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UNESCO/IOC – NOAA ITIC Training Program in Hawaii (ITP-Hawaii)  
TSUNAMI EARLY WARNING SYSTEMS  
AND THE PACIFIC TSUNAMI WARNING CENTER (PTWC) ENHANCED PRODUCTS  
TSUNAMI EVACUATION PLANNING AND UNESCO IOC TSUNAMI READY PROGRAMME  
7-18 August 2023, Honolulu, Hawaii USA

## 5.2 TER Overview:

What do TER agencies provide to the public? Challenges in Alerting, Evac, Safe-to-Return and Preparedness

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Carolina Hincapie-Cardenas

Oceanographer

UNESCO/IOC – NOAA International Tsunami Information Center



# Tsunami Emergency Response (TER)

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- **TER: Race Against Time!**
- **Goal: Save lives.  
Reduce property damage.**
- **Must: Act FAST without confusion.**
- **Notes:**
  - Tsunamis may (or may not) cause damage.  
May be “*Destructive*” or “*Non-Destructive*”
  - *Non-destructive tsunamis are small,  
but measurable on sea level gauges.*

# TER Expectations

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## Key Question:

Has a destructive tsunami been generated?  
Yes or No?

Tsunami Decision-Making Environment:

TER want “black & white => Yes or No answer”



TWC operate in “shades of grey color”



# Tsunami Warning Center (TWC)

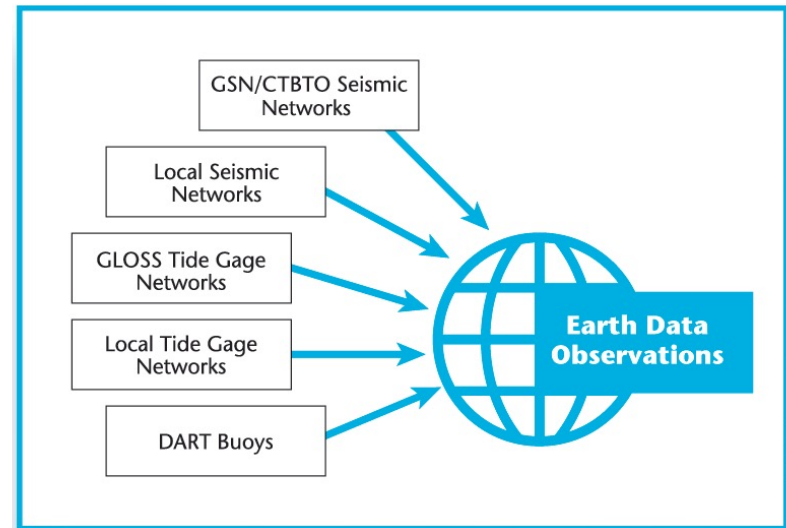
TWC: “eyes and ears” are earthquake and tsunami **detection instruments**.

Limitations include:

- Lack of timely data.
- Lack of time to analyze data before wave impact.

*Result =>*

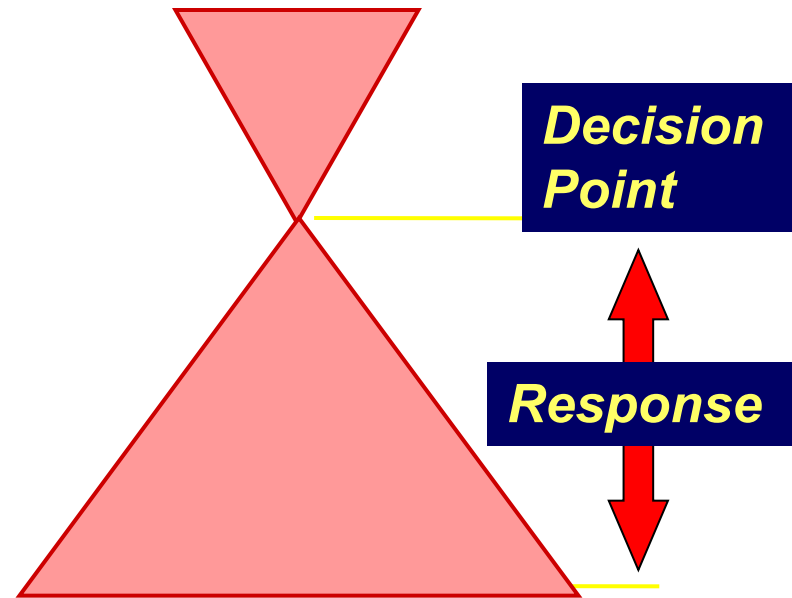
TWC may not be able to confirm existence of local destructive tsunami prior to official TER evacuation decision making.



# TWC provide – Local Tsunami

- Preliminary analysis: There is “**potential**” of a destructive tsunami.
- At time of official evacuation decision making:
  - Likely **NO confirmation** of intensity of tsunami waves.
  - Local Warning issued **based only on seismic data.**

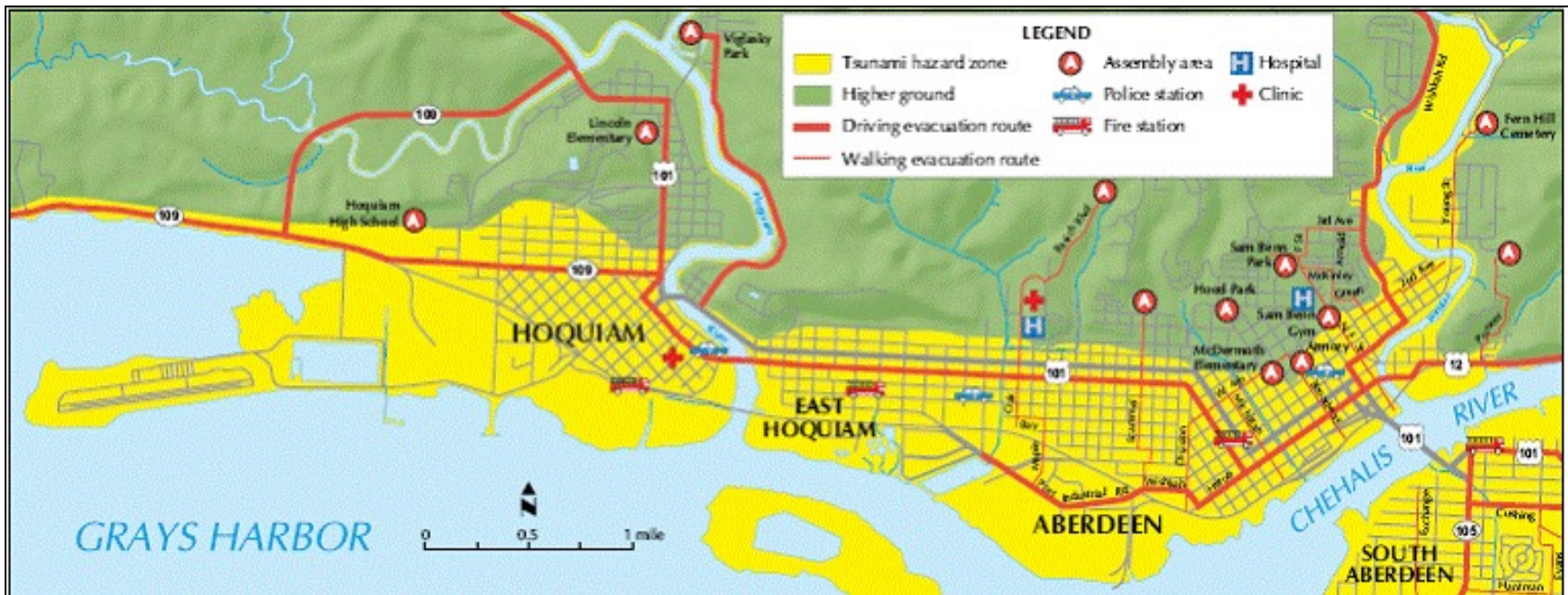
Warning Center:  
Science, Technology,  
Prediction



Emergency Operations Center:  
Public Safety Advisory  
Lives saved, Damage less

# Tsunami Evacuation

Modeling → Inundation map → Evacuation map



**Tsunami evacuation maps are community-owned**

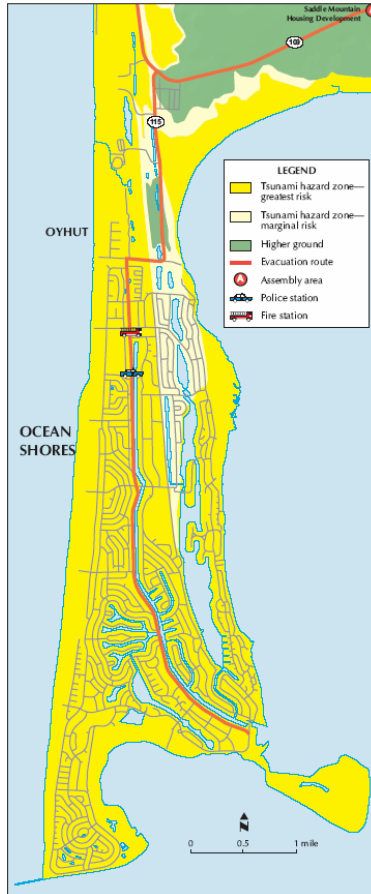
# Evacuation - Challenges

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## Distant & Local tsunami responses:

- Day time or night time
- People awake or asleep
- Regular business / school hrs vs. non-duty hrs
- Weekday vs. weekends
- Tourist Peak vs. Off-season
- Traffic jams and rush-hour periods
- Television and radio stations off-air
- Little to no response personnel available to support evacuation (*during local tsunami*)

# Evacuation Problems?



## Issues:

- No high ground
- No time to go inland
- Special needs populations

## Solution:

- Vertical evacuation



# Evacuation Siting, Spacing, and Sizing

Warning time	Ambulatory Speed*	Travel Distance**	Required Spacing
> 2 hrs	3.2 km/hr (1 m/s) 2 mph	6.4 km 4 miles	12.8 km 8 miles
30 min	3.2 km/hr (1 m/s) 2 mph	1.6 km 1 mile	3.2 km 2 miles
15 min	3.2 km/hr (1 m/s) 2 mph	0.8 km 0.5 mile	1.6 km 1 mile

\* Assumed average speed of mobility-impaired population

\*\* Must allow time for vertical circulation within refuge

# Evacuation Simulation – Owase, Japan

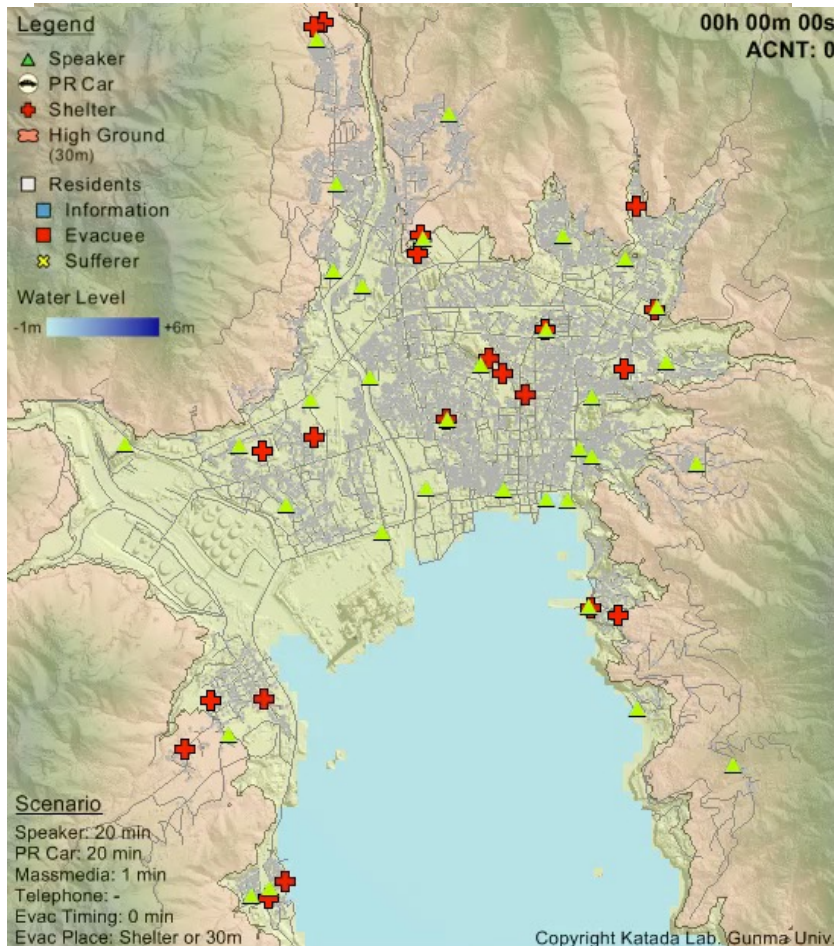
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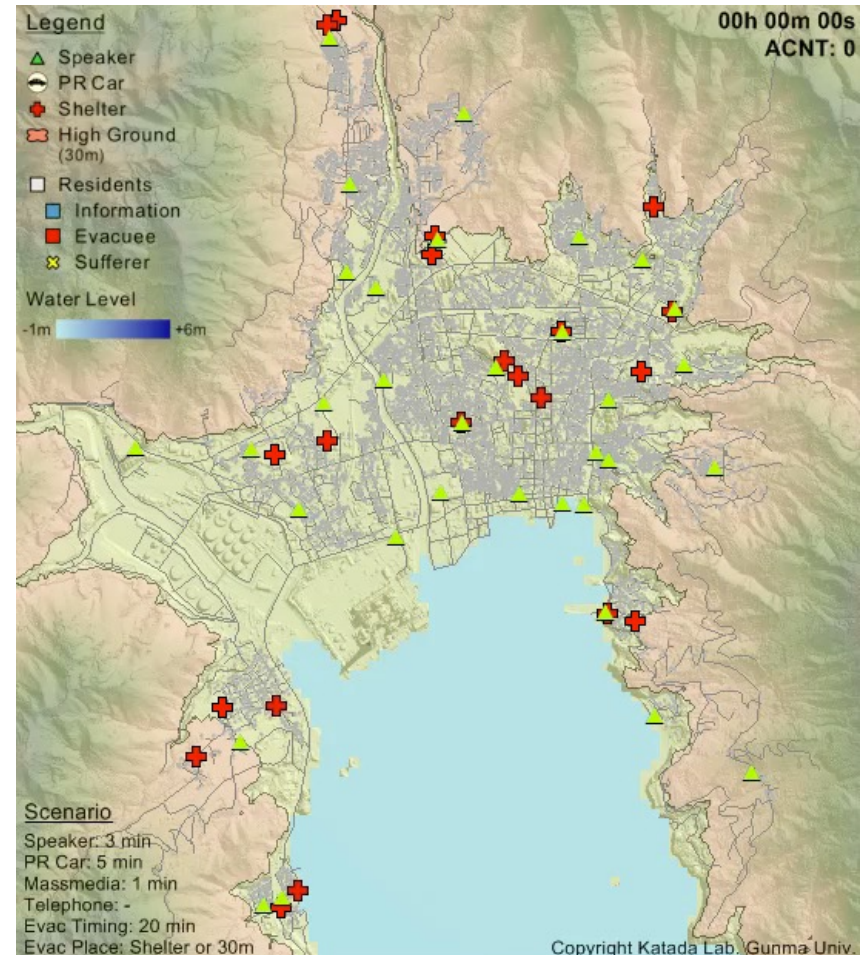
- Map of Owase City (Kii Peninsula, Japan)

# Evacuation Simulation – Owase, Japan

*Delay in Alert or Evacuation => more deaths*



**Immediate Evacuate**



**20-min delay to Evacuate**

# Evacuation Simulation – Owase, Japan

Examples of casualties resulting from simulation runs

		Timing (min) of Official Tsunami Warning													
		1	2	3	4	5	6	7	8	9	10	20	30	60	
Evacuation Start Timing (min)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	7
	1	0	0	0	0	0	0	0	0	0	0	0	1	1	10
	2	0	0	0	0	0	0	0	0	0	0	0	2	2	17
	3	0	0	0	0	0	0	0	0	1	1	1	4	6	32
	4	0	0	0	0	0	1	2	2	4	3	7	14	50	
	5	0	0	0	1	2	4	6	7	8	7	12	20	75	
	6	0	1	2	5	8	9	9	9	11	10	17	44	120	
	7	1	2	7	9	9	13	14	13	12	12	36	94	190	
	8	1	8	10	10	12	15	17	19	16	19	81	148	302	
	9	9	11	13	12	12	24	26	51	53	56	189	273	440	
	10	11	14	14	17	41	72	91	124	148	165	373	463	566	

# TWC Cancellation versus All-Clear

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- ❑ **Cancellation Message issued by TWCs**
  - Officially cancels warning, watch, and advisory messages
  - Means that destructive waves have stopped in areas that can be monitored by the TWCs
  - Does not mean it is safe to return to Tsunami Hazard Zone
  
- ❑ **Official All-Clear issued by local authority when it is safe to re-enter the Tsunami Hazard Zone**

# TER – Safe to Return (All-Clear)

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- ❑ Tsunami is a series of waves striking coastline for hours
- ❑ Resonance in bays / harbors
- ❑ Debris (floating)
- ❑ HAZMAT spills
- ❑ Additional earthquake damage
- **Who declares “All-Clear”?**  
**National/Provincial/Local TER...?**

# Evacuation Decision affects Credibility

<b><i>ACTION</i></b>	<b><i>RESULT</i></b>	<b><i>PERFORMANCE</i></b>
<b>Official Evacuation</b>	<b>Destructive Tsunami</b>	<b>Successful TWS</b>
<b>No Official Evacuation</b>	<b>Non-destructive Tsunami</b>	<b>Successful TWS</b>
<b>Official Evacuation</b>	<b>Non-destructive Tsunami</b>	<b>TWS limitation - Credibility Downgraded</b>
<b>No Official Evacuation</b>	<b>Destructive Tsunami</b>	<b>Failed TWS</b>

***Note: There will be public criticism if alert notifications took too long to reach people on the coastline, or people not notified at all.***

# Achieving Successful Outcomes

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- **Disclose “End-to-End” TWS limitations *beforehand* to Stakeholders (agencies, key decision-makers at National / Provincial / Local levels)**
- **Convene Press Conference shortly after Warning cancellation to explain what happened and how official evacuation decisions determined.**



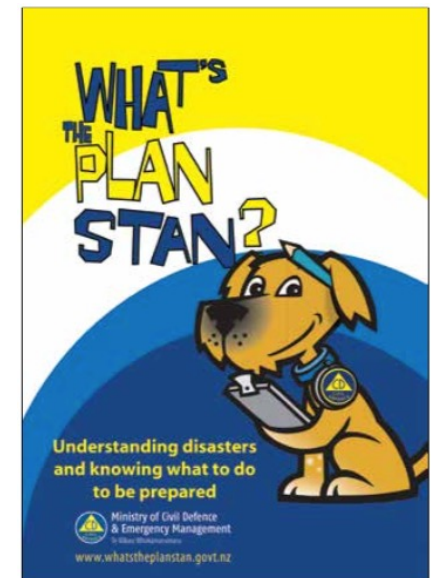


# Improving Tsunami Response

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## Community-level focus / customize outreach:

- Know tsunami natural warning signs
- Have evacuation maps
- Know evacuation routes/assembly areas
- Have community support network
- Have family plan and preparedness kit
- Know response for local and distant tsunamis
- Know community warning system



# How to Improve Tsunami Response

## Exercises Drills

- Drill evacuation of schools and communities
- Exercise communications protocols
- Exercise all levels of government





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# Thank You

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