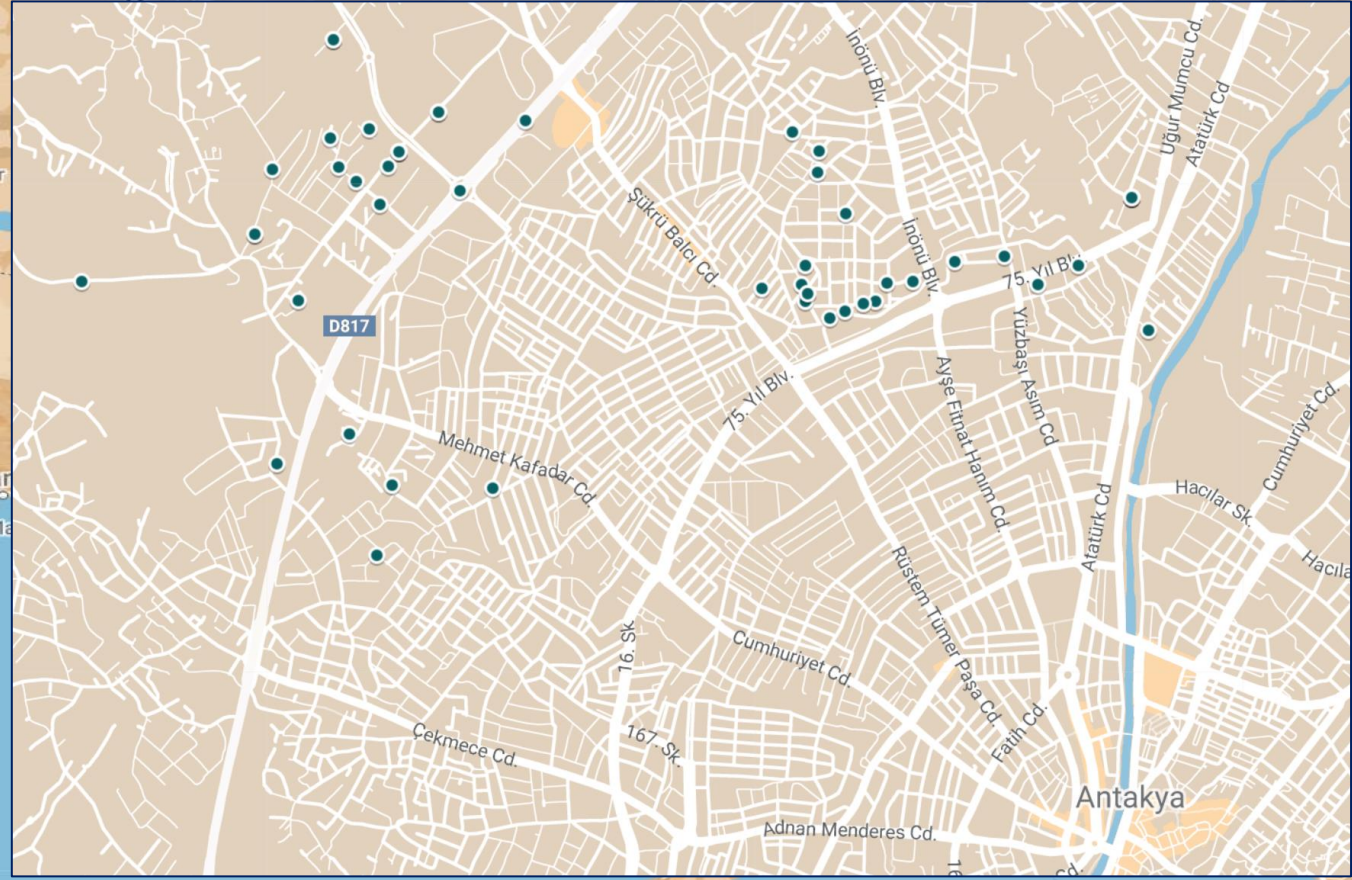
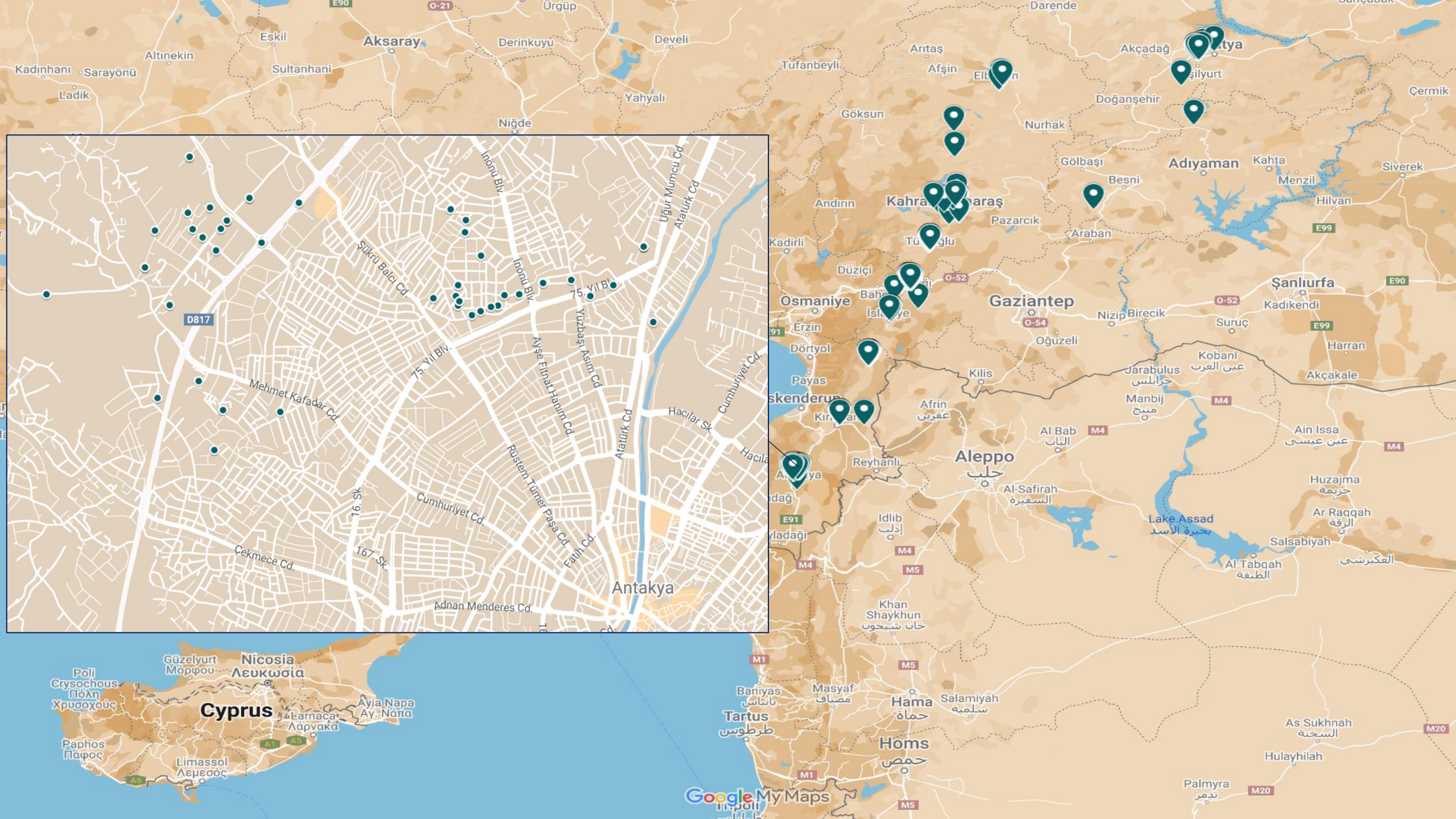
Homs

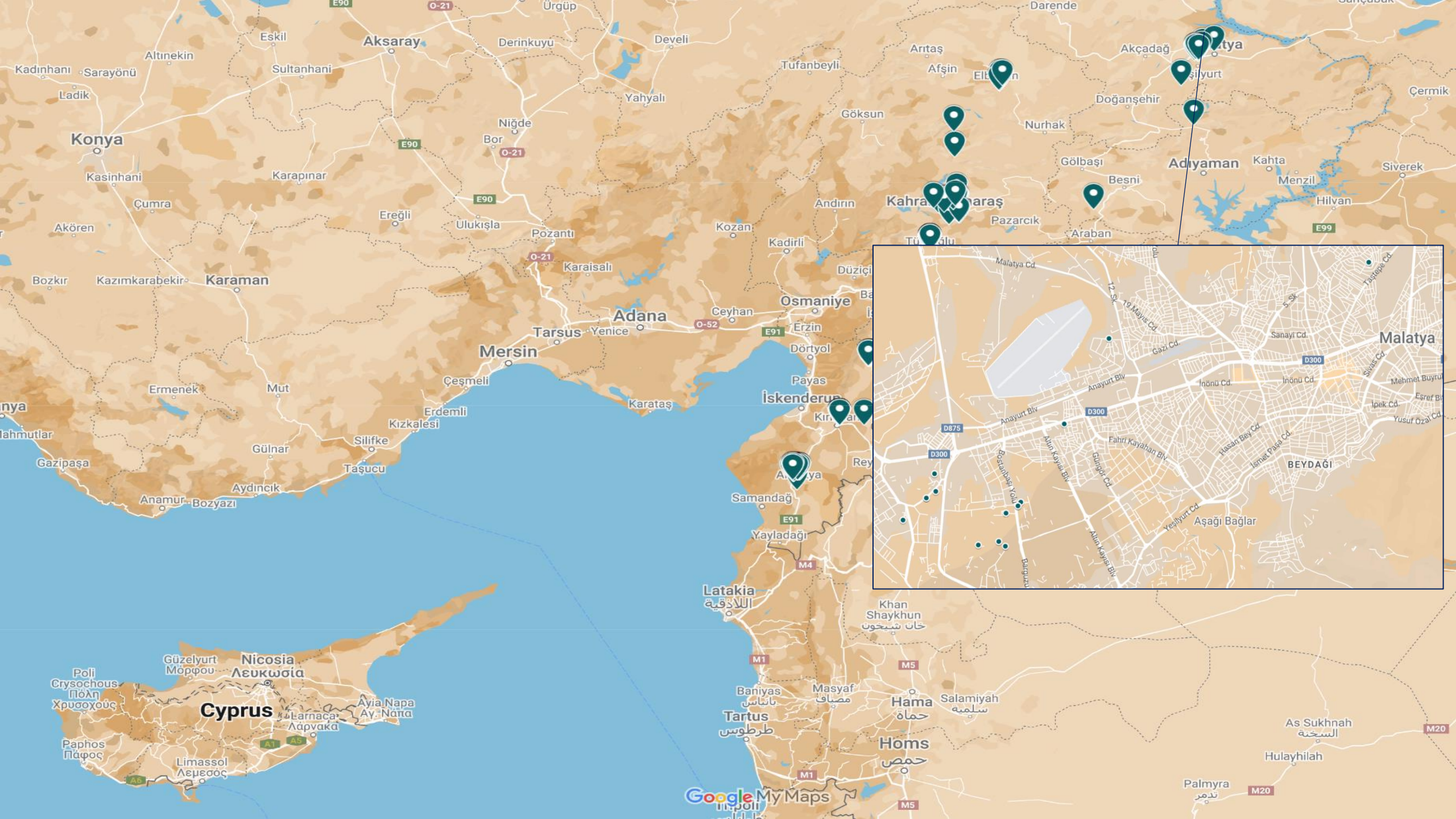
Google My Maps











Konya

Aksaray

Kahramanmaraş

Adıyaman

Malatya

Adana

Mersin

İskenderun

Malatya

Cyprus

Nicosia

Latakia

Tartus

Hama

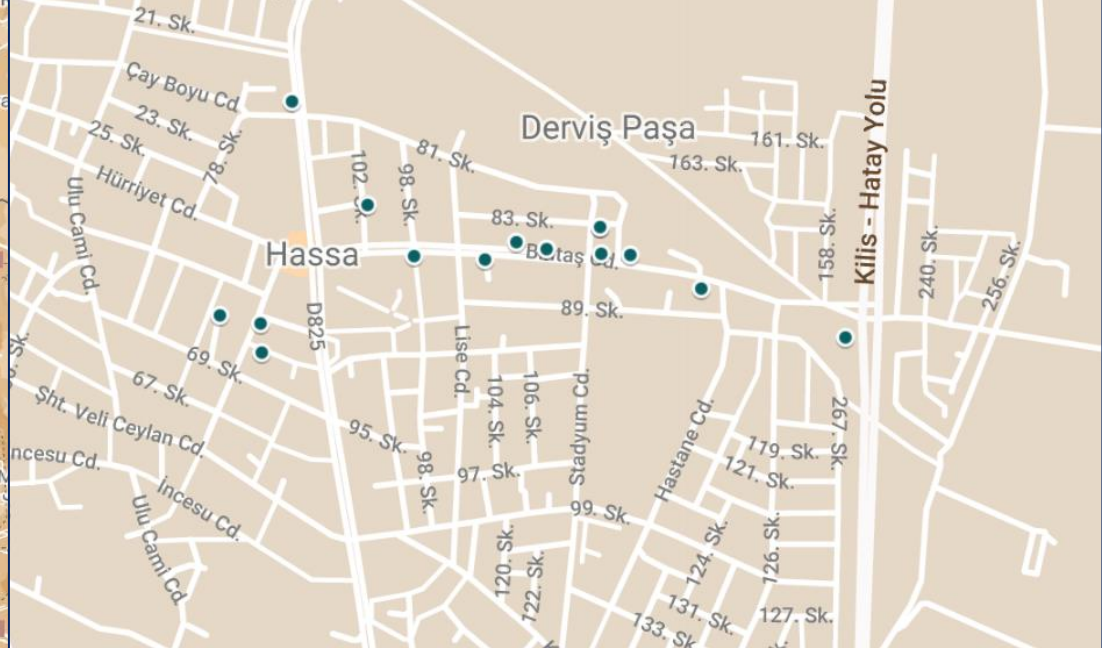
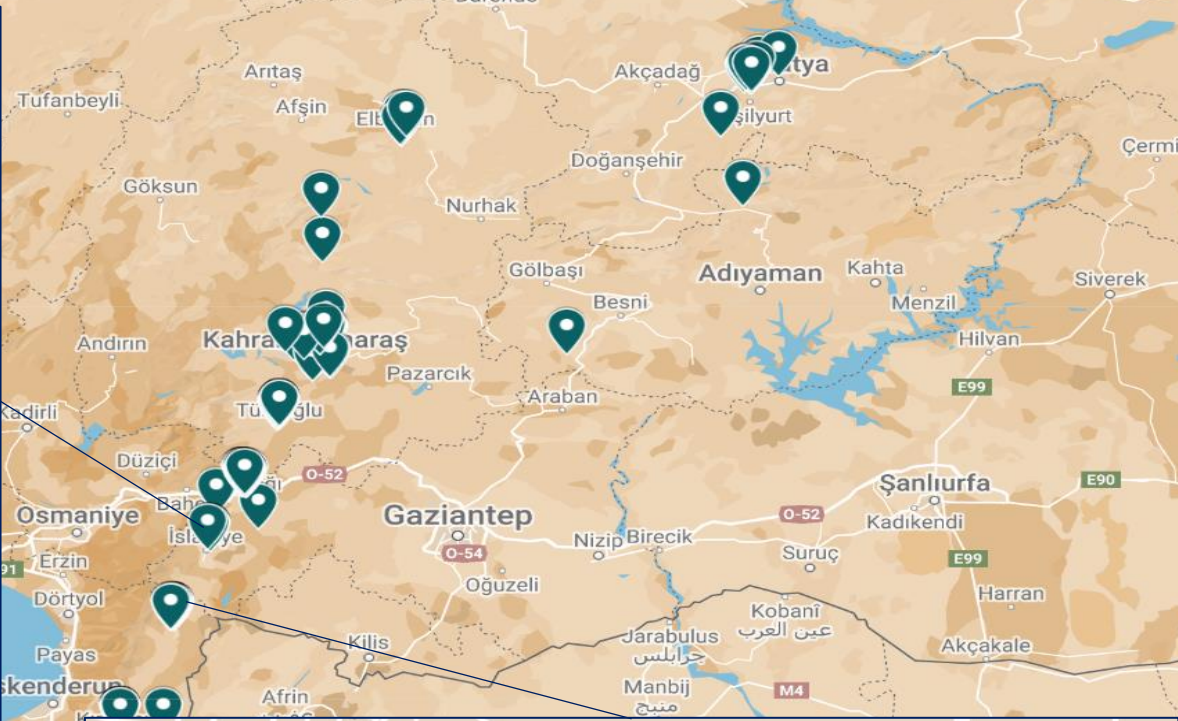
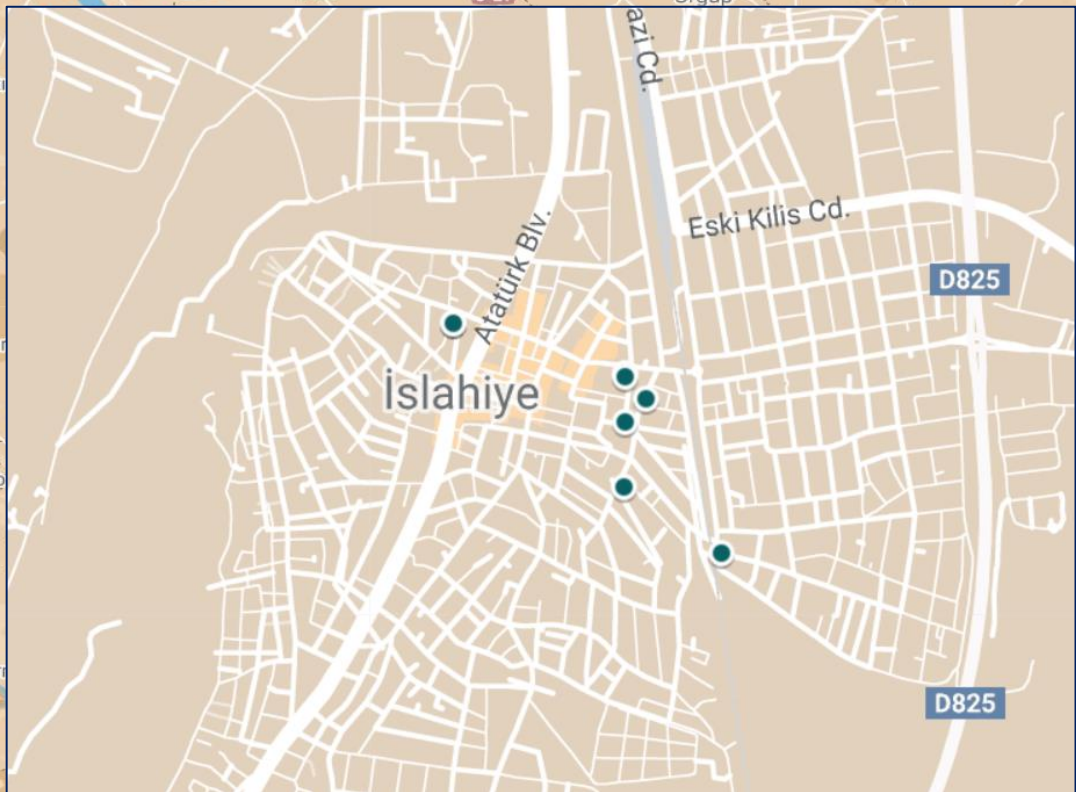
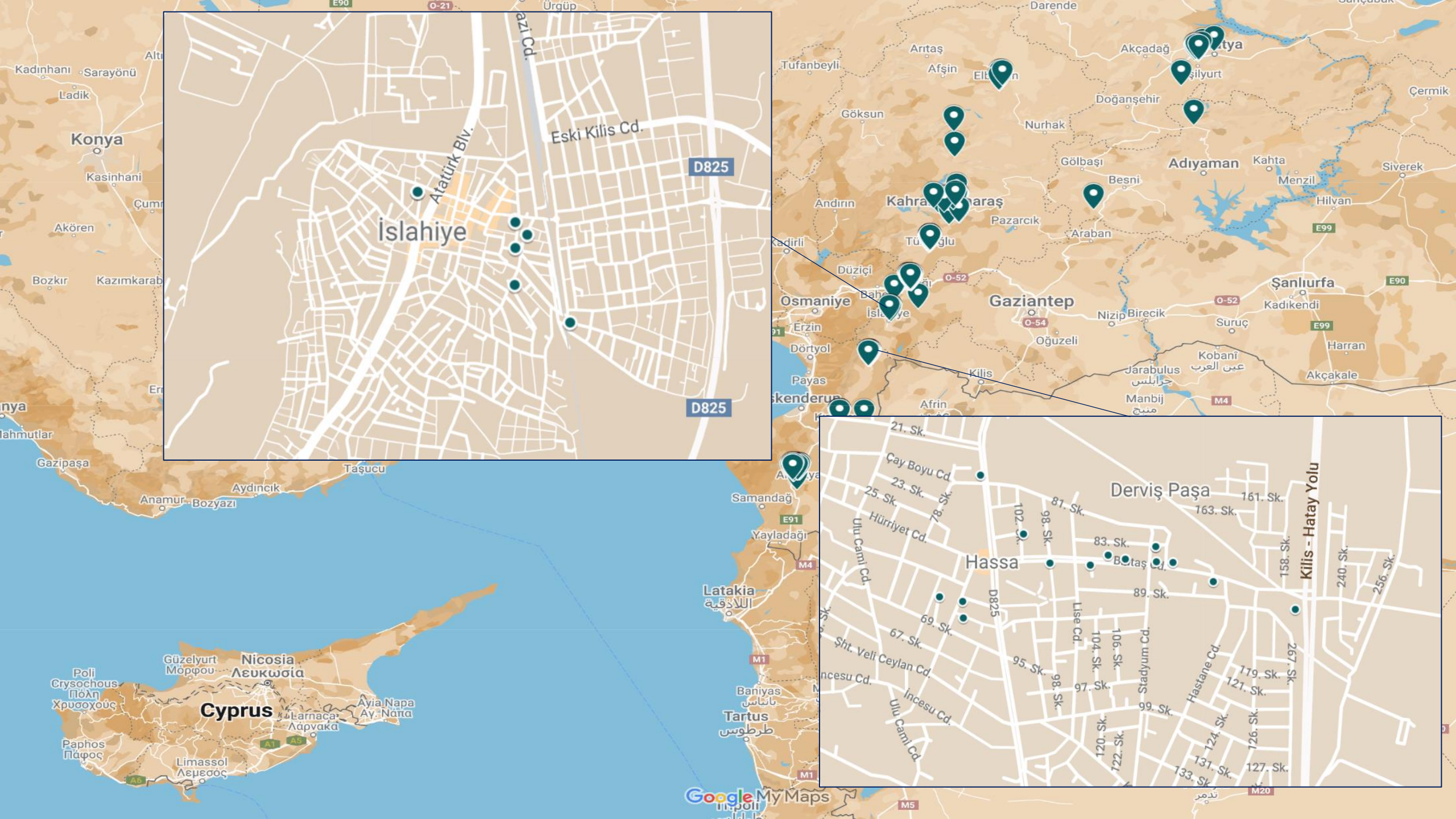
Homs

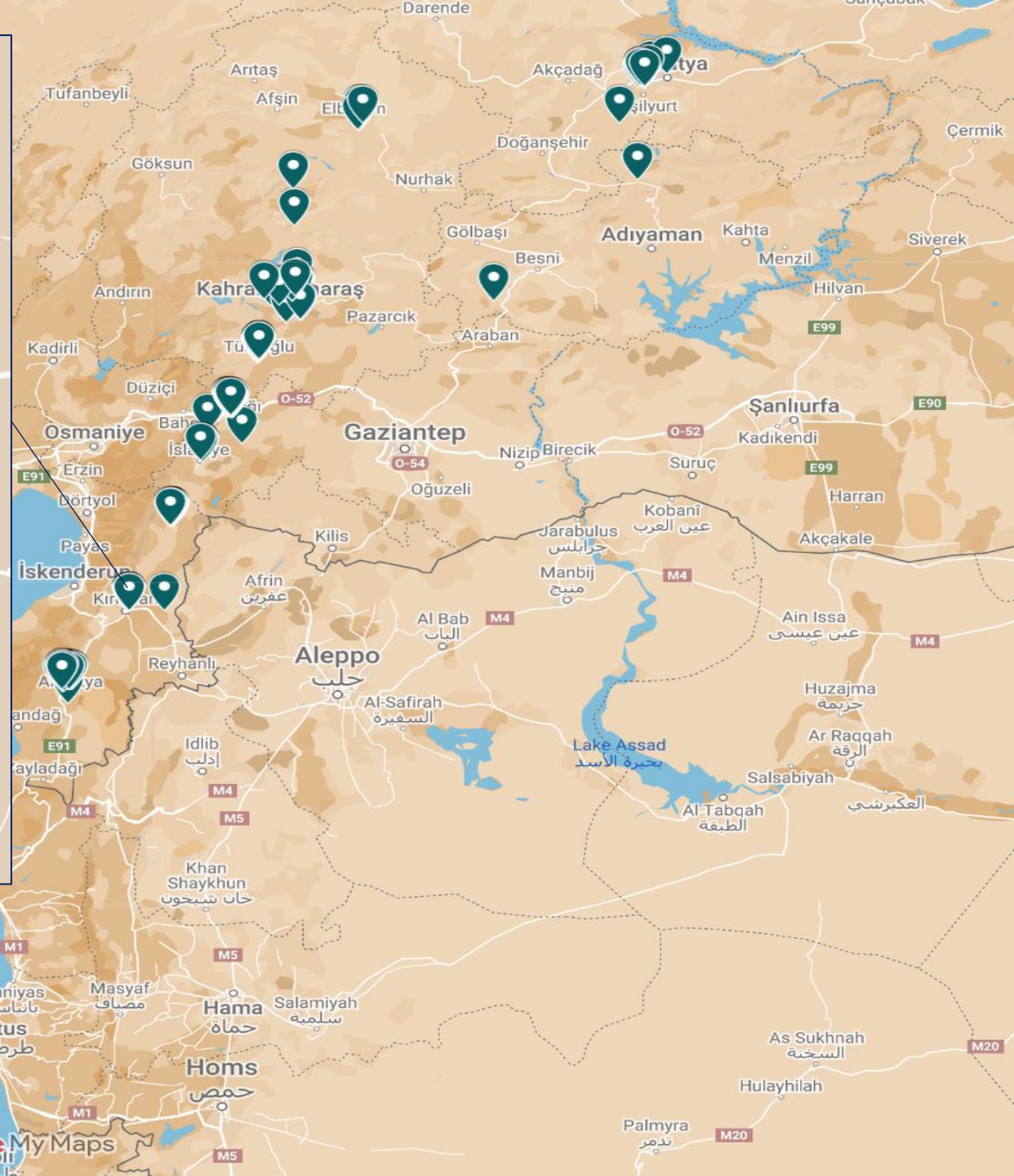
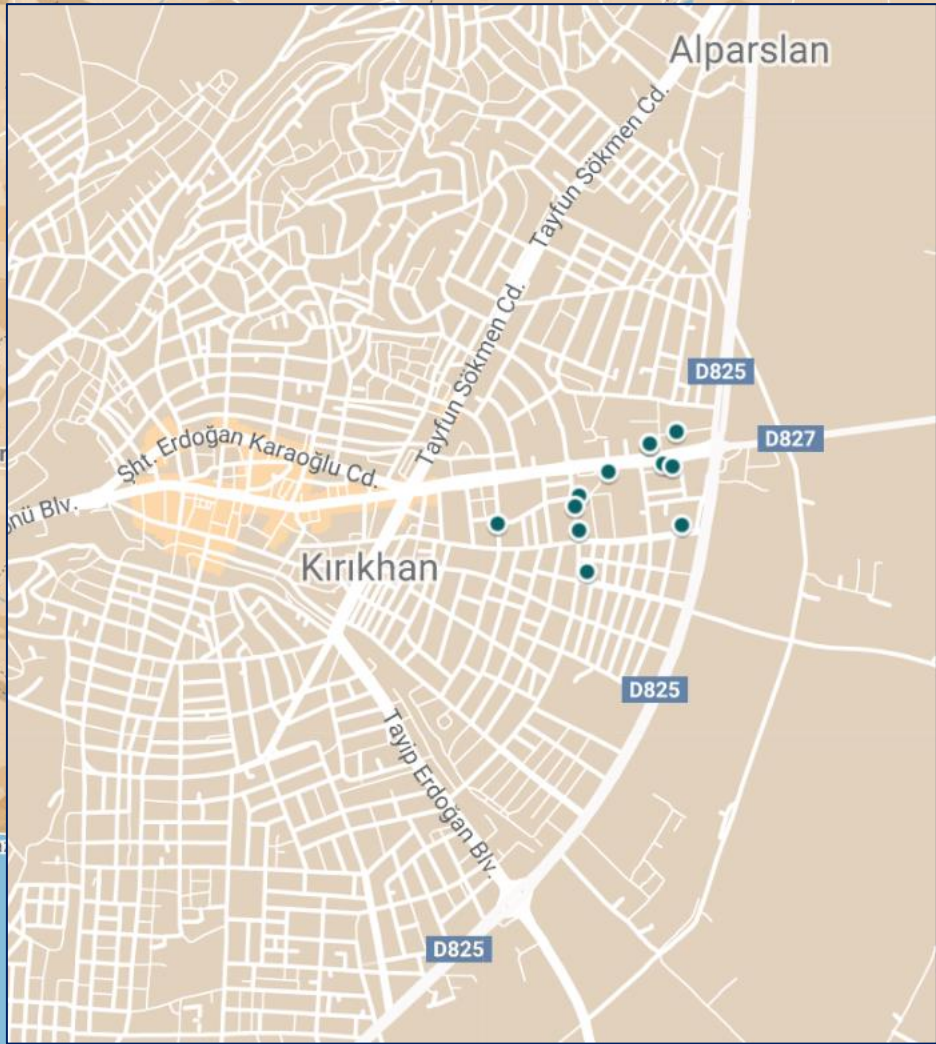
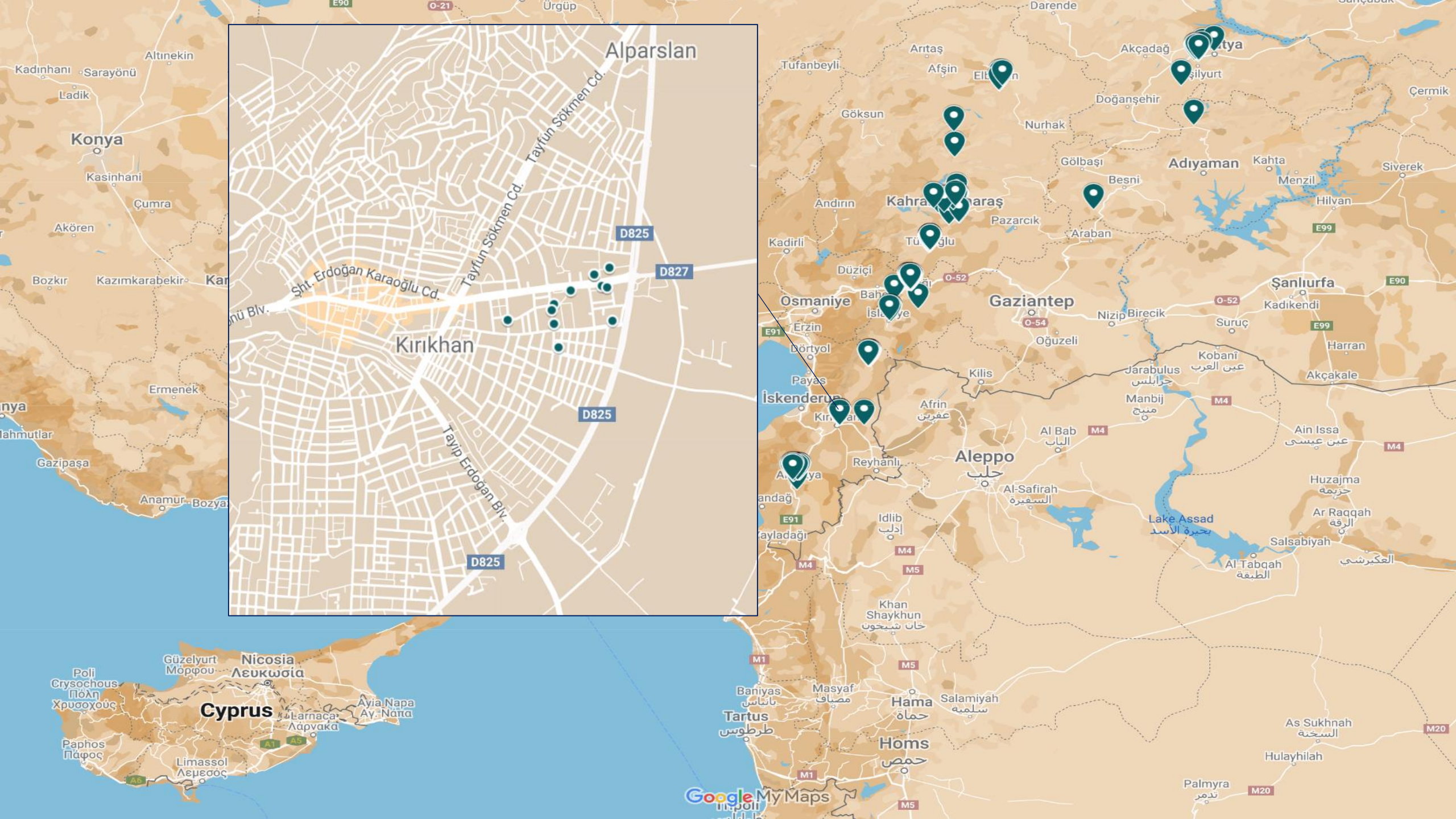
As Sukhnah

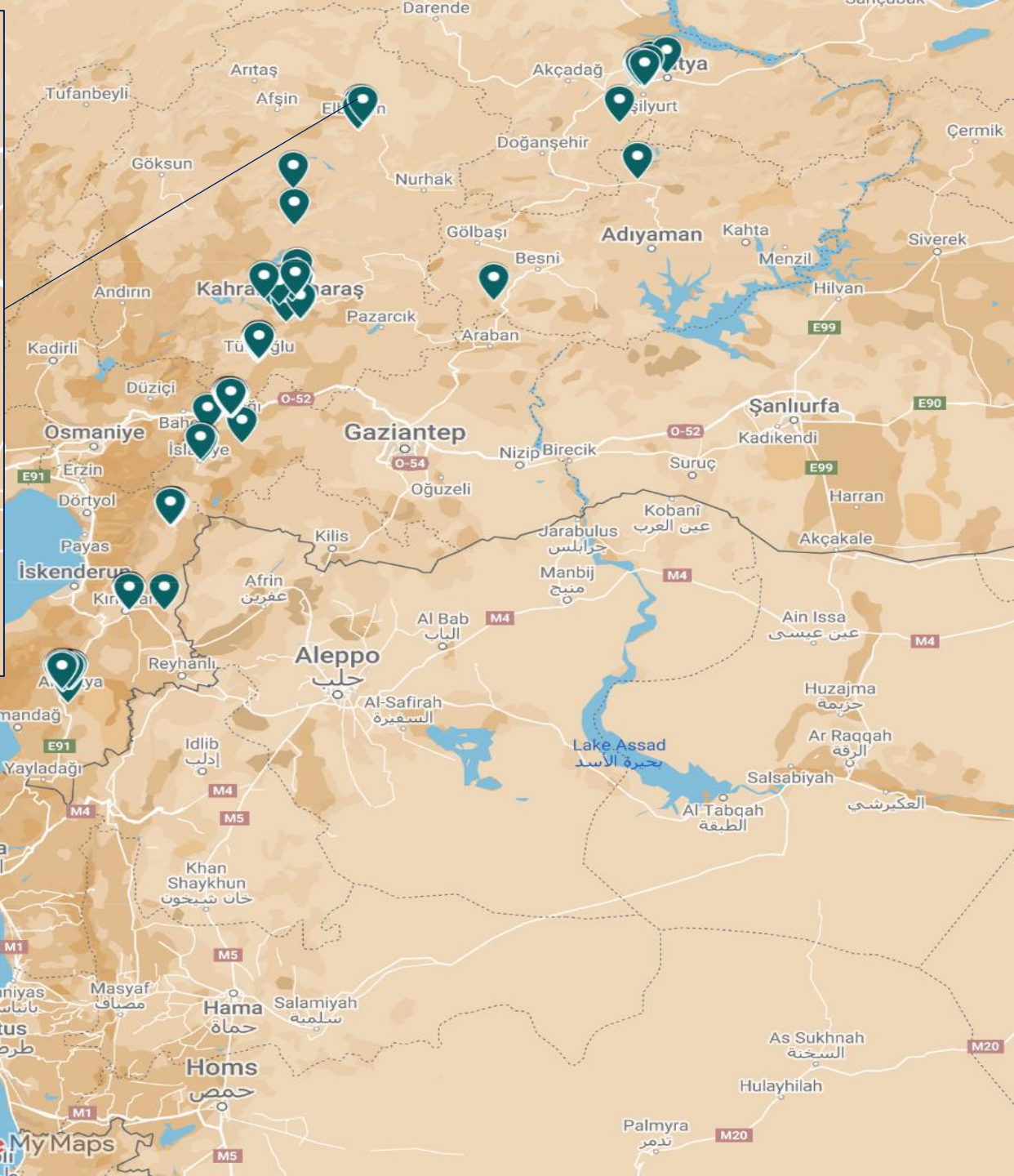
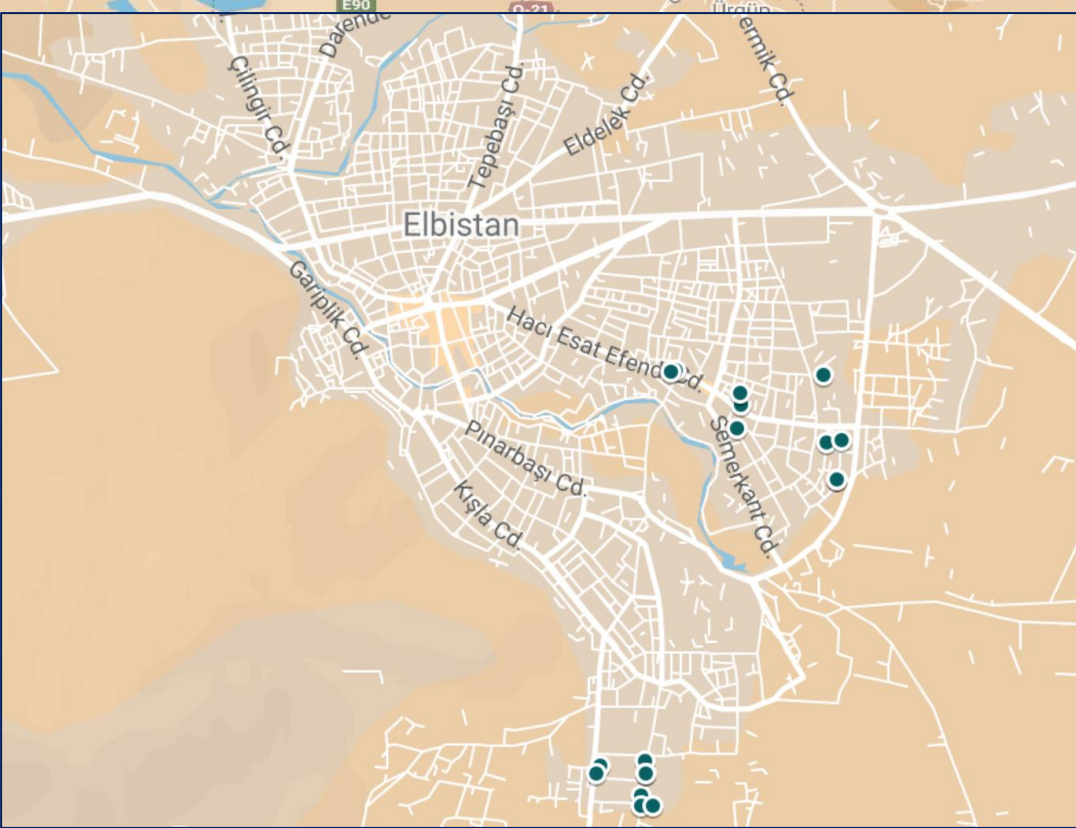
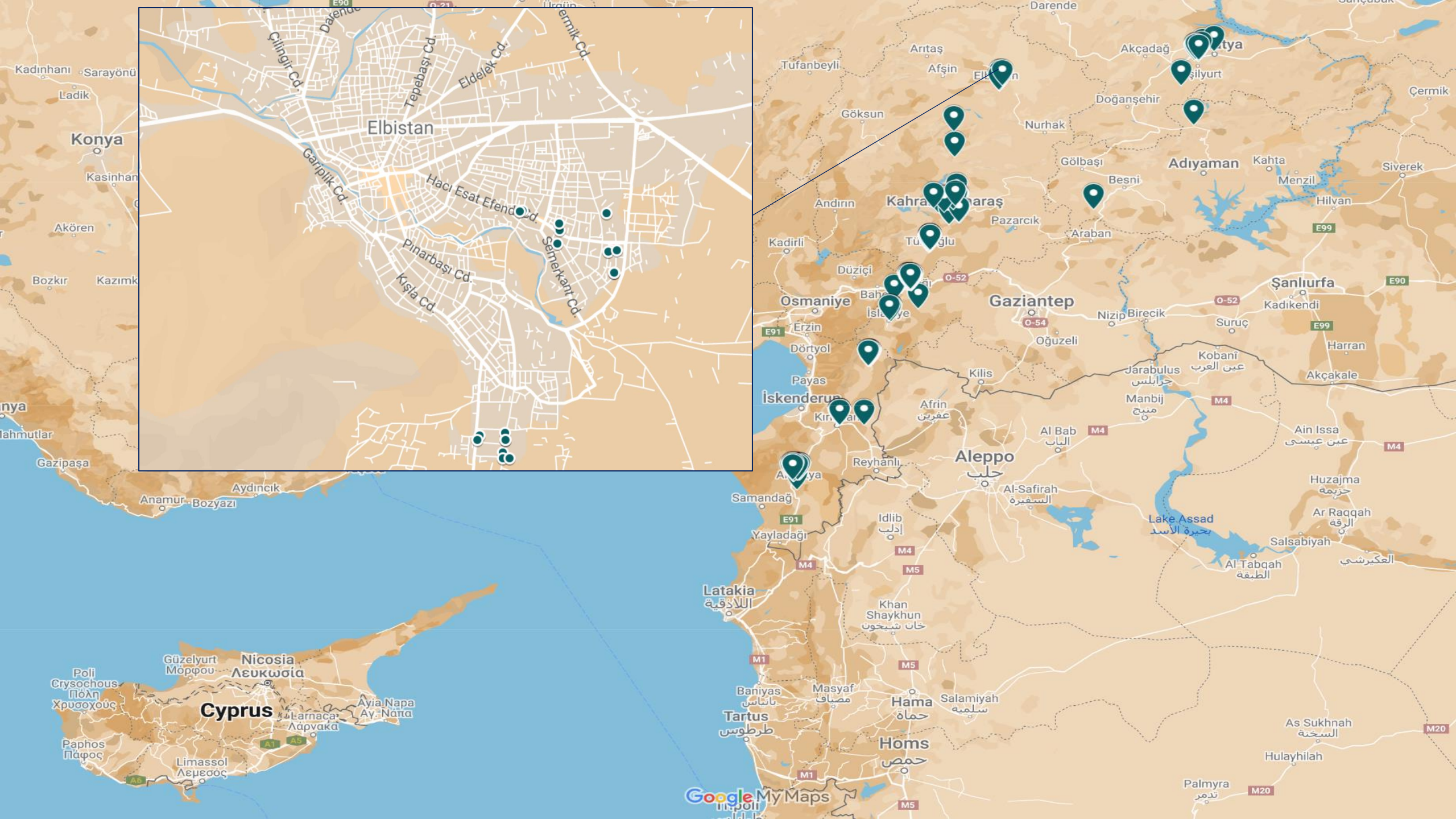
Hulayhilah

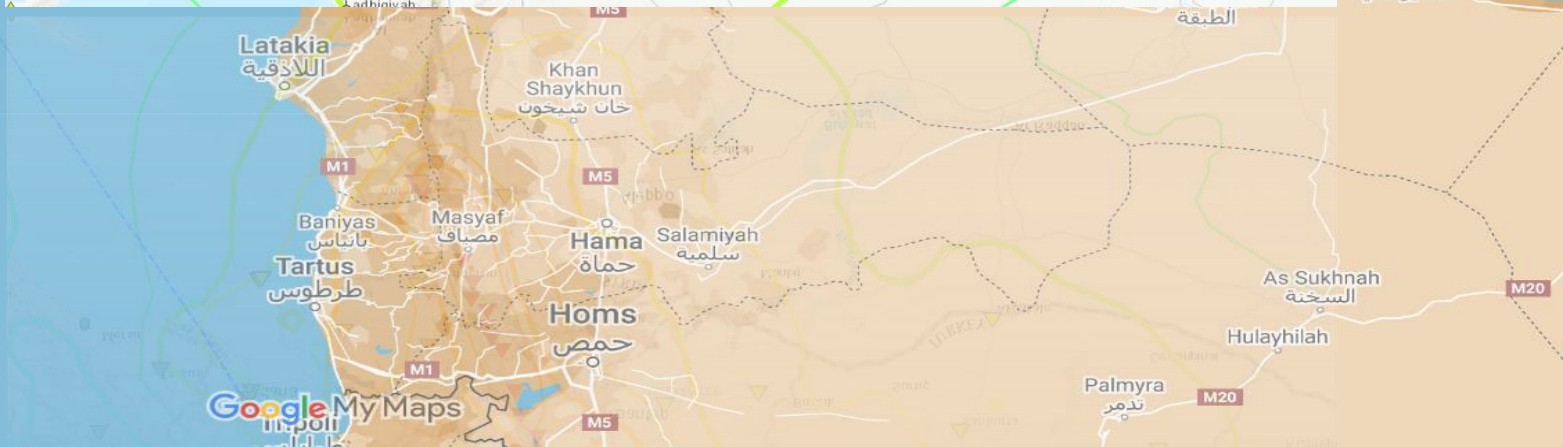
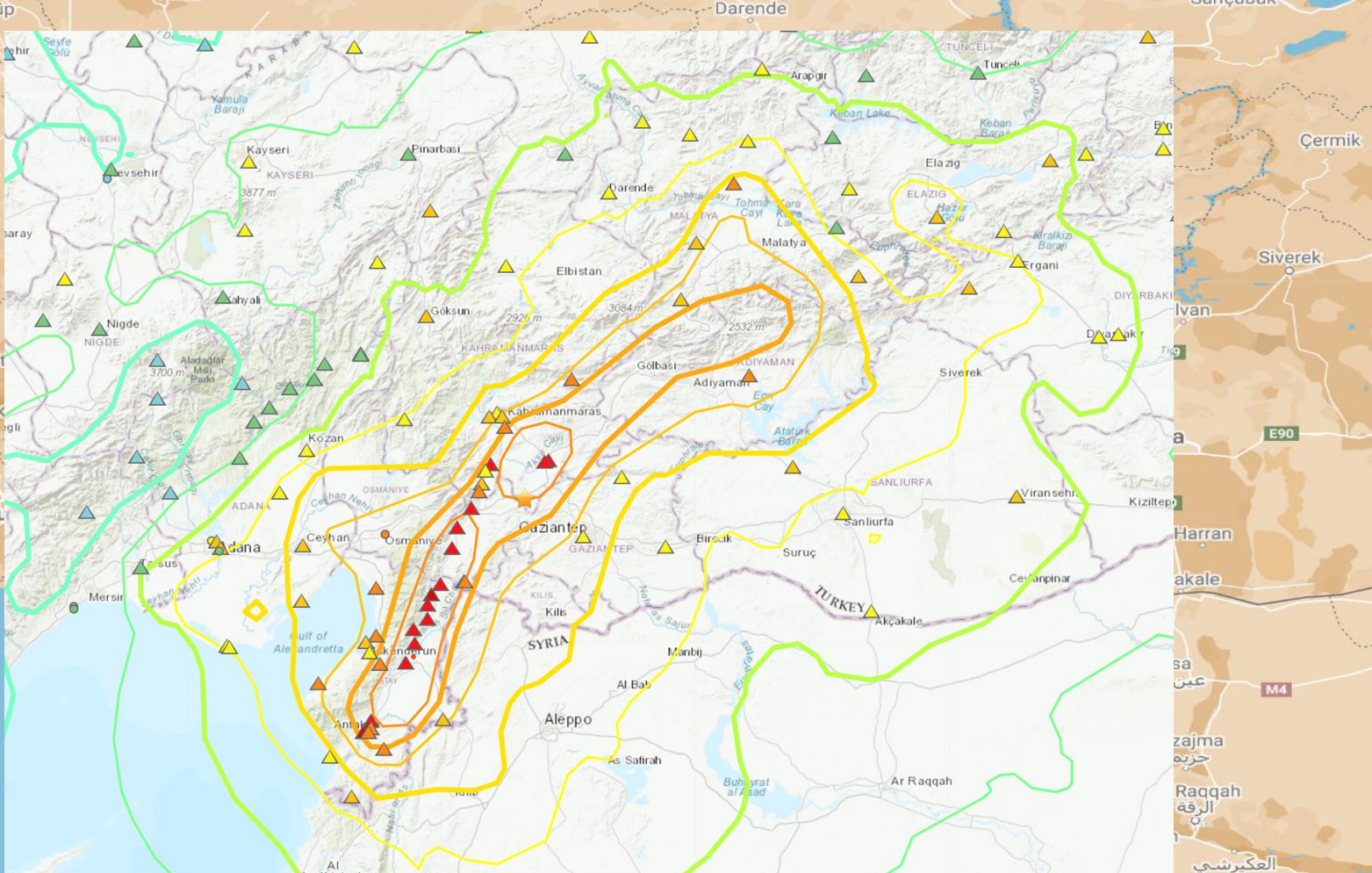
Palmyra

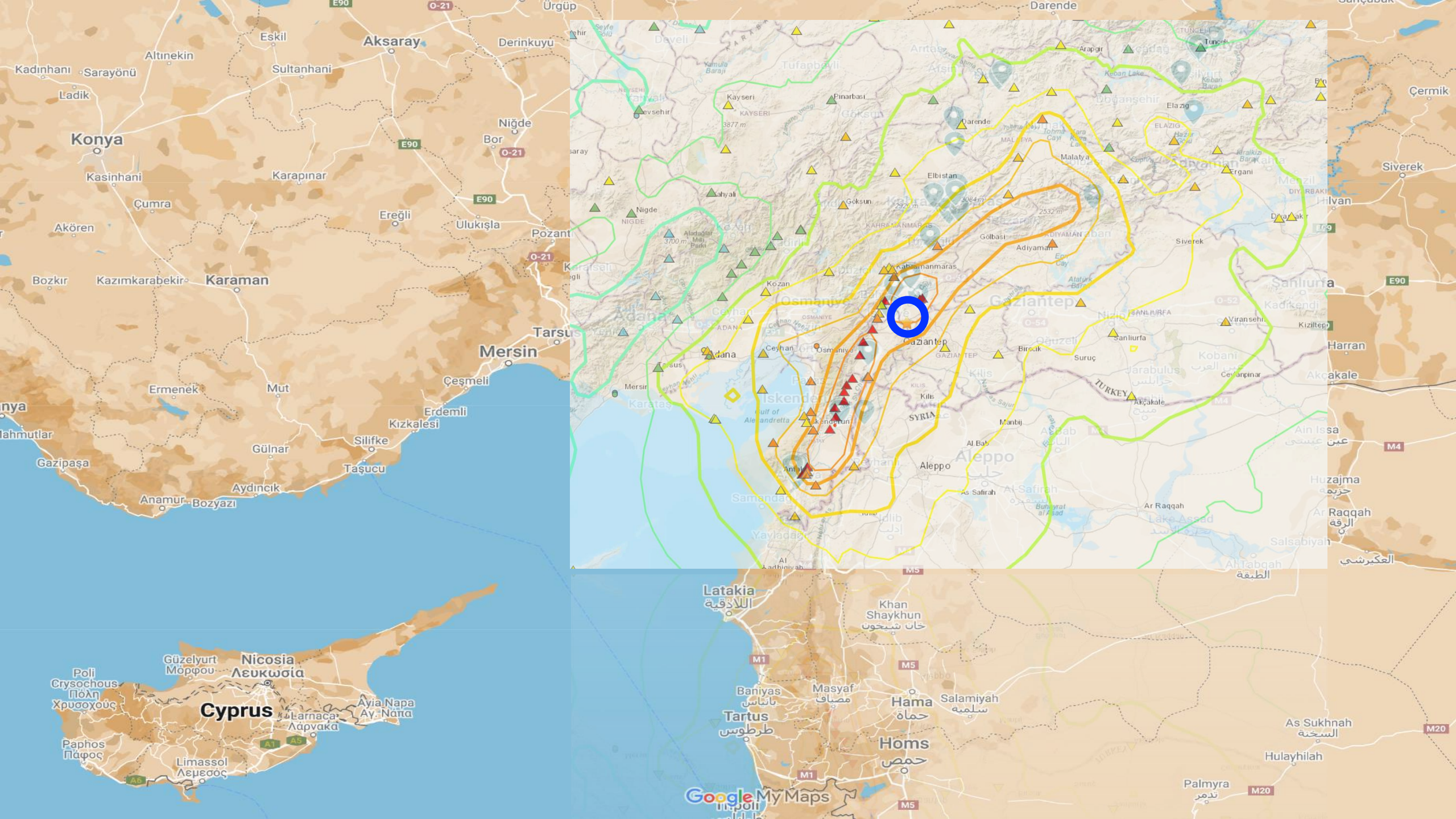
Google My Maps

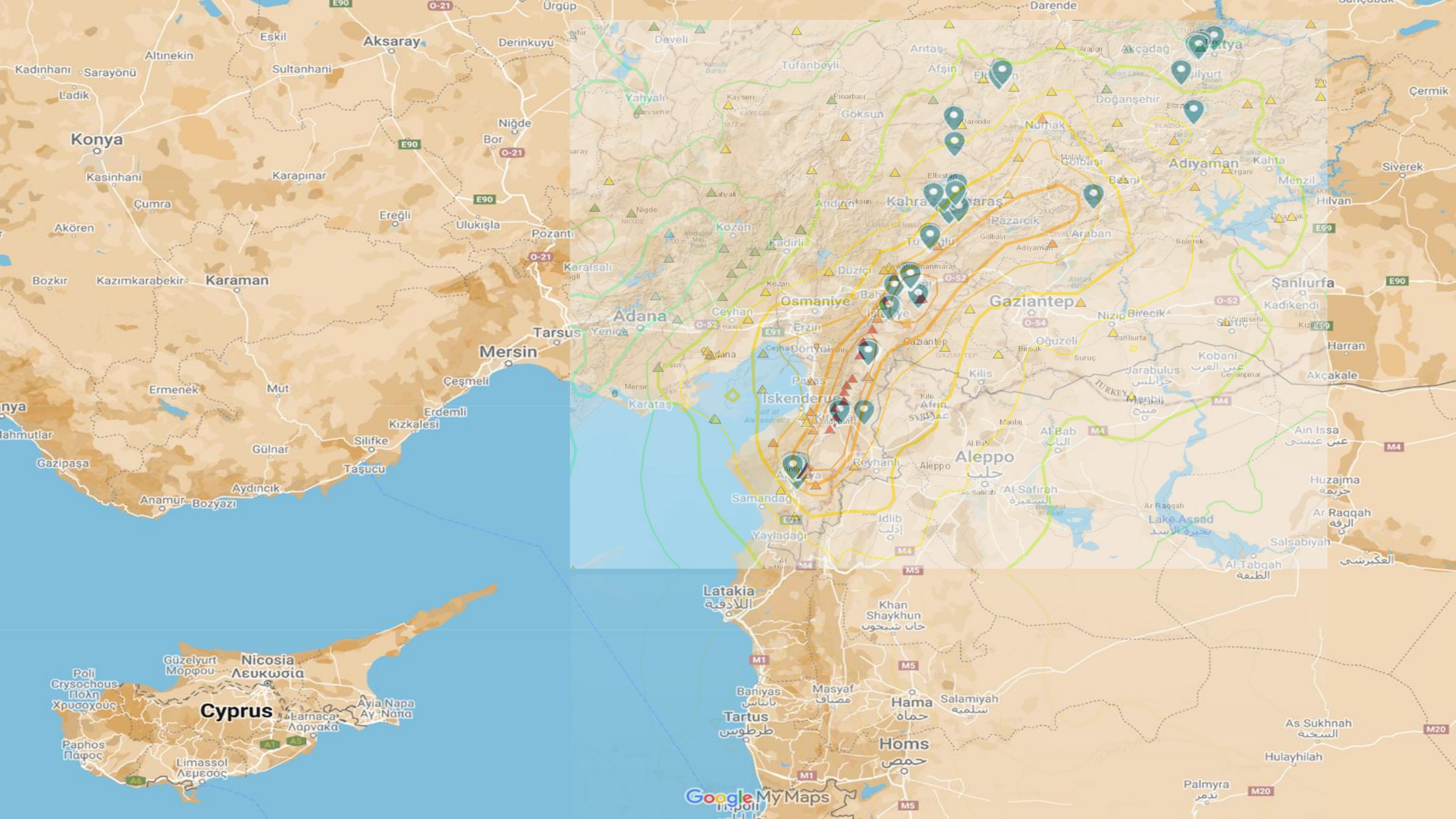


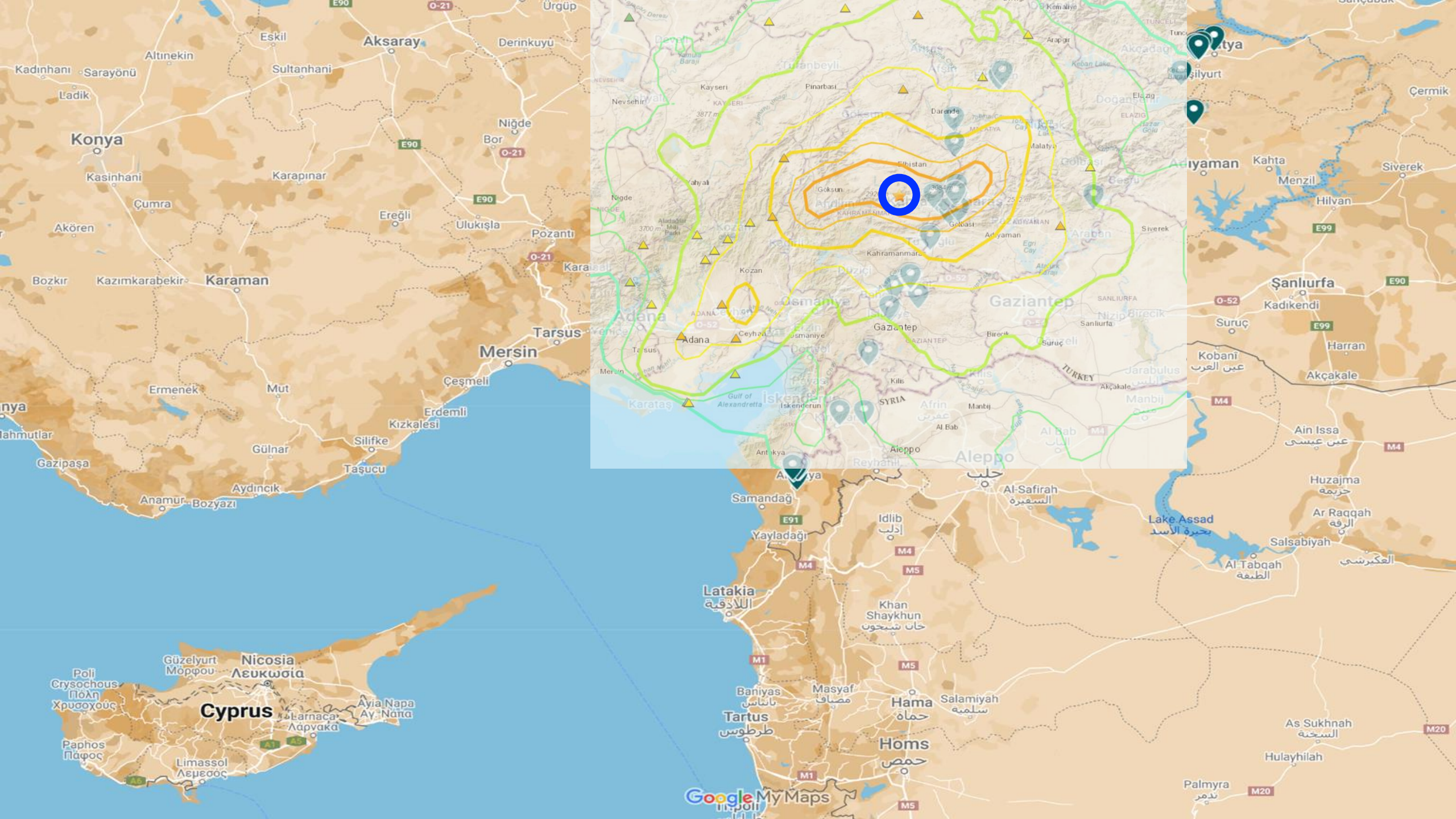














ACI 133 DATA COLLECTION









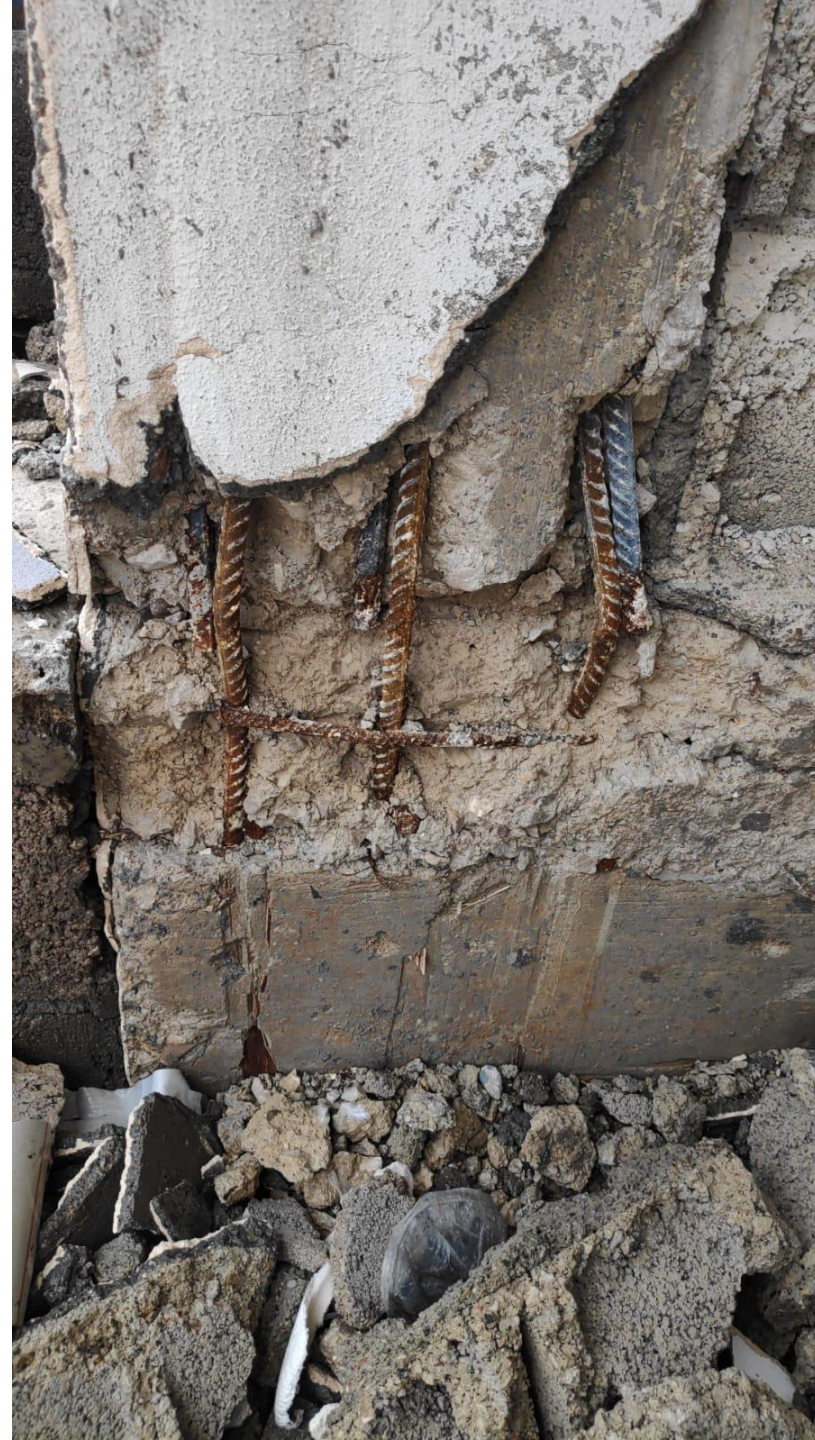
$$WI = \left(\sum A_w + \sum A_m / 10 \right) / \sum A_f$$

$$CI = \left(\sum A_c / 2 \right) / \sum A_f$$

WALL INDEX vs. COLUMN INDEX
TURKEY 2023 EQ

OBSERVATIONS ON PROPORTIONS











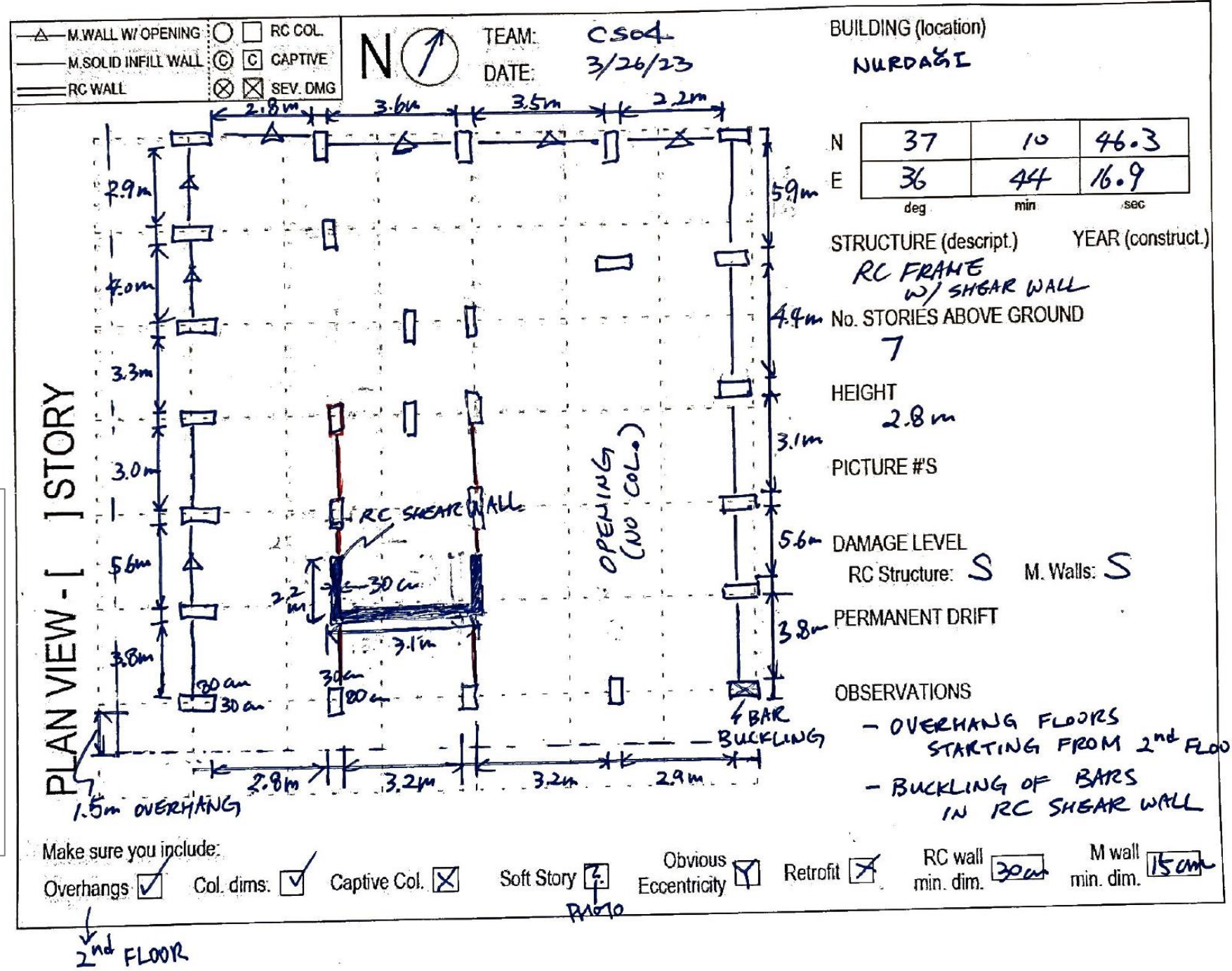
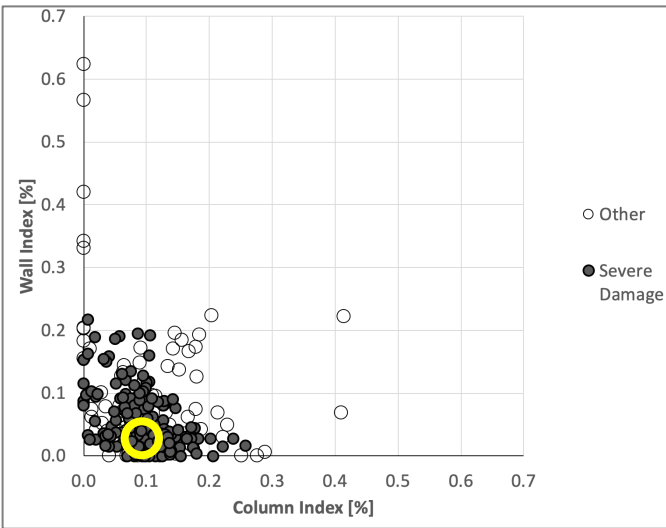








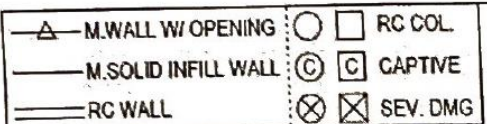
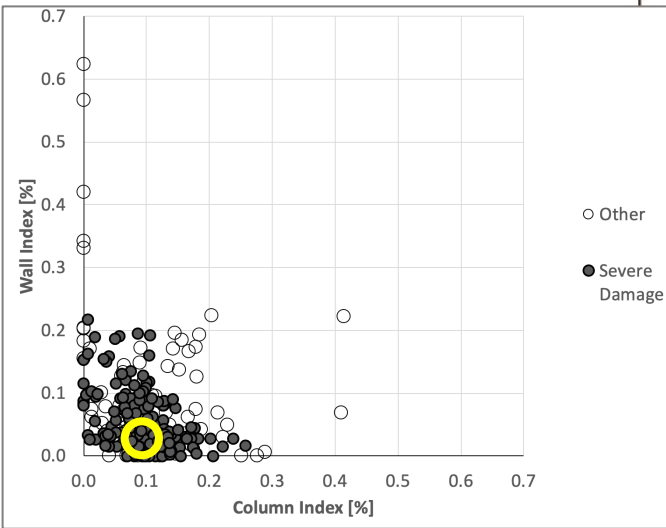
Location: Nurdagi
 PGV: 1.1 m/s
 WI: NS 0.06% EW 0.03%
 Cl: 0.1%



2nd FLOOR

Location: Nurdagi
 PGV: 1.1 m/s

WI: NS 0.06% EW 0.03%
 CI: 0.1%



TEAM: CS05
 DATE: 03/26/23

BUILDING (location)
 NURDAGI

N	37	10	46.8
E	36	44	17.3
	deg	min	sec

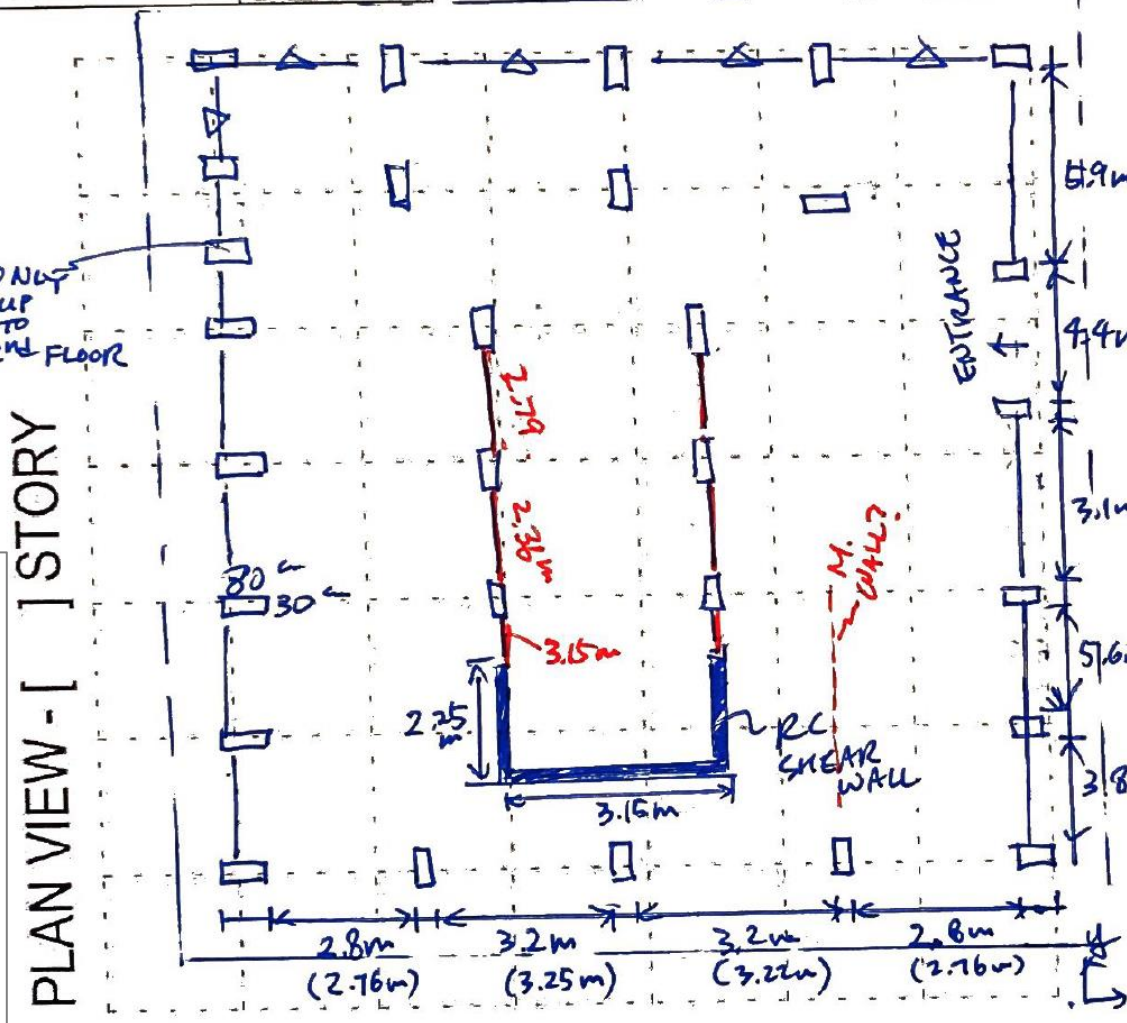
STRUCTURE (descript.) YEAR (construct.)
 RC FRAME w/ SHEAR WALL
 No. STORIES ABOVE GROUND
 7

HEIGHT
 2.7m
 PICTURE #S

DAMAGE LEVEL
 RC Structure: M M. Walls: S

PERMANENT DRIFT

OBSERVATIONS
 - LESS OPENINGS THAN CS0
 - DIFFERENT DAMAGE LEVEL IN SHEAR WALL
 DUE TO HAVING ECCENTRICITY ONLY IN 1 (4-DI STY)



Make sure you include:

- Overhangs
- Col. dims.
- Captive Col.
- Soft Story
- Obvious Eccentricity
- Retrofit
- RC wall min. dim.
- M wall min. dim.



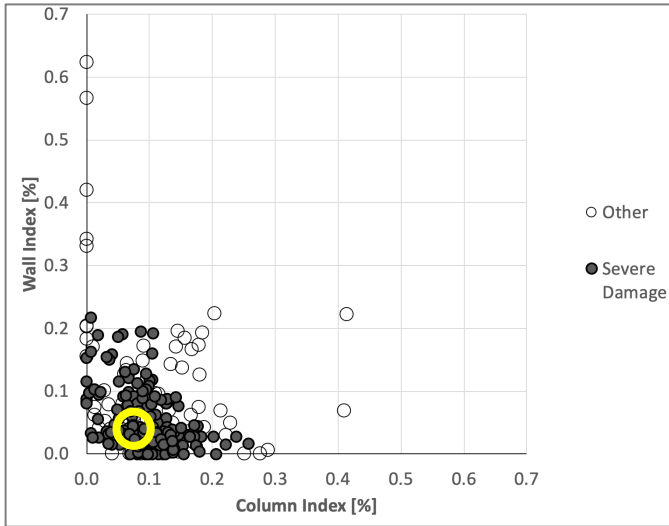


Location: Antakya

PGV: 1.9 m/s

WI: NS 0.09% EW 0.04%

CI: 0.07%



M.WALL W/ OPENING RC COL.
 M.SOLID INFILL WALL CAPTIVE
 RC WALL SEV. DMG



TEAM: CS20
DATE: 3/30/23

BUILDING (location)
HATAY ANTAKYA
SARAYCIK
PARSEL: 3784

N	36	13	35.4
E	36	8	51.6
	deg	min	sec

STRUCTURE (descript.) YEAR (construct.)

No. STORIES ABOVE GROUND

6.5

HEIGHT

2.6m

PICTURE #S

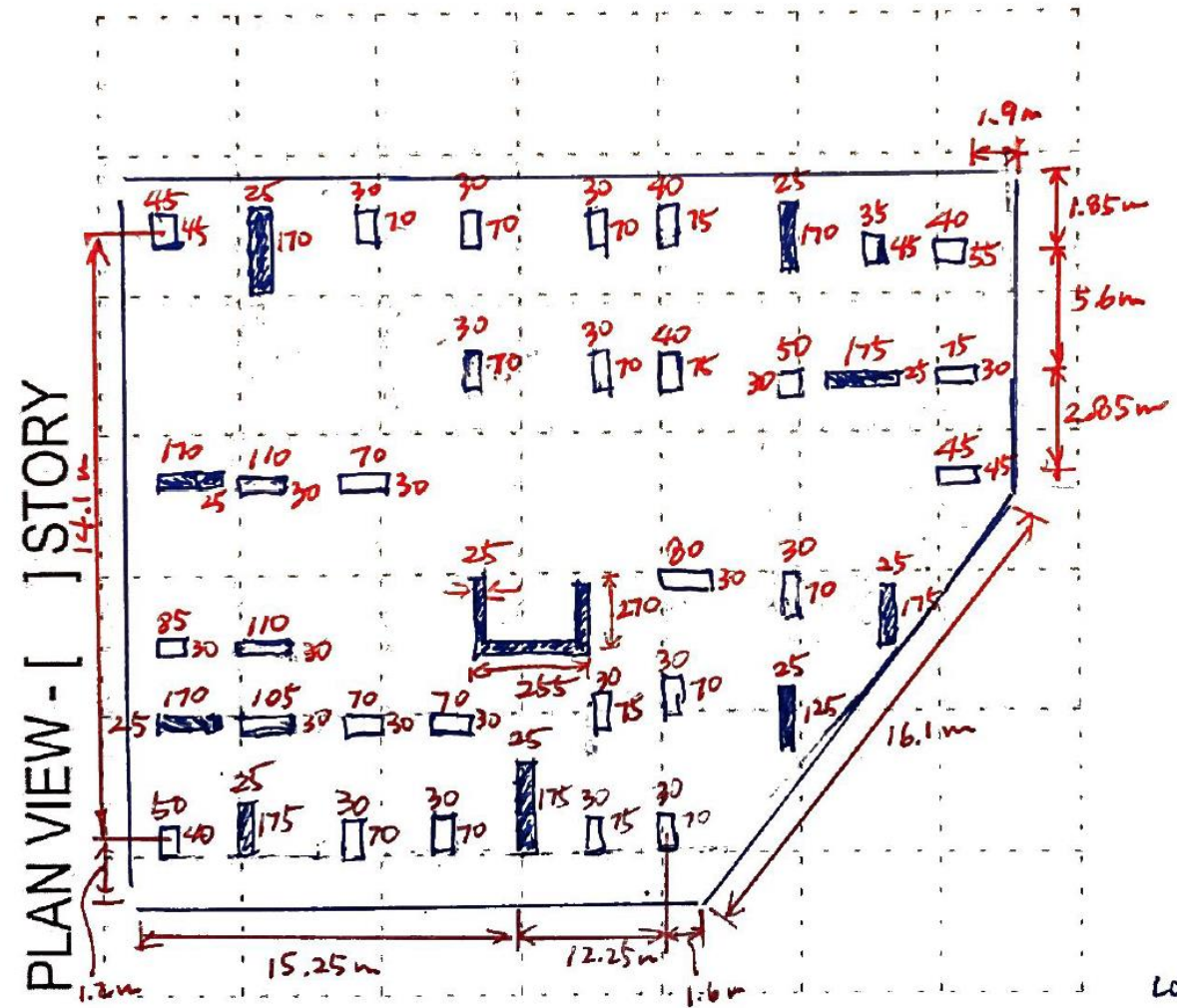
DAMAGE LEVEL

RC Structure: S M. Walls: S

PERMANENT DRIFT

OBSERVATIONS

- MANY OF THE BEAMS DAMAGED (SOME @ SPICE, SOME AS SEPARATE) LONGITUDINAL BAR BUCKLED! IN BEAMS,
- 1st FLOOR COLS. HAVE HOPE



Make sure you include:

Overhangs Col. dims. Captive Col. Soft Story Obvious Eccentricity Retrofit RC wall min. dim. M wall min. dim.



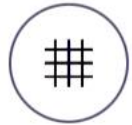




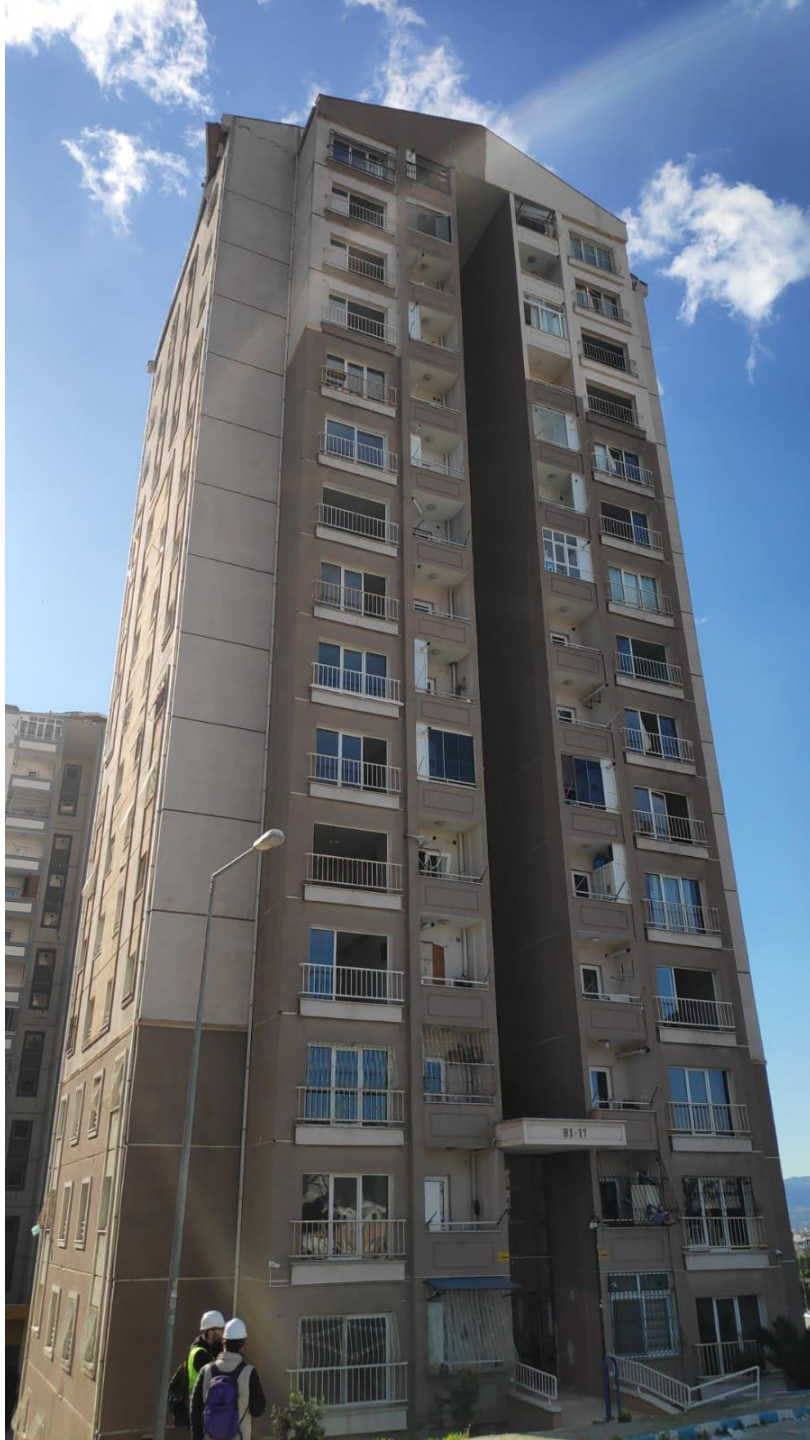




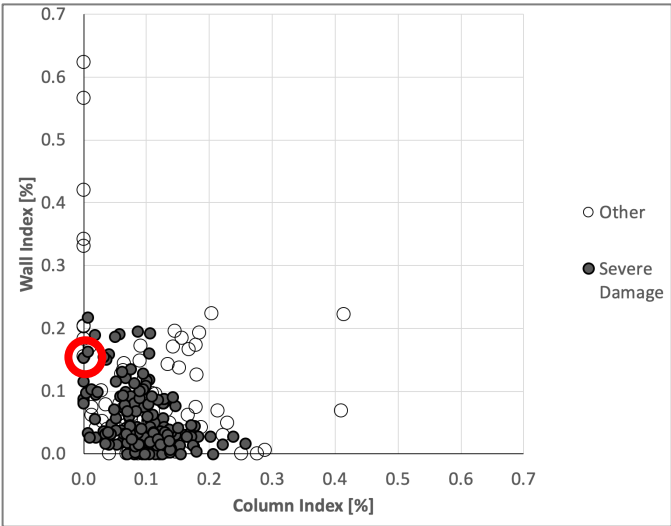








Location: Antakya
 PGV: 1.9 m/s
 WI: NS 0.15% EW 0.23%



<p> <input type="checkbox"/> M.WALL W/ OPENING <input type="checkbox"/> M.SOLID INFILL WALL <input type="checkbox"/> RC WALL </p>	<p> <input type="checkbox"/> RC COL. <input type="checkbox"/> CAPTIVE <input type="checkbox"/> SEV. DMG </p>	<p>N</p>	<p>TEAM: CS21 DATE: 3/31/23</p>
---	--	----------	-------------------------------------

PLAN VIEW - [] STORY

BUILDING (location)		
HATAY ANTAKYA GÜNYAZI		
ADA 888		
PARSEL 2787		

N	36	13	38.3
E	36	7	34.3
	deg	min	sec

STRUCTURE (descript.)	YEAR (construct.)
TUNNEL FORM RC SHEAR WALL	2013
No. STORIES ABOVE GROUND	16
HEIGHT	2.7m
PICTURE #S	
DAMAGE LEVEL	
RC Structure: S	M. Walls: S
PERMANENT DRIFT	
OBSERVATIONS	
- SHEAR WALL DAMAGE ON 1st & B	
- CAN SEE THROUGH MASONRY INFILL DAMAGE	
- ROOF (NON-STRUCTURAL) FELL DOWN DAMAGE	

Make sure you include:

Overhangs <input checked="" type="checkbox"/>	Col. dims. <input checked="" type="checkbox"/>	Captive Col. <input type="checkbox"/>	Soft Story <input type="checkbox"/>	Obvious Eccentricity <input type="checkbox"/>	Retrofit <input checked="" type="checkbox"/>	RC wall min. dim. <input type="text" value="20cm"/>	M wall min. dim. <input type="text" value="20cm"/>
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AR



Location: Antakya
PGV: 1.3 m/s (avg.)

WI: 0.04%
Estimated Drift: 6%





Location: Antakya
PGV: 1.3 m/s (avg.)

WI: 0.04%

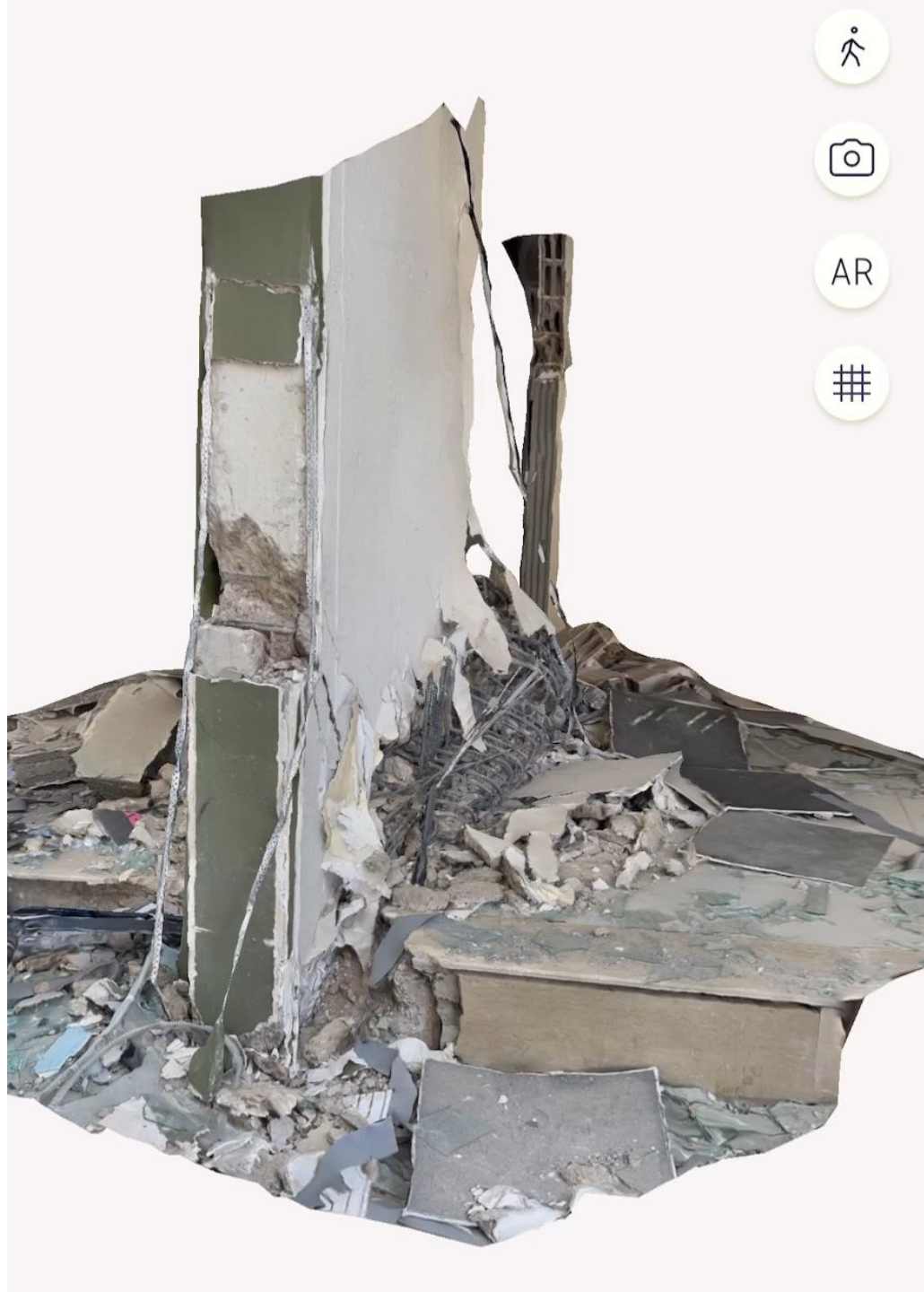
Estimated Drift: 6%













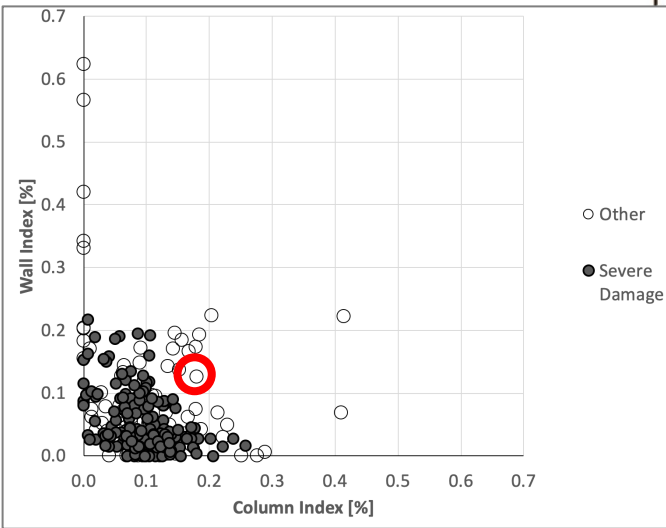








Location: Dulkadiroglu
 PGV: 1 m/s
 WI: NS 0.16% EW 0.12%
 CI: 0.18%



M.WALL W/ OPENING RC COL.
 M.SOLID INFILL WALL CAPTIVE
 RC WALL SEV. DMG



TEAM: CS16
 DATE: 3/29/23

BUILDING (location)
 DULKADIROGLU
 ADA 1622
 PARSEL 10

N	37	34	54
E	36	58	13.1
	deg	min	sec

STRUCTURE (descript.) YEAR (construct.)
 RC FRAME
 W/ SHEAR WALL 2022+
 RC SLAB

No. STORIES ABOVE GROUND
 7 (CRITICAL FLOOR AFTER 2nd FLOOR
 + 2 STORIES BELOW GROUND)

HEIGHT
 TOTAL 5.7^m (1st FLOOR)
 FLOOR HEIGHT 2.6^m (ABOVE 2nd)
 PICTURE #'S

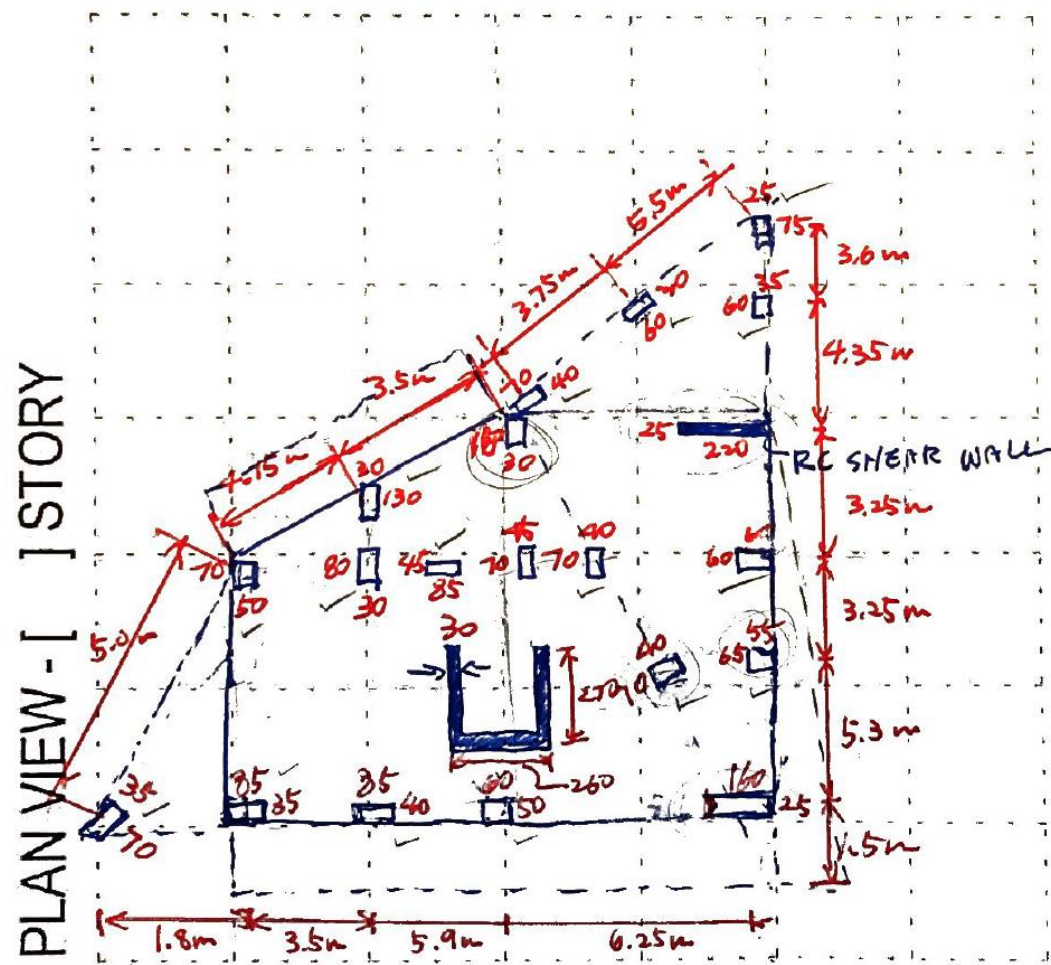
DAMAGE LEVEL
 RC Structure: L M. Walls: S

PERMANENT DRIFT

OBSERVATIONS

- CORNER BLDG
- TRIANGULAR ATTACHMENTS TO BLDG
- TRAPEZOIDAL SHAPE
- DRAWINGS AVAILABLE

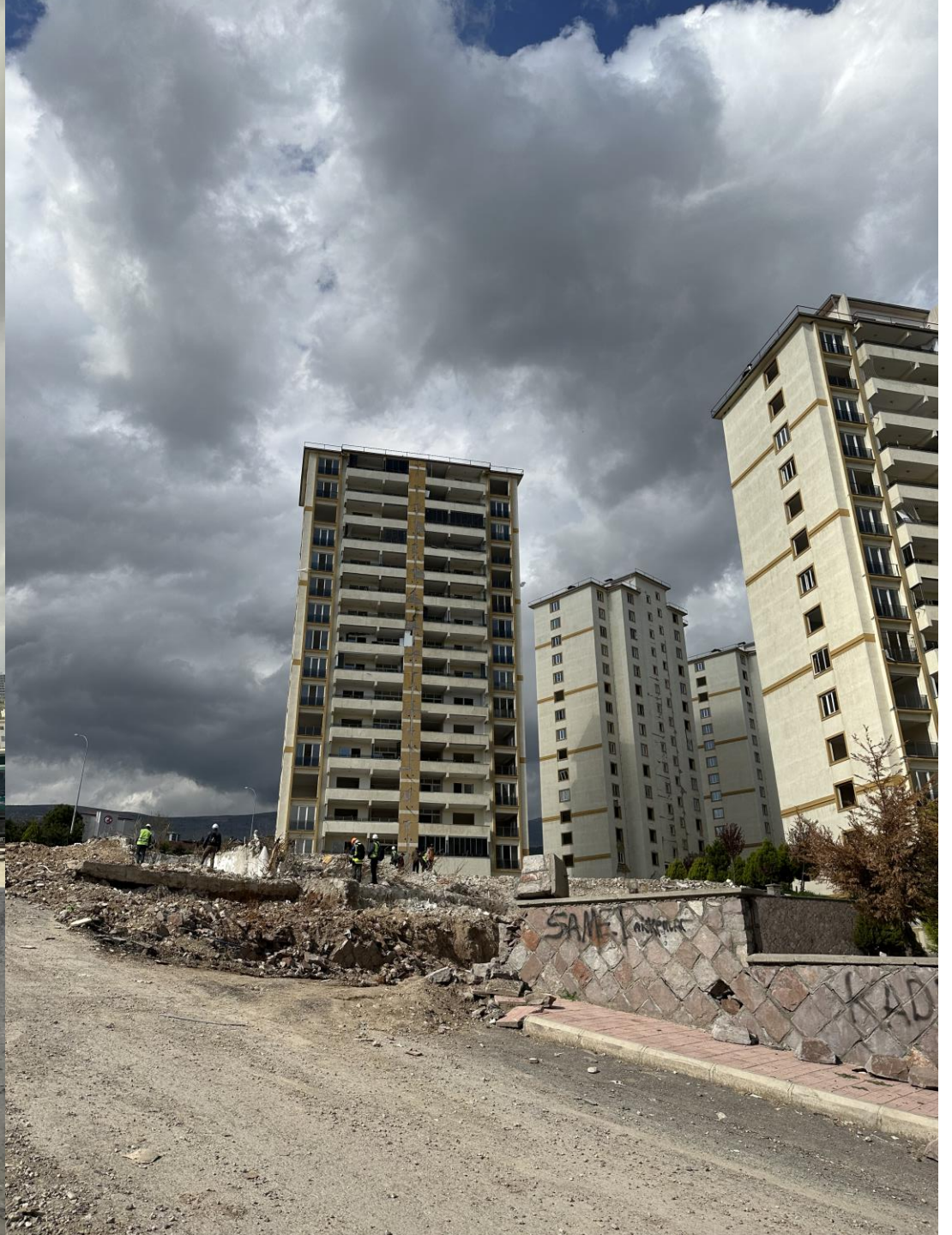
RC wall min. dim. 25cm
 M wall min. dim. 20cm



Make sure you include:

- Overhangs Col. dims. Captive Col. Soft Story Obvious Eccentricity Retrofit

PUT NO OR LIGHT DA CHAIR CR

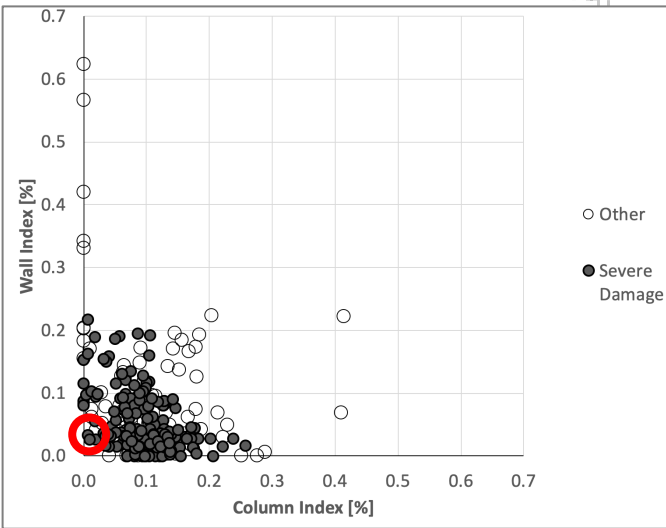
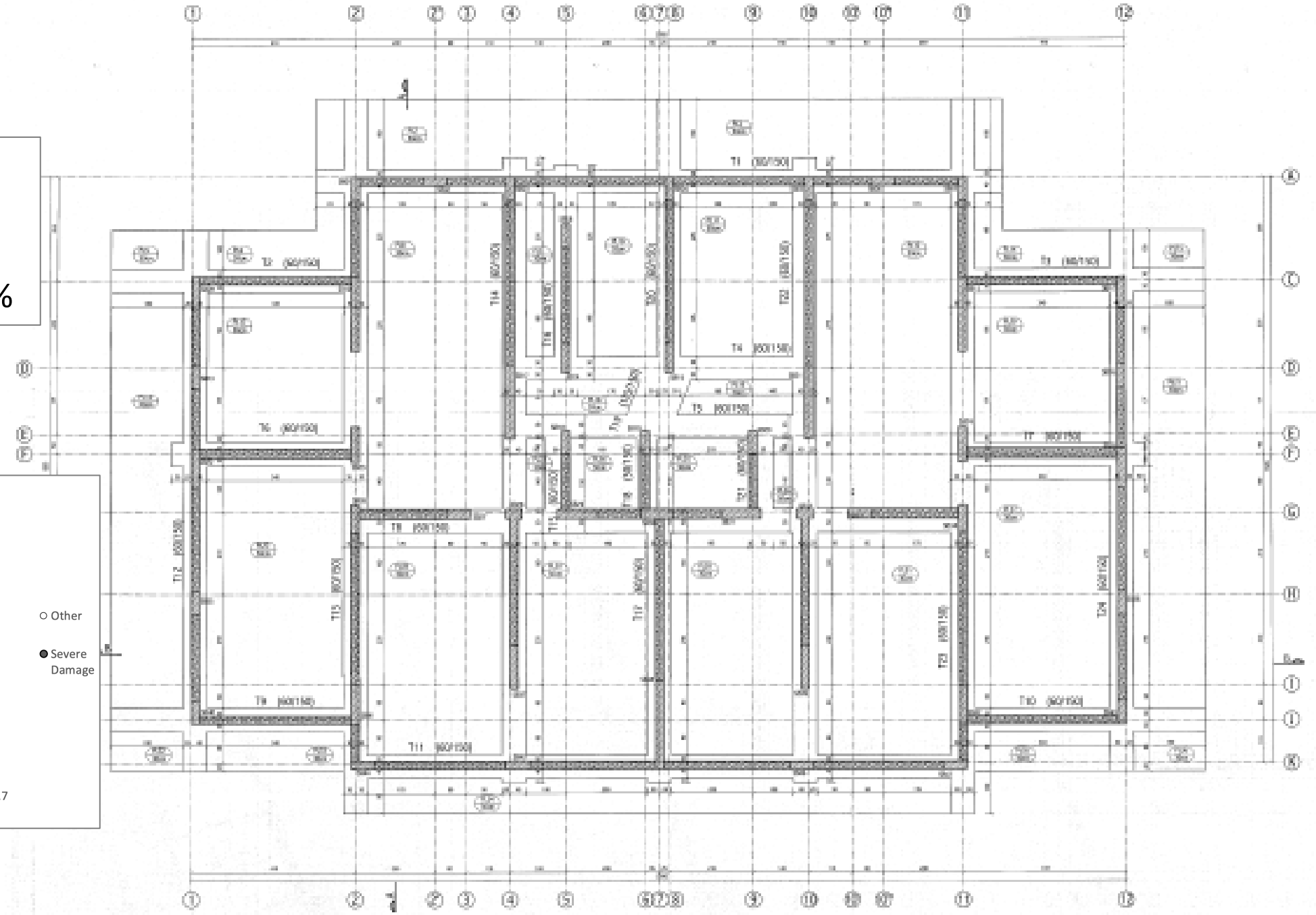








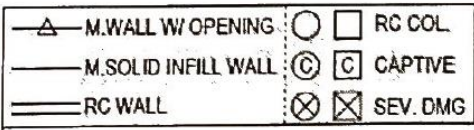
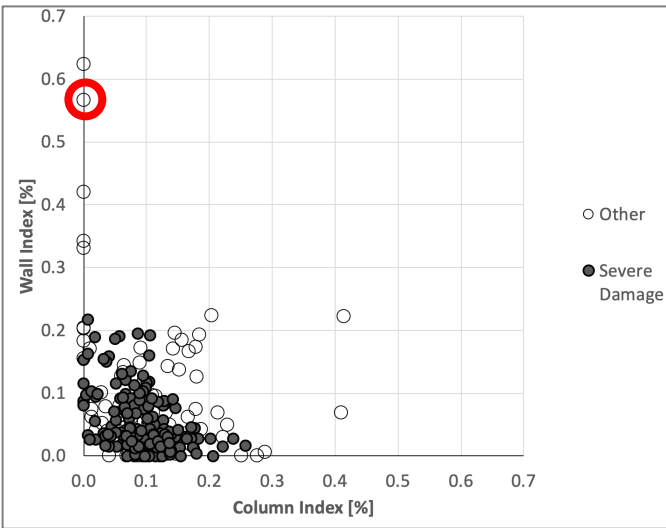
Location: Dulkadiroglu
 PGV: 1.0 m/s
 WI: NS 0.61% EW 0.03%







Location: Dulkadiroglu
 PGV: 1 m/s
 WI: NS 0.74% EW 0.57%



TEAM: CS11
 DATE: 3/28/23

BUILDING (location) CS11
 B1-23
 DULKADIROGLU

N	37	30	33.3
E	36	56	27.7
	deg	min	sec

STRUCTURE (descript.) YEAR (construct.)
 TUNNEL FORM (RC SHEAR WALL) 2021
 No. STORIES ABOVE GROUND TOKI
 5

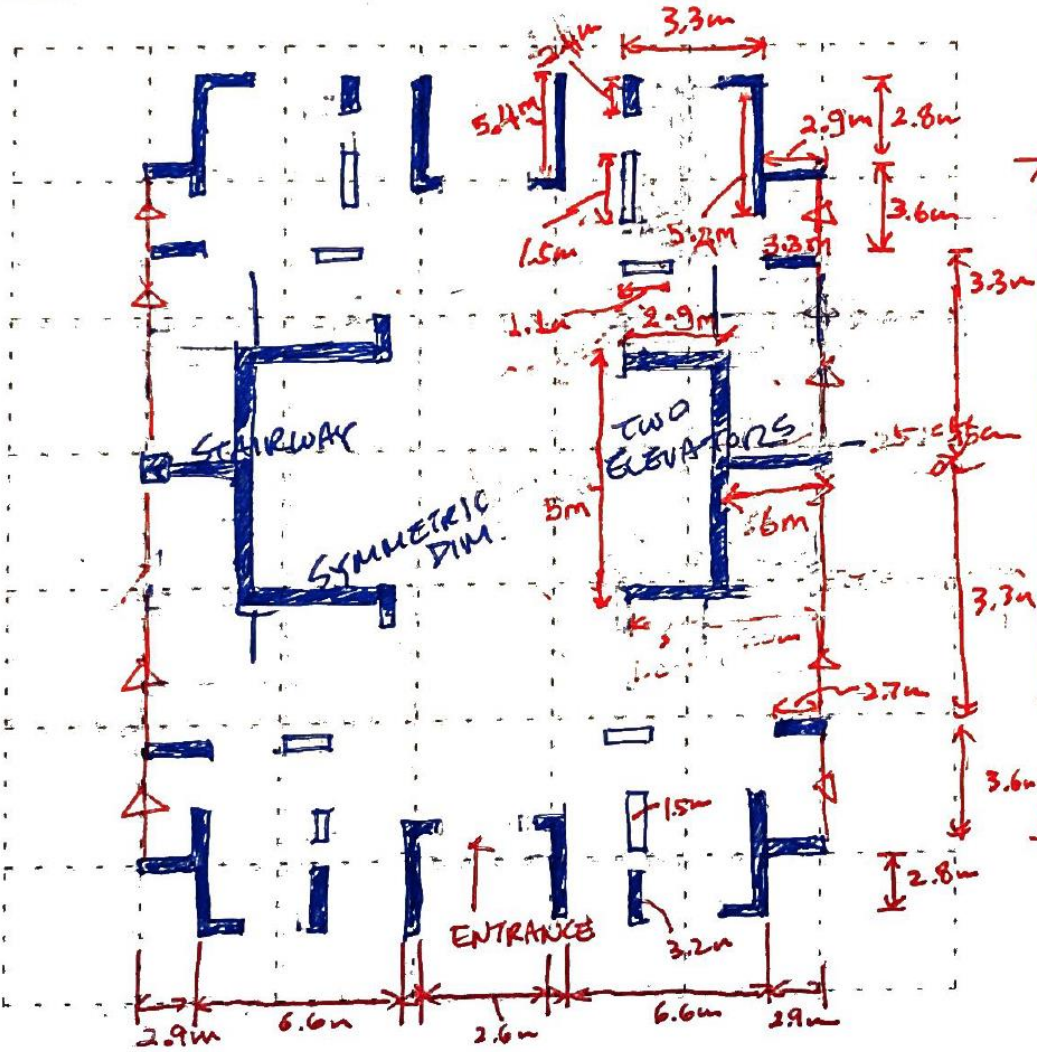
HEIGHT 3.4m

PICTURE #'S

DAMAGE LEVEL
 RC Structure: N M. Walls: L (HAIRLINE CRACKS)
 PERMANENT DRIFT

OBSERVATIONS
 - NO DAMAGE IN STRUCTURAL
 - W.I. IN E-W (0)

PLAN VIEW - [] STORY



Make sure you include:

- Overhangs
- Col. dims.
- Captive Col.
- Soft Story
- Obvious Eccentricity
- Retrofit
- RC wall min. dim.
- M wall min. dim.

IGNORE (SMALL PORTION)

SUMMARY

- *ACI 133 Team surveyed 242 reinforced concrete buildings (2-16 stories) from 10 cities over 11 days in March and April 2023.*
- *Large drift demands in elements with **inadequate detailing** lead to structural failures.*
- *However, buildings with better details that experienced large drifts still had problems with **non-structural elements** (masonry infills, stairways, facades) or **structural instability** (overturning)*
- *Collected data shows **clear correlation** between **structural performance** and measured relative cross-sectional areas of **columns** and **structural walls at base**. Buildings with smaller and fewer walls and columns are more likely to have structural and/or non-structural damage.*
- ***Controlling drift by increasing the stiffness (more walls; $WI > 0.2\%$) of buildings, and placing the structural walls in both directions will highly improve the structural performance** regardless of reinforcement details, or quality of construction.*

ACKNOWLEDGEMENTS



American Concrete Institute

Always advancing



QUESTIONS?

