Turkey/Syria earthquake:

Was the impact due to physical or human factors?

Dr Chris Spencer

UWE, Bristol

With reference to a hazardous location at a local scale, assess the importance of the physical processes and factors which have contributed to the scale and nature of the hazard. [20 marks]

‘Seismic hazards will always be harder to manage than volcanic hazards due to their unpredictability and scale.’ To what extent do you agree with this view? [20 marks]

‘The impacts of tectonic activity on a country are mainly environmental.’ Discuss. [33]

‘Human factors contribute more than physical factors to the risks posed by severe tectonic hazards.’ How far do you agree? [33]

‘Levels of economic development determine the impacts people experience from seismic hazards.’ Discuss. [33]

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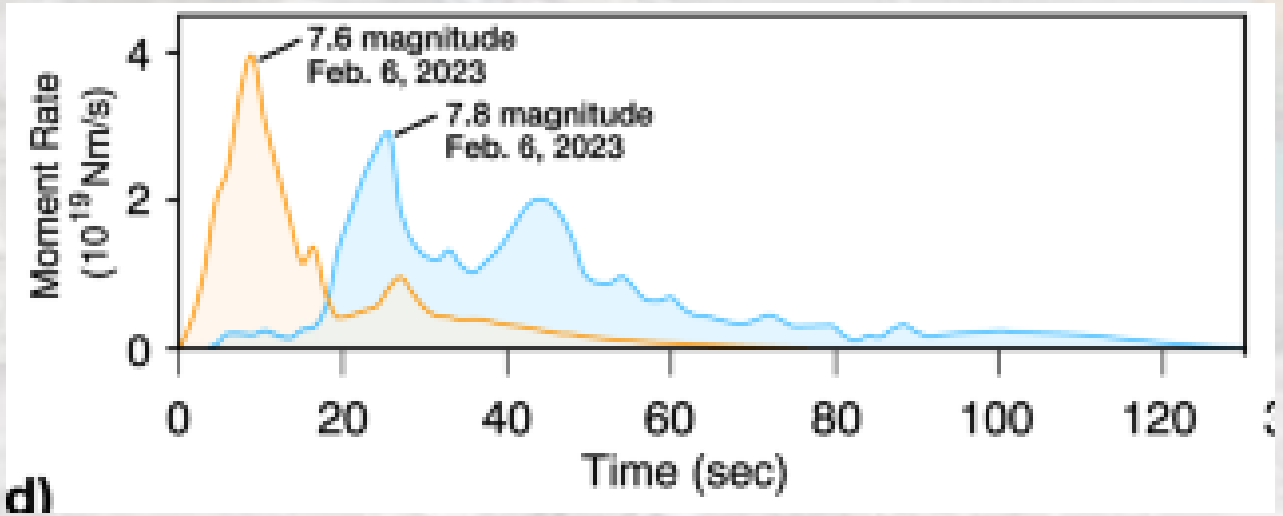
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- 6th February 2023: two large-magnitude earthquakes (M_w7.8 and M_w7.6) near the Turkey-Syria border
- by 3rd March 2023: ~10,000 aftershocks; (USGS)

- Turkey: 50,783 killed; Syria: 8,476 killed (Reliefweb, 2023)

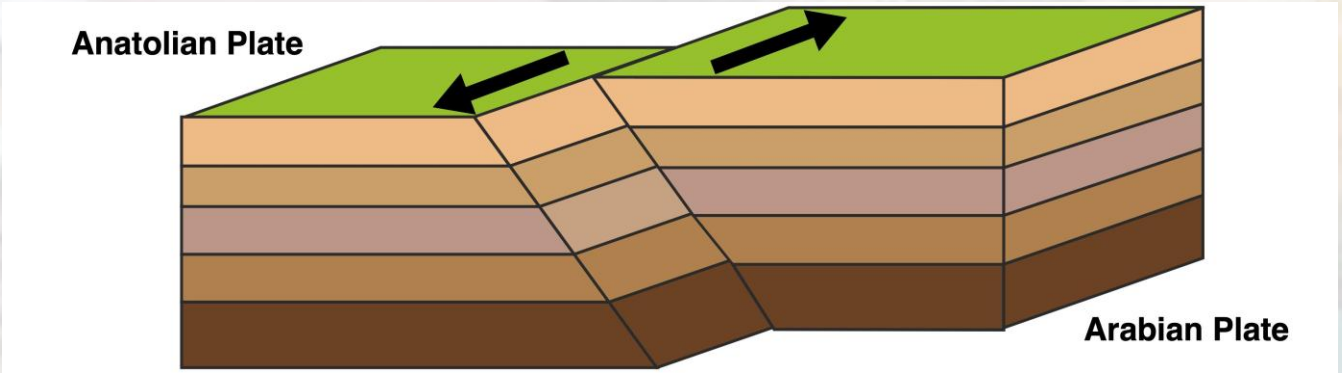
- in Syria, compounded by a humanitarian crisis created by civil war
- an example of a natural disaster arising from a natural hazard ??

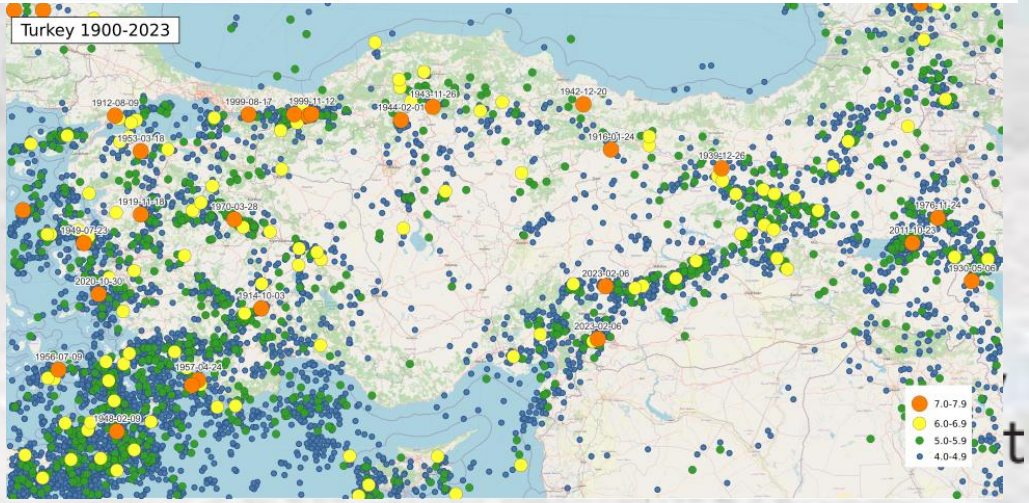




- occurred on the East Anatolian Fault (EAF) seismically-active area and area of seismic risk
- annual slip deficit along EAF: approx. 10mm / yr
- pre-2023, last >7M earthquake was in AD1114 seismic gap
- accumulated stress and strain; eventually exceeds frictional forces -> large magnitude earthquake

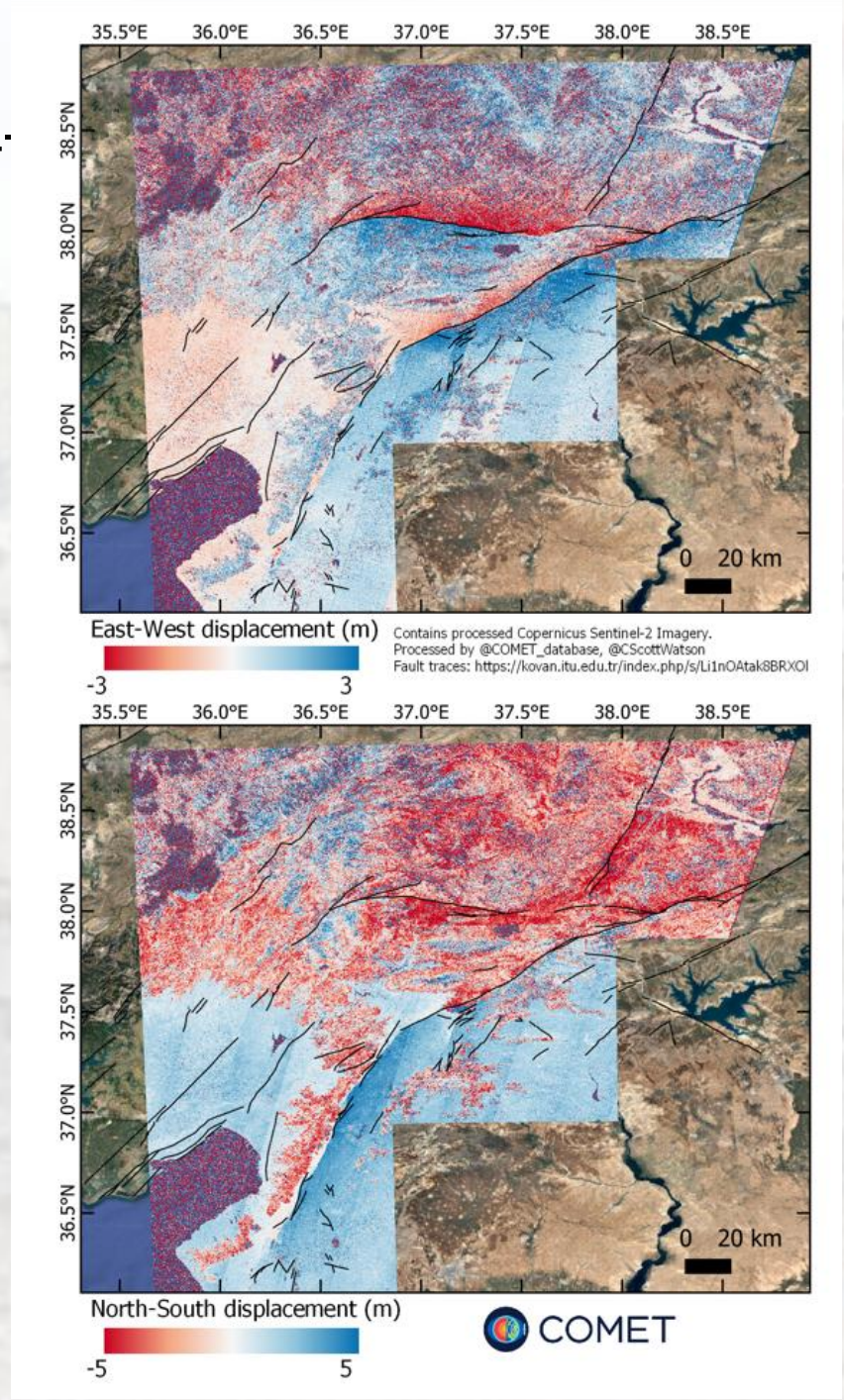




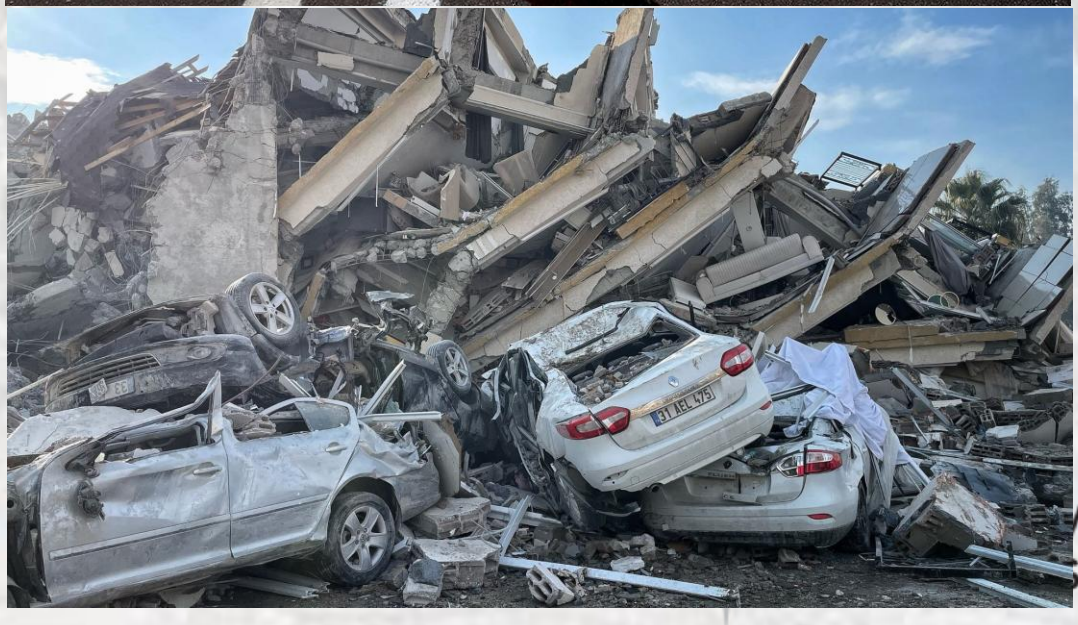


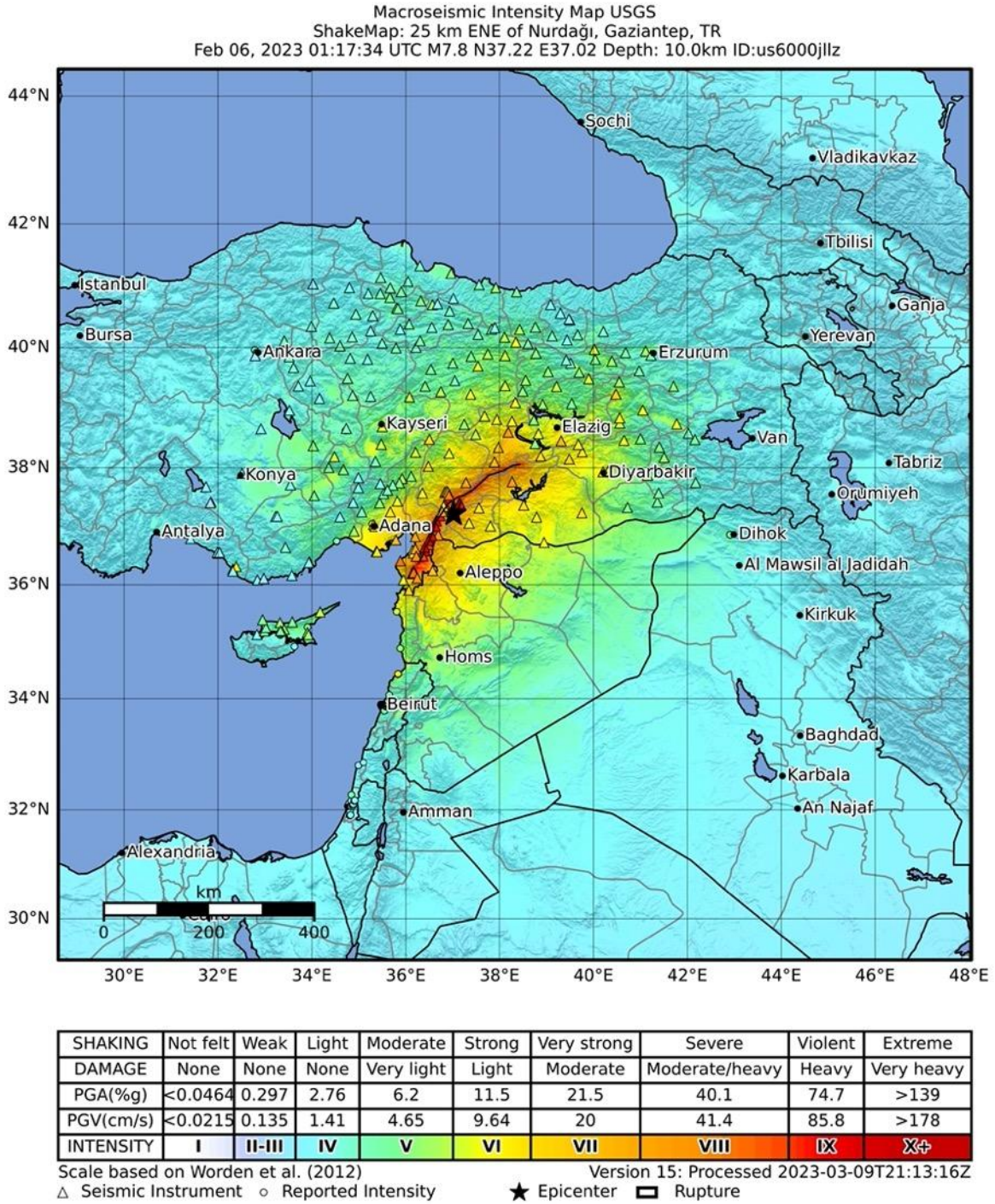
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Ground displacement imaged by SENTINEL-2 polar-orbiting satellites (European Space Agency):









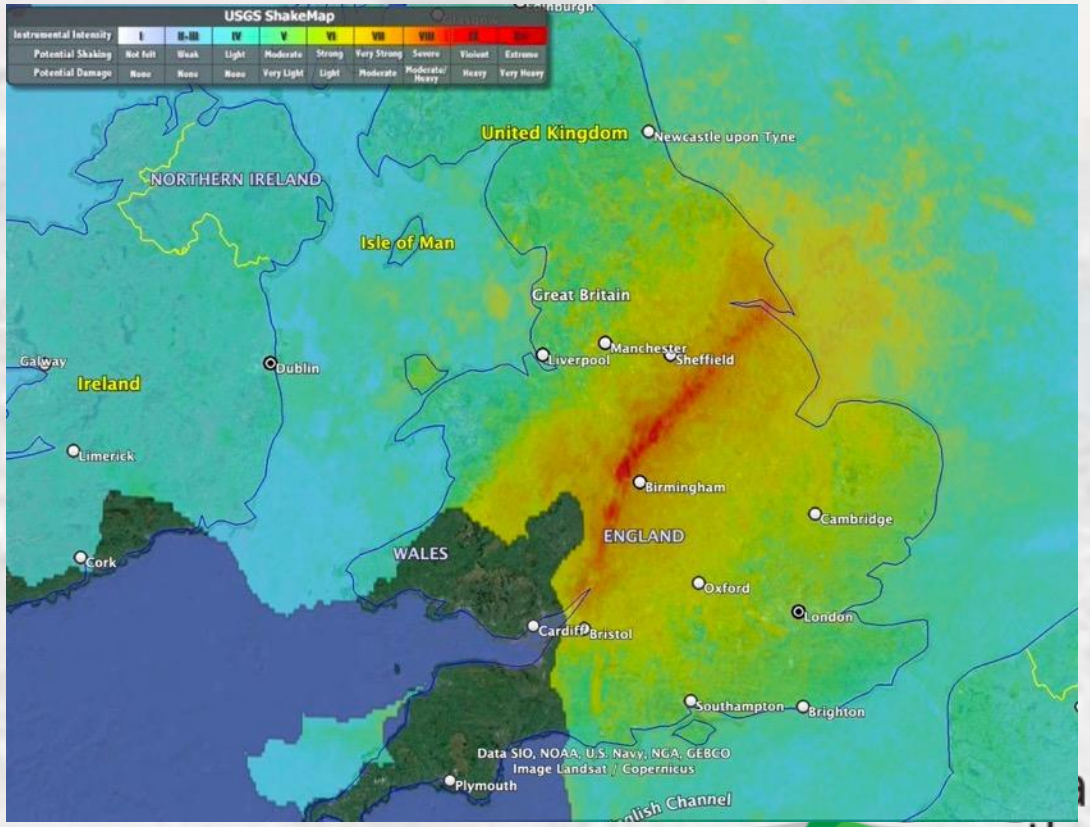
SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	None	None	None	Very light	Light	Moderate	Moderate/heavy	Heavy	Very heavy
PGA(%g)	<0.0464	0.297	2.76	6.2	11.5	21.5	40.1	74.7	>139
PGV(cm/s)	<0.0215	0.135	1.41	4.65	9.64	20	41.4	85.8	>178
INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Scale based on Worden et al. (2012) Version 15: Processed 2023-03-09T21:13:16Z

△ Seismic Instrument ○ Reported Intensity ★ Epicenter ▭ Rupture

Intensity of ground shaking (Mercalli scale) during the first, Mw 7.8 earthquake.

Scaled against the British Isles…

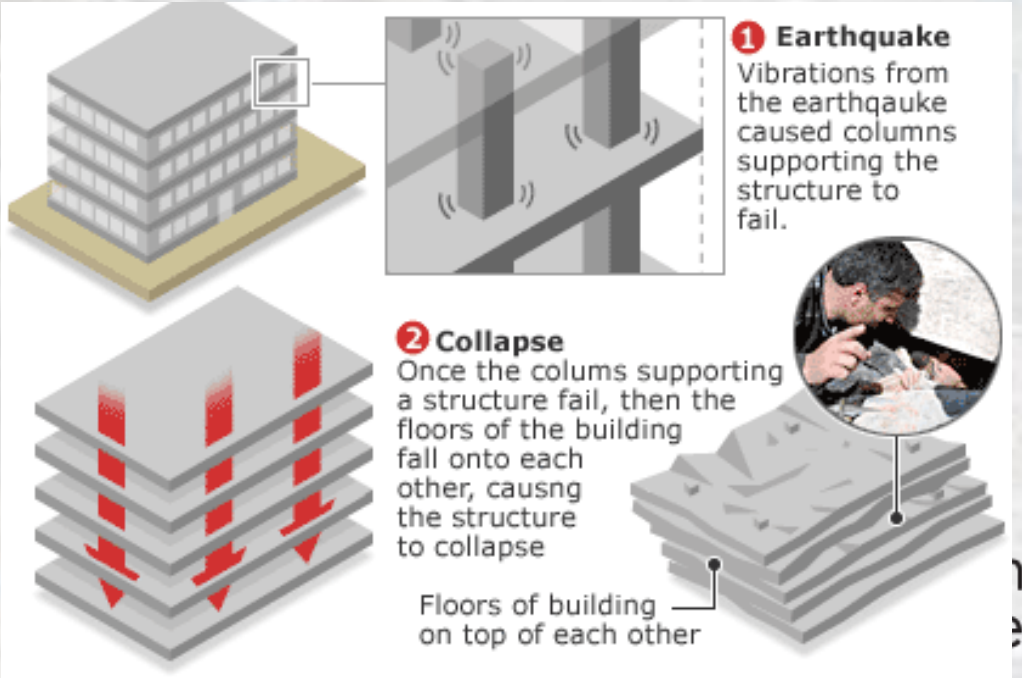


Primary effects:

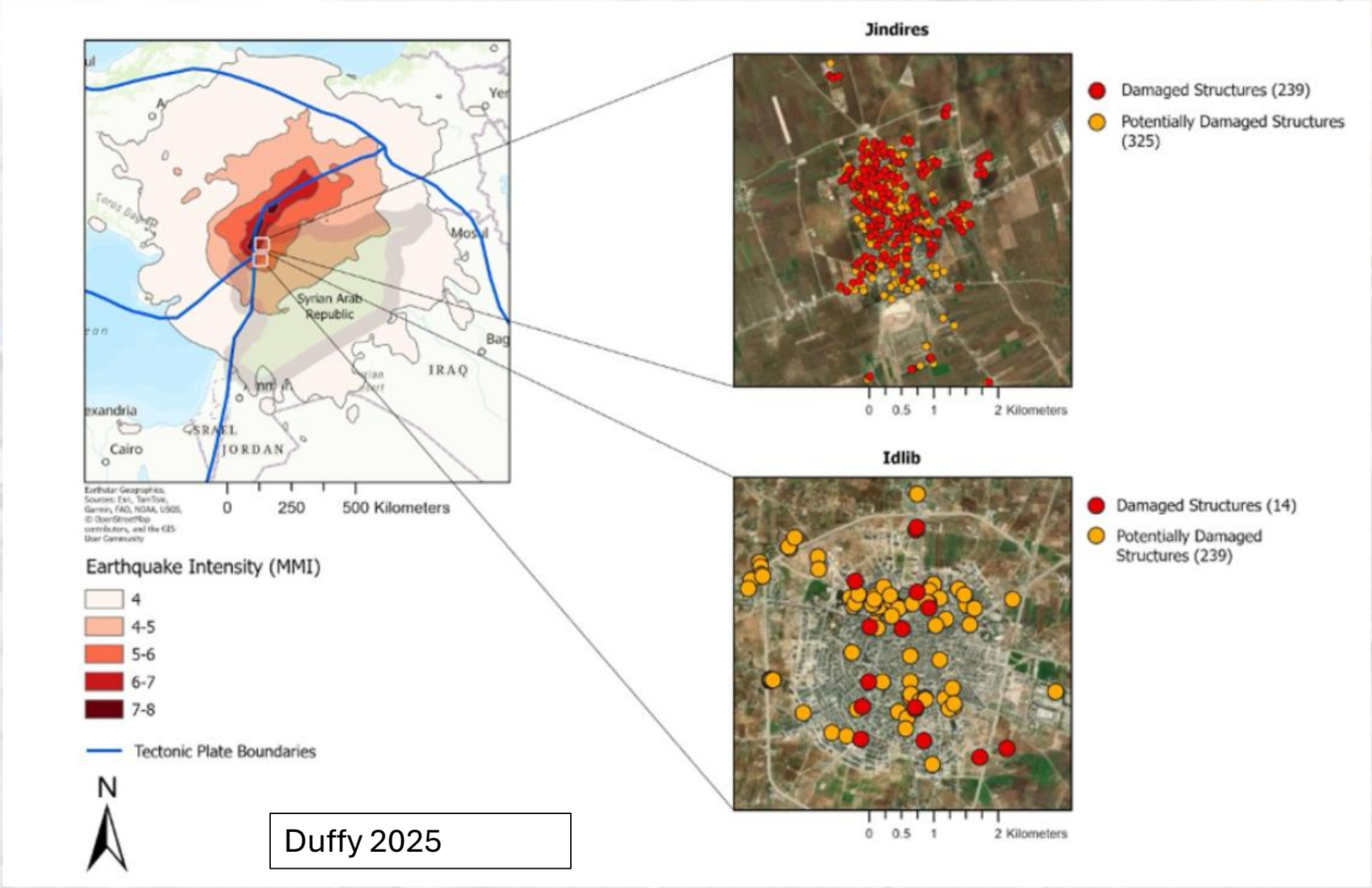
- magnitude, intensity and duration of ground shaking: extensive damage in Turkey and Syria

- Type of building collapse
  - CCTV footage shows people fleeing when quake hit Turkey (youtube.com)

- Damage caused in Syria
  - Drone footage shows scale of earthquake destruction in Syria (youtube.com)



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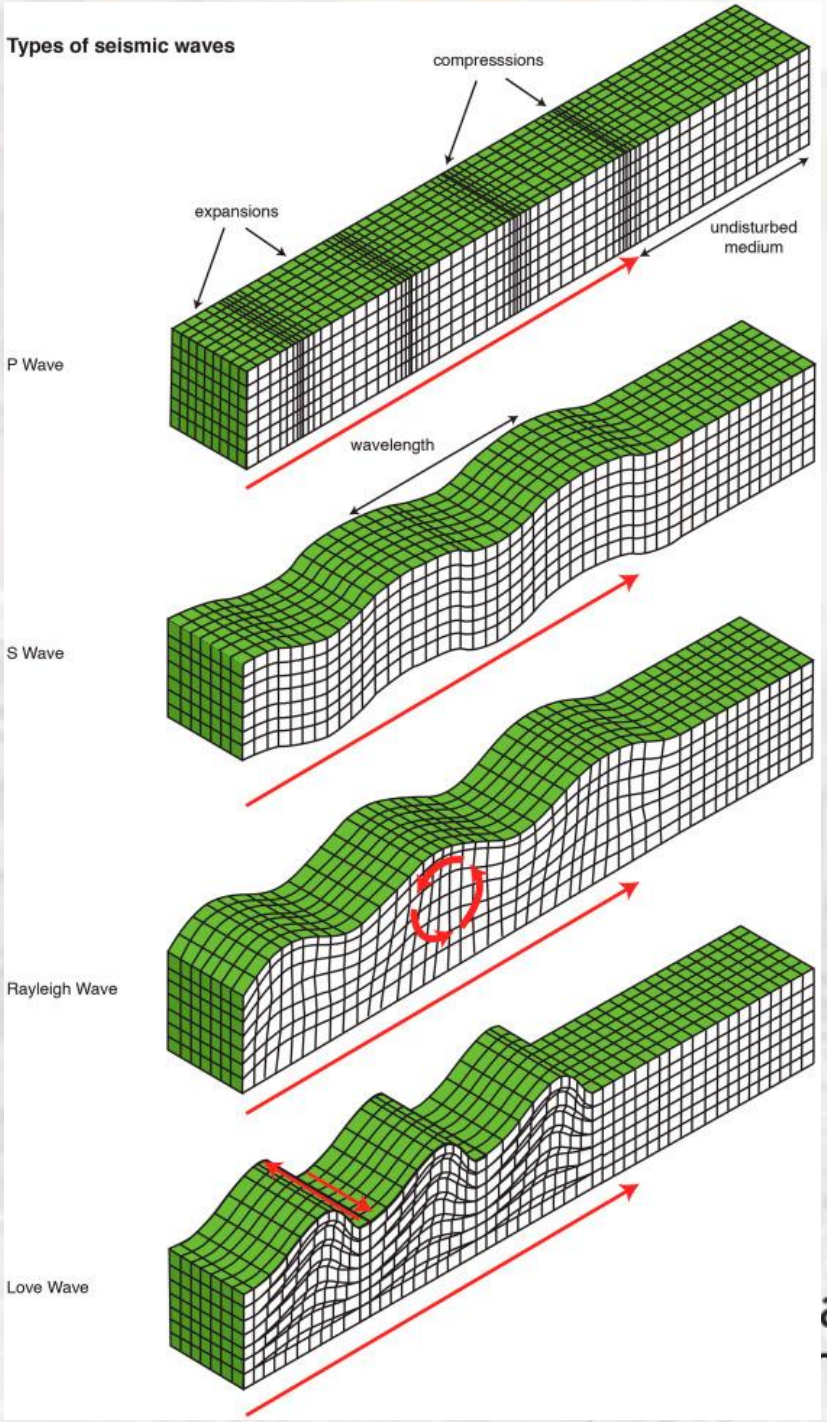
Duffy 2025

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Earthquake energy is spread through waves

https://www.youtube.com/watch?v=H9lfk0Bde4Q



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Secondary effects:

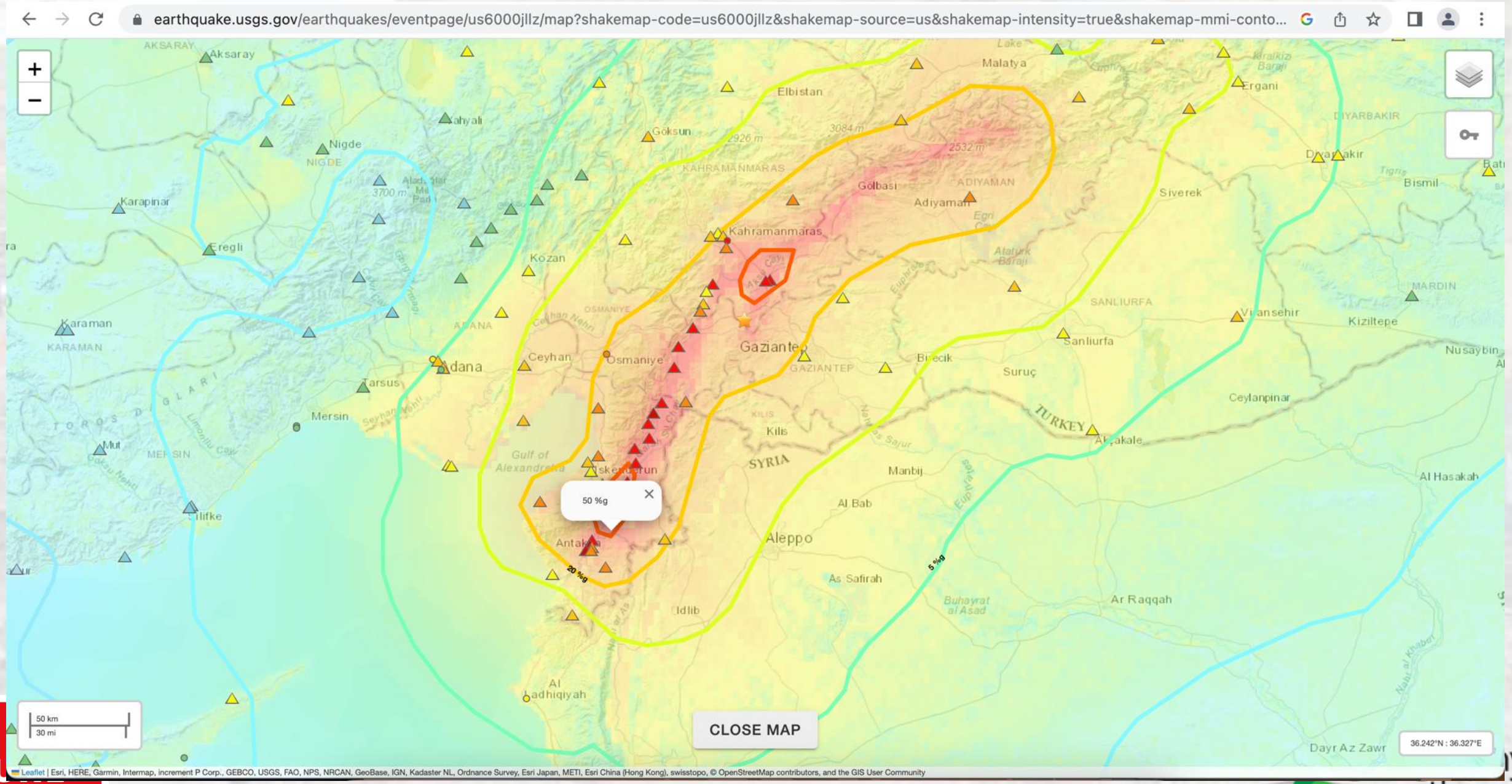
Liquefaction
Tsunamis
Landslides

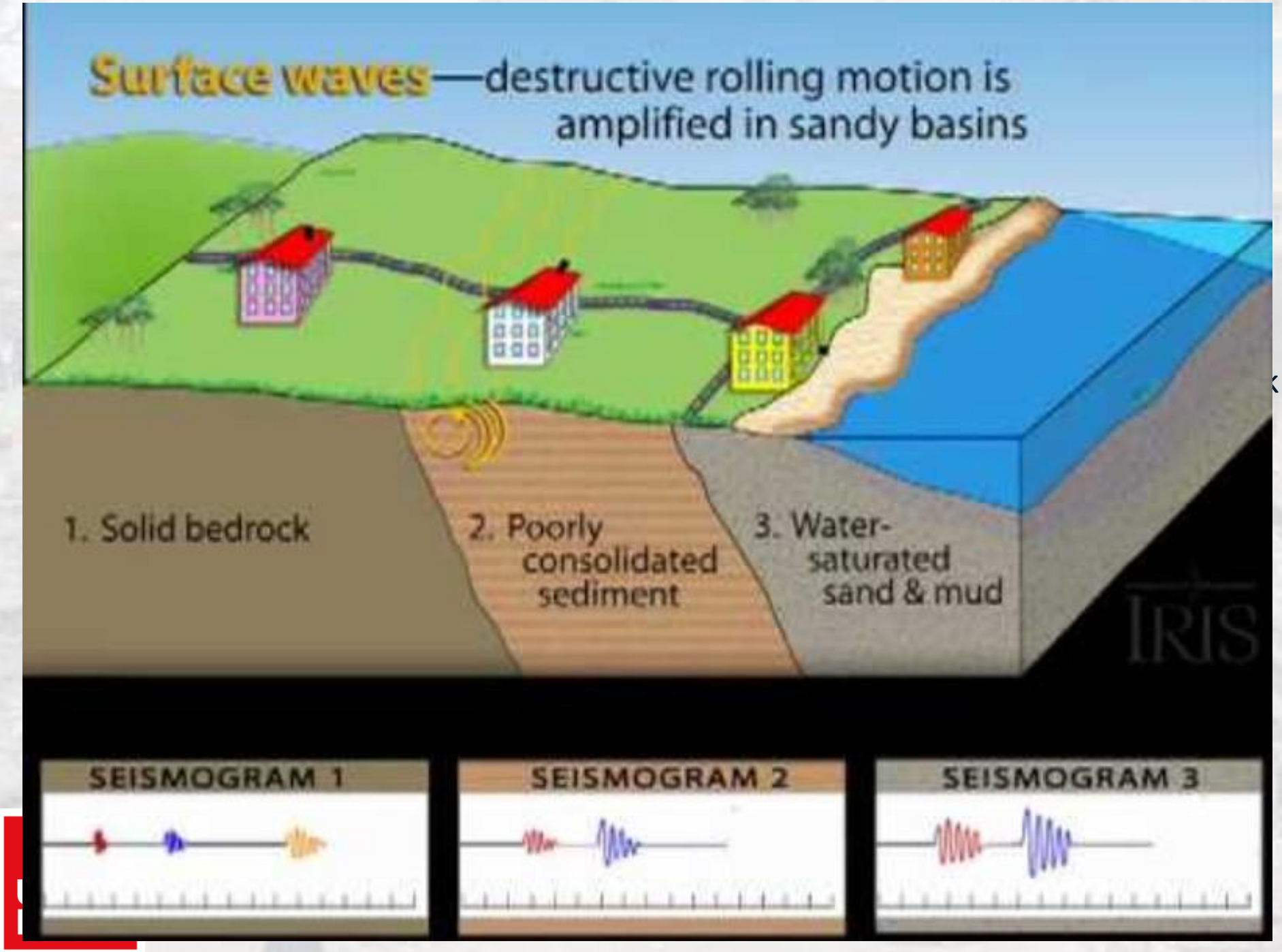




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earthquake.usgs.gov/earthquakes/eventpage/us6000jllz/map?shakemap-code=us6000jllz&shakemap-source=us&shakemap-intensity=true&shakemap-mmi-conto...
AKSARAY
Aksaray
Nigde
NIGDE
Karapinar
Eregli
Karaman
KARAMAN
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MERSIN
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Tarsus
Adana
ADANA
Ceyhan
Osmaniye
OSMANIYE
Kozan
Elbistan
Goksun
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Gölbasi
Adiyaman
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Gaziantep
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DIYARBAKIR
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Siverek
Bismil
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Sanliurfa
Viransehir
Kiziltepe
MARDIN
Nusaybin
Birecik
Suruç
Ceylanpinar
TURKEY
Akçakale
Kilis
SYRIA
Manbij
Al Bab
Aleppo
Al Hasakah
As Safirah
Ar Raqqah
Idlib
Al Ladhiqiyah
Gulf of Alexandretta
Dayr Az Zawr
50 %g
20 %g
5 %g
50 km
30 mi
CLOSE MAP
36.242°N : 36.327°E
Leaflet | Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community



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Liquefaction



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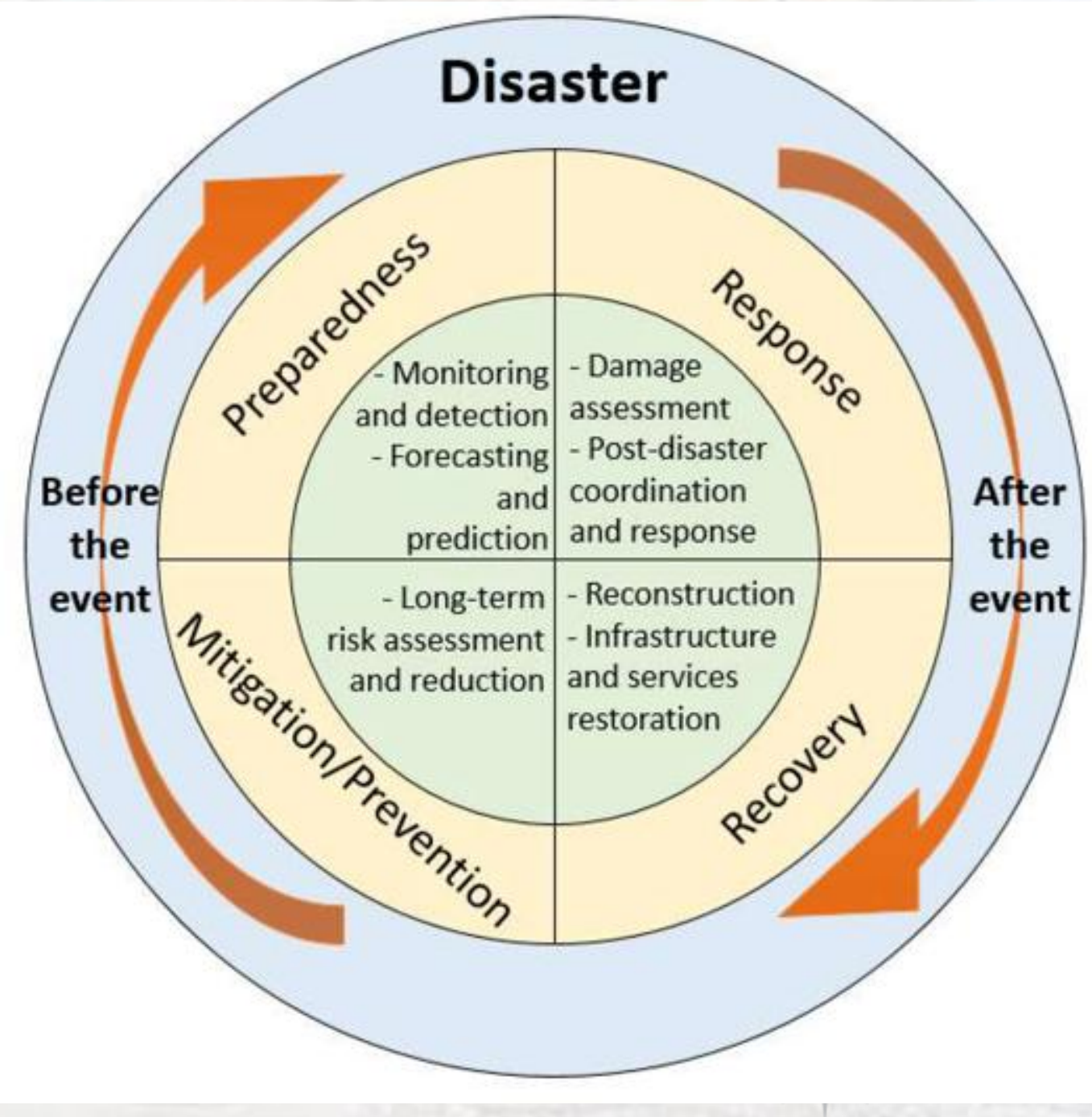
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Is there anything we can do?

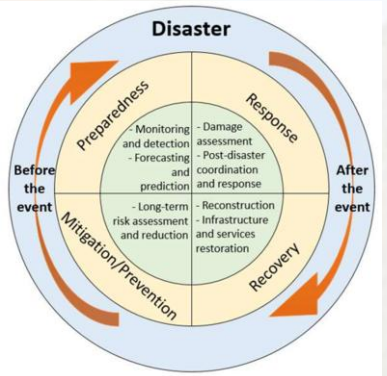
Disaster management cycle

Aim to reduce the impact of a disaster and ensure a full recovery

Advantages or disadvantages?



Mitigation

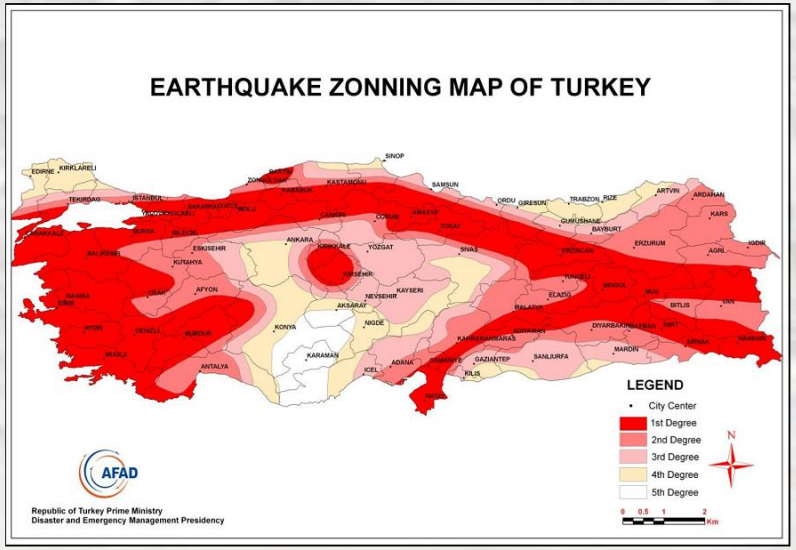


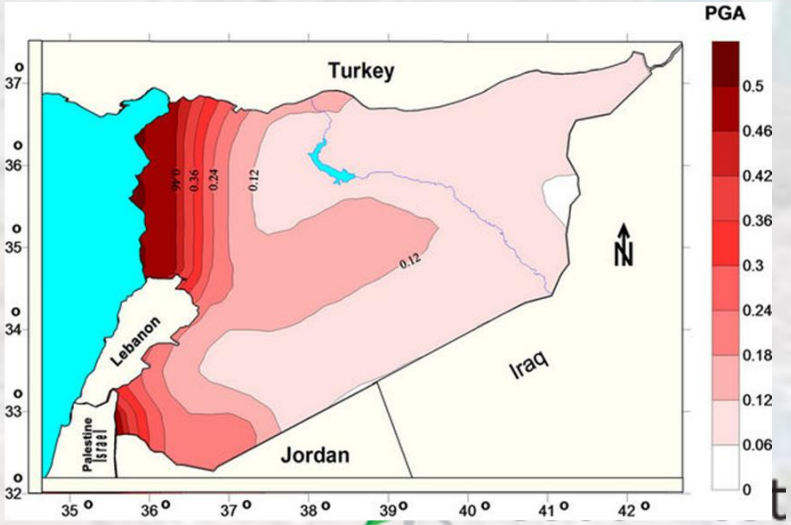
Mitigation phase of the DMC comprises all actions designed to reduce the impact of future disasters (Alexander, 2002)

Non-structural measures, e.g. risk analysis, land use planning, insurance, legislation, public education and evacuation planning

Structural measures: e.g. engineering solutions

Turkey and Syria have national plans for earthquake disasters....



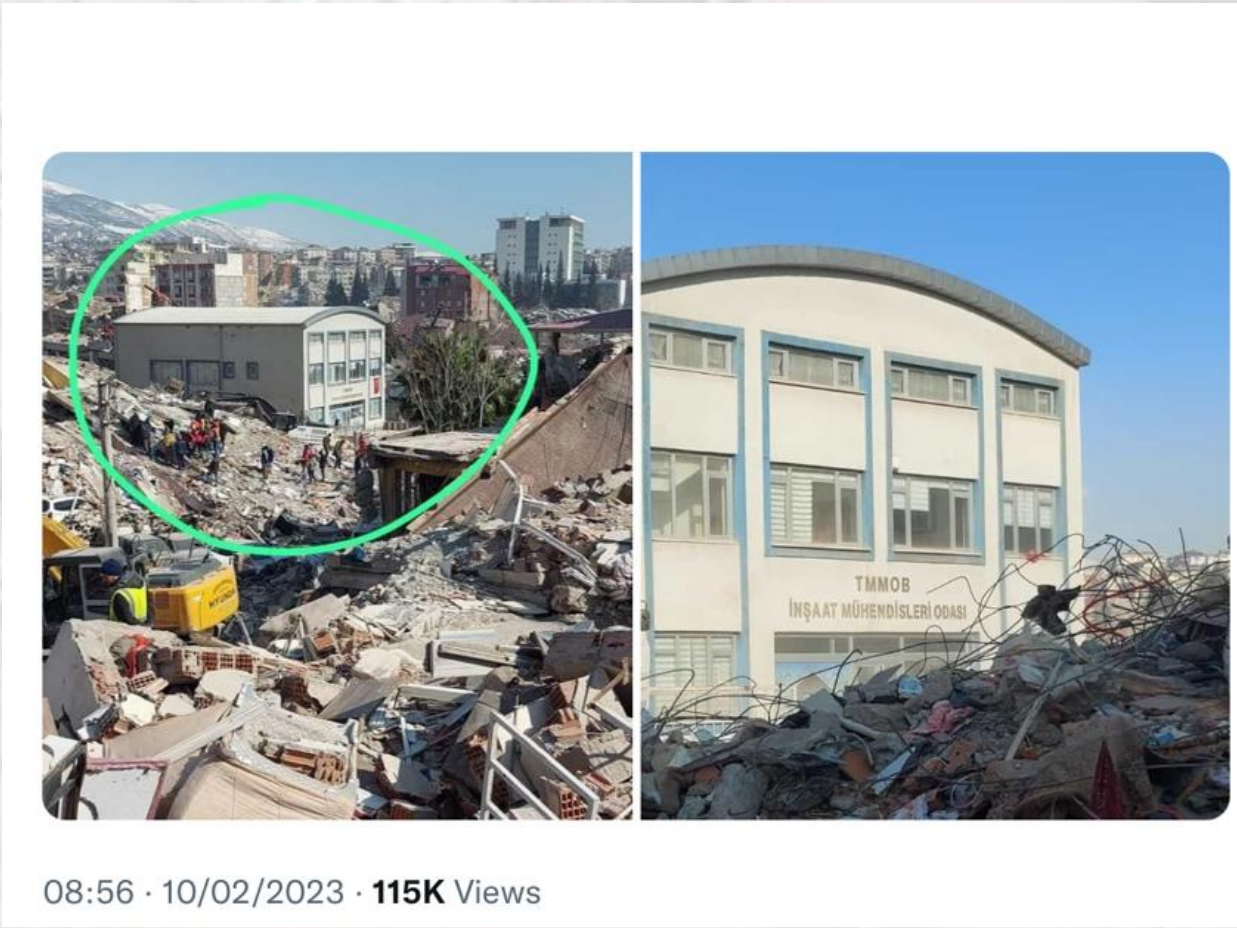


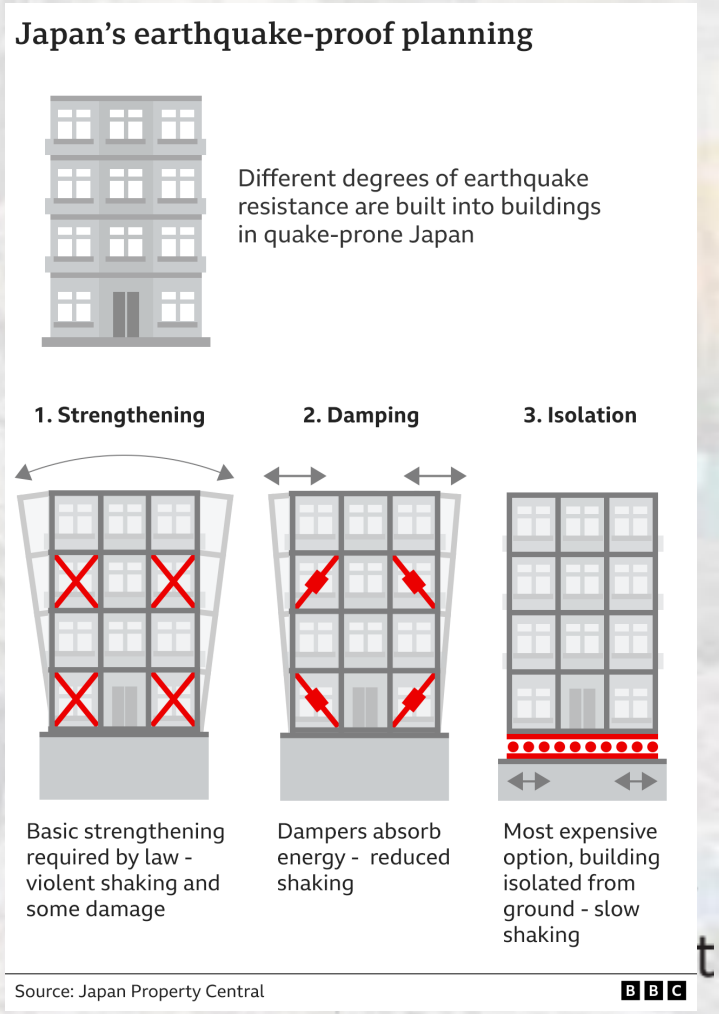
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Mitigation

Were the correct land use planning and structural design followed….







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Confusion Matrix



Good Geotech **Good Structural**	Bad Geotech Good Structural
Good Geotech Bad Structural	Bad Geotech Bad Structural







Mitigation

- “damage reflects construction malpractice and violation of design standards” (Elbanna, Milburn and Ben-Zion, 2023)

- “This is a disaster caused by shoddy construction, not by an earthquake,” (David Alexander, in an interview with ABC News)

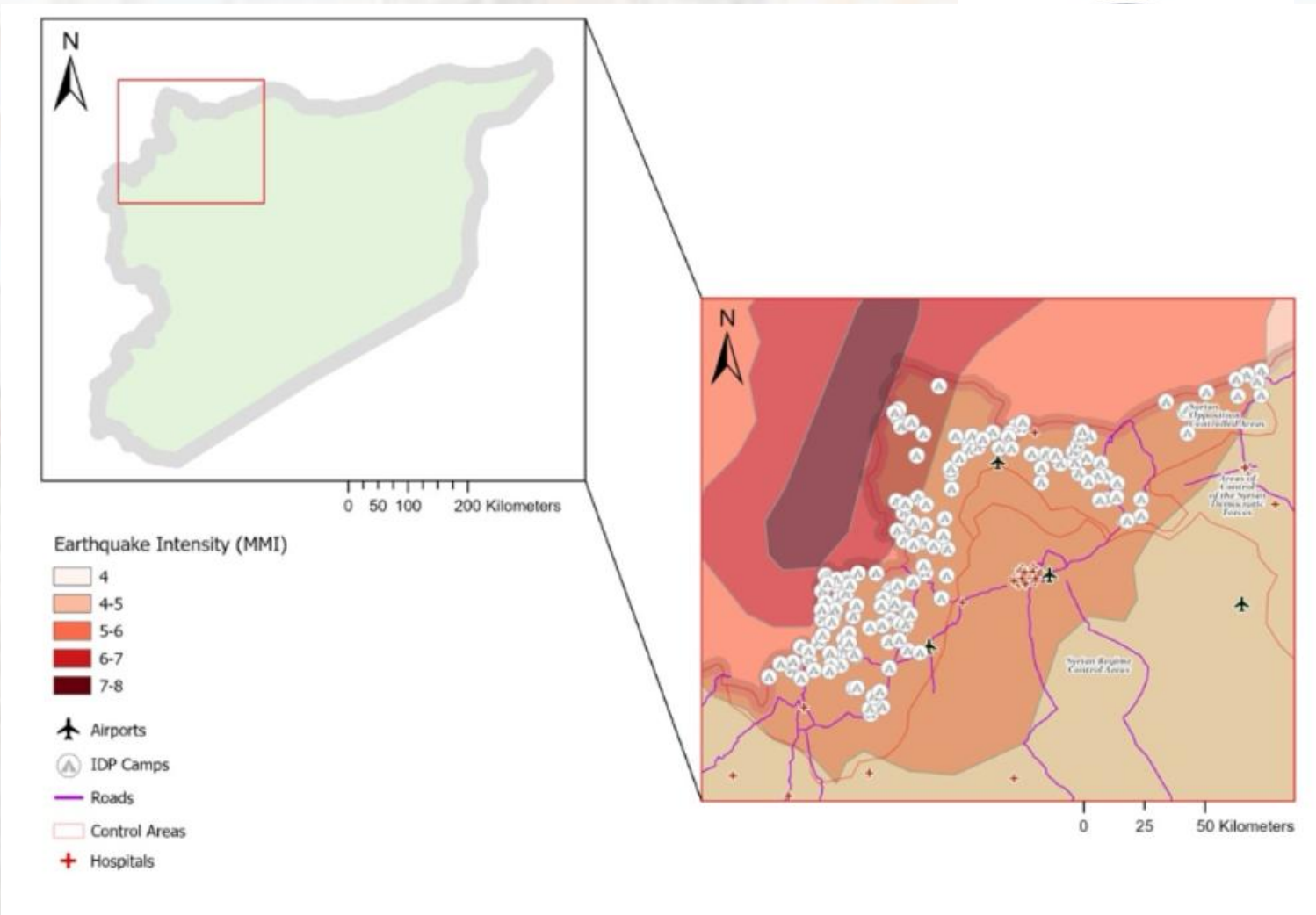
Mitigation

- Challenges

- Turkey, pressure for development
  - land use plans not followed
  - Corruption
  - Poor building materials

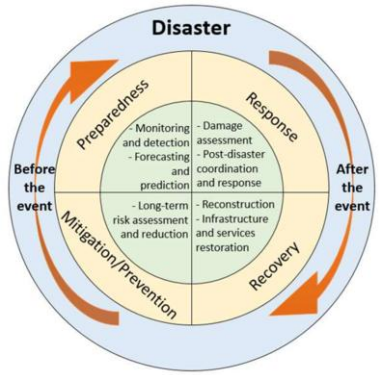
- Syria
  - Focus is on the civil war
  - Internally displaced people increases vulnerability and exposure

- Physical or human factors?



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Preparedness
actions taken to reduce the impact of disasters when they are forecast or imminent (Alexander, 2002)



<u>Preparedness should look like this…</u>

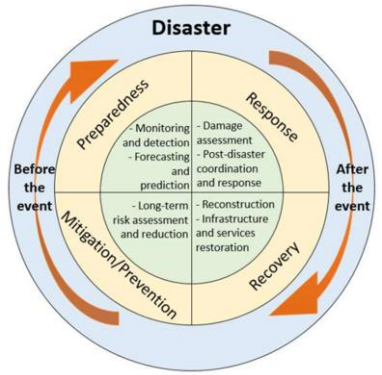
- Monitoring and detection
- forecasting and prediction
- early warning system (Japan 80 seconds)
- preparedness plans
- emergency exercises and training
- security measures e.g. the evacuation of vulnerable populations

- But - the exact time, location and magnitude of an earthquake cannot be predicted (United States Geological Survey – USGS)

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Preparedness



Challenges

- Turkey
  - Communication breakdowns with early warning
  - Problems due to poor mitigation overwhelmed preparedness plans

- Syria
  - Poor seismic monitoring
  - No early warning system
  - Plans, training, evacuation disrupted by Civil war

- Physical or human factors?

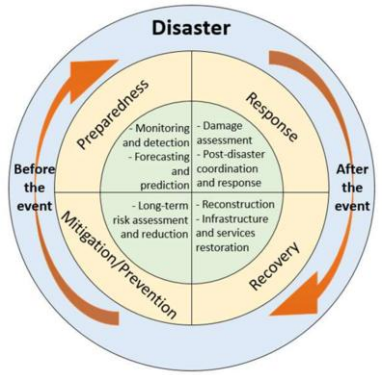
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Response

- emergency actions taken during the impact of a disaster and the short-term aftermath:
  - saving and safeguarding human lives
  - rescuing and tending to the immediate needs of survivors

(Alexander, 2002)





1. Damage assessment
2. Post disaster co-ordination and response
3. International co-ordination and response

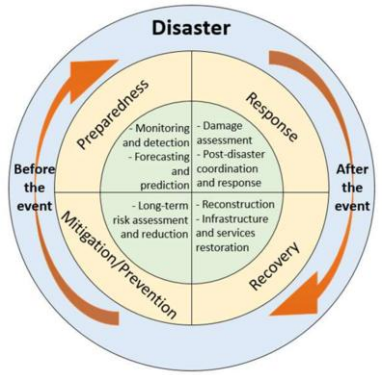
Before search and rescue specialists arrive who is responding?

- Things will help and hinder that response
- Search and rescue talk about the ‘golden hour’
- Crush syndrome – severe organ damage



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Response



Turkey – led by Turkish Disaster and Emergency management Authority (AFAD)

Syria – led by the Syrian Civil Defence ‘white helmets’

Both called on international relief





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Response

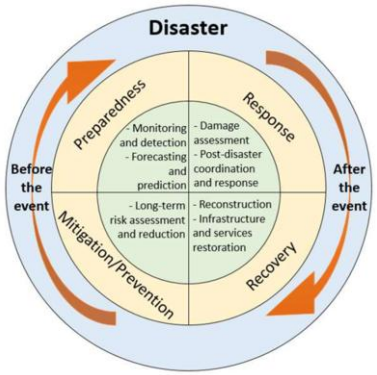
Challenges

- Access roads, airports
- Equipment – lifting / medical / power
- Training
- Hospitals
- Border crossings / bureaucracy
- UN sanctions

- In Syria the Civil War exaggerates all of the above

- physical or human factors?



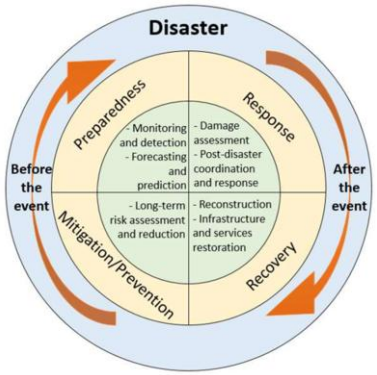




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Recovery



"the process of repairing damage, restoring services and reconstructing facilities after disaster has struck. After major catastrophes it may take as long as 25 years." (Alexander, 2002)

Turkey has made good progress to recovery

Syria still has a long way to go

- Residential
- Health infrastructure
- Transport
- Water / food
- Economy



Post-earthquake reconstruction shows remarkable progress

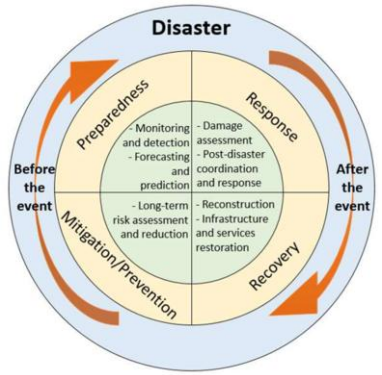
Post-earthquake reconstruction shows remarkable progress

By Ahmet Erarslan
May 29, 2024 11:21 AM GMT+03:00

Share

A year after the earthquakes in Pazarcik, Elbistan, and Kahramanmaras, extensive rehabilitation and reconstruction efforts by the state have led to the construction of numerous homes, workplaces and social facilities in the

Recovery

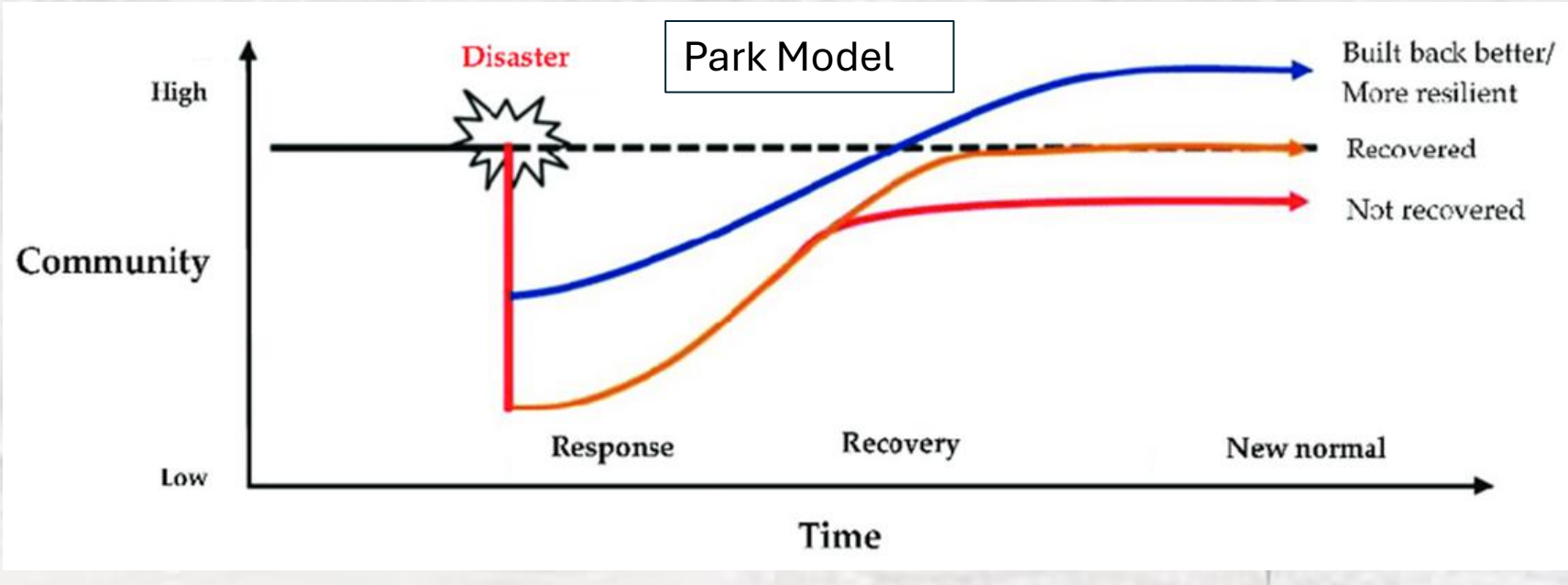


Challenges:

Turkey due to level of development should recover well, this will be easier for some in society than others

Syria due to development issues, on-going political instability, country-wide damage due to the civil war the impact was longer, the recovery will be longer and some areas may be very long

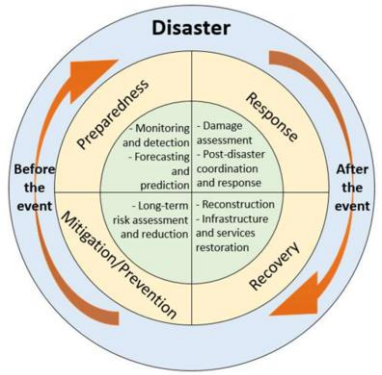
Physical or human?



Exposure and Vulnerability

Exposure - The situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazard-prone areas.

Vulnerability - The conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards.





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Summary:

Turkey / Syria earthquake was a very significant natural hazard with significant physical effects

The impacts of these were exaggerated by many human factors that made the situation much worse

Key elements were exposure and vulnerability and we can understand these through studying the disaster management cycle

Geographers are very well placed to understand these issues and to develop effective hazard management solutions to reduce the impact of such hazards

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