What do TERs do with TWC information? Challenges in Alerting, Evacuation and Safe to Return

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Outline

- Roles and Responsibilities
- Alerting
- Evacuation
- Cancellation and All-Clear
- Measuring Success

Tsunami Emergency Response (TER)

- **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.

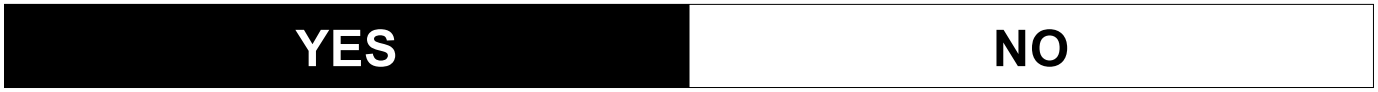
TER Expectations

Key Question:

Has a destructive tsunami been generated?
Yes or No?

Tsunami Decision-Making Environment:

TER want "black & white => Yes or No answer"



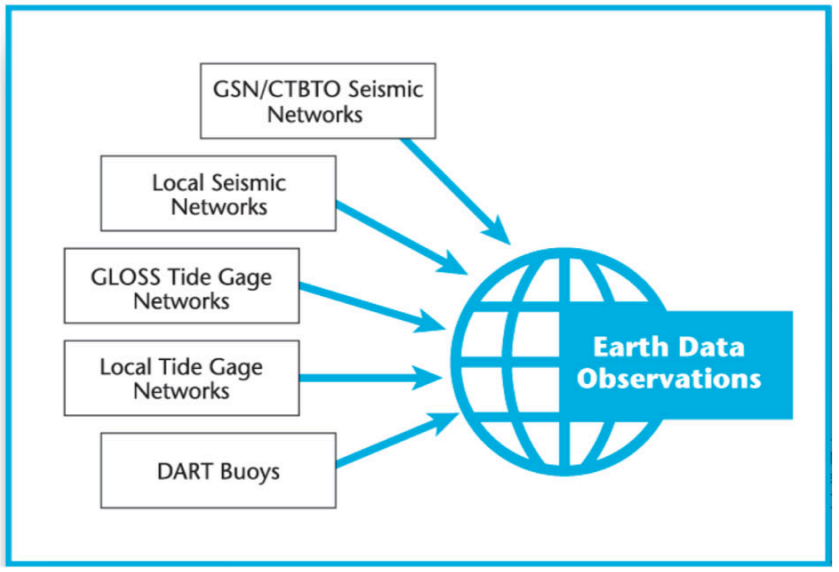
TWC operate in "shades of grey color"

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.**



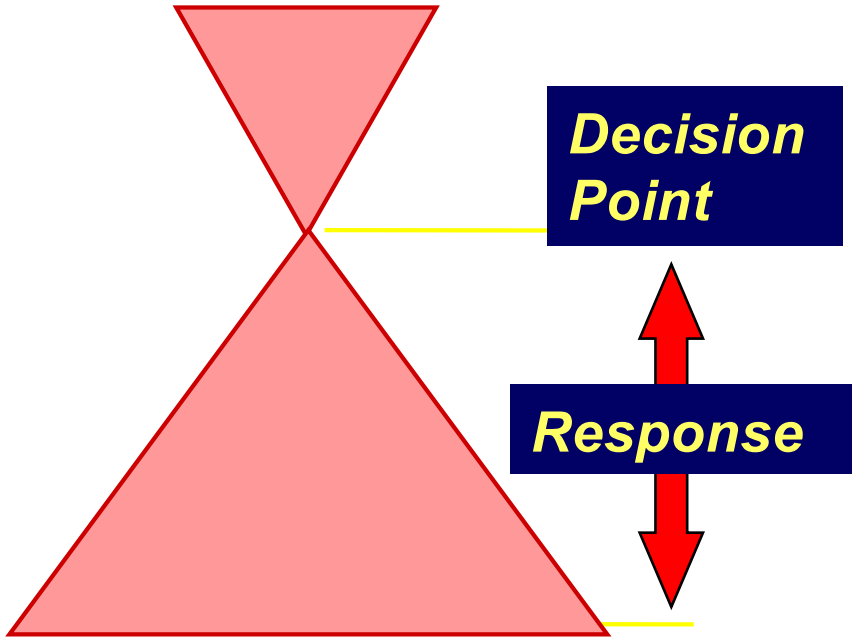
***Result* =>**

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

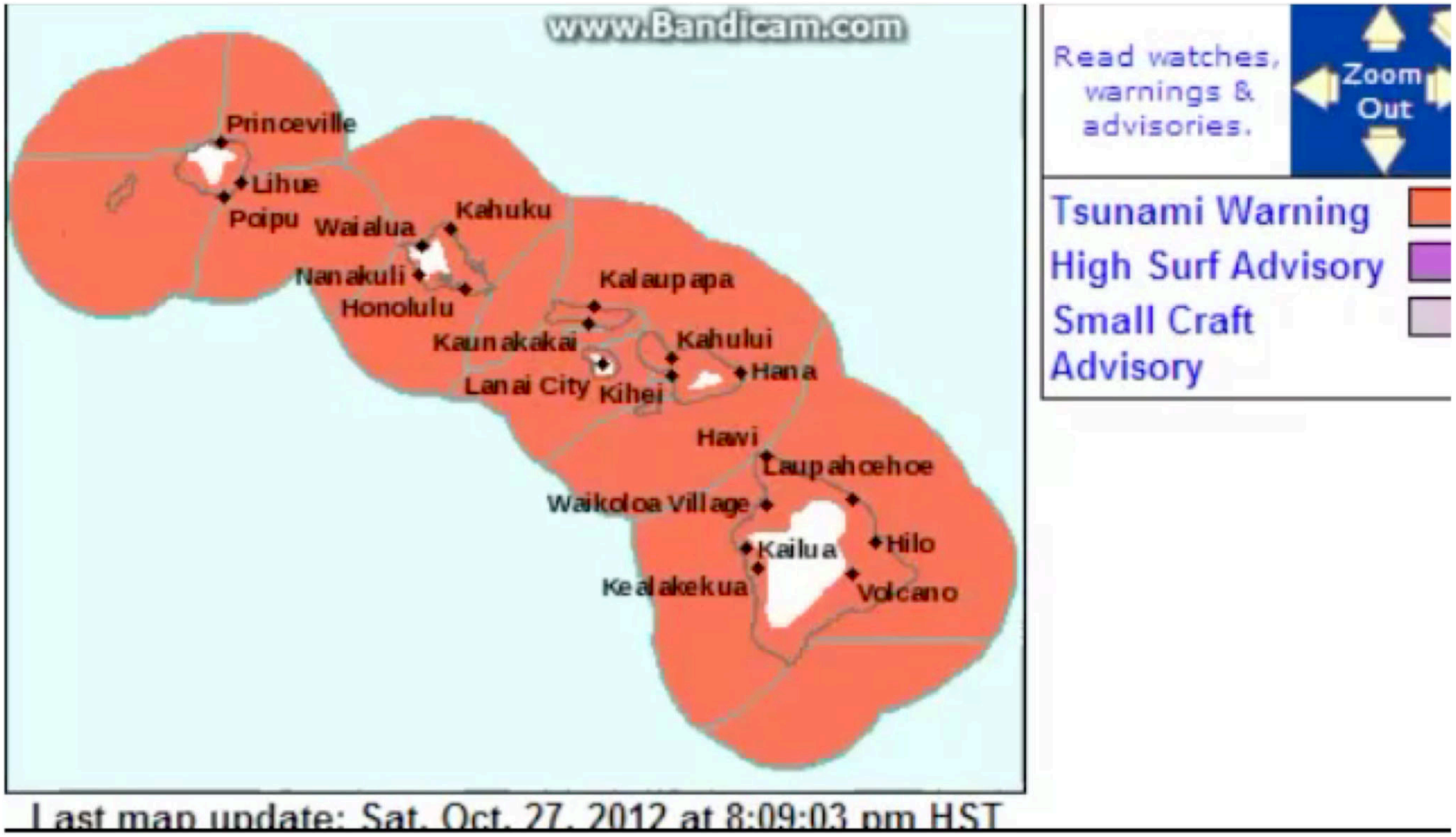


Emergency Operations Center: Public Safety Advisory Lives saved, Damage less

TER – Alerting Requirements

- 4 R's: Robust, Reliable, Redundant, Ready
- Wide Accessibility
- Speed
- Accurate and reliable
- Live updates
- 24/7
- Skilled Human Resources
- Established Infrastructure
- Established Broadcasting SOP
- Experience in Breaking News
- Provide Guidance

Alerting Example – Hawaii EAS Radio/TV

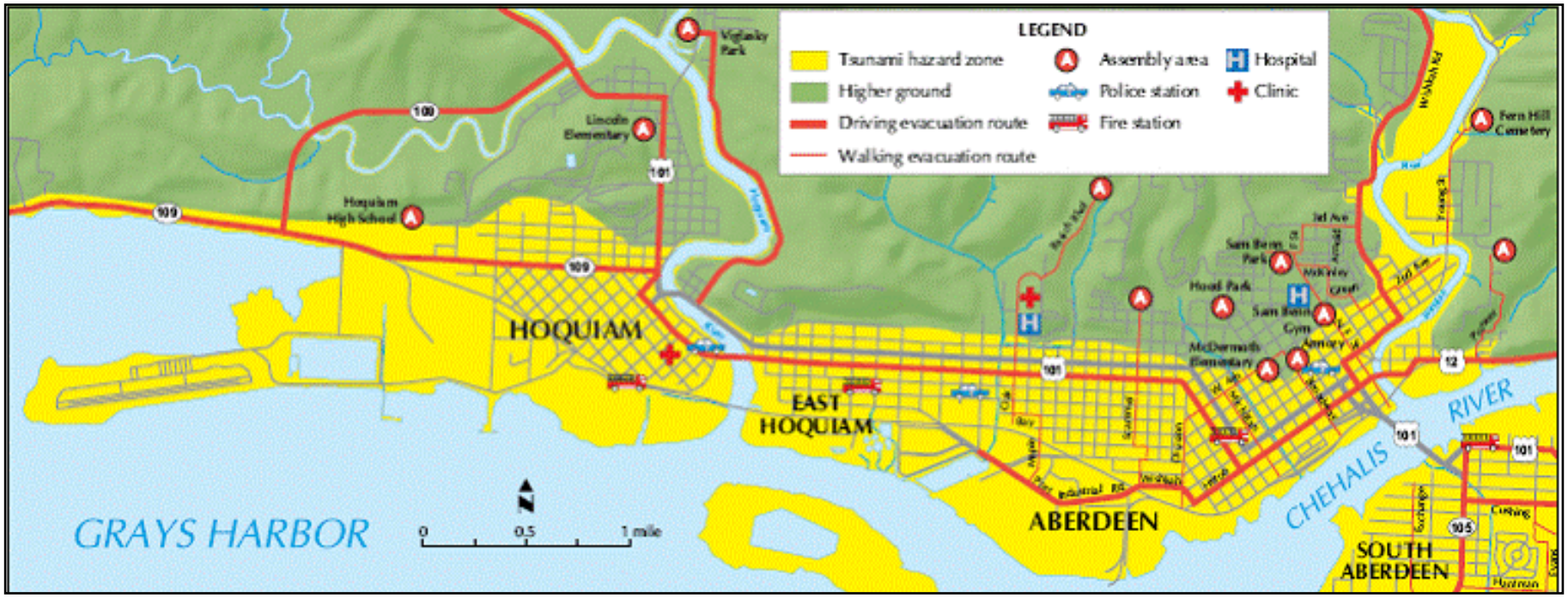


Alerting - Challenges

- Utility and communications systems disrupted or destroyed due to earthquake
- Areas where electricity is scarce
- Time of day (night people are sleeping TV/radio off)
- Communication system overloaded

Tsunami Evacuation

Modeling → Inundation map → Evacuation map



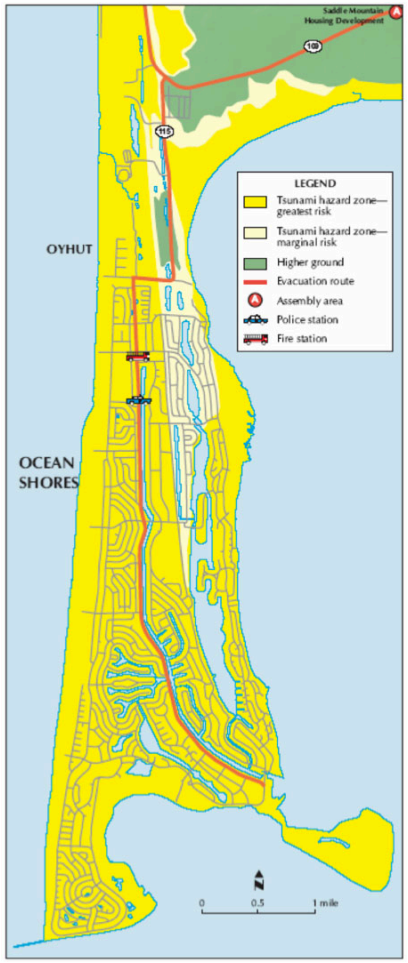
Tsunami evacuation maps are community-owned

Evacuation - Challenges

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

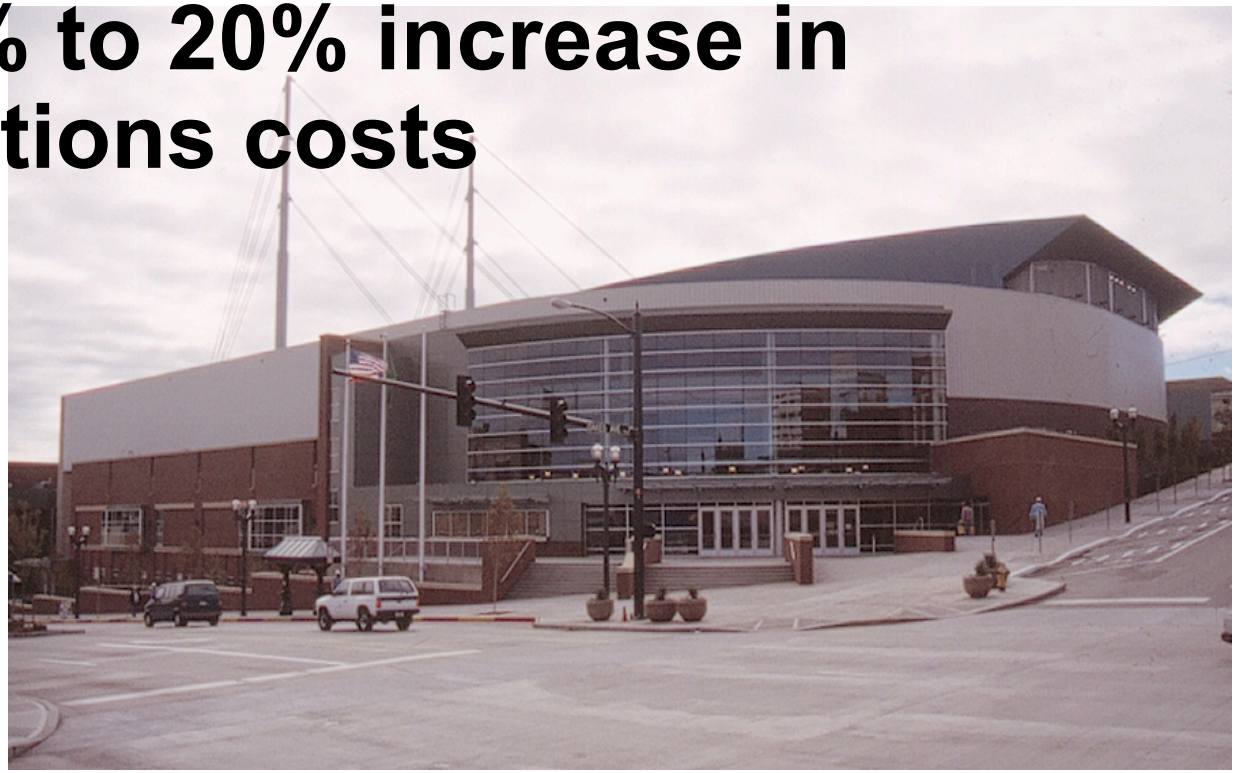
* Assumed average speed of mobility-impaired population

** Must allow time for vertical circulation within refuge

From ATC-64 Design and Construction Guidance for Vertical Evacuation from Tsunami

Vertical Evacuation - costs

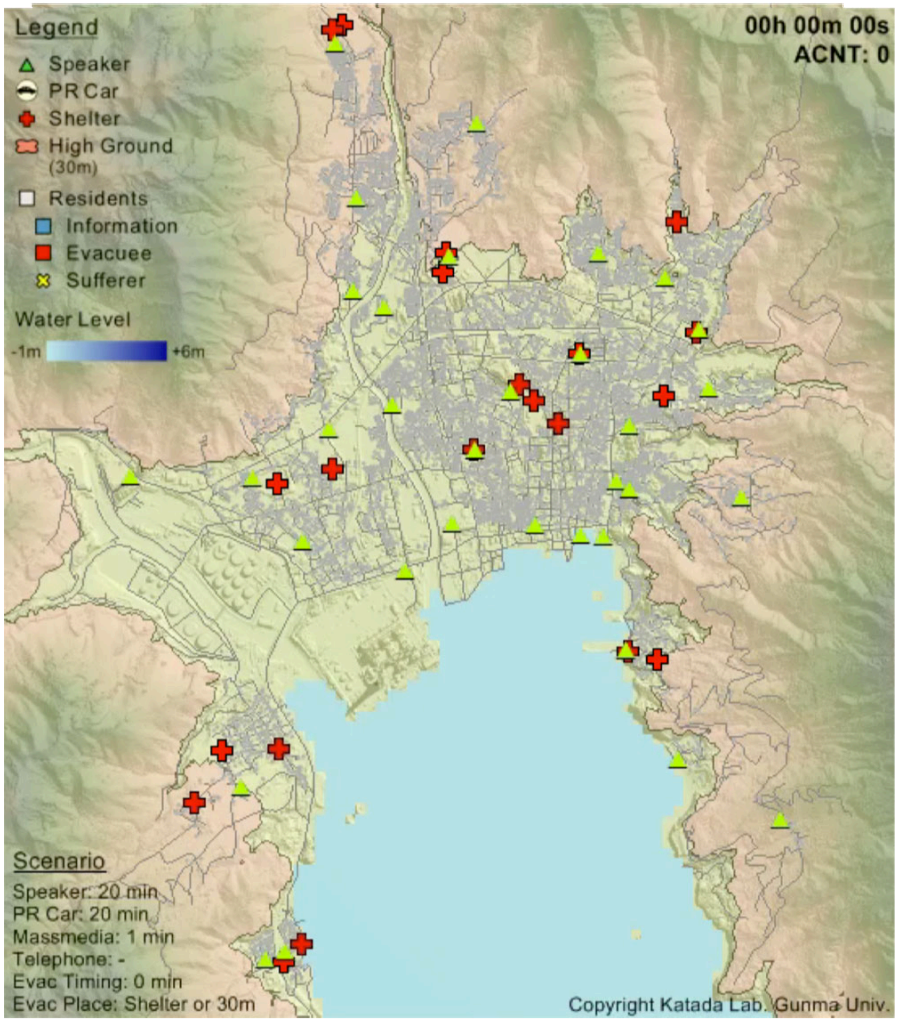
- **Structural costs higher**
- **Structural only a portion of total building costs (5% to 40%)**
- **Tsunami-resistant structures estimated 10% to 20% increase in total constructions costs**



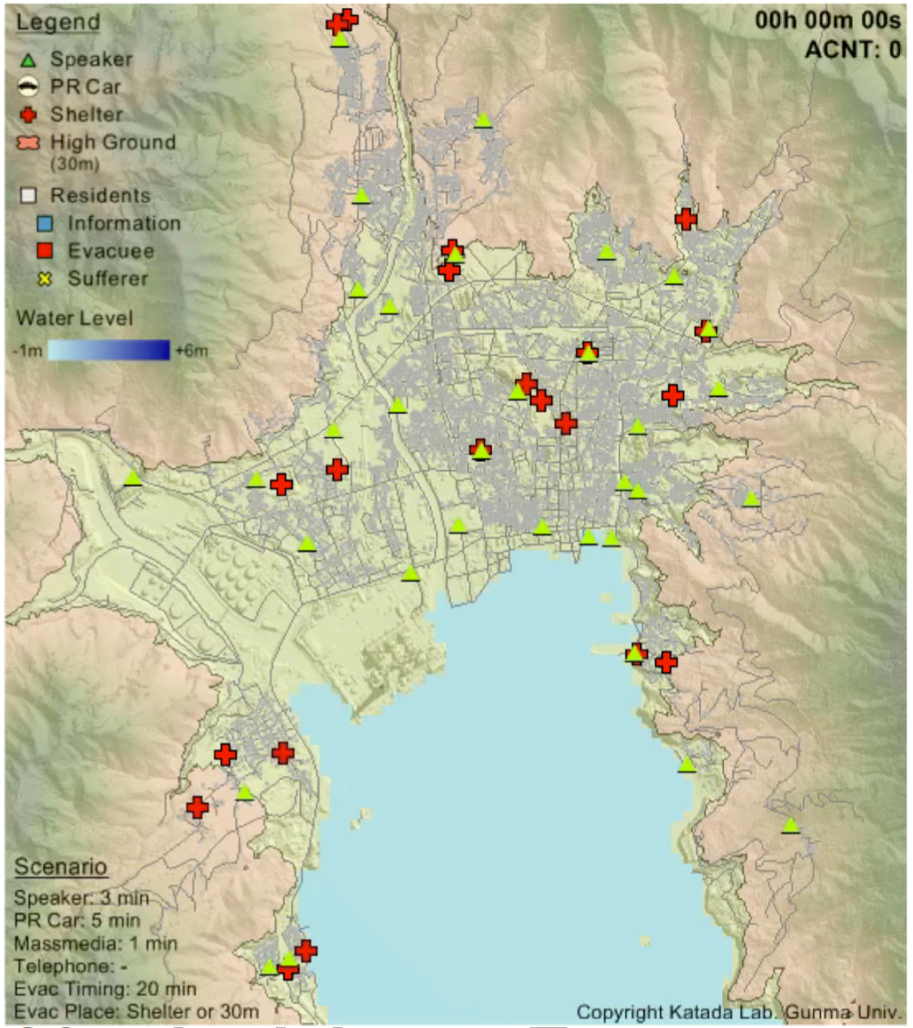
From ATC-64 Design and Construction Guidance for Vertical Evacuation from Tsunami

Evacuation Simulation – Owase, Japan

Delay in Alert or Evacuation => more deaths



Immediate Evacuate



20-min delay to Evacuate

T. Katada, Gunma Univ

TWC Cancellation versus All-Clear

- **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)

- 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 TWS Credibility

ACTION	*RESULT*	*PERFORMANCE*
Official Evacuation	**Destructive Tsunami**	**Successful TWS**
No Official Evacuation	**Non-destructive Tsunami**	**Successful TWS**
Official Evacuation	**Non-destructive Tsunami**	**TWS limitation - Credibility Downgraded**
No Official Evacuation	**Destructive Tsunami**	**Failed TWS**

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

Hawaii example: Cost of “False warning”

Pacific-wide Tsunami Warnings Issued
Sirens sounded, Statewide evacuations

BUT small, non-destructive tsunamis

- **1986 - mid-afternoon to pm rush hour**
  1994 - early morning to am rush hour

Losses
(DBEDT Study) => $50M
(extrapolated) => $30M
(extrapolated) => $68M

- **Media reports shape public opinion**

Achieving Successful Outcomes

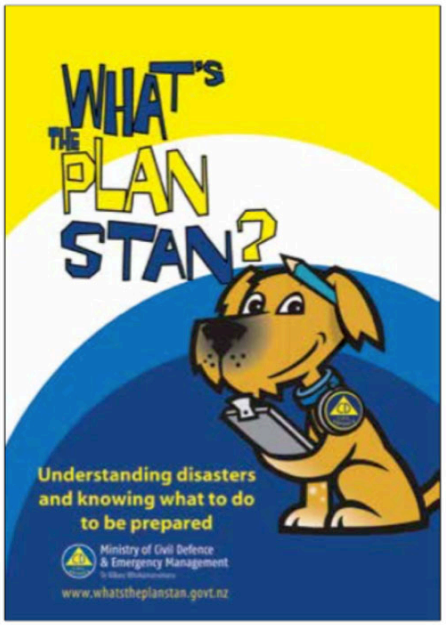
- ***Disclose "End-to-End" TWS limitations beforehand*** **to Stakeholders (agencies, key decision-makers at National / Provincial / Local levels)**

- **Convene Press Conference shortly after Warning cancellation to explain what happened and how official evacuation decisions determined.**

Improving Tsunami Response

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

Thank You

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