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Hydrodynamic Echoes: An Investigation of Seiche Activity Following the March 28, 2025 Myanmar Earthquake*Aggeliki Barberopoulou^{1, 2, *}, George Malaperdas³, Sarah Firth²**¹ Hellenic Center for Marine Research, Anavyssos, Attiki Greece**² Tsunami Society International, Derry NH 03038 United States**³ Department of History, Archaeology and Cultural Resources Management, University of the Peloponnese, Old Campus 24133, Kalamata, Greece*** Aggeliki Barberopoulou, Email: a.barberopoulou@hcmr.gr***Abstract**

This article presents a unique dataset of standing waves, also known as seiches, observed in swimming pools and other small bodies of water (ponds, lakes, fish tanks etc.) near the epicenter of the M7.7 Myanmar earthquake and in neighboring countries. While this phenomenon of seiching is not frequently documented on such a scale, these waves may provide valuable insights. Although this dataset is certainly not exhaustive due to its reliance on reported observations (versus available observations), these collected observations are crucial to better understand the initiation of seiches due to earthquake ground motions and their dependence on local geological and geomorphological characteristics. This study aims to contribute to the field by providing a unique collection of records linked to this seismic effect.

Keywords: Myanmar, seiches, 28 March 2025 Myanmar earthquake

1. Introduction

Seiches is a more sophisticated term used to describe standing waves generated in enclosed or semi-enclosed water basins due to a disturbance. The generating mechanism can vary, but the focus of this work is on seismic seiches—those caused by ground shaking due to an earthquake (e.g. Kvale, 1955; McGarr, 1965; McGarr and Vorhis, 1968; Barberopoulou et al. 2004, 2006; Rabinovich, 2009). Both distant and regional earthquakes have been associated with the generation of these waves, but local earthquakes can cause them as well (e.g. Kvale, 1950; Canitano et al. 2017; Barberopoulou et al. 2023). Such waves have been observed as early as the 18th century (Forel, 1876; Wilson, 1972), but most of the available data remains limited in size (i.e., number of observations per event).

In general, reported observations of seiches are infrequent and lack spatial or temporal density, with very few exceptions (McGarr, 1965; McGarr and Vorhis 1968; Barberopoulou et al. 2006; Barberopoulou et al, 2023). Most of them are linked to distant earthquakes. In contrast, seiches associated with local earthquakes have only been documented in few publications with some of the largest collection of observations documented by Barberopoulou et al (2004; 2023) for Washington state in the U.S. and for the Kahramanmaraş, Turkey earthquake (M7.8, 6 Feb 2023). The latter is also the only dataset of seiche observations known for the Eastern Mediterranean to-date. More recently, the widespread availability of smartphones with high-resolution cameras, the use of private security cameras, and the extensive presence of swimming pools in both residential and commercial areas have enabled more frequent observations of this phenomenon. Observations of seismic seiches in lakes and other natural water bodies are scarce, mainly because data collection is sporadic. This is due to the need for a witness to be present at the time of the event, which must usually occur during daylight hours in frequently visited locations. When analyzing the geographical distribution of these observations, the location of lakes and ponds in and around the epicentral region must also be considered. This article explores the idea of using swimming pools as recording devices for this phenomenon.

2. The Earthquake and its Impact

On March 28, 2025, at 06:20:52 (UTC), a powerful M7.7 strike-slip supershear earthquake struck Central Myanmar near Mandalay, the country's second-largest city

(U.S. Geological Survey 2025). The epicenter as determined by the USGS was located at 22.001°N, 95.925°E on the Sagaing Fault, a major 1400 km-long transform fault that runs down the center of Myanmar (Tun and Watkinson, 2017). Many of the country's cities—including Yangon, Naypyidaw, and Mandalay—are situated along this fault in the eastern plains between the Shan Mountains and the Irrawaddy River. The Burma and Sunda plates slide past each other at a rate of 18–49 mm per year, and the Sagaing Fault is Myanmar's largest and most active seismic source (Wang et. al, 2011). Eleven minutes after the first earthquake, a M6.7 aftershock struck with an epicenter approximately 32km to the south at 21.698°N, 95.969°E (U.S. Geological Survey 2025).

The maximum intensity reached IX - X (Extreme) on the Modified Mercalli scale (MMI, USGS; Shake USGS; Map Fig.1). The epicenter was situated in the city of Mandalay (USGS, 2025a), Myanmar's second largest city with a population of at least 1.2 million people (Myanmar's 2024 Census Provisional Results, 2025). The disaster affected over 17 million people across the region, with 9 million severely affected. The state government of Myanmar reported an official death toll of 3,770, with 5,106 injuries and 106 people missing (Peck 2025), although due to government censorship, the true number of casualties is likely much higher (The United Nations, 2025). The vast majority of fatalities occurred in Myanmar, with deaths also reported in Thailand. The World Bank estimated structural damage at US\$11 billion, representing 14% of Myanmar's GDP. This was the most powerful earthquake to strike Myanmar since March 1912 (1912-05-23, M7.9 Myanmar; U.S. Geological Survey 2025). Ongoing civil war in the country since March 2021 severely hindered disaster relief efforts and contributed to the high number of casualties (The United Nations, 2025). The conflict also made it difficult to obtain accurate casualty reports due to censorship and lack of transparency from Burmese sources (2025 Sagaing Earthquake Archive, 2025).

In addition to major impacts in Myanmar, the earthquake disproportionately affected the Bangkok region in Thailand—approximately 1,000 km from the epicenter—due to the city's unique surface geology. Bangkok is underlain by a layer of soft alluvial clay sediment, making its many high-rises especially vulnerable to ground motion from distant powerful earthquakes (e.g. [Ornthammarath, 2023](#))

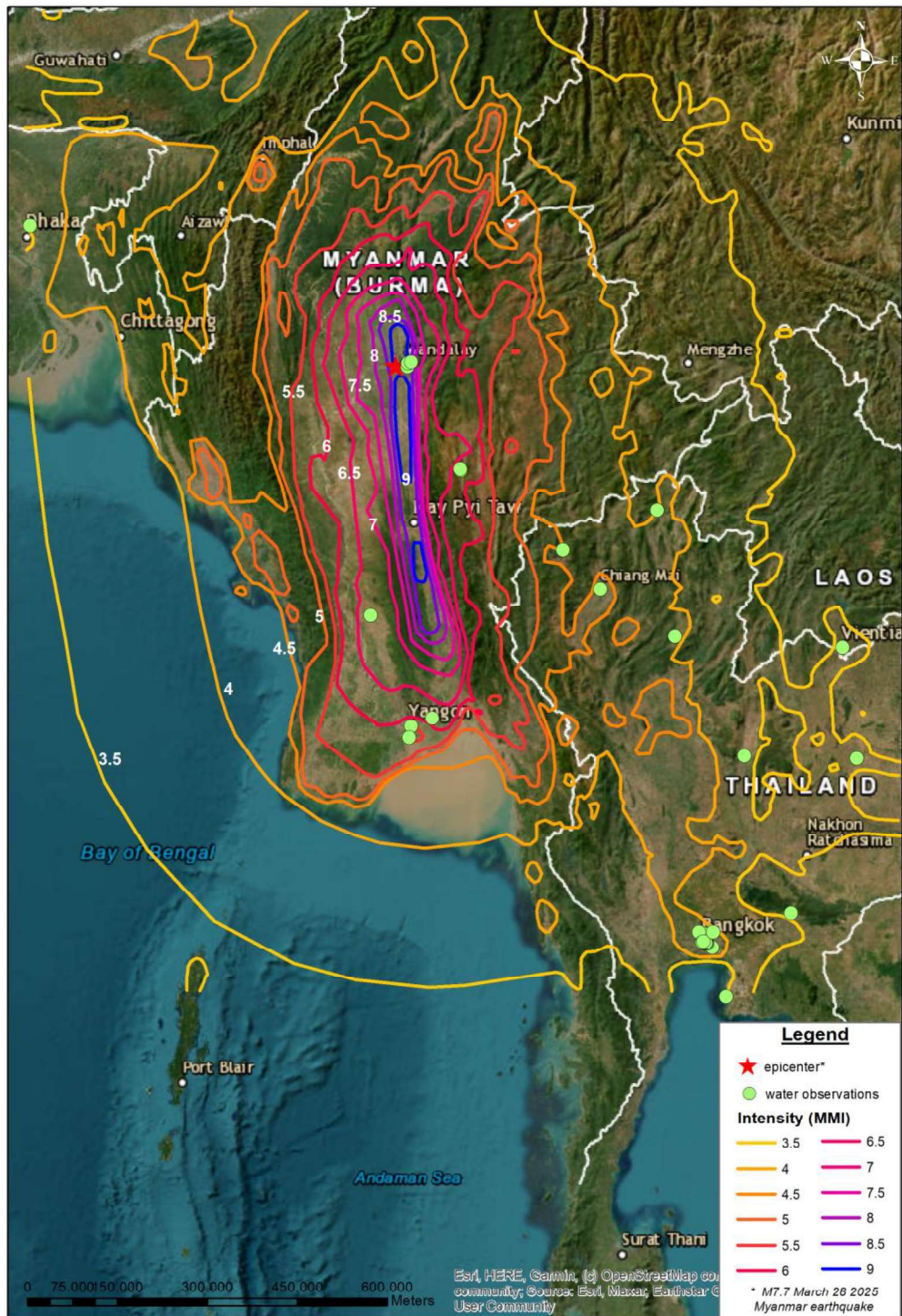


Figure 1. Intensity contours of the 28 March earthquake as reported by the USGS overlaid by observations of water waves collected for this work. Red star shows epicentral location of the March 28, 2025 Myanmar earthquake.

3. Materials and Data

Data in this article includes observations captured by security cameras and cellphones. Videos were found in a wide variety of social media platforms such as YouTube, Tik Tok, Instagram and X. The primary search engine terms (in English) used to find observations included combinations of “earthquake,” “waves,” “pools,” “rooftop,” “shaking,” “water” and “pond,” and other related terms. Search results were limited to those shortly after 28 March 2025 to identifying these observation videos as a record of the effects of the March 28, Myanmar earthquake. Additionally, geographic specific search terms such as the name of the country or town were also included as necessary. In addition to searching for videos filmed in Myanmar, online searches were conducted in the appropriate native languages of Myanmar and neighboring countries, including but not limited to Thai, Burmese, Lao, Vietnamese, and Bengali. Google Translate was the translation service utilized.

The collection methodology followed for this unique collection of observations follows next:

1. **Identifying Videos:** Various social media platforms were searched that integrate video, including but not limited to YouTube, Facebook, TikTok, Instagram, and X.
 - a. Only seiche events documented by at least one video clearly depicting the wave directly were included in the dataset. Seiches with recordings that showed only peripheral effects, such as water spilling down structures, provided limited information for future analyses and were not included in this dataset.
2. **Verifying** links to March 28 Myanmar earthquake: Videos should be posted after March 28 and ideally within a few days of the earthquake. In nearly all cases, contextual clues were used to ensure the recordings captured the mainshock M7.7 event, not the M6.7 aftershock, as there was a noticeable calm in both people and the environment preceding the seiches.
3. **Location Determination:** Video locations were determined using various methods:
 - a. Direct Information: Some videos included the location directly in the description.
 - b. Identifiable features: Some videos had easy to identify landmarks in the

background, e.g. the MahaNakhon skyscraper in Bangkok.

- c. Public Addresses: Other videos were posted on official business social media accounts that were linked to a public address.
- d. Account Holder's Location: For videos with limited details, we often identified the location based on the account holder's general whereabouts, as indicated either explicitly on the account information or through other videos posted under the same account.
- e. User Comments: In some instances, additional clues for correctly identifying the location were found in the comments.
- f. If the location could not be identified with a reasonable degree of confidence and accuracy (minimum city/town or general district), the observation was excluded from the dataset.

4. **Geographical location** (latitude and longitude) and other identifying information were assigned to each observation based on available address or other location information.

- a. Identified locations were verified by looking at Google Street View as available, photos from the business's website if applicable (e.g. for hotels and restaurants), and all other public photos associated with the address on Google Maps

The above process yielded a dataset of 35 unique observations with confirmed location data (Table 1, Figures 1 & 2). Events listed under the same ID number (for example, 4.1, 4.2, etc.) represent multiple angles of a single event at one location and are not counted as unique. For each entry, the dataset details the geographical information—including city, country, latitude, and longitude—along with location accuracy (exact or approximate) and a description of the water basin where the seiching occurred (e.g., lake or rooftop pool). Due to space constraints, not all attributes are shown in the table.

This dataset does not necessarily represent all seiches that occurred throughout the region. Charts and maps only show locations where seiches were captured on video. If a seiche was observed in one body of water, it's reasonable to infer that nearby bodies of water of similar size likely experienced seiches as well—even if they weren't caught on camera.

3.1 Attribute Descriptions

ID: assigns a unique identification number to each observation. In the case of multiple videos of the same observation, this is marked as x.1, x.2, x.3, etc.

Country: country in which the seiche was observed

City: city or town in which the seiche was observed

Lat, Long: geographic location of where seiche was observed

Loc. accuracy: location information could be determined with high confidence and precision (exact) or moderate (approximate).

Description: identifying details about the seiche observation, including what type of body of water, etc.

Recording device: specifies what type of recording device was used (e.g. cellphone camera, CCTV, etc.)

Slosh behavior: additional informative data about water movement (not shown on this table)

Table 1. Water observations associated with the M7.7 March 28, 2025 Myanmar earthquake

ID	Country	City	Lat	Long	Loc. accuracy	Description	Video Type
1	Thailand	Samut Prakan	13.6504776	100.67986	Exact	Rooftop pool on a skyscraper	Cellphone
2	Thailand	Sukhumvit, Bangkok	13.70671	100.59981	Exact	Rooftop pool on hotel skyscraper. Pool not very clearly shown as camera pans around, but can still see seiche movement at times in video	Cellphone
3	Thailand	Chatuchak, Bangkok	13.82659	100.56717	Exact	Rooftop pool on hotel skyscraper. In pool are floating pillows, some of which flow over	CCTV
4.1	Thailand	Pathum Wan, Bangkok	13.7469	100.52897	Exact	Rooftop pool on a hotel skyscraper. Taken from someone sitting on chair outside of pool.	Cellphone
4.2	Thailand	Pathum Wan, Bangkok	13.7469	100.52897	Exact	Rooftop pool on a hotel skyscraper. Taken from someone sitting on chair outside of pool.	Cellphone
4.3	Thailand	Pathum Wan, Bangkok	13.7469	100.52897	Exact	Rooftop pool on a hotel skyscraper. Taken from someone sitting on chair outside of pool.	Cellphone
4.4	Thailand	Pathum Wan, Bangkok	13.7469	100.52897	Exact	Rooftop pool on a hotel skyscraper. Taken from someone sitting on chair outside of pool.	Cellphone
5	Myanmar	Koksu	16.9680313	96.4818259	Exact	Water sloshes in what is presumably a fish farm open pool	Cellphone

6	Thailand	Chiang Mai	18.8021702	98.9993307	Approximate	Ground level pool in personal home	CCTV
7	Thailand	Pattaya	12.9309639	100.882261	Exact	Taken from water level on a rooftop pool	Cellphone
8	Thailand	Bang Rak, Bangkok	13.7262607	100.526874	Exact	L shaped pool on rooftop	Cellphone
9	Vietnam	Hanoi	21.0166887	105.83146	Approximate	Fish tank in office	Cellphone
10	Thailand	Chiang Rai	19.9198413	99.8483288	Approximate	Several small fish tanks	CCTV (recorded on iPad)
11	Thailand	Phetchabun (town)	16.4205357	101.160636	Approximate	Fish tank in a personal home with gold fish	Cellphone
12	Thailand	Khet Chatuchak, Bangkok	13.8498149	100.567673	Exact	Public large ground level swimming pool	Cellphone
13	Myanmar	Mandalay	21.9278214	96.1080981	Approximate	Personal rooftop pool at private home	CCTV
14	Thailand	Pai city, Mae Hong Son province	19.3587896	98.4372542	Approximate	Personal background pool at ground level	CCTV
15	Myanmar	Nattalin	18.4248062	95.5591082	Exact	Pond in rural area	CCTV

16	Myanmar	Inle Lake	20.4875978	96.9051996	Approximate	Lake upon which are situated houses on stilts (famous "floating villages")	Cellphone
17	Thailand	Khon Kaen province	16.3809968	102.845767	Exact	Large Shrimp pond in center of restaurant	CCTV
18	Thailand	Phae Province	18.1341342	100.117836	Exact	Khoi pond or similar sloshes around flooding restaurant	Cellphone
19	Myanmar	Yangon (a.k.a Rangoon)	16.8470287	96.1637198	Approximate	Water in bubbler plastic water holder swishes back and forth	Cellphone
20	Myanmar	Mandalay	21.9742823	96.1184641	Exact	Violent shaking in medium fish tank in spa	CCTV
21	Bangladesh	Dhaka	23.8741471	90.4558927	Approximate	Pond, small movement	Cellphone
22	Myanmar	Patheingyi	21.9951314	96.162847	Approximate	Violent shaking in ground level pool	Cellphone
23	Vietnam	Long An	10.5430036	106.406968	Exact	Some sort of fish pond in center of restaurant	CCTV
24	Myanmar	Yangon (a.k.a Rangoon)	16.685195	96.1347726	Approximate	Roadside ditch	Cellphone
25	Myanmar	Inle Lake	20.5041287	96.9037099	Approximate	House floating on stilts shakes	Cellphone
26	Laos	Vientiane	17.97698	102.632003	Approximate	Ground level (?) pool in personal backyard	CCTV
27	Vietnam	Hanoi	21.0211323	105.821531	Approximate	Fish tank in personal home	Cellphone

28	Thailand	Bangkok	13.7165547	100.58501	Exact	Extremely violent shaking on rooftop pool	Cellphone
29	Thailand	Nonthaburi	13.8737704	100.479168	Exact	Seiche viewed from another nearby rooftop	Cellphone
30	Thailand	Bangkok	13.7250924	100.525231	Exact	Seiche on floor 20 of hotel. Unique motion creates standing wave with multiple peaks.	Cellphone
31.1	Thailand	Bangkok	13.7224147	100.581341	Exact	Seiche on rooftop pool of hotel. View from above pool level, allowing to see seiche directly.	Cellphone
31.2	Thailand	Bangkok	13.7224147	100.581341	Exact	View of previous observation from adjacent apartment building. Can see water spilling down off the edges.	Cellphone
31.3	Thailand	Bangkok	13.7224147	100.581341	Exact	Video of previous observation from ground level	Cellphone
32	Thailand	Bangkok	13.7263033	100.526886	Exact	L shaped pool on rooftop	Cellphone
33	Thailand	Bangkok	13.7390346	100.545124	Exact	Backyard pool at ground level at the Dutch Embassy	Cellphone
34	Thailand	Bangkok	13.8780358	100.690773	Approximate	Ground level pool in private residence	Cellphone
35	Thailand	Na Di	14.149498	101.854829	Approximate	Pond next to road with large waves	Cellphone

4. Results

A total of 39 water observations were collected from various countries linked to the March 28 Myanmar earthquake. Of these, 35 were from unique locations that were identified with a high degree of confidence. A sample of the kind of observations collected (still images from videos) were mosaicked for Figure 2.

We created various maps and charts to visualize the data and identify patterns in the observation distribution. A map of observations collected (white circles), overlay countries with observations (colored polygons) in Figure 3. This map illustrates the geographic distribution of observations by water body type. Three inset maps are provided, with clusters of observations shown near the earthquake's epicenter in Mandalay and Yangon, Myanmar, as well as in Bangkok, Thailand. Observations have also been grouped by country and by category (Fig.4). Based on our collection of data, most observations were collected from Thailand. Most observations were from manmade water basins, and especially rooftop pools specifically. A few observations were collected from natural water basins (lakes; Fig.4). Videos from swimming pools tend to show clear side to side motion along the short side of pools especially in Thailand. Water motions from closer-to-the-epicenter locations show more complex water motion.

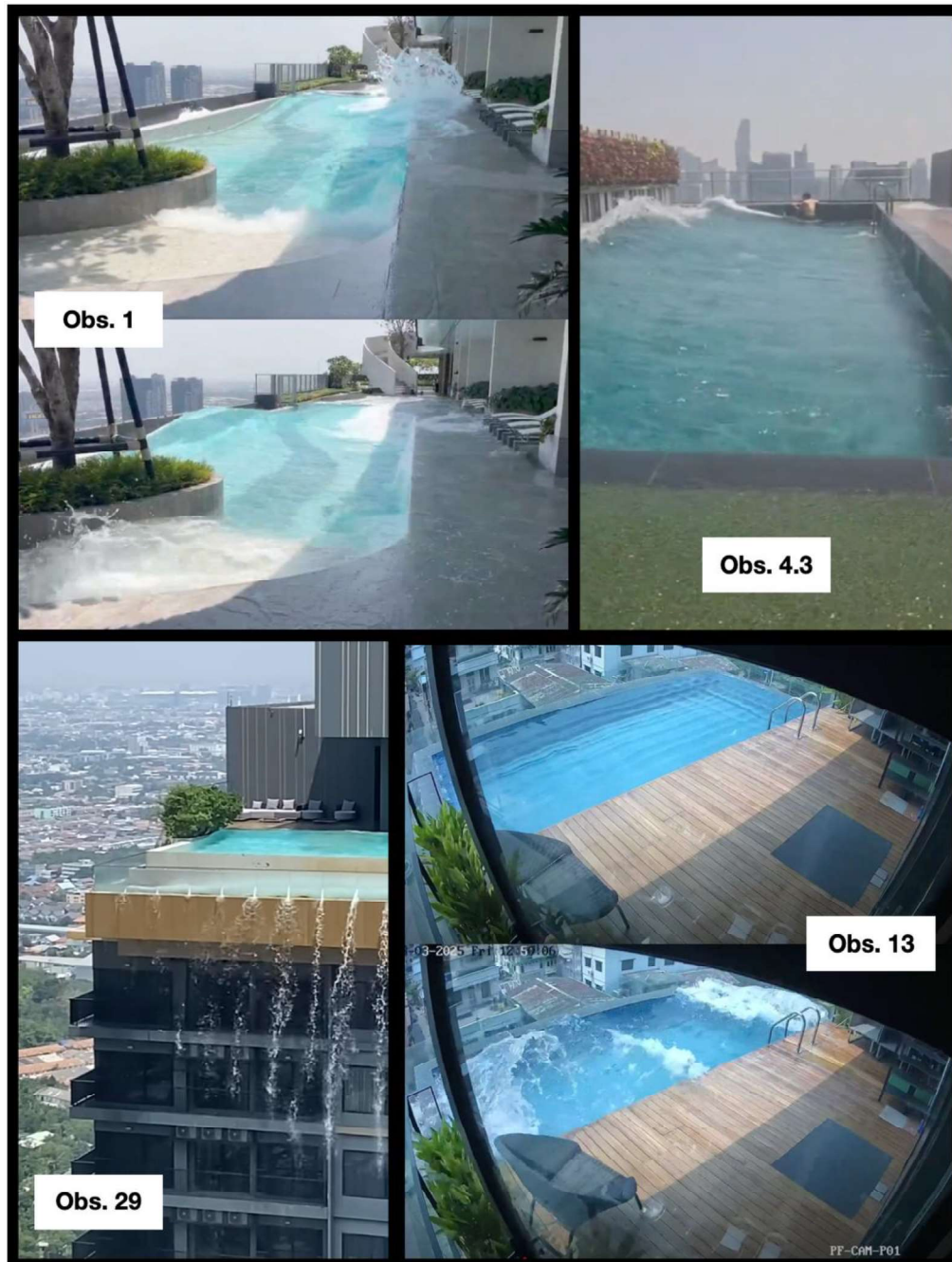


Figure 2. Selected still images captured from various videos in the dataset show water motion in small bodies of water. Observation 1 shows water sloshing in a rooftop pool on a skyscraper in Thailand, where the water moves from side to side along the pools' shorter side. Observation 4.3 shows similar side to side motion from another rooftop pool. The first frame of Observation 13 was taken just after ground shaking began and shows a complex wave motion. A few seconds later, the second frame shows violent splashing, first along the long side and then later (not shown) along the short. Observation 29 shows water sloshing from side to side along the width of a swimming pool in Nonthaburi, Thailand. Spilling from rooftop swimming pools was a unique characteristic of earthquake effects in this earthquake.

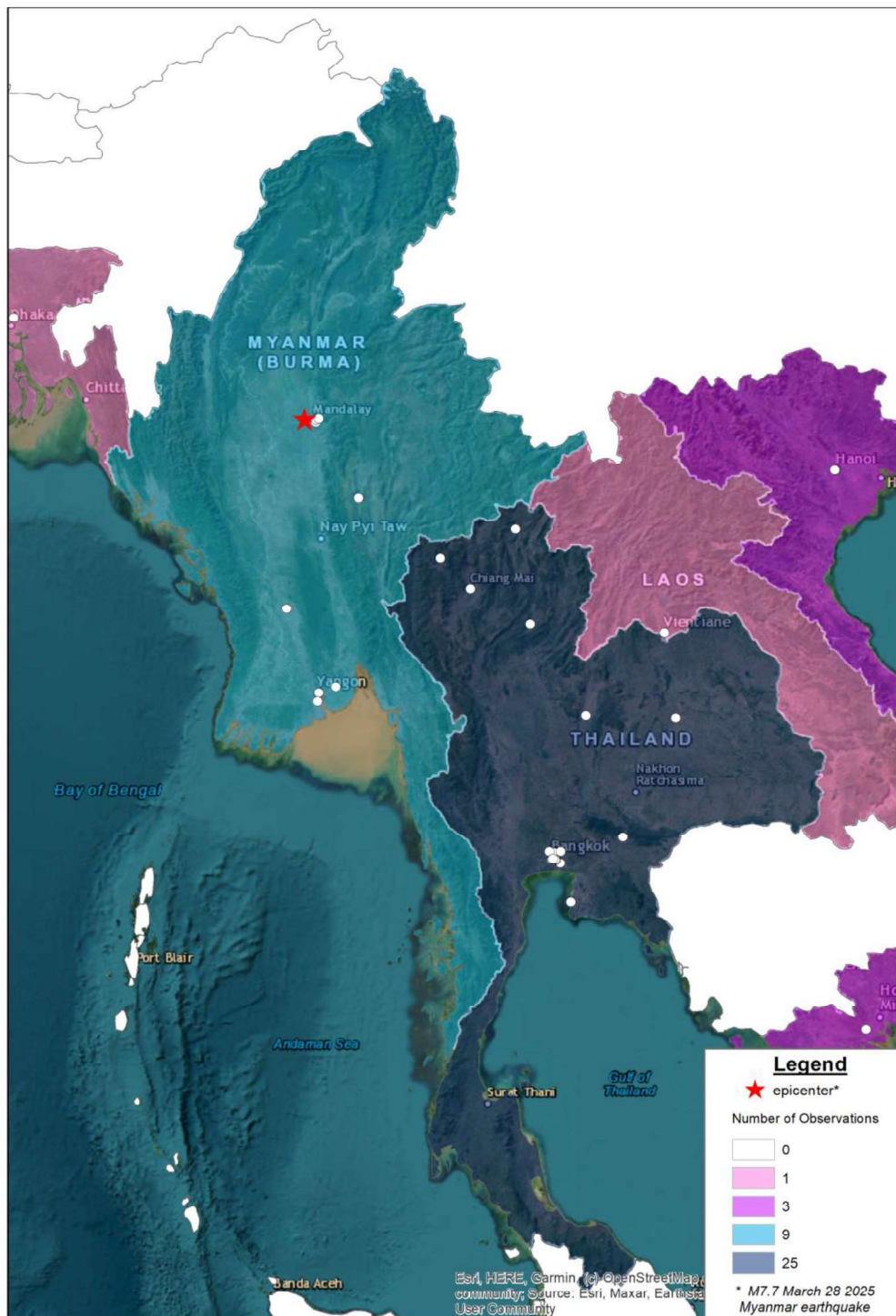


Figure 3 Set of unique observations (white circles) collected after the March 28, Myanmar M7.7 earthquake. Countries with observations appear colored according to number of observations (the darker the shade the more observations).

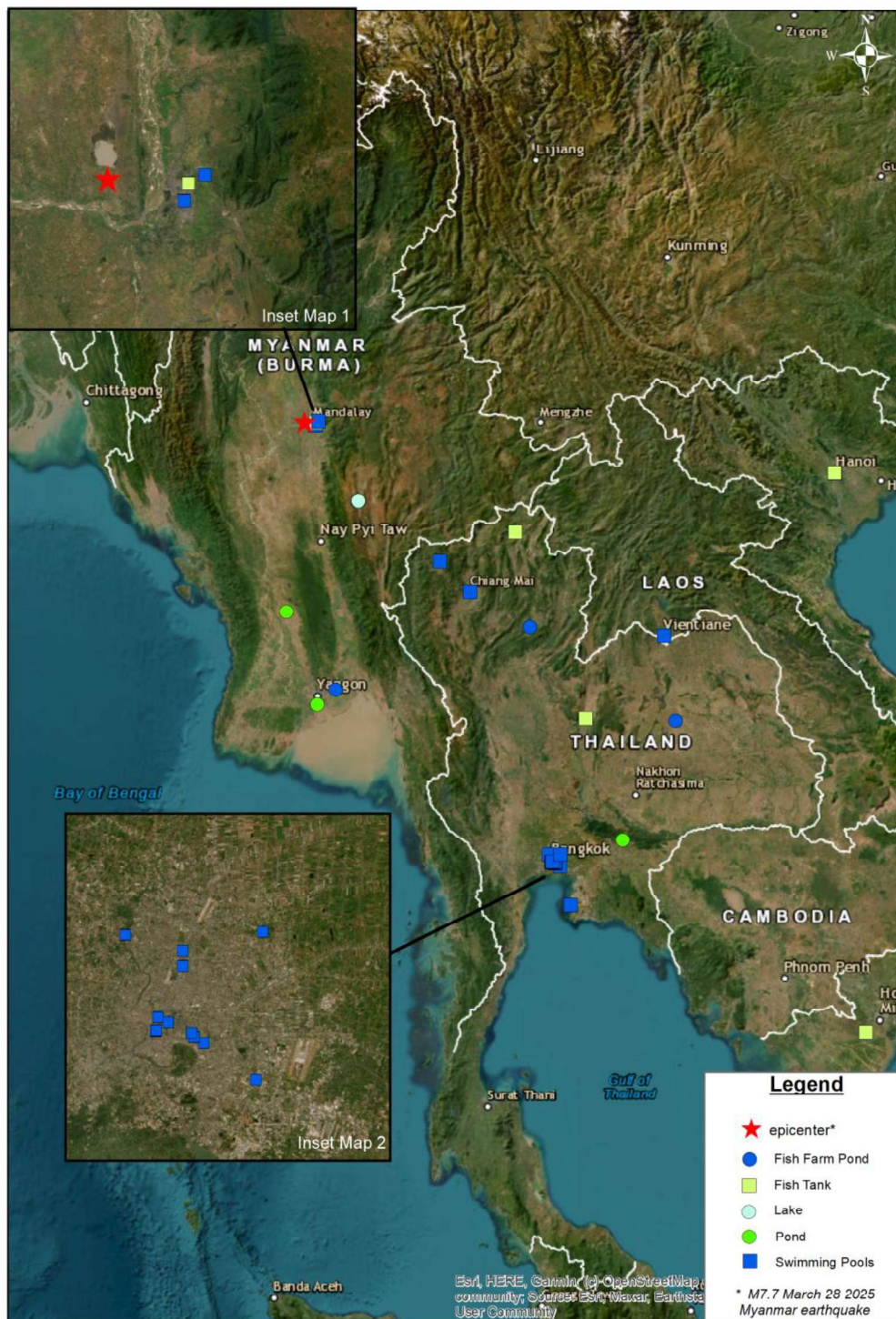


Figure 4. Geographic distribution of observations by type of body of water. Inset maps (from top to bottom) show clusters of observations nearby the epicenter in Mandalay, Myanmar; in Yangon, Myanmar; and in Bangkok, Thailand.

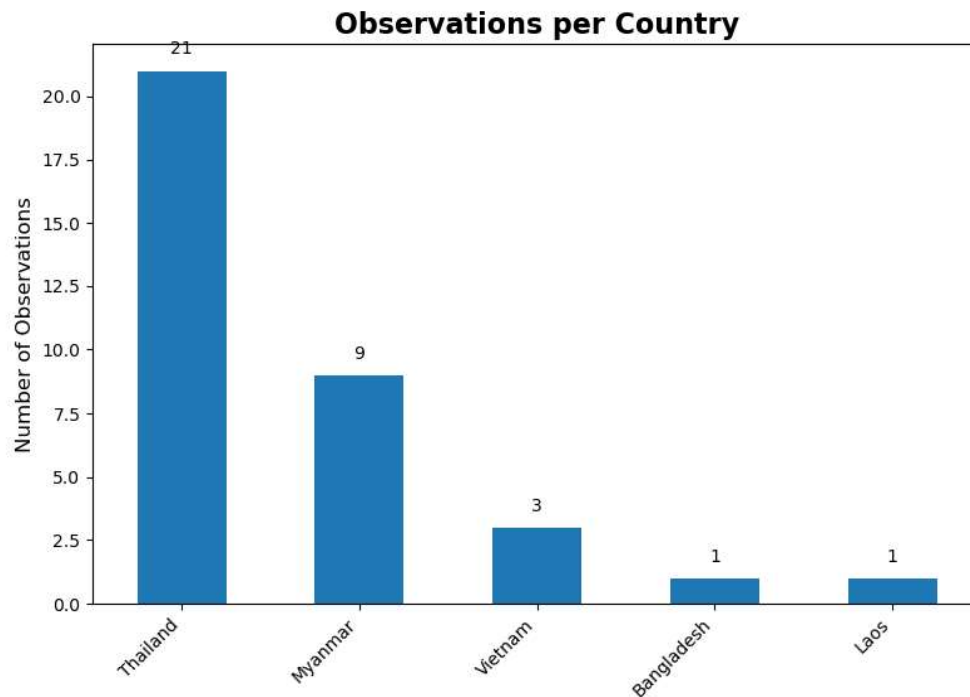


Figure 5. Unique observations grouped by country.

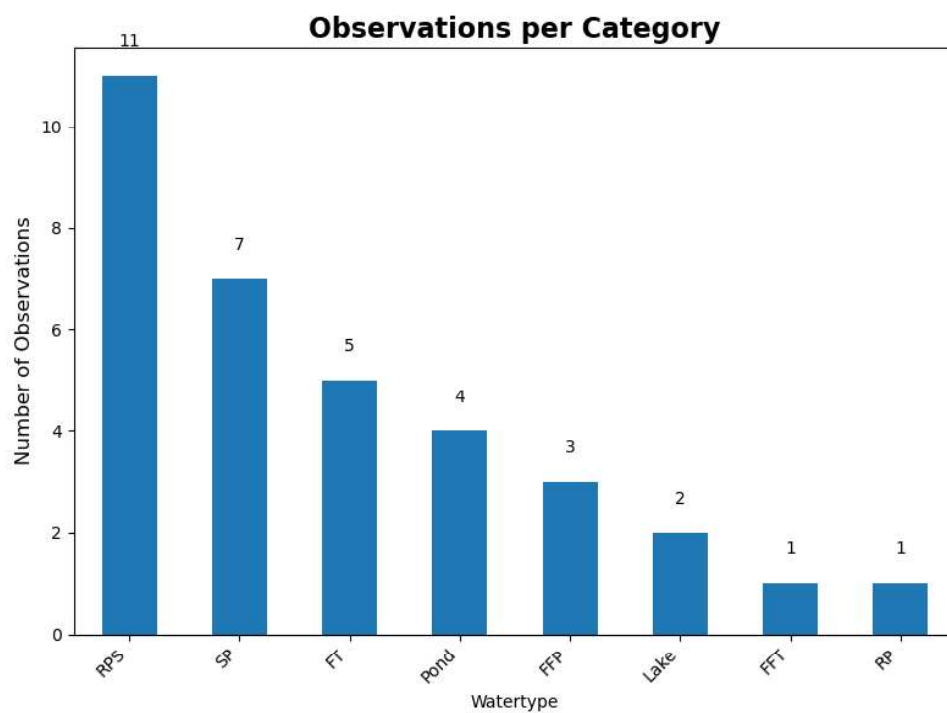


Figure 6. Eight categories were used to group observations from similar settings. Abbreviated names correspond to, Rooftop Pools on Skyscrapers (RPS), Rooftop Pools (RP) for rooftop pools on other buildings, Swimming Pools (SP) for other pools such as residential pools on the ground, Fish Tanks (FT) and Fish Farm Ponds (FFP) and Fish Farm Tanks (FFT).

5. Discussion and Conclusions

On March 28, 2025 a M7.7 struck Mandalay city in Myanmar. The impact of the earthquake was quite severe with at least 3,700 deaths, many collapsed buildings and damaged infrastructure. Due to censorship the number of fatalities and destructed buildings may be larger. The earthquake impacted also neighboring countries such as Thailand in locations as far as 1000km. One of the “identifying” seismic effects of this earthquake was the spilled water over skysrise buildings which was a result of sloshing initiated in rooftop pools as a result of earthquake ground motions. This phenomenon also known as seismic seiching was the focus of our paper. Specifically, a total of 39 (35 unique) water observations with locations confidently identified were collected from various countries that are associated with the March 28, Myanmar earthquake. The unique video collection associated with the observations listed in this article from various water basins (fish tanks to lakes), resembled an experiment of water wave generation in different settings under seismic shaking.

Although the epicenter was in Myanmar, most of the observations were from Thailand likely a result of bias. More specifically, Bangkok's surface geology renders it particularly sensitive to ground movement (e.g., Ornthammarath et al., 2023). This sensitivity, alongside the city's abundance of high-rise buildings, rooftop pools, and security cameras, provides a logical explanation for why a majority of our observations originate from Bangkok despite the epicenter being in Myanmar. More importantly, this study is in line with previous findings that large sedimentary basins exert a strong control on the location where these observations occur (McGarr, 1965; McGarr and Vorhis, 1968; Barberopoulou et al., 2004, 2006).

This paper's primary aim was the systematic documentation and preservation of this unique dataset, alongside some basic analysis of the findings. While a full, comprehensive analysis is planned for a future study, the fundamental question we seek to address is whether the collected observations, through this meticulous documentation, can yield new insights that advance our understanding of seismic seiche waves.

6. References

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