中山大學
SUN YAT-SEN UNIVERSITY

Tsunami Hazard Assessment for Shantou University with Disaster Prevention Strategies Informed

Date：Dec 22, 2025

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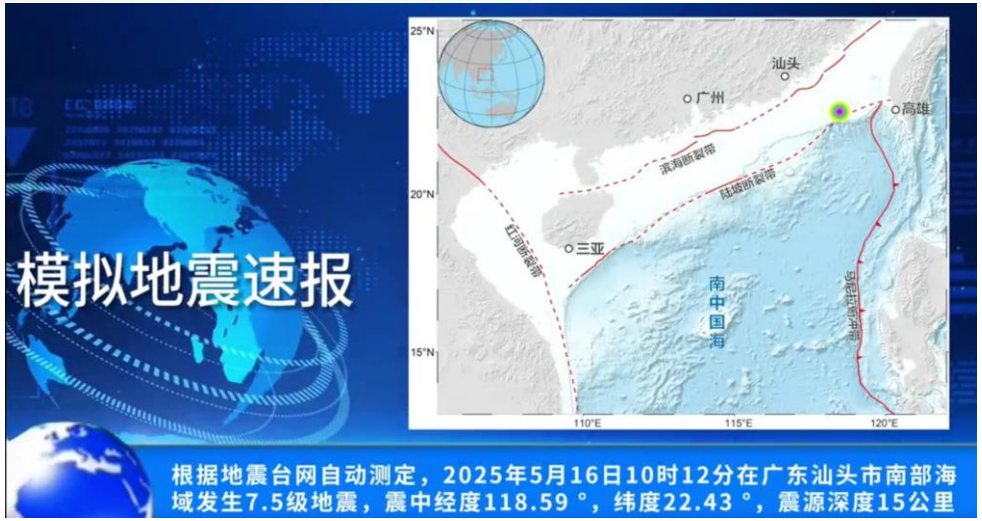
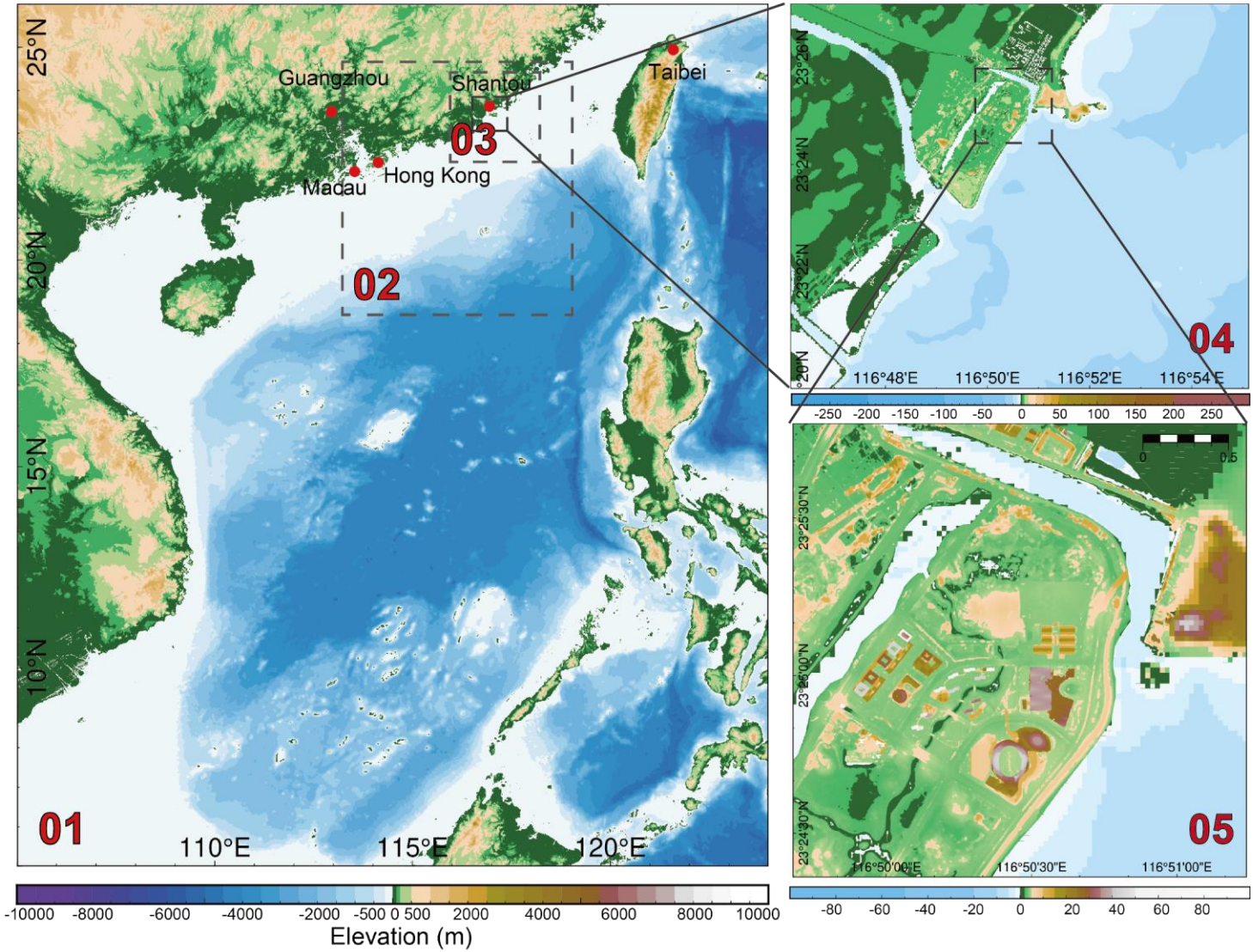
Specific Study area (Shantou University)

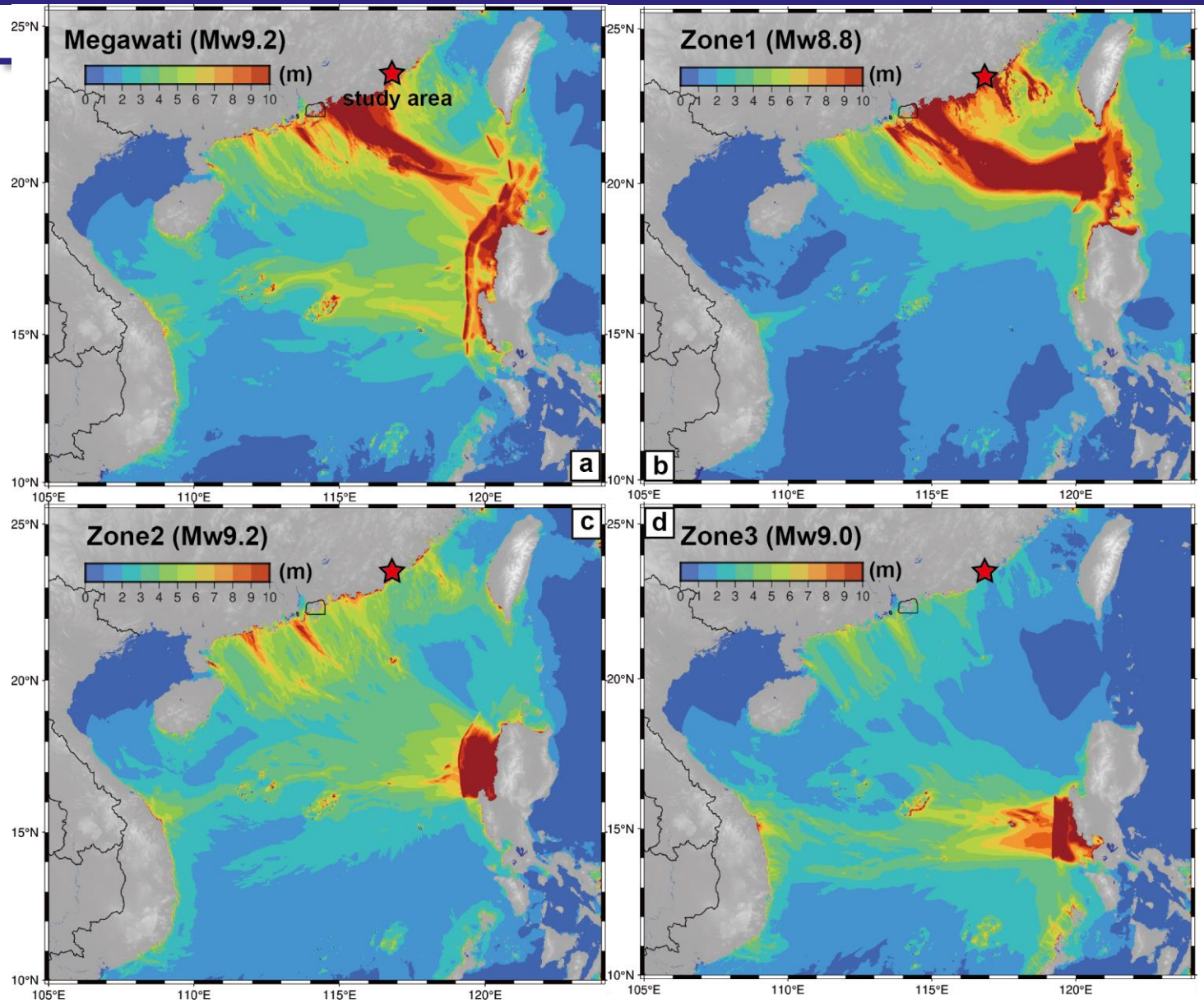


Live Evacuation View



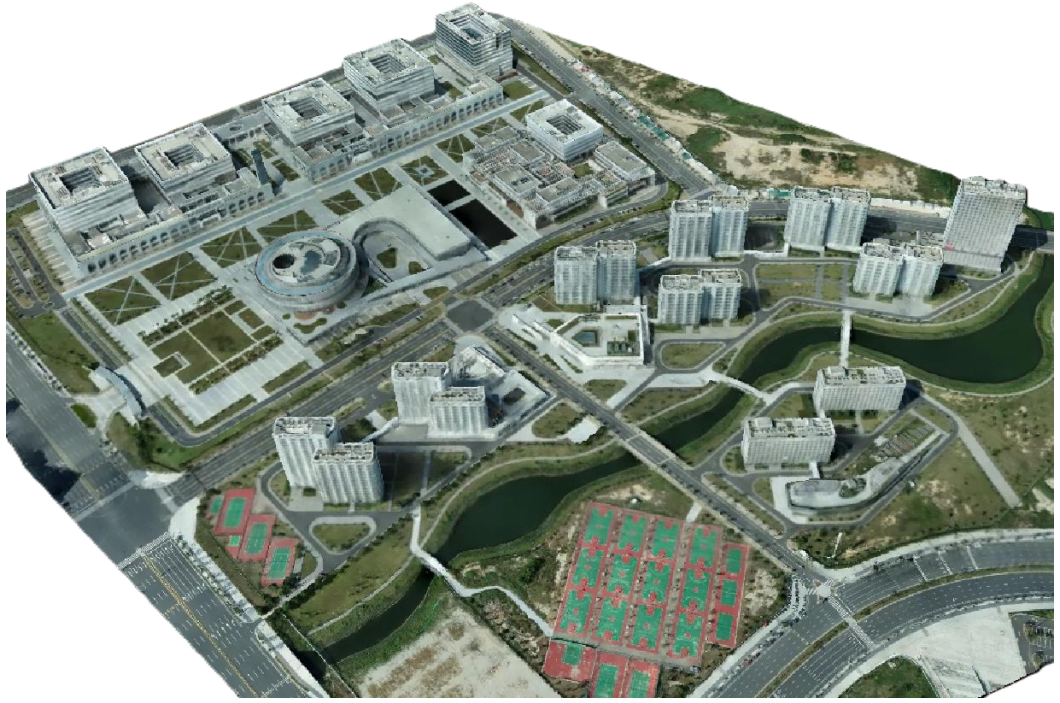
Shantou University Location and DEM

Tsunami source and Data Acquisition



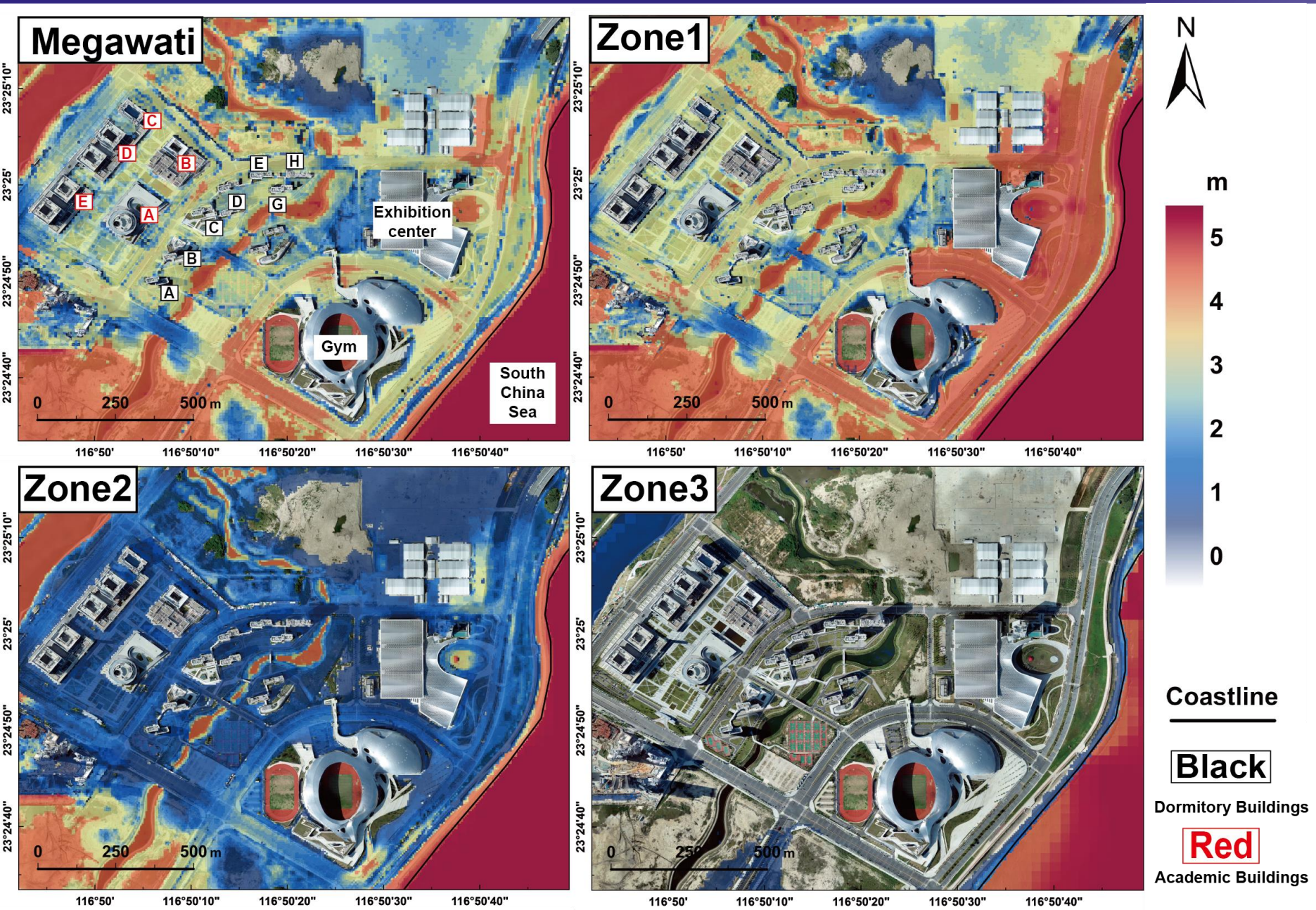
Maximum Wave Height for the Four Manila Trench Scenarios

Data Acquisition



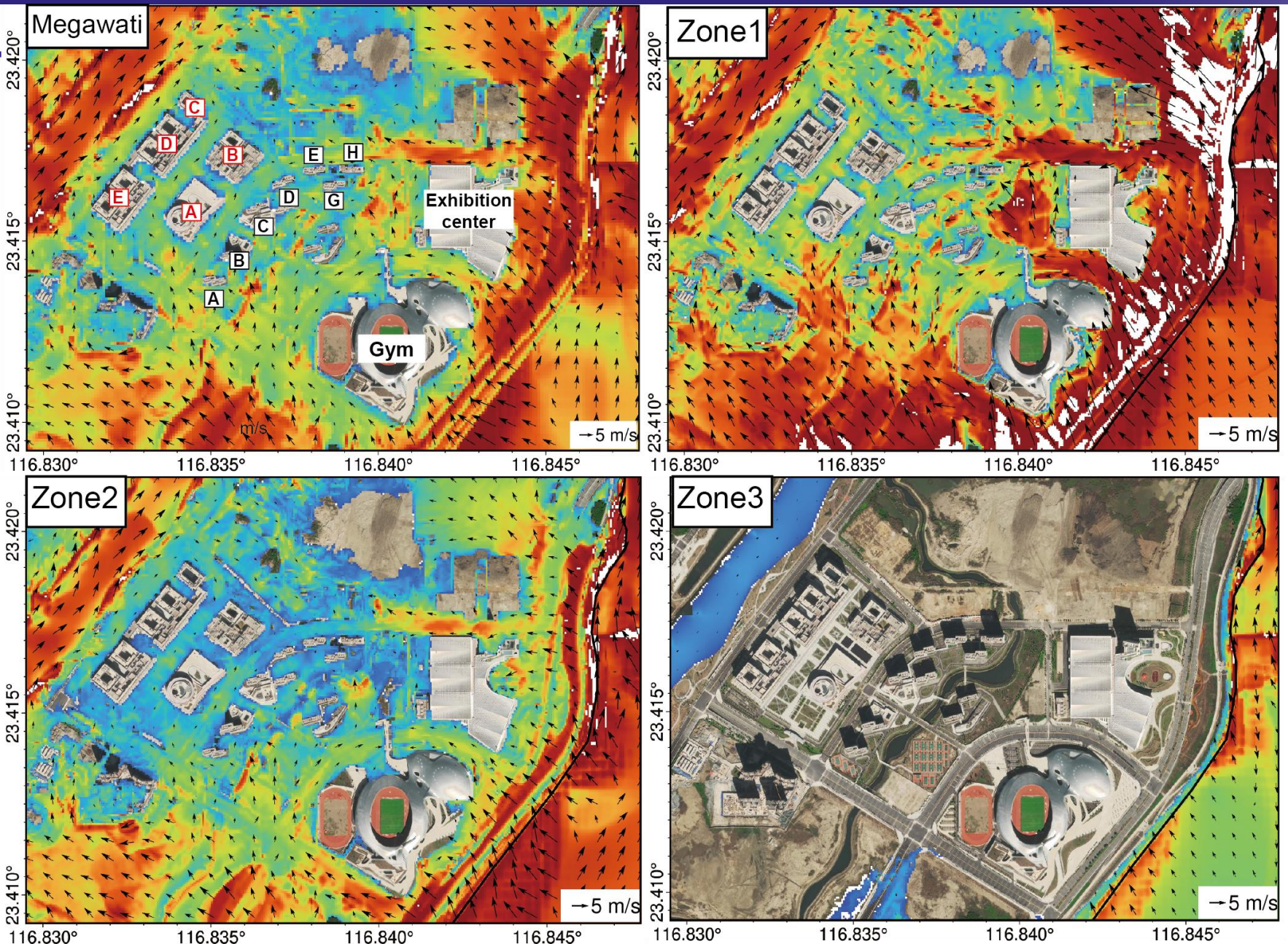
3D Model of Shantou University

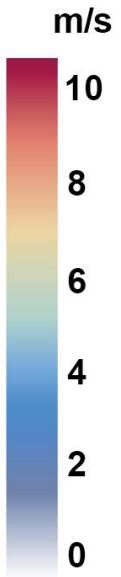
Maximum Inundation Depth



- The **northern segment of the Manila subduction zone(zone1)** leads to the deepest flooding.
- **Overall, the tsunami wave height at the coastline ranges between 10~15 meters, leading to an inland inundation depth of 1~4 meters within the study area.**

Maximum Flow velocity and Direction





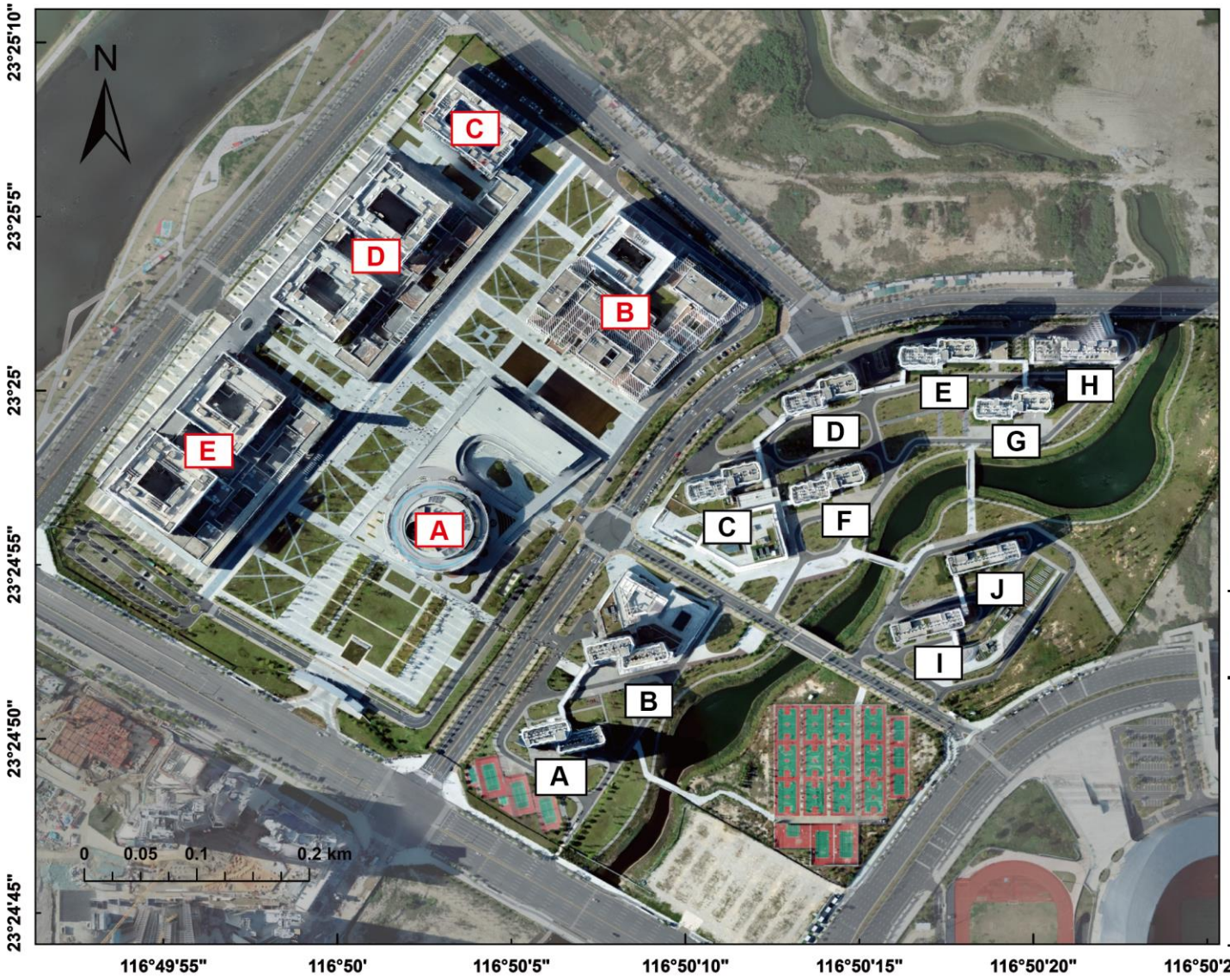
- Overall, the maximum flow velocity of the tsunami as it reaches the coastline exceeds **10 m/s**, while the maximum flow velocity across the entire campus ranges between **1–4 m/s.**
- The overall flow was observed to be in a **north-northwesterly direction.**

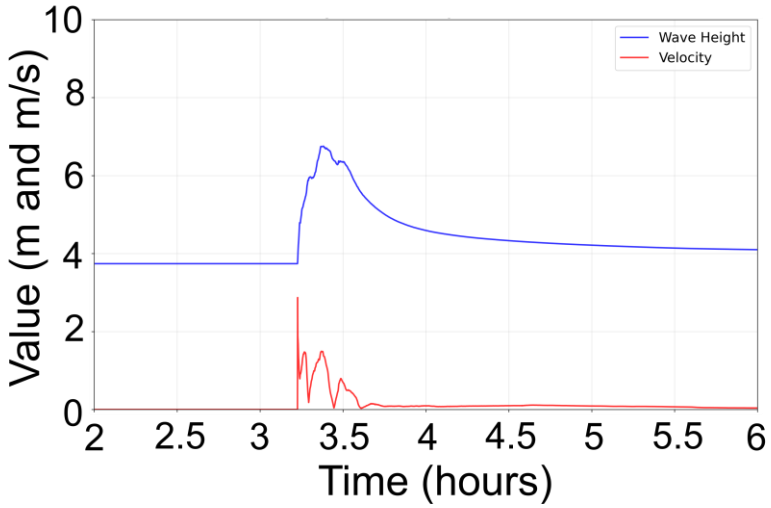
Coastline

Black
Dormitory Buildings

Red
Academic Buildings

Hydrodynamic Force





$$F_d = \frac{1}{2}\rho C_d B (hu^2)_{\max}$$ (FEMA, 2012)

	Megawati	Zone1	Zone2
Dorm Building **A**	424	66	25
Dorm Building **C**	150	79	3
Acad Building **A**	366	108	18
Acad Building **E**	377	95	27

Unit: KN

Digital Orthophoto Map and Critical Facility Numbering

Black Labels: Dormitory Buildings; **Red Labels**: Academic Buildings

Key points:

- This study presents one of the first few studies to assess tsunami risk to high-rise buildings. Tsunami risk assessment from the **Manila Trench** was performed for the **Shantou University** campus (China) using high-resolution DEM data **(5 m)** which leverages topographic and building data acquired via UAVs.

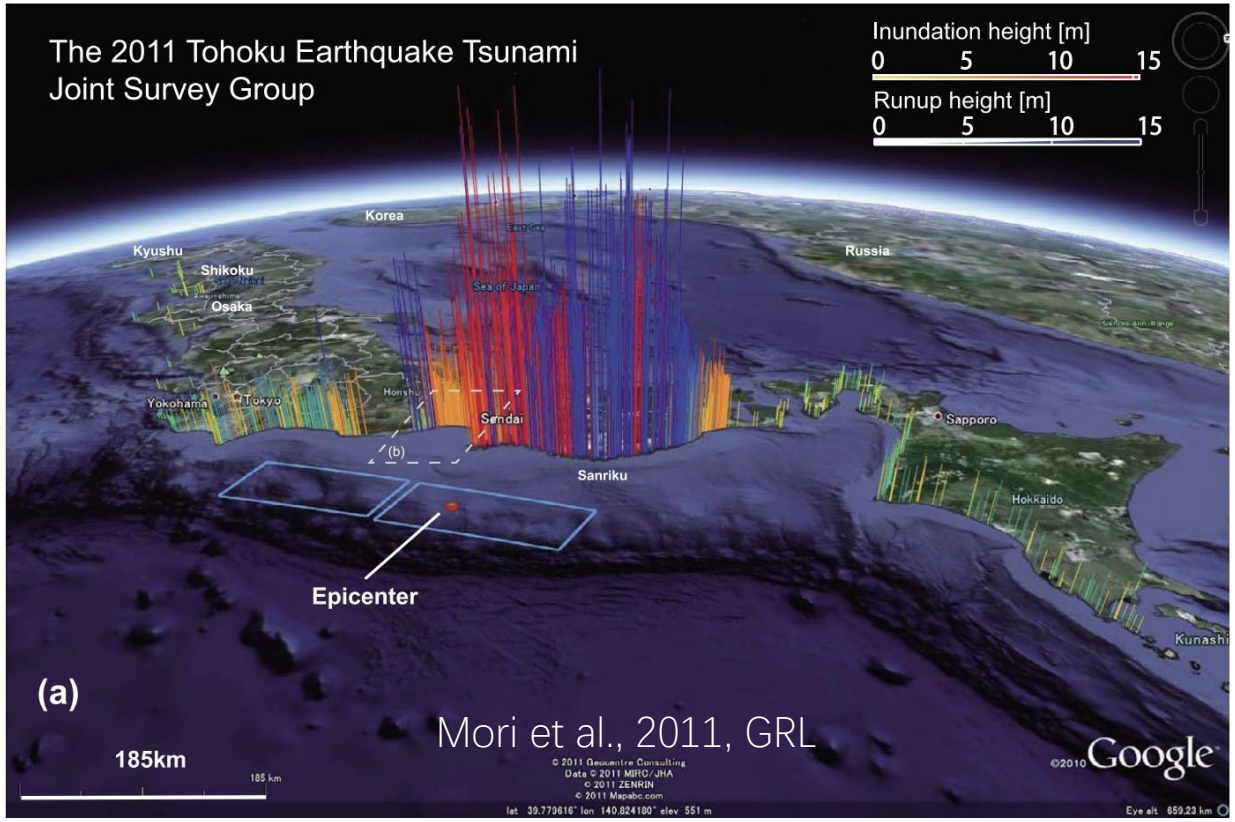
- Unlike previous studies which use hydrodynamic force derived from maximum inundation depth and maximum flow velocity, this study uses non-equivalent hydrodynamic force. Maximum force in the Shantou University campus was found to be 424 KN **(Dormitory Building A).**

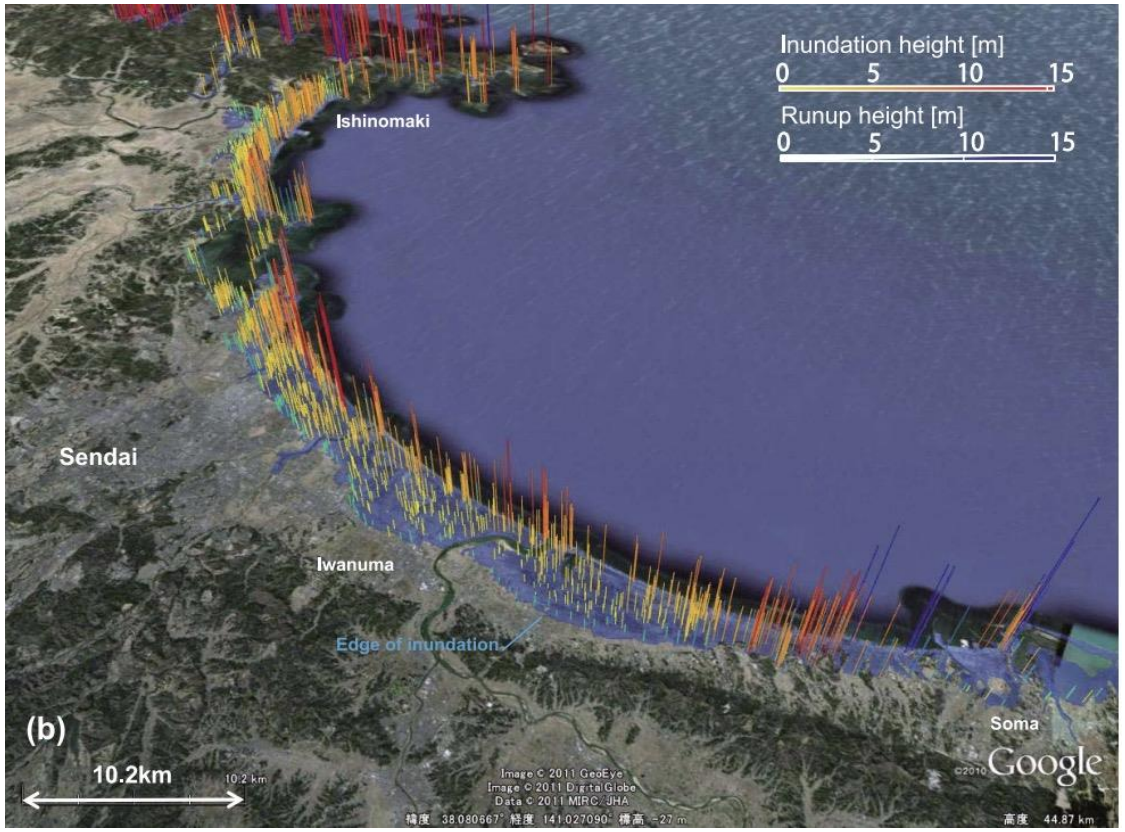
- **Several buildings were also identified to be unsafe from tsunami impacts, which informs the design of evacuation plans for the Shantou University Campus.**

2011Mw9.0 Japan Tohoku Tsunami: Impact on Japan

- 297 researchers from 63 universities. and institutions in Japan participated.
- 2000 km of coastline.
- 5300 Measurements.

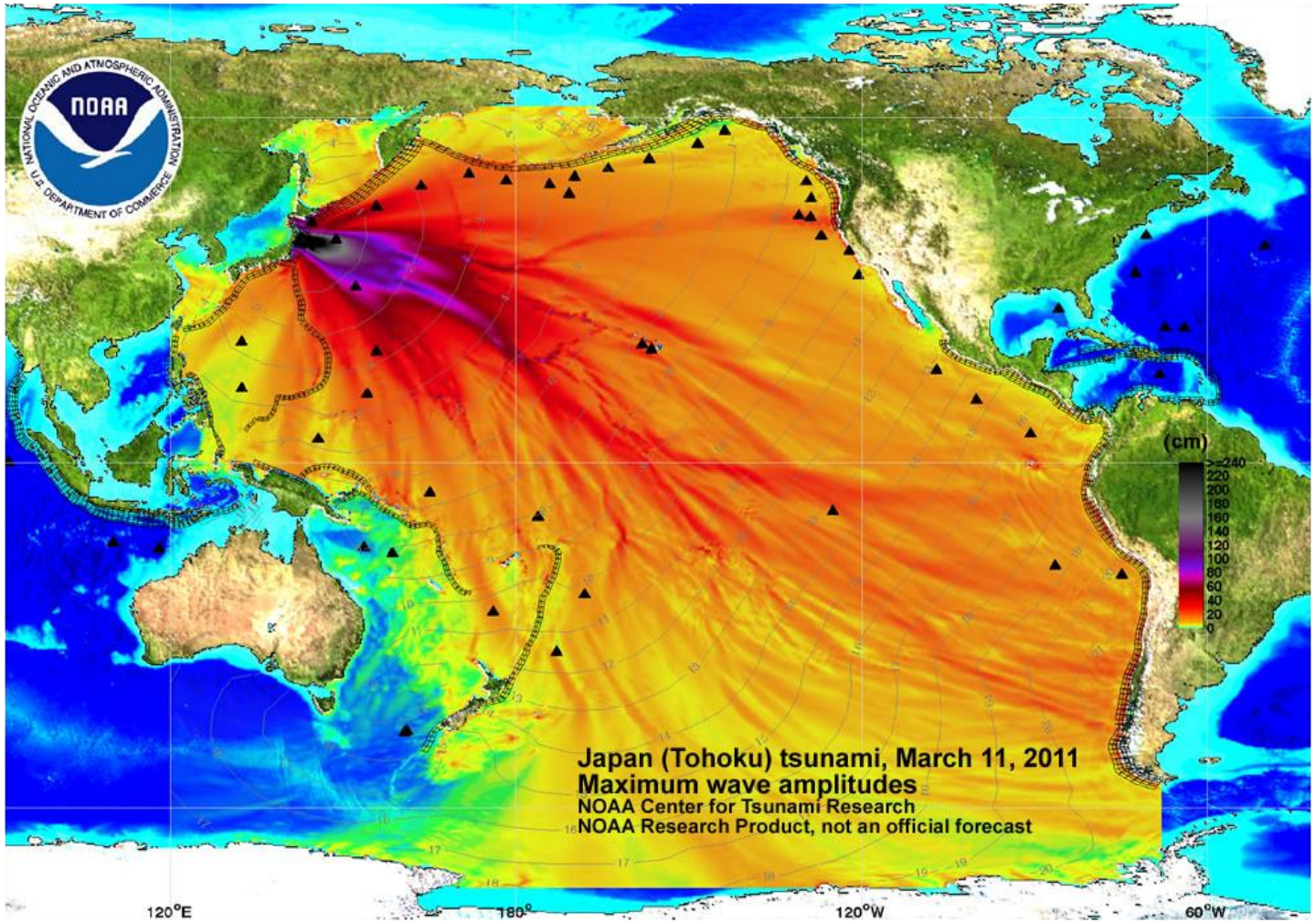
- Maximum tsunami wave height: **39.7m.**
- **290 km** of coastline had a maximum run-up height **over 20m.**
- Maximum inundation distance on the Sendai Plain: **5 km.**





2011Mw9.0 Japan Tohoku Tsunami: Global Impact

Economic Loss： Approximately USD 235 billion



Near-field Impact:

Damaged 28612 ships,319 pier and 1725 port facilities.

Direct economic losses: USD 12 billion.

Far-field Impact:

Tsunami-induced strong currents caused about USD 90 million in damages along the U.S. West Coast.

Lynett et al., 2012, EPSL

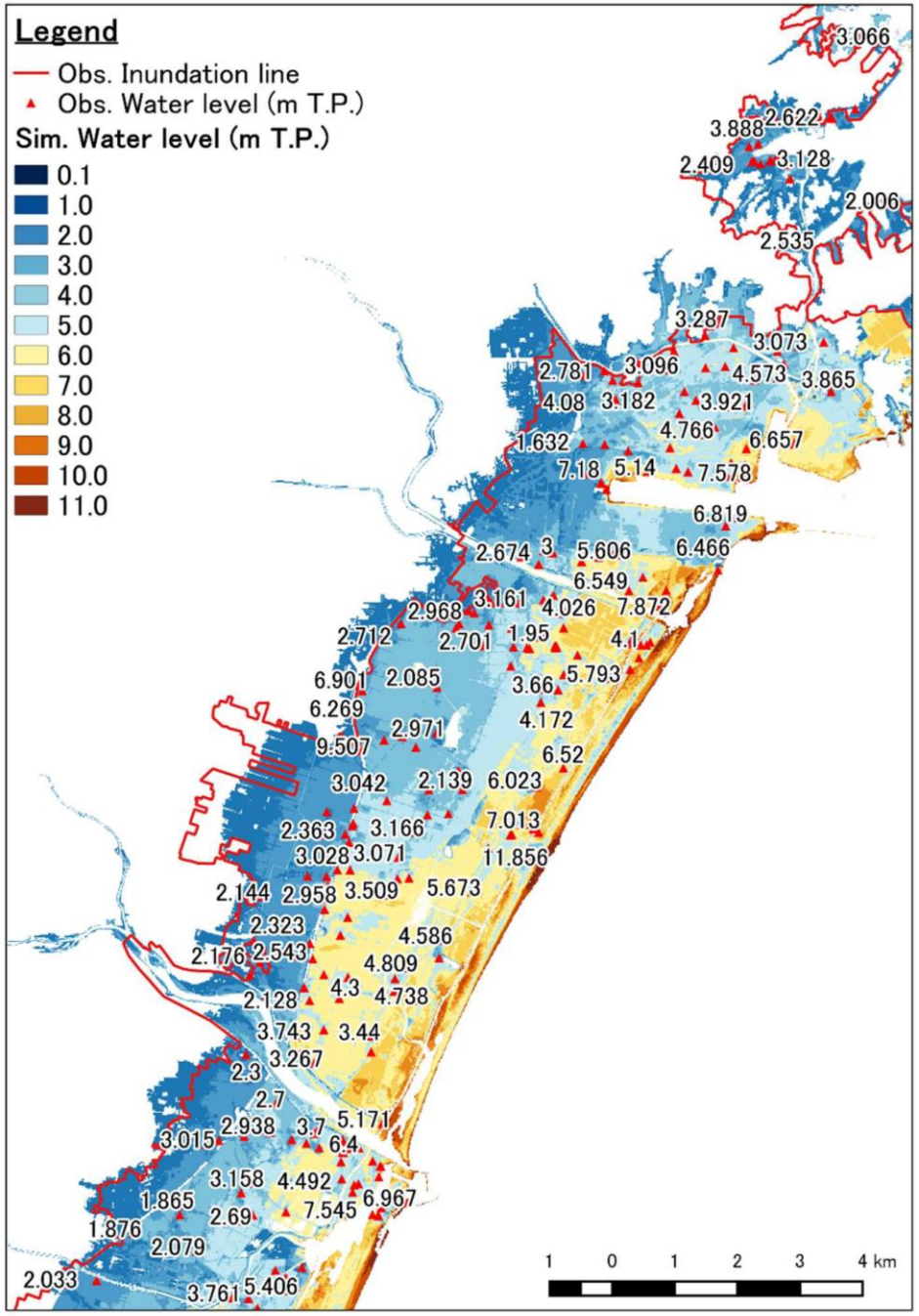
Tsunami Disaster Prevention and Mitigation Practices in Sendai City

Remembrance & Warning—Case Studies

- Arahama Elementary School, Sendai
- Nakahama Elementary School, Sendai

Protection and Evacuation—Response Measures

- Line: Seawalls, canals, elevated roads
- Point: Evacuation facilities, “Millennium Hope Hills



Remembrance & Warning

Ruins of the Great East Japan Earthquake: Sendai Arahama Elementary School

Before the Tsunami

After the Tsunami

仙台市
若林区荒浜

海と貞山堀、水田の恵みを受け、半農半漁の営みも多い荒浜。深沼海水浴場は仙台市民のオアシスだ。津波で全域が浸水し、海岸線から約700メートルにある荒浜小は、4階建ての建物が2階まで水没したものの津波に耐え、上層階に避難した児童や住民約320人の命を守った。震災半年後、周辺の緑は少しずつ回復しつつある。

2011年4月17日

Remembrance & Warning

Ruins of the Great East Japan Earthquake: Sendai Arahama Elementary School

During the Great East Japan Earthquake on March 11, 2011, the tsunami surged to the second floor of Arahama Elementary School. **The building served as an evacuation shelter for 320 residents, students, and school staff.**

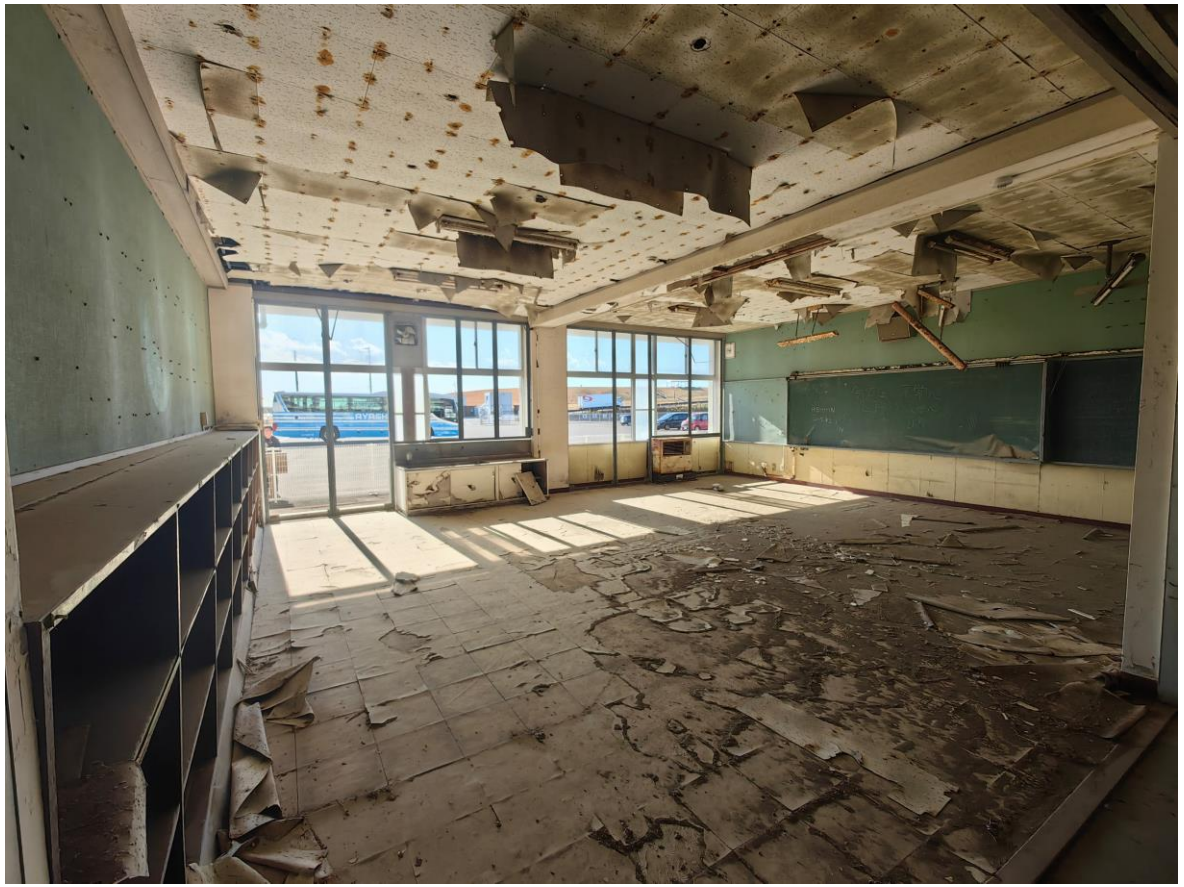
海啸淹没高度记录牌

The stationary clock in the gym

Remembrance & Warning

School Site, First Floor

Damaged Ceiling



Damaged Classroom

Tsunami Deposits

Remembrance & Warning

School Site, Second Floor

Tsunami Inundation Marks

Tsunami Splash Marks

Cabinet with Tsunami Marks

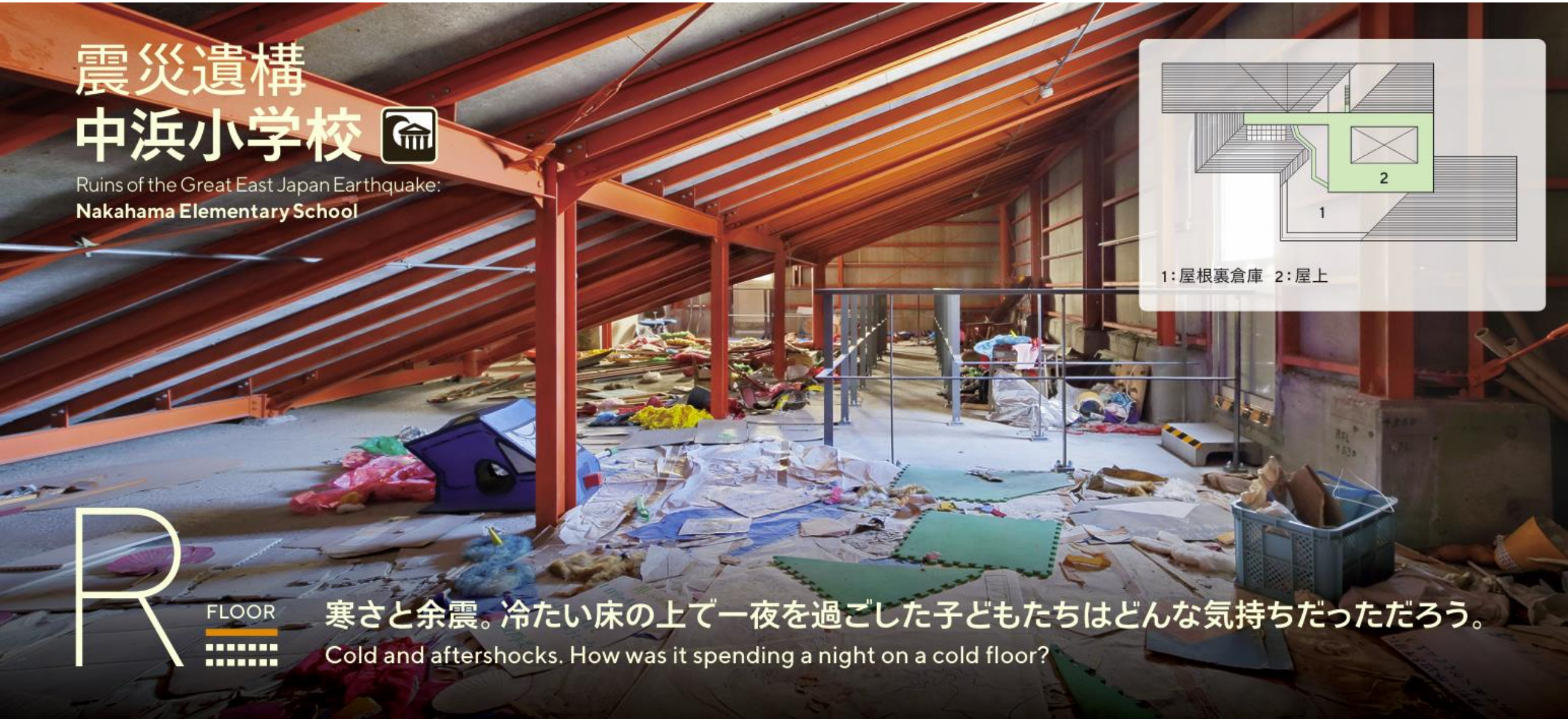
Collapsed Wall, Second Floor

Remembrance & Warning

Ruins of the Great East Japan Earthquake: Nakahama Elementary School

Because they had prepared for tsunamis in advance, 90 children and local residents survived the 2011 Great East Japan Earthquake.

Remembrance & Warning



Due to the first and second floors being flooded, all children, teachers, and local residents crowded into the top-floor storage room and spent a cold night there.

Remembrance & Warning

School Site, First Floor

Destroyed Windows

Damaged Floor

Walls with Rust

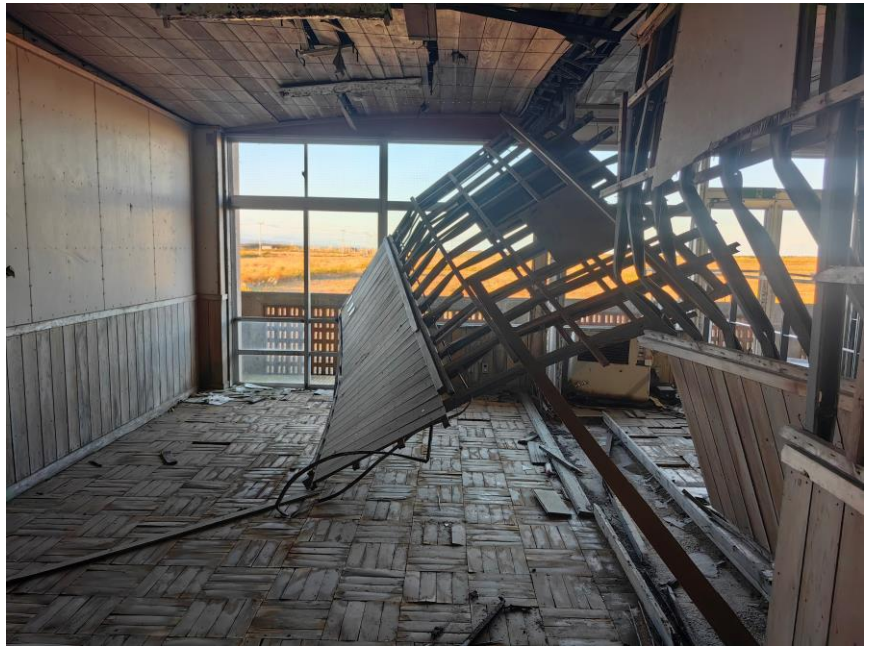
Damaged Ceiling

Remembrance & Warning

School Site, Second Floor

Destroyed Windows

Damaged wall



Damaged partition

Tsunami Deposits

Remembrance & Warning

Residential Area, Arahama District

Washed-away Houses

Foundation Debris

Foundation Debris

Manhole lifted by buoyant force

Multiple lines of defense for comprehensive tsunami protection

Multiple lines of defense

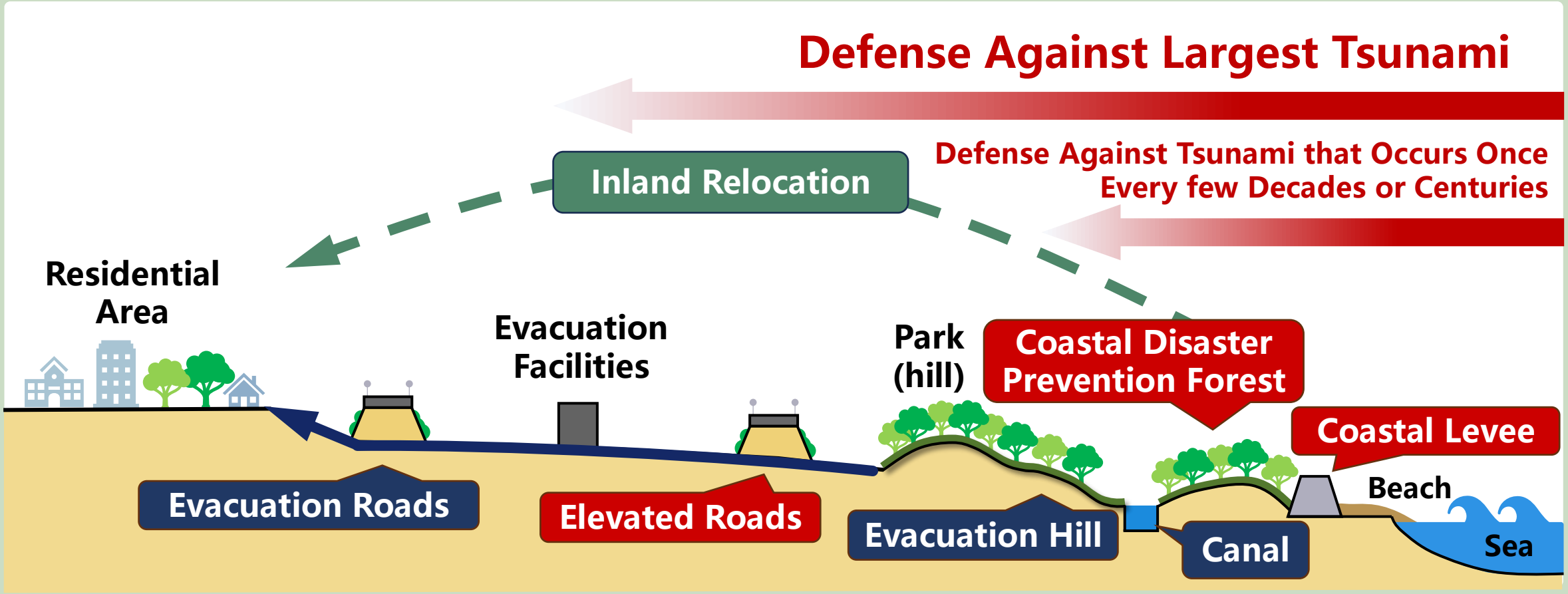
Coastal Levees, Disaster Prevention Forests, and Elevated Roads

Evacuation

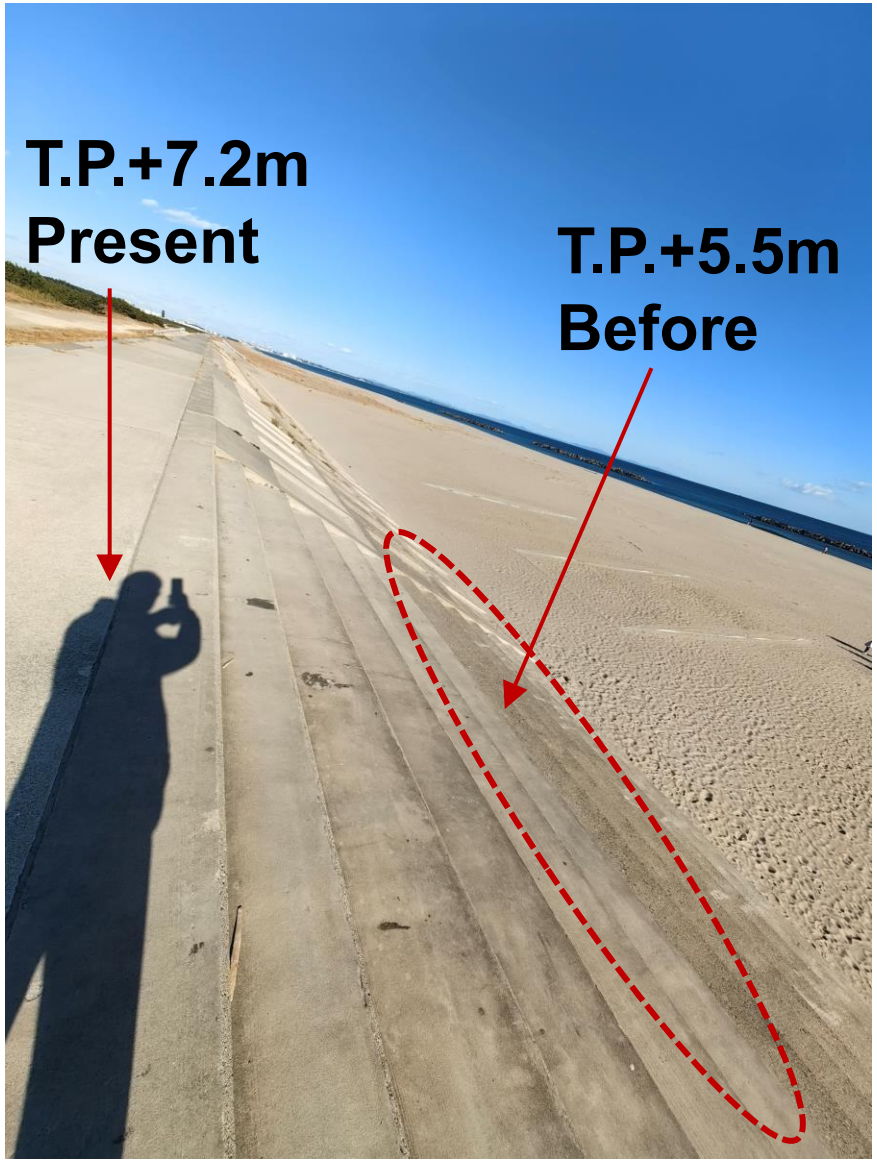
Evacuation Roads and Facilities Construction

Relocation

Collective Relocation to Safer Inland Areas

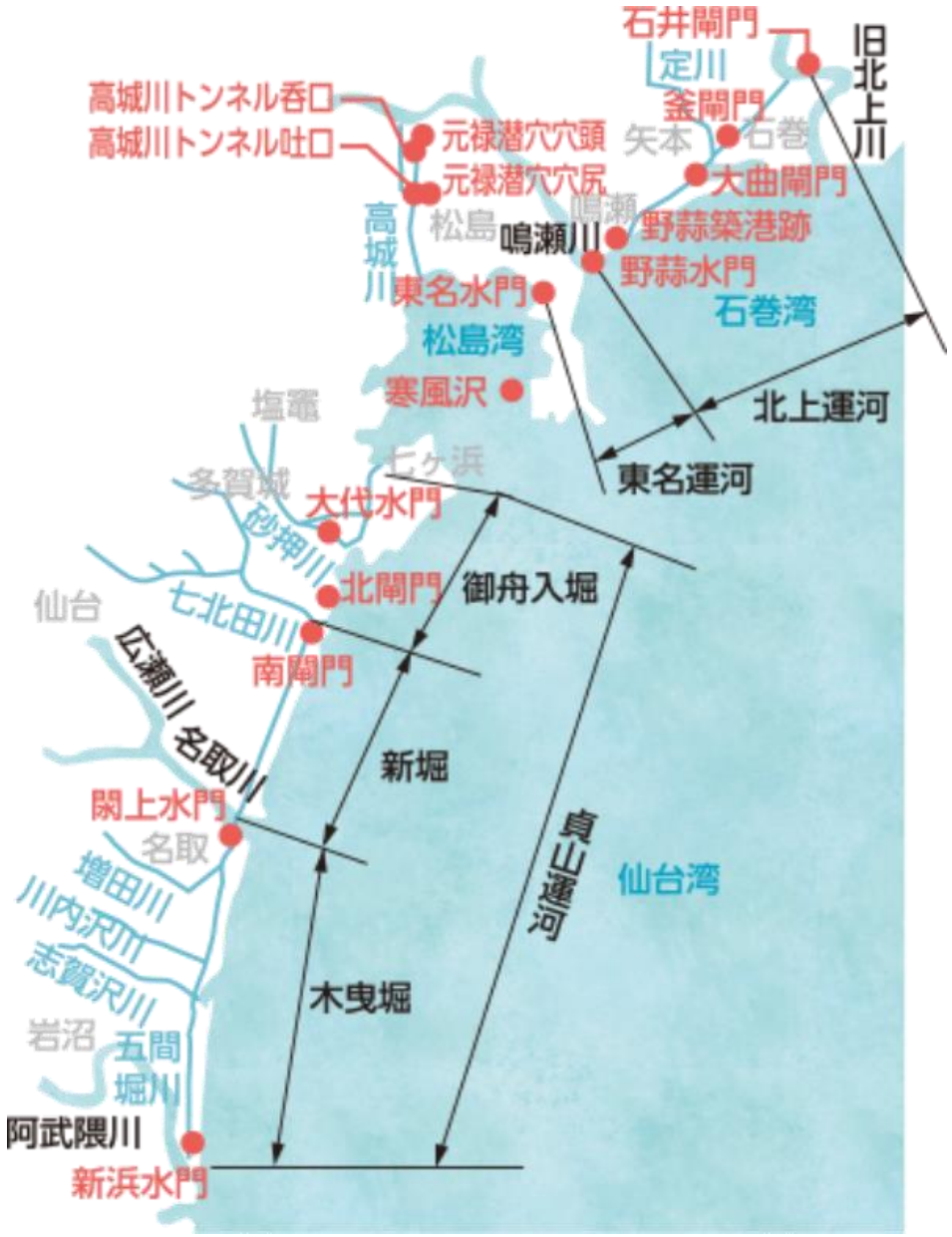


Linear Infrastructure Project I： Coastal Levee



https://sendai-resilience.jp/efforts/government/development/coastal_embankment.html

Linear Infrastructure Project II： Canal



贞山运河对海啸产生了有效的减灾效果：

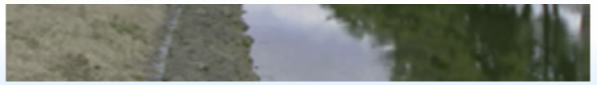
- **流速衰减、延迟效应、汇流导流。**

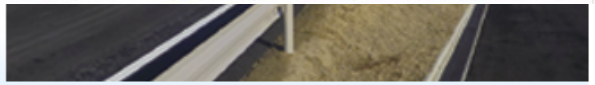
Figure 1 Tsunami propagation through Kita-Teizan Canal on March 11th, 2011

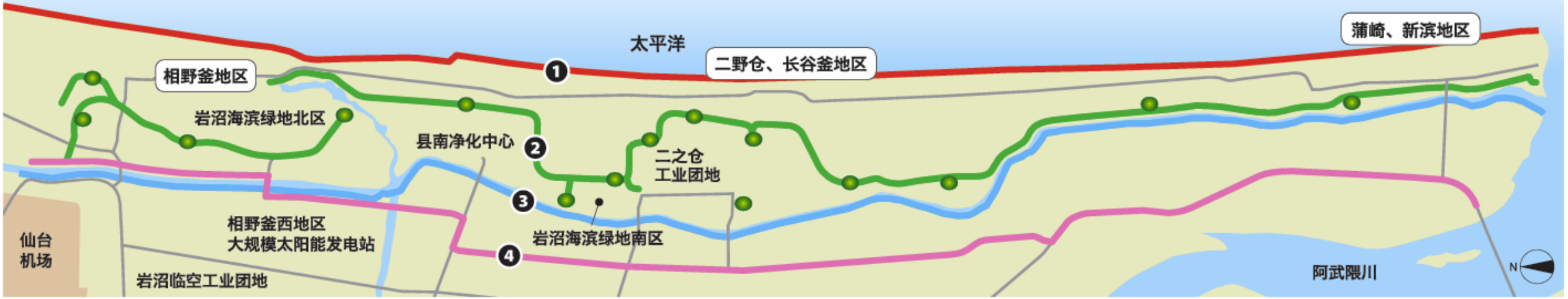
Linear Infrastructure Project III： The elevated road

❶防波堤　❷千年希望之丘、园路　千年希望之丘

❸贞山河护岸　❹加高的公路

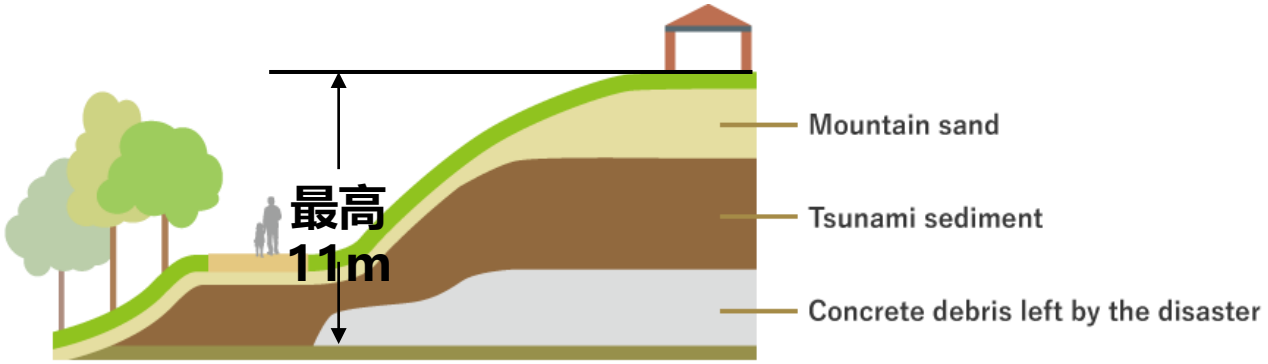

③贞山河护岸


④加高的公路



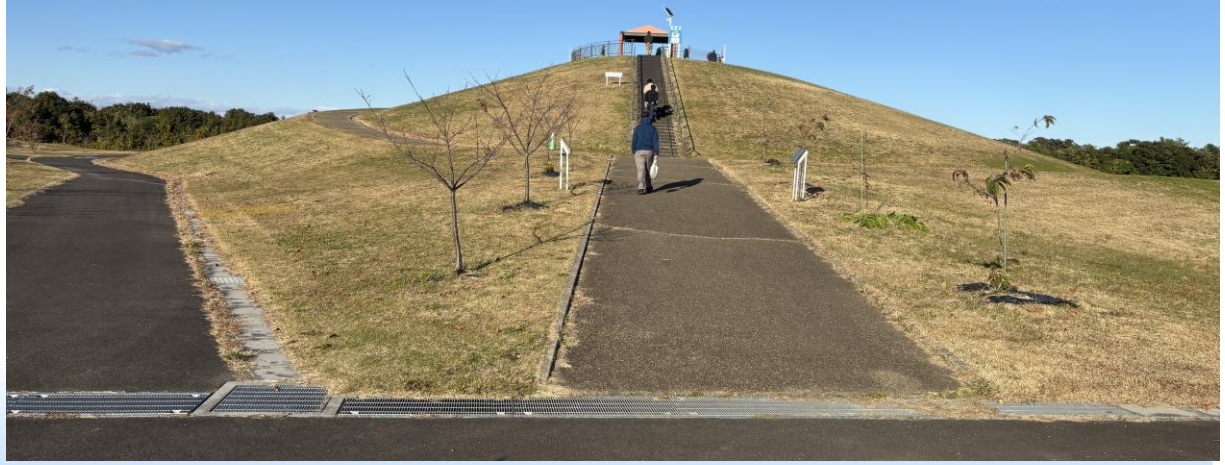
Point Infrastructure Project I

Millennium Hope Hills and Park Pathways



Built using debris from the Great East Japan Earthquake and tsunami, these hills reach a maximum height of 11 meters.

A total of 15 such hills have been constructed along a 10-kilometer stretch of the coastline



https://sennen-kibouno-oka.com/english/eng-activities/

Point Infrastructure Project II
Tsunami Evacuation Facilities

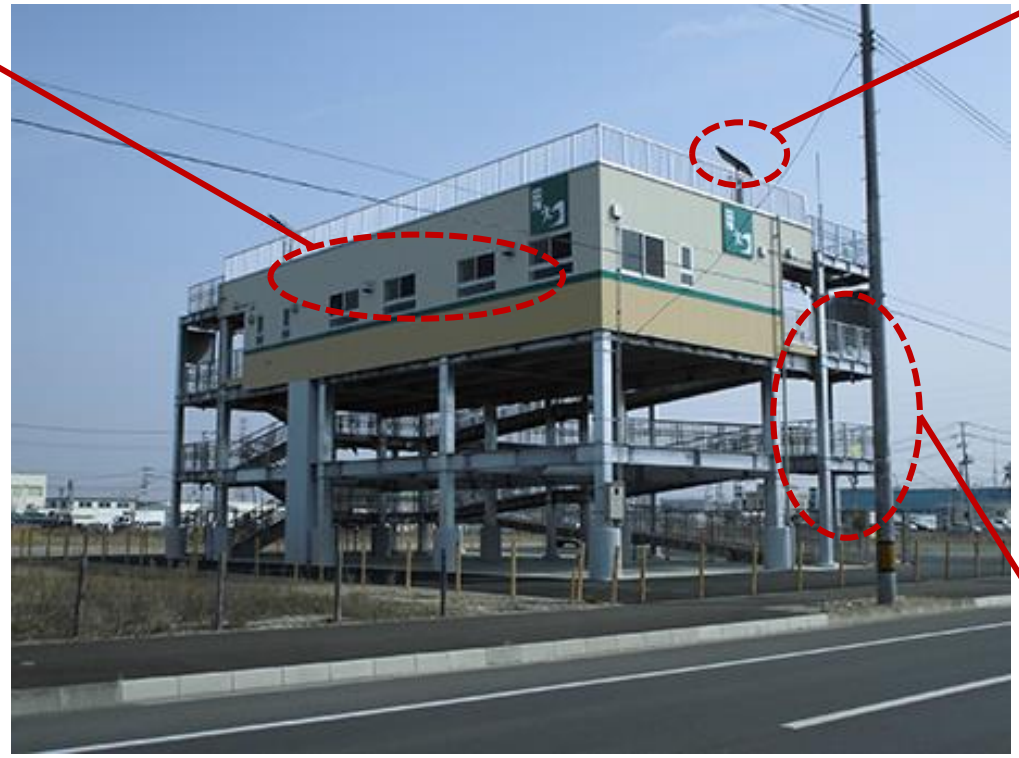
Nakano 5-chome Tsunami Evacuation Tower

Outside Evacuation Stairs

Tsunami Evacuation Tower

The enclosed refuge floor provides protection from cold.

- **Double-layer steel frame structure**
- **Refuge floor is 6.5m above ground**
- **The evacuation platform is 10m above ground**
- **The structure utilizes foundation piles over 20 meters long**



Located in Nakano 5-chome

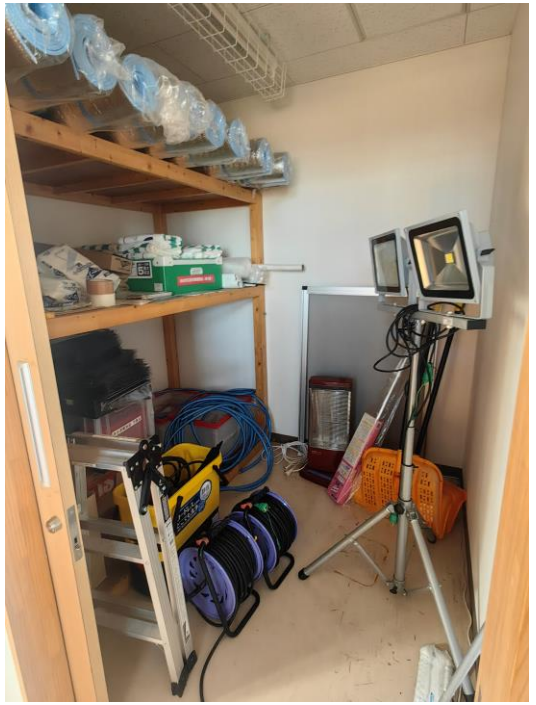
This evacuation tower is a sturdy structure designed to withstand tsunami waves and impacts from floating debris.
It can evacuate up to 300 people to a height of at least 6 meters above ground level

Solar panels on the roof power emergency lighting.

Its ramp is designed to enable safe evacuation for wheelchairs and strollers.

Emergency Supplies for Evacuation Personnel

- **Life Support:** Food, Water, Blankets
- **Medical & Communication: First Aid Kits, Two-Way Radios**
- **Power & Lighting:** Generator, Floodlight
- **Logistics Equipment:** Gas Stove, Temporary Toilet, Ropes
- **Life-Saving Gear:** Life Jackets, Lifebuoys



Inoue: **"Preparation for disasters is not a preparation if it's done after they occur.** We don't know if a big earthquake might happen in a minute from now, even today."

宫城中浜小学校长：“**防灾准备若在灾害发生后才进行，便不能称之为准备**。我们不知道大地震是否会发生在下一分钟，甚至有可能就在今天。"

It is better to be a thousand days without disaster than one day without prevention.

宁可千日无灾，不可一日不防

Research:

- **High-resolution Urban Flood Simulation**
- **Disaster Risk Reduction for Coastal Critical Infrastructure**

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张意林

吉林 长春

扫一扫上面的二维码图案，加我为朋友。