Seismic Hazard Assessment for Northern Egypt

Insights from Earthquake Catalog Analysis and Gutenberg-Richter Parameters

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Experience (2020 ~ 2024)

- Bachelor's Degree in Civil Engineering from **Ain Shams University**, Cairo, Egypt (2020).
- Three years of experience working on structural design at **Edges** and **Union Consult.**
- One year of experience at the **Nuclear Power Plants Authority (NPPA)** in Egypt.

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- **Title:** Seismic Hazard Assessment for Northern Egypt
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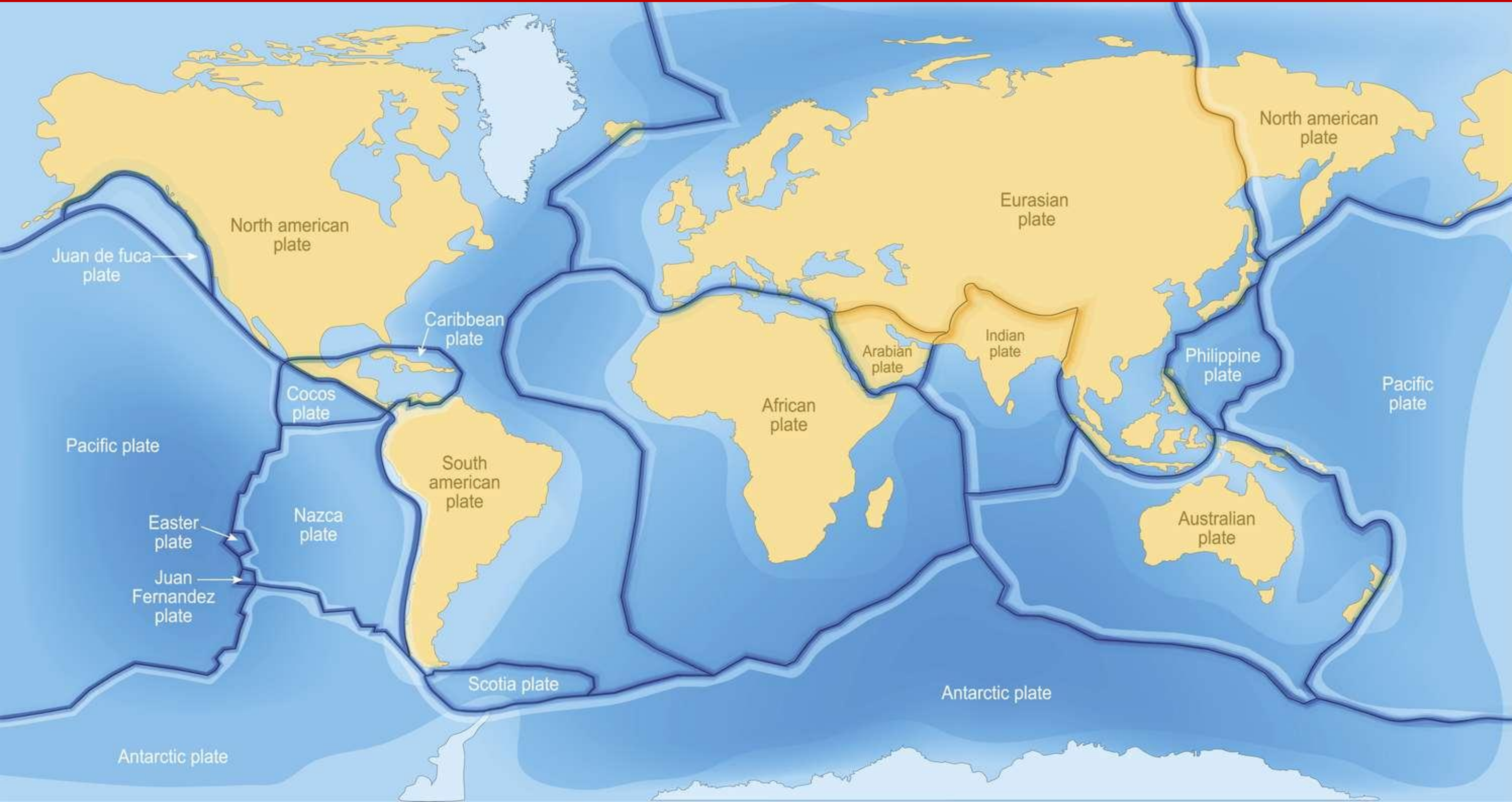

1. Introduction

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With growing interest in infrastructure development, including nuclear power plants, in Northern Egypt, it is essential to conduct thorough seismic hazard assessments to ensure the safety of critical nuclear infrastructure.

- **Characterization of seismic sources**
  A seismic catalog for Northern Egypt was compiled, magnitude scales were homogenized, and Gutenberg-Richter parameters (*a* and *b*) were estimated to assess regional seismicity.

Part of El-Dabaa NPP Construction Site

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2. Methodology

❑ Data Sources:

Aspect	ISC	ISC-GEM	ISC-EHB	GCMT	NEIC
Full Name	International Seismological Center Bulletin	ISC Global Earthquake Model Catalogue	Engdahl–Hilst–Buland (EHB) ISC Bulletin	Global Centroid Moment Tensor Catalogue	USGS – National Earthquake Information Center (NEIC)
Primary Purpose	To collect, review, and publish a global bulletin of seismic events by integrating data from worldwide networks.	To provide a homogenized, long-term global earthquake catalog (Mw ≥ ~5.5 since 1904) for seismic hazard assessment.	To **relocate earthquake hypocenters** using advanced algorithms and a global velocity model, improving depth and epicenter accuracy.	To provide **moment tensor solutions and focal mechanisms** for moderate to large earthquakes (M ≥ ~5.5) using waveform inversion.	To **detect, locate, and report global and U.S. earthquakes rapidly**, and support emergency response and public safety.
Data Span	~1900–present	1904–2020	1964–2021	1976–present	1960s–present
Magnitude Type(s)	ML, Mb, Ms, Mw (varied by report ing agency)	Homogenized Mw (Global Moment Magnitudes)	Mw, Ms, Mb from reviewed sources	Mw from moment tensor inve rsion	Mb, Ms, Mw (varied sources)
Location Accuracy	Varies; raw phase data	High (reviewed & reprocessed)	High (relocated using EHB method with travel-time corrections)	Moderate (based on centroid location)	Good (NEIC manual review)
Review Status	Reviewed by ISC analysts	Fully reprocessed and reviewed	Reviewed (EHB relocation)	Fully automated but quality-checked	Mixed: preliminary and revie wed

A total of 5,234 earthquakes were recorded in Northern Egypt, with their epicenters illustrated in the figure.

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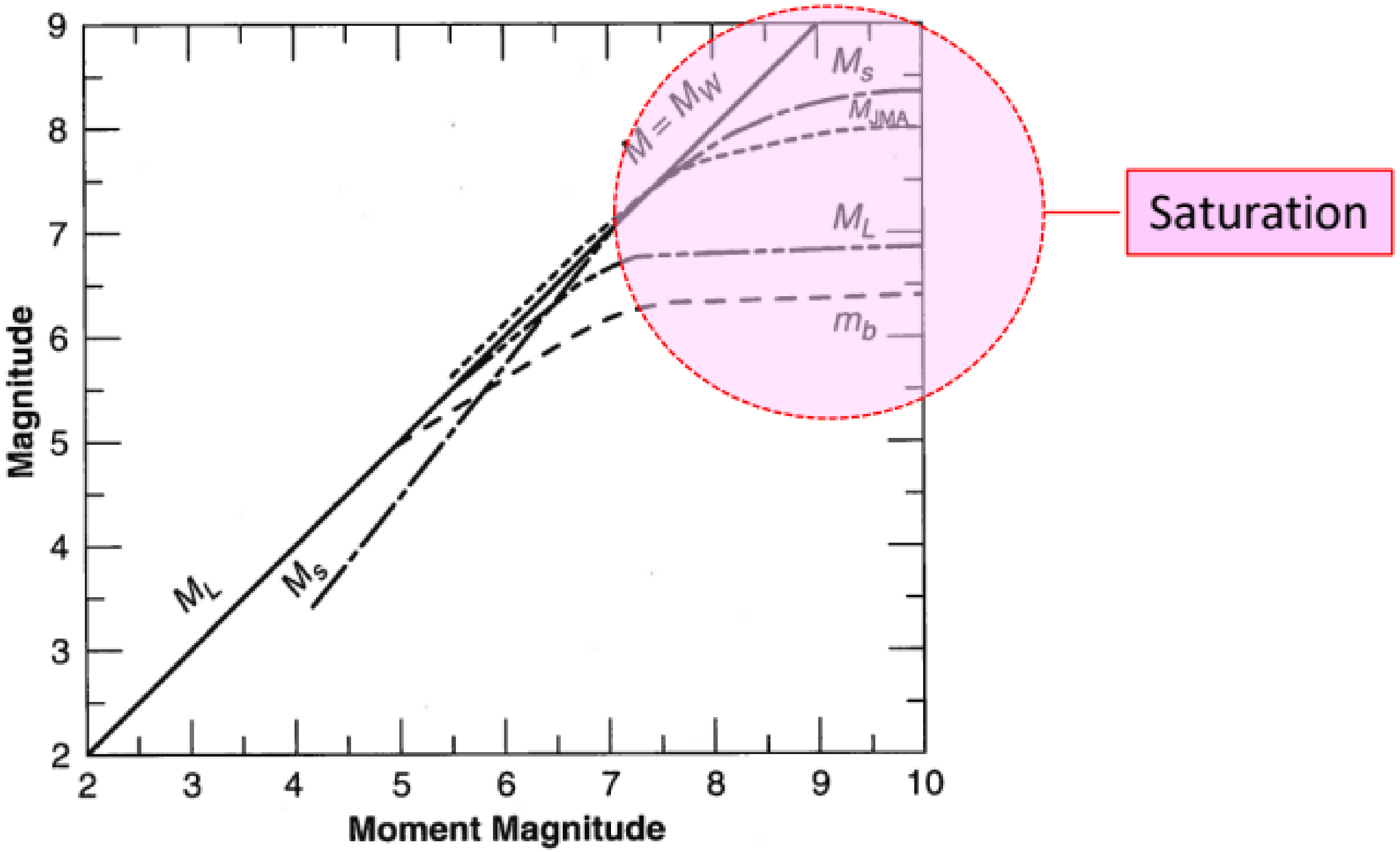
2. Methodology

❑ Why Magnitude Homogenization and Why Mw?

- In the shaded area, traditional magnitude scales like ML and Ms **saturate** and don't accurately reflect the size of large earthquakes beyond Magnitude 6.5–7 . So that Moment magnitude (Mw) is preferred in earthquake studies as it increases linearly with seismic energy and offers a reliable measure of earthquake energy release across a broad range of magnitudes.



- In this study, various magnitude types were converted into a single, standardized moment magnitude scale Mw.

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2. Methodology

❑ Magnitude Homogenization

Empirical regression relationships from the literature (Weatherill et al. [1]) which is developed for the African region.
And it’s Applied based on:

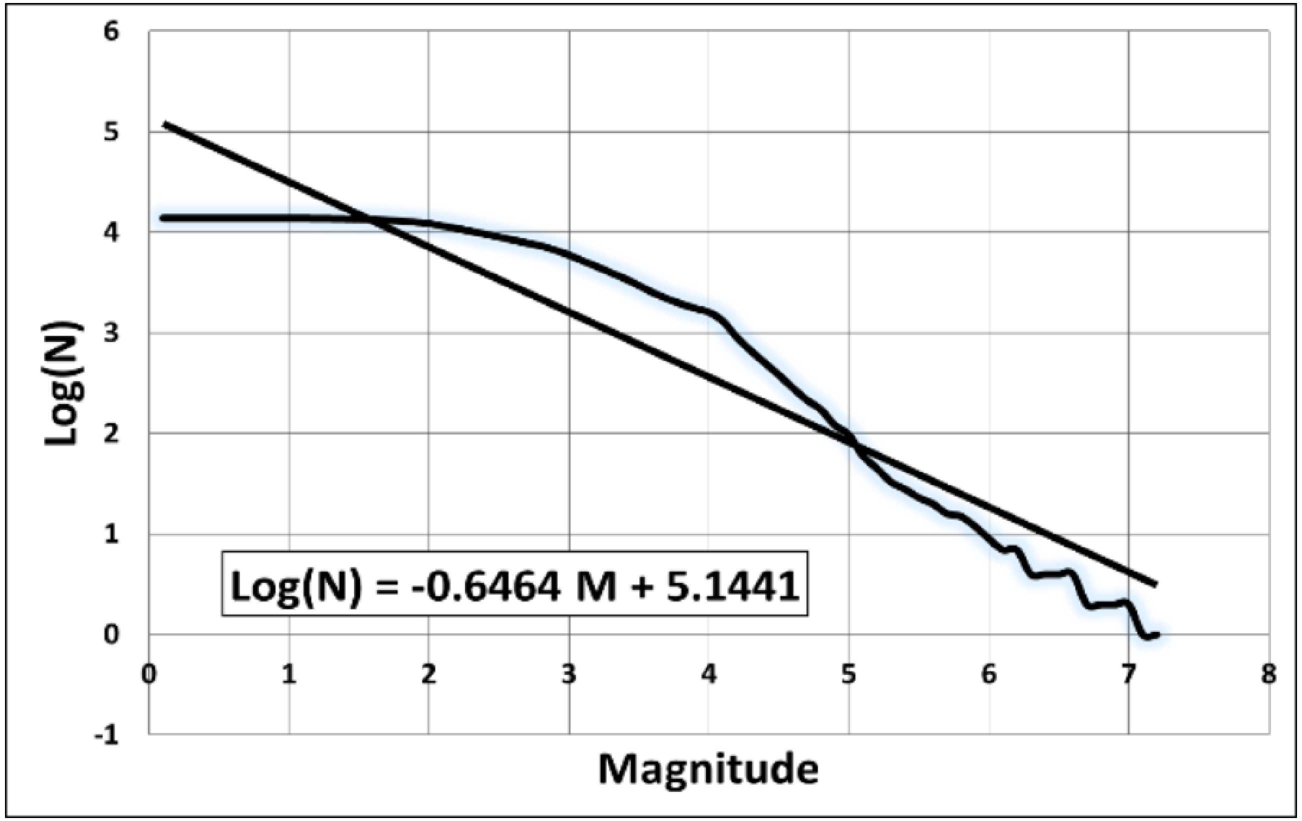
- Agency (ISC, NEIC)
- Type of Mag Scale (MS, MSZ, mb)
- Lowest Standard deviation (σ) of fit

Agency/Magnitude	Conversion		σ
ISC M_S	$M_w^{PROXY} = 0.616M_S^{ISC} + 2.369$	if $M_S^{ISC} \leq 6.0$	0.147
	$M_w^{PROXY} = 0.994M_S^{ISC} + 0.1$	if $M_S^{ISC} > 6.0$	0.174
NEIC M_S	$M_w^{PROXY} = 0.723M_S^{NEIC} + 1.798$	if $M_S^{NEIC} \leq 6.47$	0.159
	$M_w^{PROXY} = 1.005M_S^{NEIC} + 0.026$	if $M_S^{NEIC} > 6.47$	0.187
NEIC M_{SZ}	$M_w^{PROXY} = 0.707M_{SZ}^{NEIC} + 1.933$	if $M_{SZ}^{NEIC} \leq 6.47$	0.179
	$M_w^{PROXY} = 0.950M_{SZ}^{NEIC} + 0.359$	if $M_{SZ}^{NEIC} > 6.47$	0.204
NEIC m_b	$M_w^{PROXY} = 1.159\ M_b^{NEIC} - 0.659$		0.283
ISC m_b	$M_w^{PROXY} = 1.084m_b^{ISC} - 0.142$		0.317

[1] Weatherill et al, Exploring earthquake databases for the creation of magnitude- homogeneous catalogues: tools for application on a regional and global scale. Geophysical Journal International, Vol. 206, p. 1652, 2016.

❑ Gutenberg-Richter Law

Formula: log N = a – bM
a: Seismic activity level
b: Frequency decay of magnitude



a = 5.144 → Moderate seismic activity
b = 0.646 → Relatively higher proportion of moderate-to-large earthquakes.

- The lower b-value we observed implies that Northern Egypt could experience stronger.
- This supports the inclusion of conservative seismic design margins in nuclear projects.

4. Conclusions

- 5,234-event catalog created
- Mw homogenization applied
- G-R law fitted with a = 5.144, b = 0.646

These findings provide a reliable basis for seismic hazard assessments in Northern Egypt, particularly for critical infrastructure projects such as nuclear power plants. The study highlights the importance of understanding regional seismicity for ensuring safety and resilience in infrastructure development.

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THANK YOU