unesco

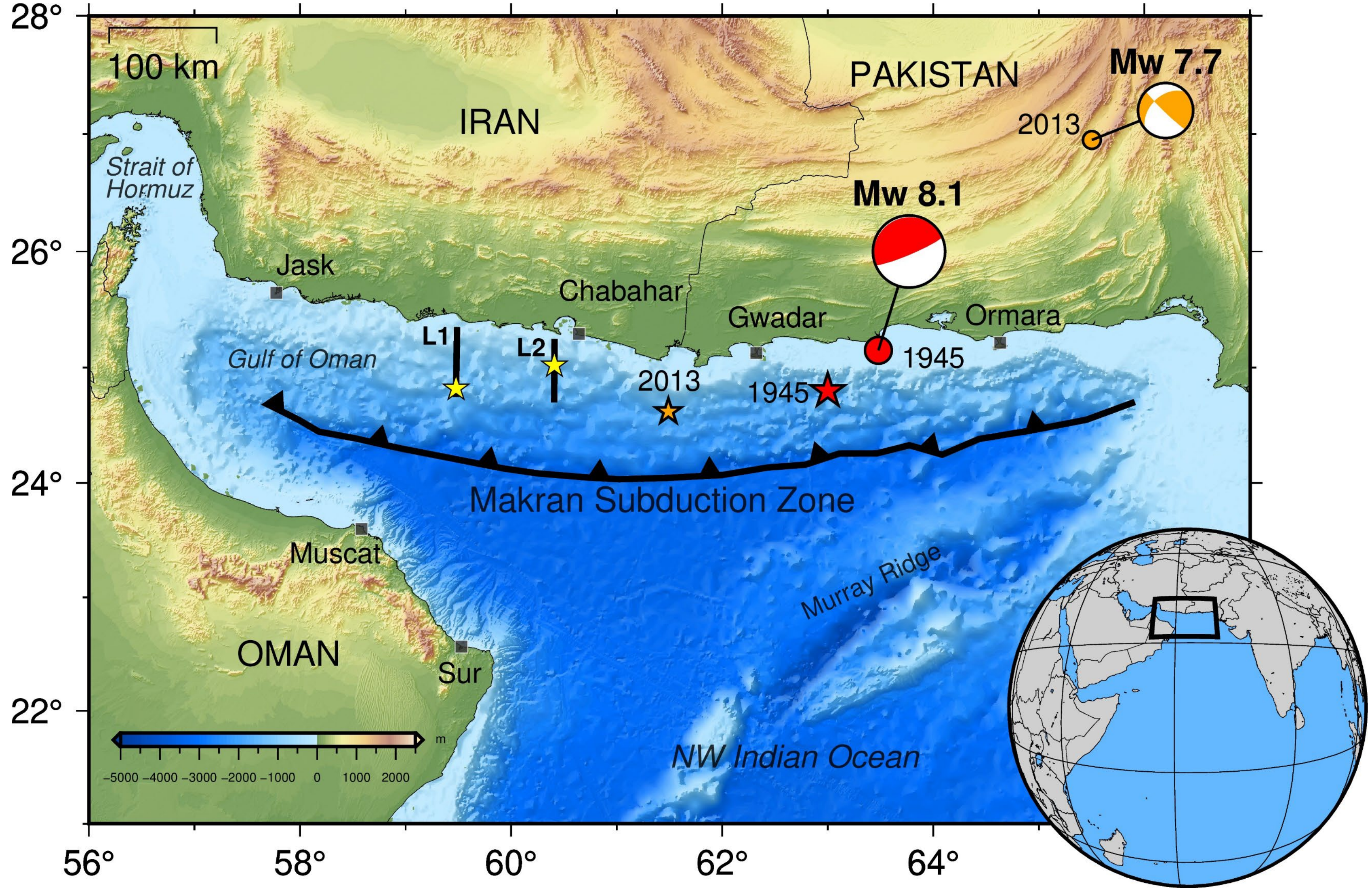
Intergovernmental
Oceanographic
Commission

Non-Seismic Tsunamis Makran NWIO

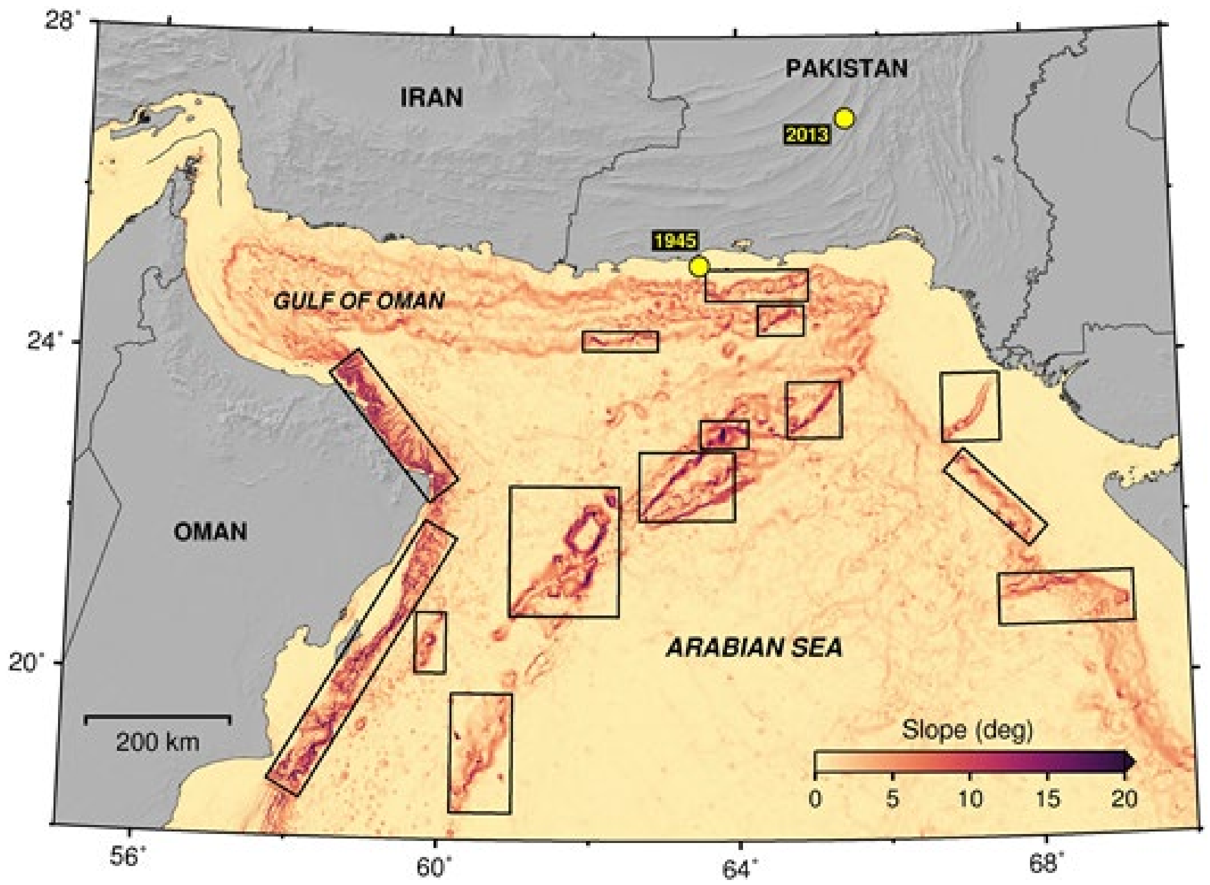
Dr. Mohammad Mokhtari

ICG/IOTWMS Sub-regional Working Group for the North-West Indian Ocean
08 October 2025

Study Area


28°
26°
24°
22°
56°
58°
60°
62°
64°
100 km
IRAN
PAKISTAN
Mw 7.7
2013
Strait of Hormuz
Mw 8.1
Jask
Chabahar
Gwadar
Ormara
L1
L2
Gulf of Oman
1945
2013
1945
Makran Subduction Zone
Muscat
Murray Ridge
OMAN
Sur
NW Indian Ocean
−5000 −4000 −3000 −2000 −1000 0 1000 2000
m

Landslide Potential and Previous Research

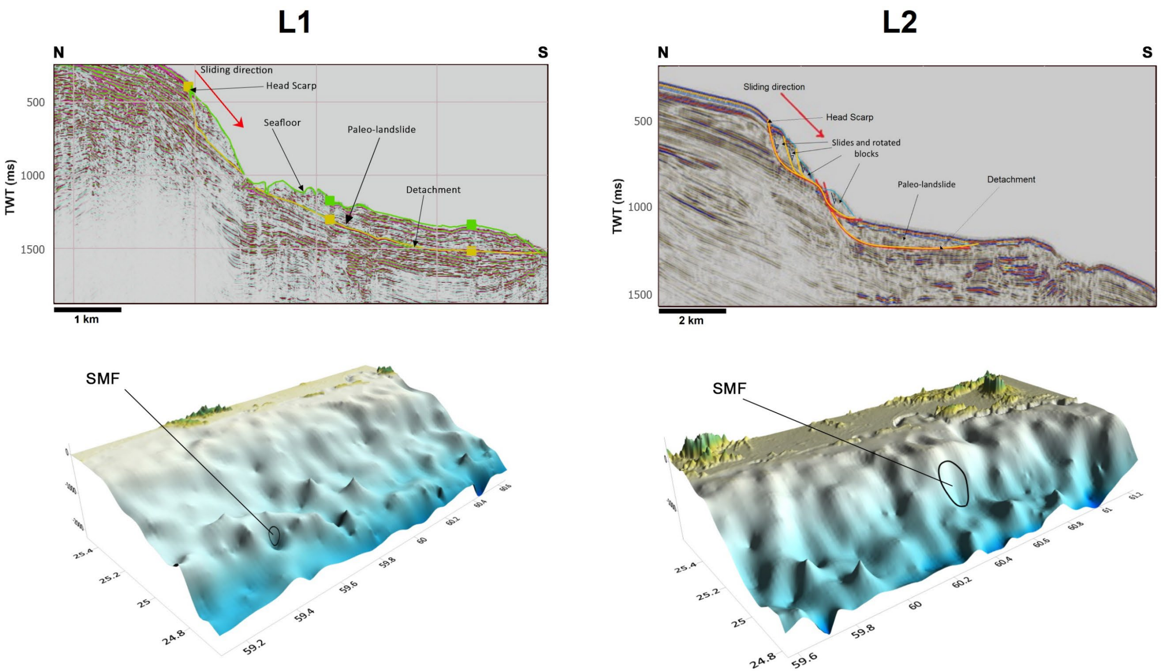


Western Makran has thick, unconsolidated sediments with low cohesion.

Active seismicity may trigger submarine landslides.

Previous studies: Heidarzadeh & Satake (2014, 2017); Salmanidou et al. (2019); Baptista et al. (2020); Rashidi et al. (2020); Nouri et al. (2023). Rashidi et al. (2025)

Data and Methodology



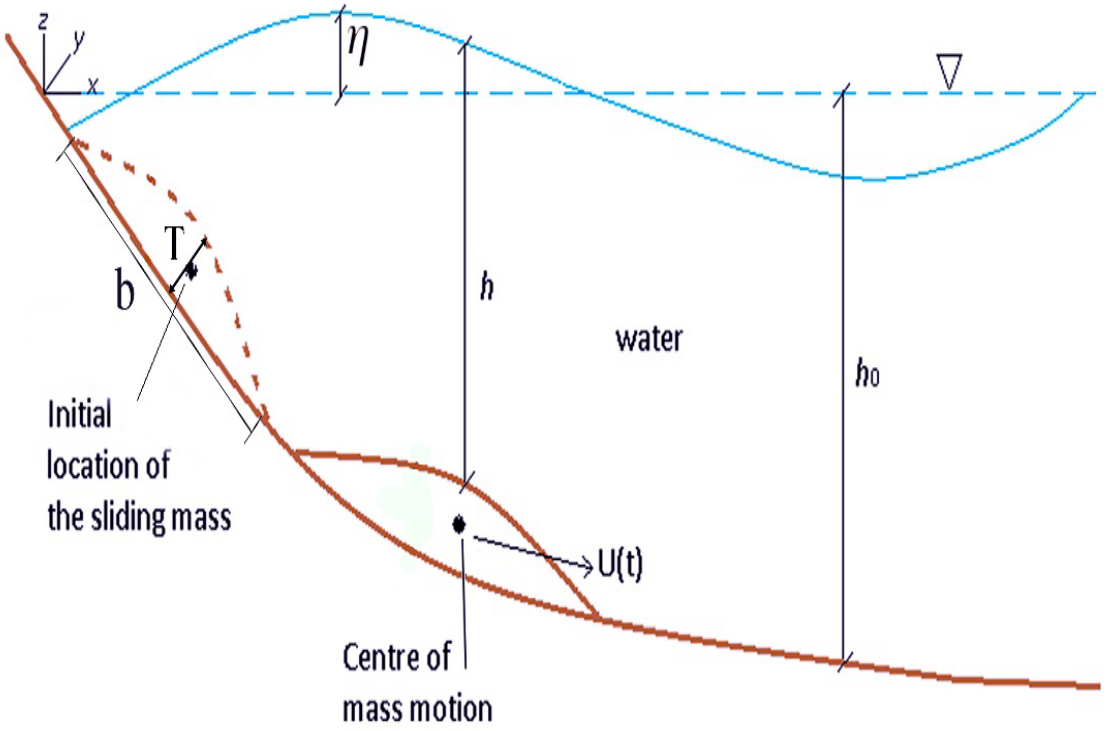
Seismic-reflection data:
Persian Carpet 2000 (PC-2000, NIOC).

Bathymetric data:
GEBCO (15″), Ports & Maritime Org. (3″)

Topography:
SRTM (1″).

Approach:
probabilistic and statistical modelling; Gaussian process learning; numerical tsunami simulation using nonlinear shallow-water equations

Identified Submarine Landslides



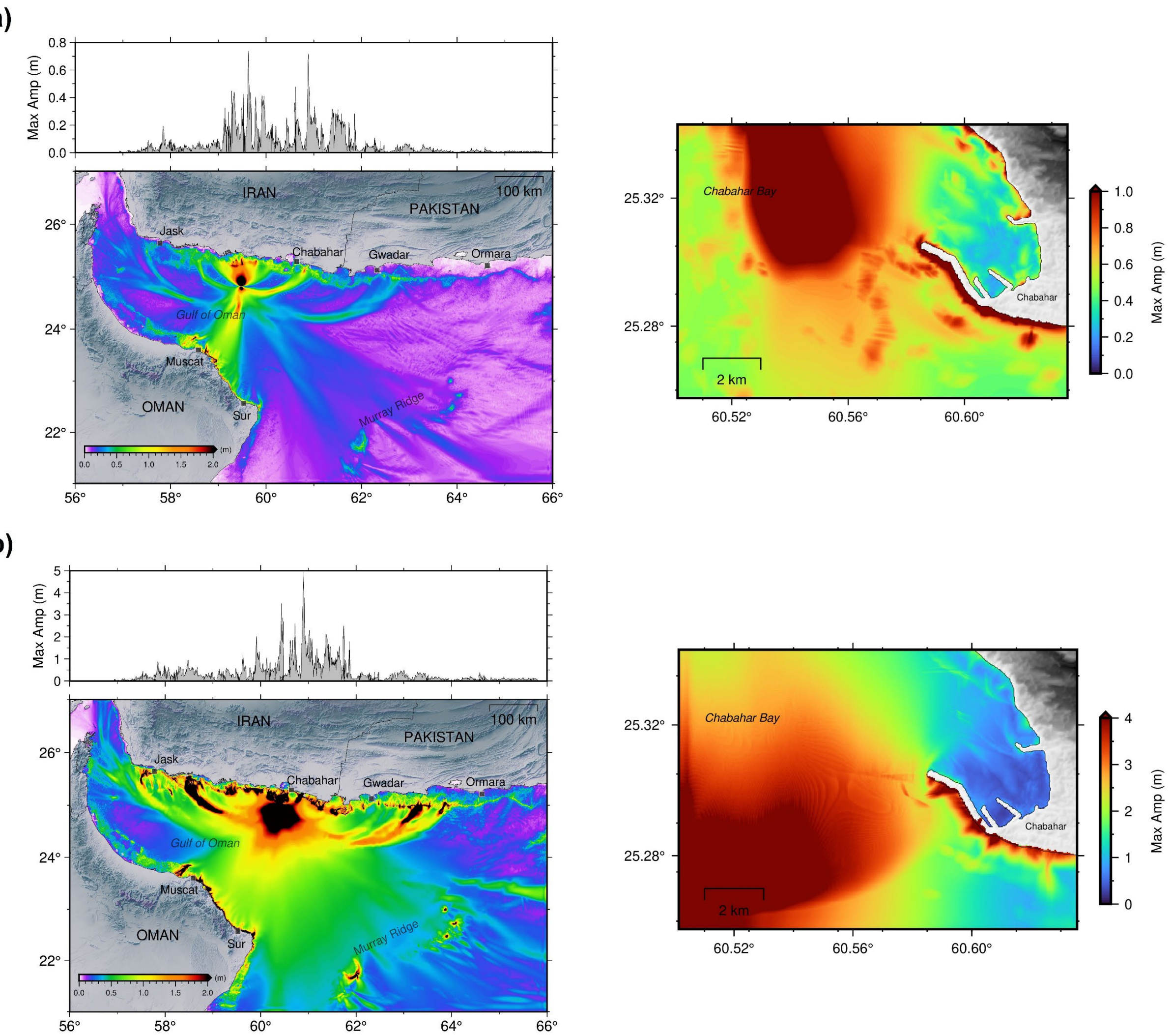
Slide Mass L1: ~120 km offshore Chabahar; L ≈ 3 km, W ≈ 1.5–3 km, T ≈ 260 m.

Slide Mass L2: ~40 km offshore Chabahar; L ≈ 6 km, W ≈ 3–6 km, T ≈ 250 m.

Both consist of loose silty-sand layers.

Width estimated as half to full length due to 2-D seismic limitation.

Numerical Modelling of Tsunami Generation



Based on Wang & Power (2011) nonlinear shallow-water equations.

Finite-difference solver, nested grids, time step = 1 s, duration = 3 h.

Manning friction = 0.025; moving-boundary algorithm for run-up simulation.

Six virtual stations at 100 m depth near main ports.

Results and Probabilistic Analysis

unesco
Intergovernmental Oceanographic Commission

I. Maximum wave heights: ~6 m (Iran), 2–2.5 m (Pakistan).

II. Arrival times: Chabahar 10–15 min; Jask 40–50 min; Muscat 25–30 min.

III. Inundation ≈ 300 m inland at Chabahar (Scenario 8).

IV. 2 000 random scenarios produced; Gaussian model predicts ≈ 0.8 probability of > 1 m amplitude at Chabahar.

Conclusions

I. **Makran shows realistic potential for landslide-generated tsunamis.**
II. **Probabilistic Gaussian modelling enables fast hazard estimation for early warning.**
III. **Need for high-resolution bathymetry and 3-D seismic data.**
IV. **Future work: non-hydrostatic 3-D dynamic simulations.**
V. Deep Learning for Offshore Landslide Tsunami Sources in the Makran Subduction Zone.
VI. Integrating AI and Geophysical Data to Identify Landslide-Generated Tsunami Hazards in the Makran Margin.
VII. **Potential funding: UNESCO/IOC**, **UNESCAP**, **national tsunami program**, or **research grant like EU Horizon/Nordic…….**