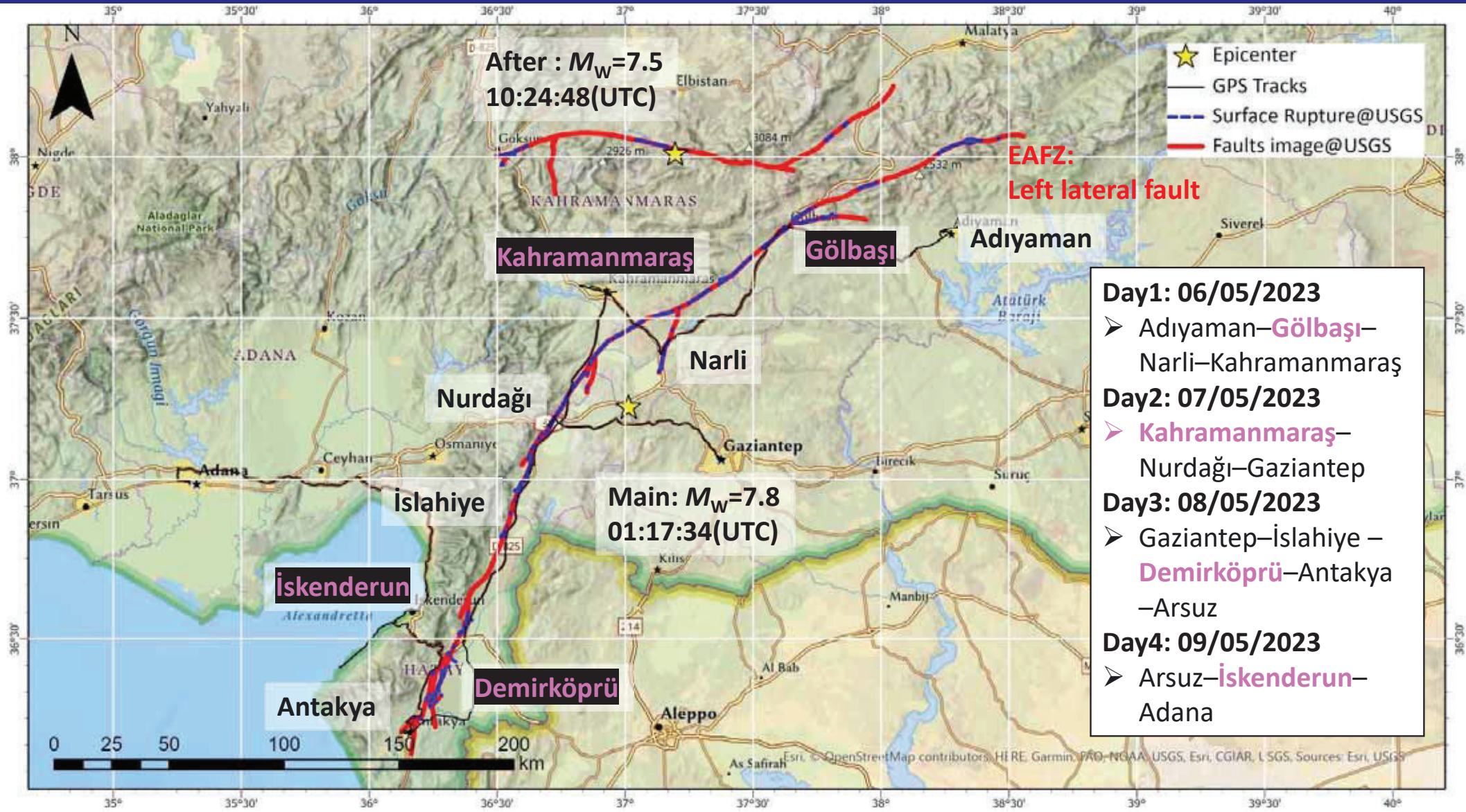
Preliminary report on the investigation of the damage caused by the 2023 Turkey-Syria earthquake

JSCE Earthquake Damage Reconnaissance Team

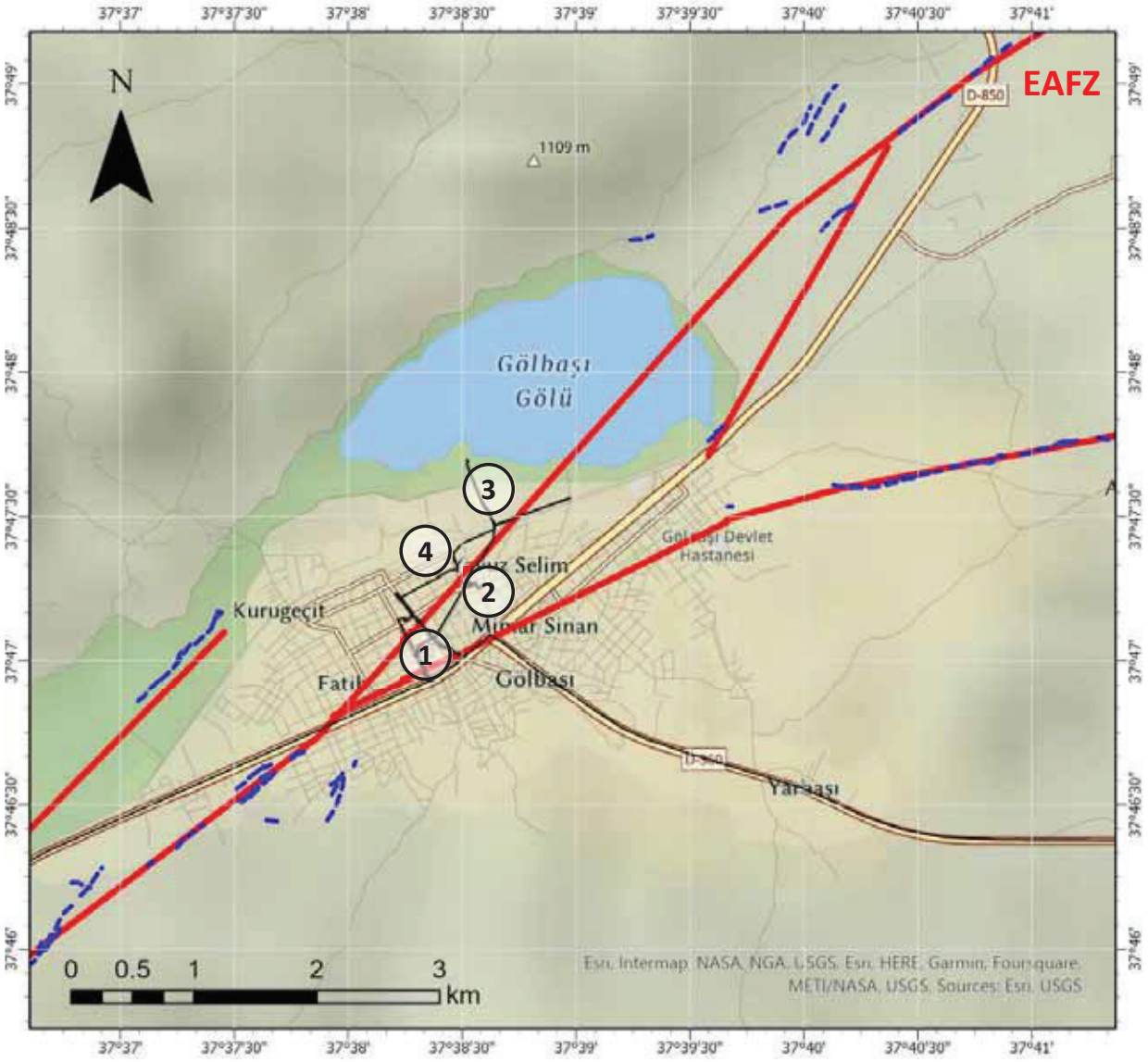
03/05/2023 – 09/05/2023

Keisuke Ishikawa, Tokyo Denki University

Overview


After : M_W=7.5
10:24:48(UTC)
Main: M_W=7.8
01:17:34(UTC)
Epicenter
GPS Tracks
Surface Rupture@USGS
Faults image@USGS
EAFZ:
Left lateral fault
Kahramanmaraş
Gölbaşı
Adıyaman
Narli
Nurdağı
Gaziantep
İslahiye
İskenderun
Demirköprü
Antakya
Aleppo
Day1: 06/05/2023
➢ Adıyaman–Gölbaşı–Narli–Kahramanmaraş
Day2: 07/05/2023
➢ Kahramanmaraş–Nurdağı–Gaziantep
Day3: 08/05/2023
➢ Gaziantep–İslahiye –Demirköprü–Antakya –Arsuz
Day4: 09/05/2023
➢ Arsuz–İskenderun–Adana
0 25 50 100 150 200 km

Gölbaşı



Topographical characteristics:

The Gölbaşı Basin is the largest basin along the East Anatolian Fault Zone and is classified as a **pull-apart basin**.

According to Onder Yönlü et al. (2013), it is believed that the Gölbaşı Basin was formed approximately 32,000 years ago due to a massive landslide that obstructed the flow of the Aksu River.

Within the basin, fluvial sediments and lacustrine deposits can be observed unconformably overlaying the basement rocks.

Characteristics of damage:

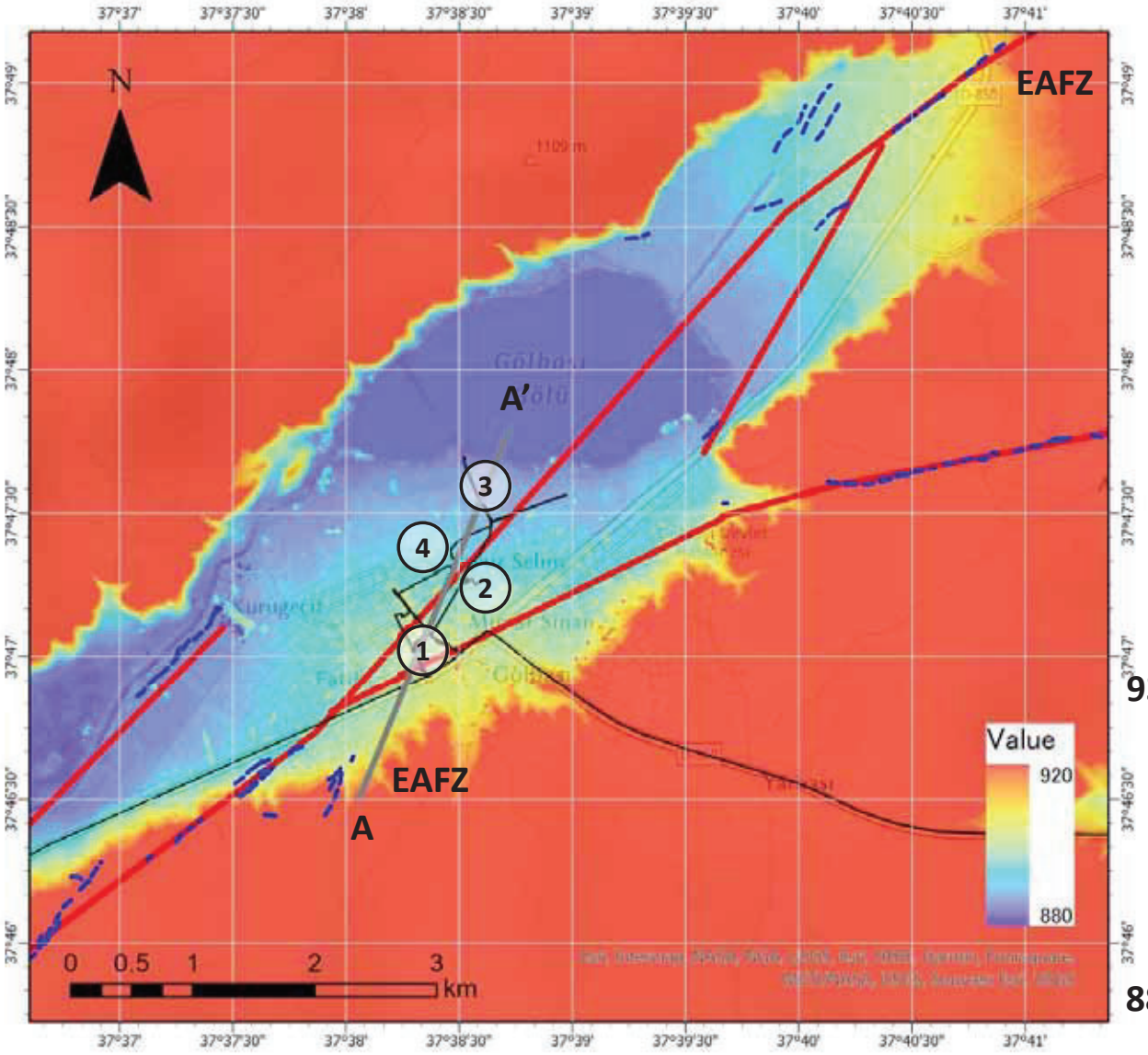
① **Structural damage due to seismic motion/ fault displacement**

② **Building settlement and tilting due to liquefaction**

③ **Lateral spreading of the ground**

④ **Settlement and tilting of buildings due to loss of bearing capacity**

Gölbaşı



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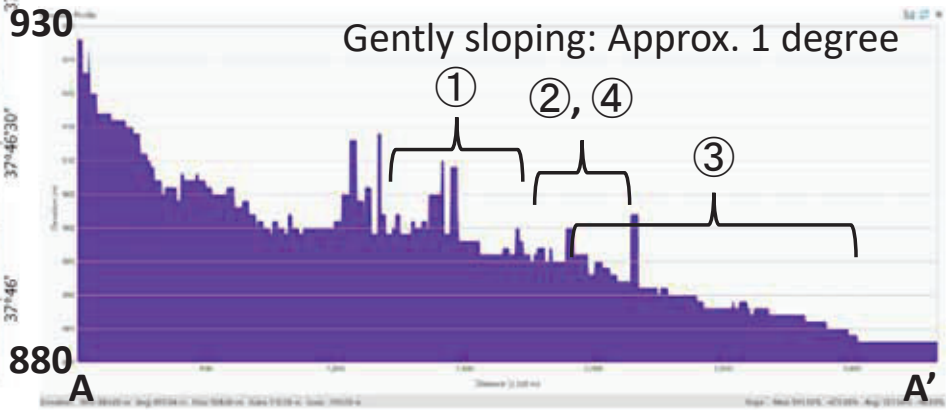
Ground surface profile by 20m DEM



Gölbaşı

Building damage due to surface rupture or severe seismic motion: N37.78359597,E37.63840377

Building movement due to surface rupture: N37.78370000,E37.63863000
These buildings were lined up in the same position before the earthquake. This building is rotating.

Gölbaşı


Excavated soil from buried pipe work

Road uplift caused by building settlement and tilting due to liquefaction: N37.78771333,E37.64247833
No damage to exterior walls or windows.

Angle of inclination:
2.5 degree


Penetration settlement: 0.5 m – 1 m

Building settlement and tilting due to liquefaction:
N37.78788500,E37.64269167
The soil deposited on the building was plastic sandy silt.

Gölbaşı

Inclined building due to liquefaction?:
N37.78749333,E37.64292167
Possible loss of bearing capacity of soft ground?

Inclined building due to liquefaction? :
N37.78750000,E37.64312500
Settlement and tilting of small buildings is minor.
Why have no road surface deformations occurred?

Gölbaşı

Opposite side across the creek…

Apartment complex is settlement and tilting: N37.78797963,E37.64211058

What factors have contributed to the reduced settlement and tilting of the buildings?

- ✓ **Is it primarily because the buildings are not adjacent to each other?**
- ✓ **Or is it related to alterations in the surface properties of the ground?**

Gölbaşı

Deformation of creek revetment due to compressive displacement of ground: N37.78966333,E37.64352500 There is a 15 cm crack in the road surface, indicating that the ground has moved in the direction of the lake.

Open cracks in creek revetment: N37.78972167,E37.64348500

Gölbaşı

Open cracks in agricultural land near Lake Gölbaşı:
N37.79147833,E37.64386500
The open cracks are about 1 m in length and are distributed in a geese pattern.

Deformation of the railway line along Lake Gölbaşı:
N37.79269833,E37.64961500
Lateral spread of the ground toward Lake Gölbaşı caused the deformation of the railway line and embankment.

Gölbaşı

North area of the surface rupture…

Settlement and tilting of a 5-story building: N37.78915000,E37.64116000

No liquefaction layer? Thin layer of soft clay soil?

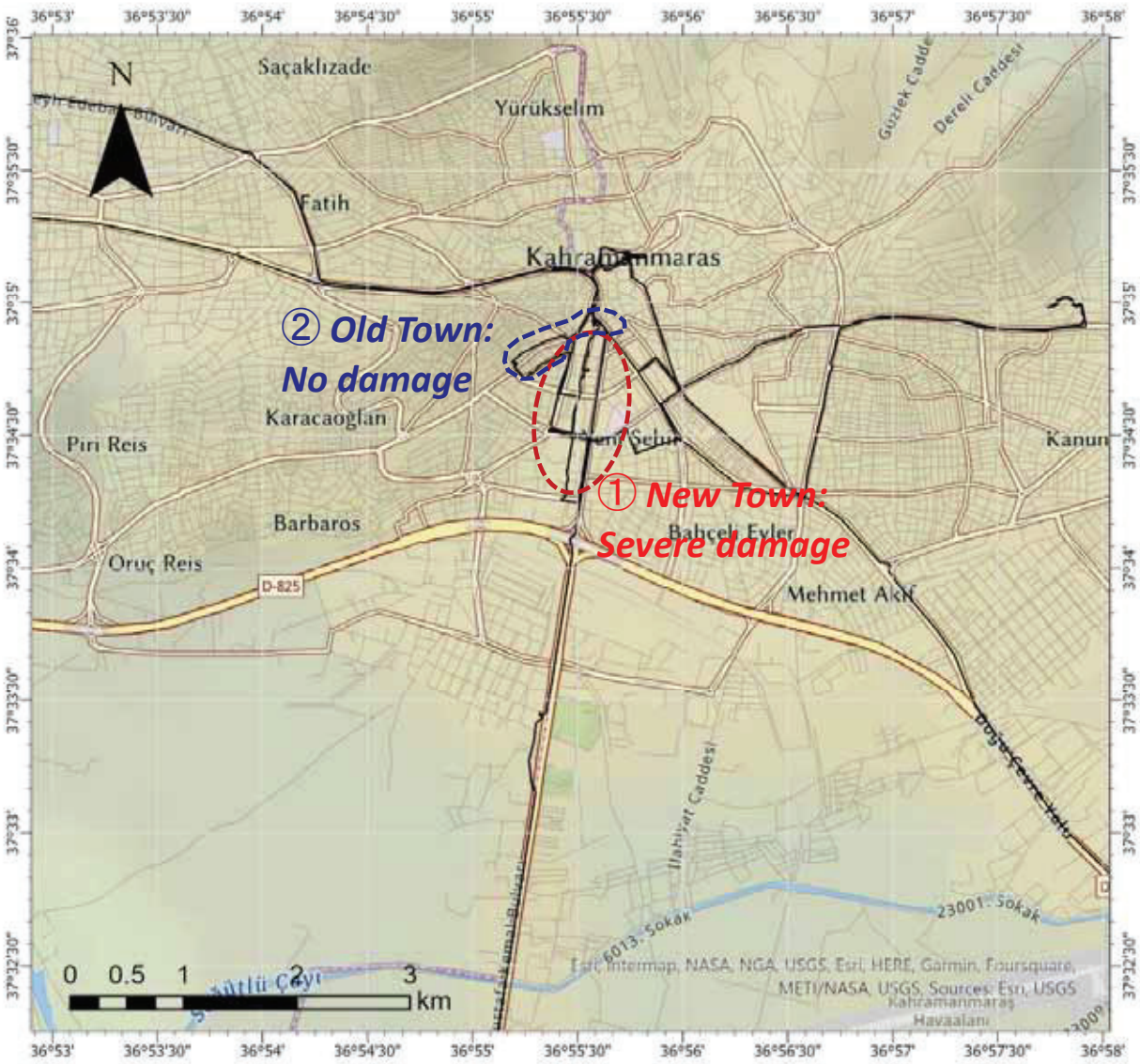
In addition, open cracks in the road surface occurred at regular intervals in this area from Lake Gölbaşı.

Tilt due to nonuniform settlement of older small buildings: N37.78846833,E37.64055167

No damage to exterior walls or windows.

Settlement and tilting damage due to decrease or loss of bearing capacity of soft clay soils?

Kahramanmaraş



Topographical character:

The **New Town** of Kahramanmarash was constructed by landfilling the bottom of a hilly valley.

Dredged soil from the river that flowed to the south of the city area was used for the landfill construction.

The **New Town** area was originally used as **agricultural land**.

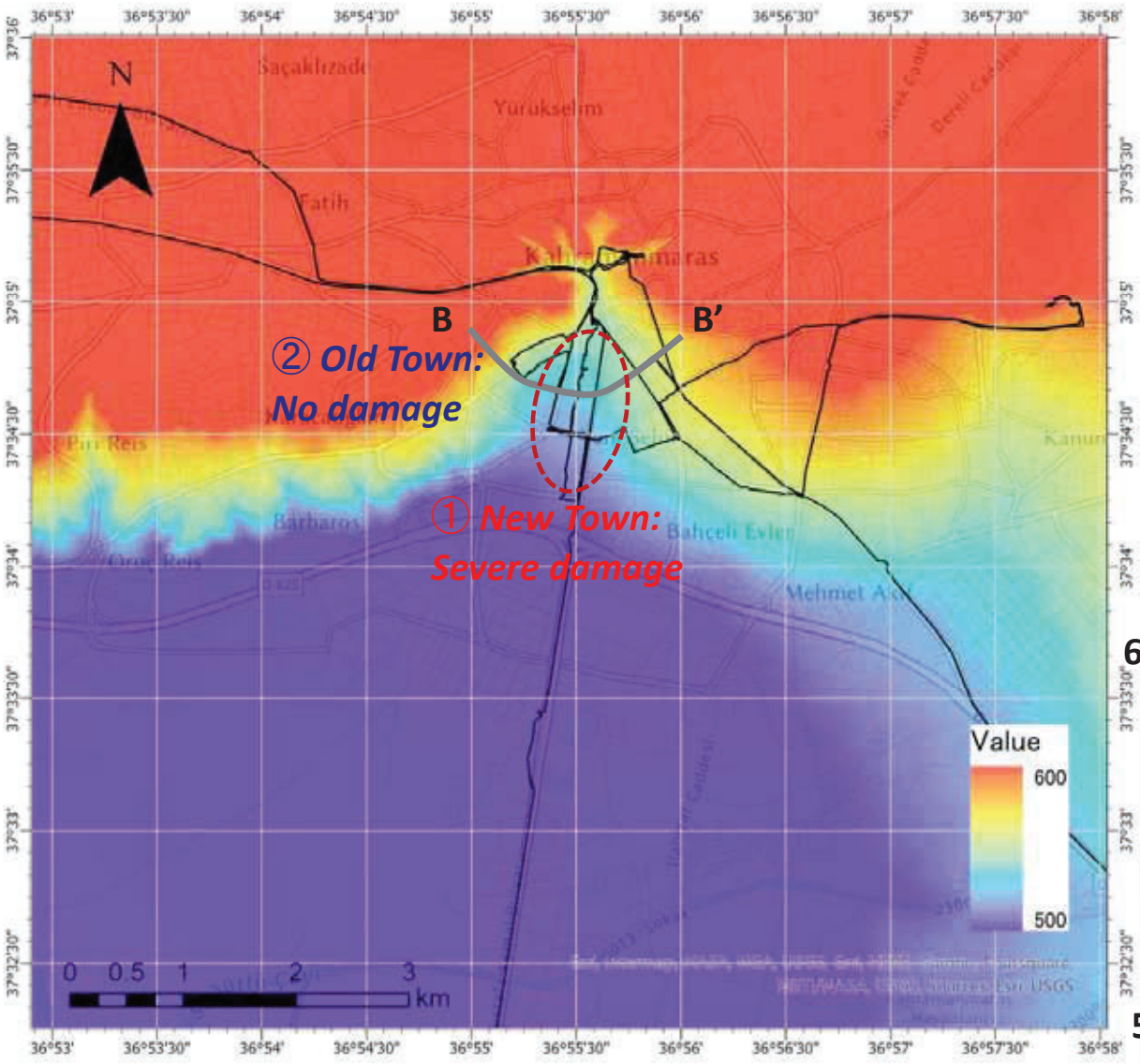
Characteristics of damage:

① **The collapsed buildings were concentrated in the New Town**.

② **No collapse on older residential buildings on the hillside.**

The amplification and frequency of seismic motion in the valley floor plain may have affected the building structure.

Kahramanmaraş



Characteristics of damage:

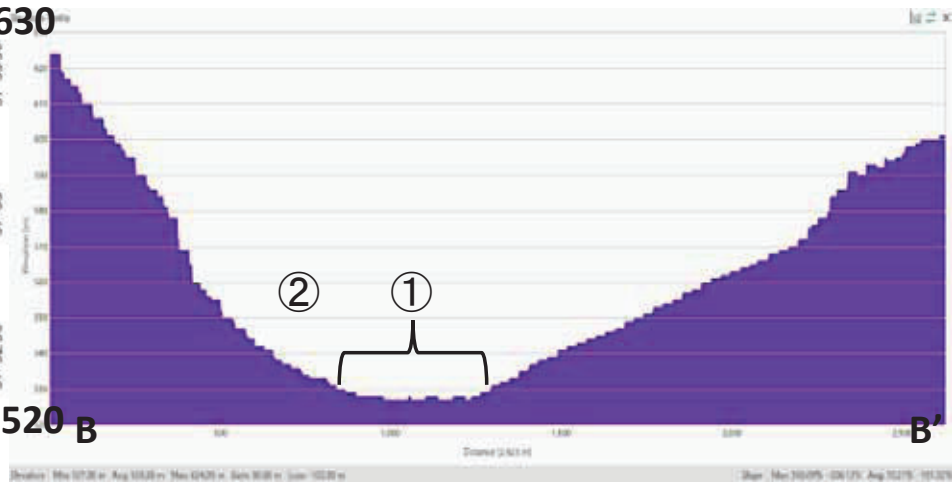
① **The collapsed buildings were concentrated in the New Town.**

② **No damage to buildings in older residential areas on hilly terrain**

Residents' Testimony:

- **Seismic duration: approx. 90 sec.**
- **Three powerful tremors in one hour**
- **Many buildings collapsed after the first quake**

Ground surface profile by 20m DEM



Kahramanmaraş

Many buildings damaged near the boundary with the hillside: N37.57974500,E36.92288833
Were seismic motions and displacements amplified near the topographic boundary?

Old city on hilly terrain: N37.58003500,E36.92053833
Building is old but not collapsed. There is damage from shaking, such as collapsing outside walls.

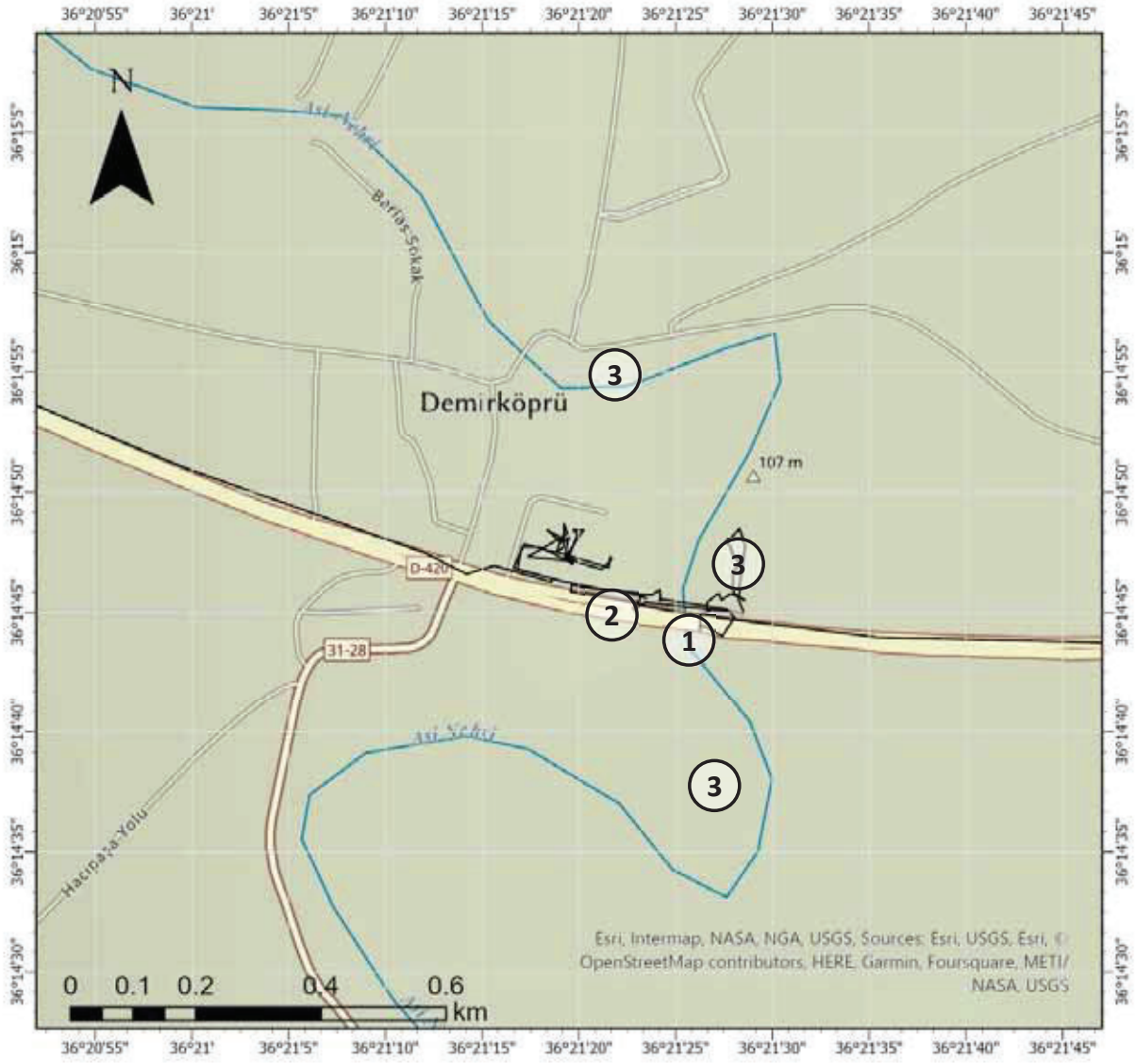
Kahramanmaraş

Devastation of New Town on the valley floor:
N37.57912500,E36.92572333
The damaged buildings had been removed and were in a state of disrepair.

Underground river systems have been established in the valley floor plain: N37.57803833, E36.92531833

- ✓ The underground river had a lot of water.
- ✓ Groundwater easily collects from the surrounding hills.

Demirköprü



Topographical character:
Demirköprü is a small village surrounded by the meandering area of the Asi-Nehri River.

Characteristics of damage:

① Deformation of the Asi-Nehri River abutment on D-420
② Deformation of embankment attached to abutment
③ Liquefaction induced flow deformation along the Asi-Nehri River

Demirköprü

Bridge abutment on west side of D-480

Deformation of the embankment attached to the abutment: N36.24596500,E36.35660667
The embankment behind the abutment was deformed and stepped.

Deformation of bridge abutments: N36.24612167, E36.35683333
The abutment foundation moved into the river area in response to the liquefaction-induced deformation, which caused the abutment to rotate.

Demirköprü

Bridge abutment on east side of D-480

Deformation of the embankment attached to the abutment: N36.24590833,E36.35762333
East side has the same deformation as the west side.

Deformation of bridge abutments: N36.24612167, E36.35683333
Why are the RC piles placed on the abutment in a single row?

Demirköprü

Liquefaction-induced ground flow

Movement of agricultural facilities due to liquefied induced deformation: N36.24596047,E36.35770262
The Facility probably moved 5–10m to the river side.

Lateral spread due to liquefaction: N36.24575333, E36.35633167
Surface deformation is also observed on the agricultural land along the Asi-Nehri River.

İskenderun

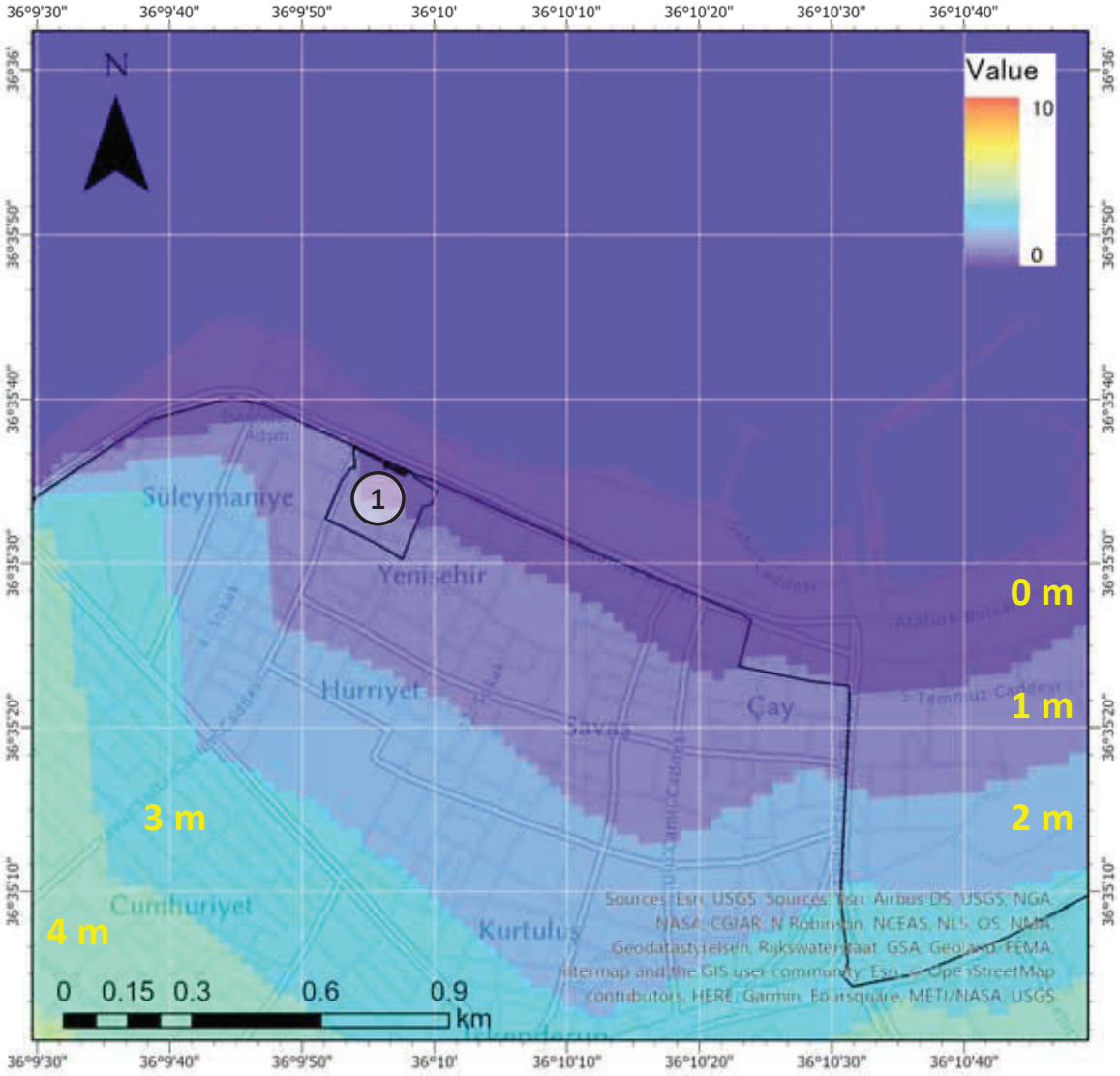
Topographical character:
The coastal district of İskenderun appears to have been reclaimed and developed 60 years ago.
Main Street appears to be the original coastline.

Characteristics of damage:
① **There is a slight settlement of the building, but it is not tilted.**

New mosque along the coast is reported to be a pile foundation structure.

Why the difference in damage caused by liquefaction in this coastal area?
The difference between reclaimed and natural ground could have made a significant difference.

İskenderun



Topographical character:
The coastal district of İskenderun appears to have been reclaimed and developed 60 years ago.

Characteristics of damage:

① **In this area, there is a slight settlement of the building, but no tilting.**

New mosque along the coast is reported to be a pile foundation structure.

Why the difference in damage caused by liquefaction in this coastal area?
The difference between reclaimed and natural ground could have made a significant difference.

İskenderun

Elevation 0 m area at 20m DEM

Buildings along the coastline:
N36.59319167,E36.16618333
The building is slightly settled but not tilted.
Sidewalks and driveways are cracked.

Open cracks in the roadway:
N36.59276000, E36.16663667
Near the boundary between 0m and 1m elevation at 20m DEM

İskenderun

Elevation 1 m area at 20m DEM

Buildings along the coastline:
N36.59244667,E36.16491333
No ground deformation can be observed in this area.

Other damages

Narli

Deformation of power tower due to fault displacement : N37.40201167,E37.15233833
Graben in front of power tower due to fault displacement

Motorway: D-835

Deformation of motorway due to fault displacement: N37.48005500,E37.04264167
The fault displacement moved one lane.
There is no problem for driving a car because of the lateral displacement fault.

Other damages

İslahiye

Ground deformation due to fault displacement: N37.04485000,E36.62950667
İslahiye State Hospital's foundation is isolated and undamaged

Thank you for kind attention!!

For questions or comments,

↓↓↓

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