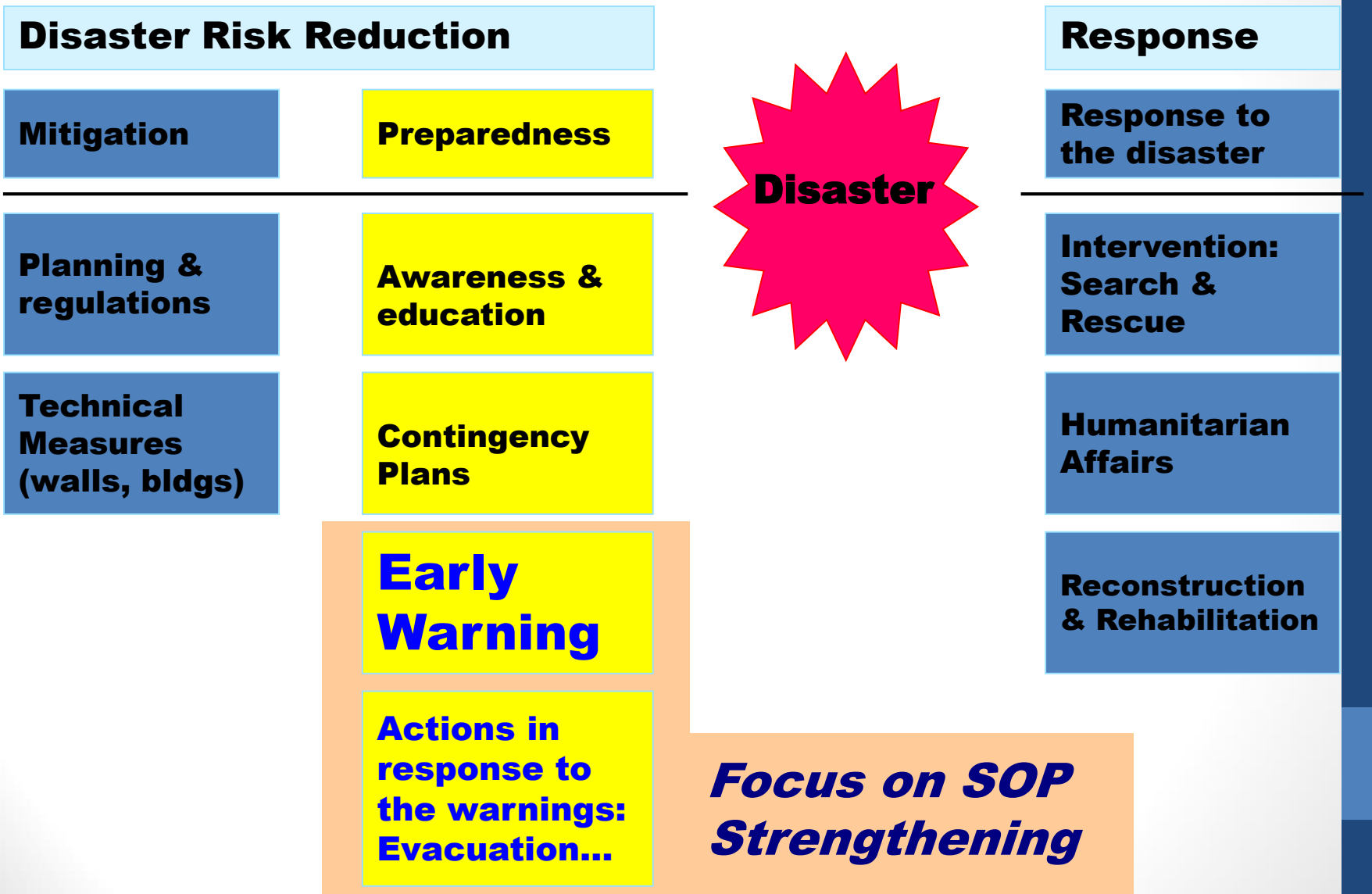
Regional Training Workshop on Pacific Tsunami Warning Center Enhanced Tsunami Products for ICG/CARIBE EWS
31 October – 02 November, 2017
Cartagena, Colombia

2.1 Responding Rapidly and Effectively: Tsunami Warning and Emergency Response Requirements and Timeline-driven SOPs

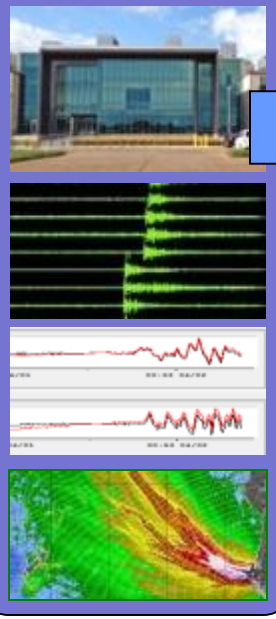
Christa von Hillebrandt-Andrade
NOAA-NWS Caribbean Tsunami Warning Program

Early Warning is part of Preparedness

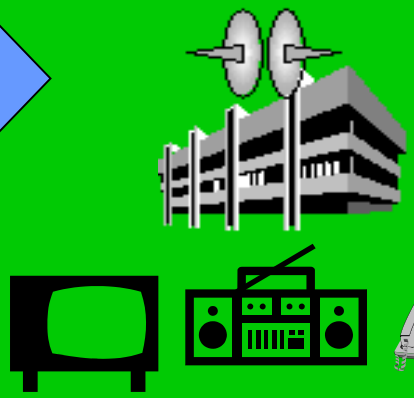


End-to-End Tsunami Warning

EQ
Tsunami



Country Alert System



Emergency Alert System & Mass Media

TWC - Science

Intl / Natl

DMO – Public Safety Evacuate / All-Clear

Natl / Local Govt

Public

ITIC, SeismicReady Consulting 2009 after Japan Cabinet Office 2005

Effective Tsunami Warning

- 2 Essential Stakeholders
  - Both must work closely together.
- NATIONAL TSUNAMI WARNING CENTER
  - **ISSUES WARNING**
  - Assess and confirm dangerous tsunami
- NATIONAL / LOCAL DISASTER MANAGEMENT
  - **RECEIVES WARNING**
  - Assess threat to coastal community
  - Inform community/public what to do (Evacuate, All-Clear safe-to-return)

Taking Action – Timely Warnings

- Goal:
  w/o confusion

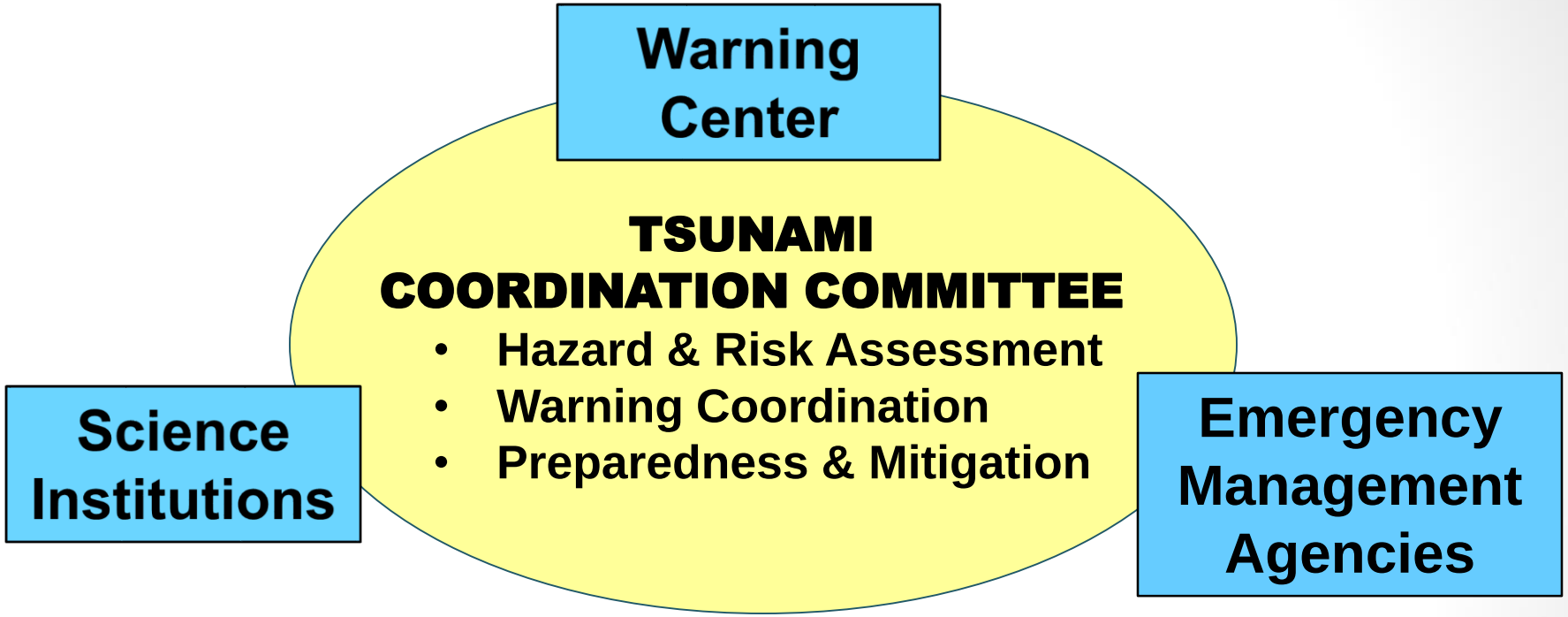
- Requirements:
  - Know what to do
    - Develop TWC and TER / DMO SOPs
  - Practice
    - Test Communications end-to-end
    - Conduct Drills since tsunamis are infrequent

SOP Definition

"A description and procedure on agreed steps by institutions used in coordinating who, what, when, where and how for tsunami early warning and response"

From Indonesia Local SOP Workshops: Capacity Building for Development of Local SOPs for Tsunami Early Warning and Response. 2006-2007

Stakeholder Coordination is Essential



Civil Society & NGOs

- Community organizations (social, gender, cultural, age, language, religious …)
- Trade, business organizations
- Disaster response & relief

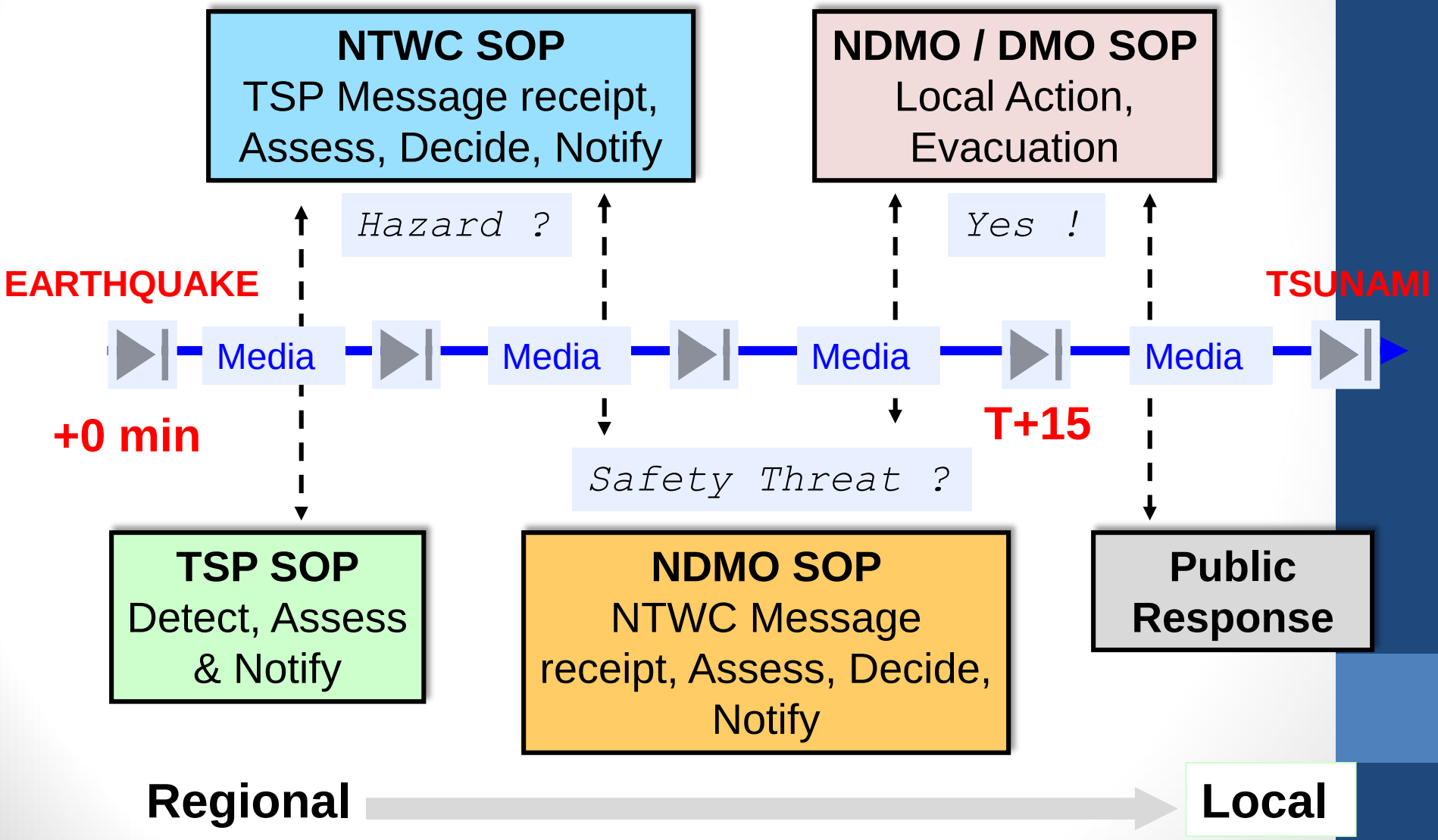
Government Agencies:

- Planning & Development
- Transportation
- Health & Education
- Coastal Management
- Social Services

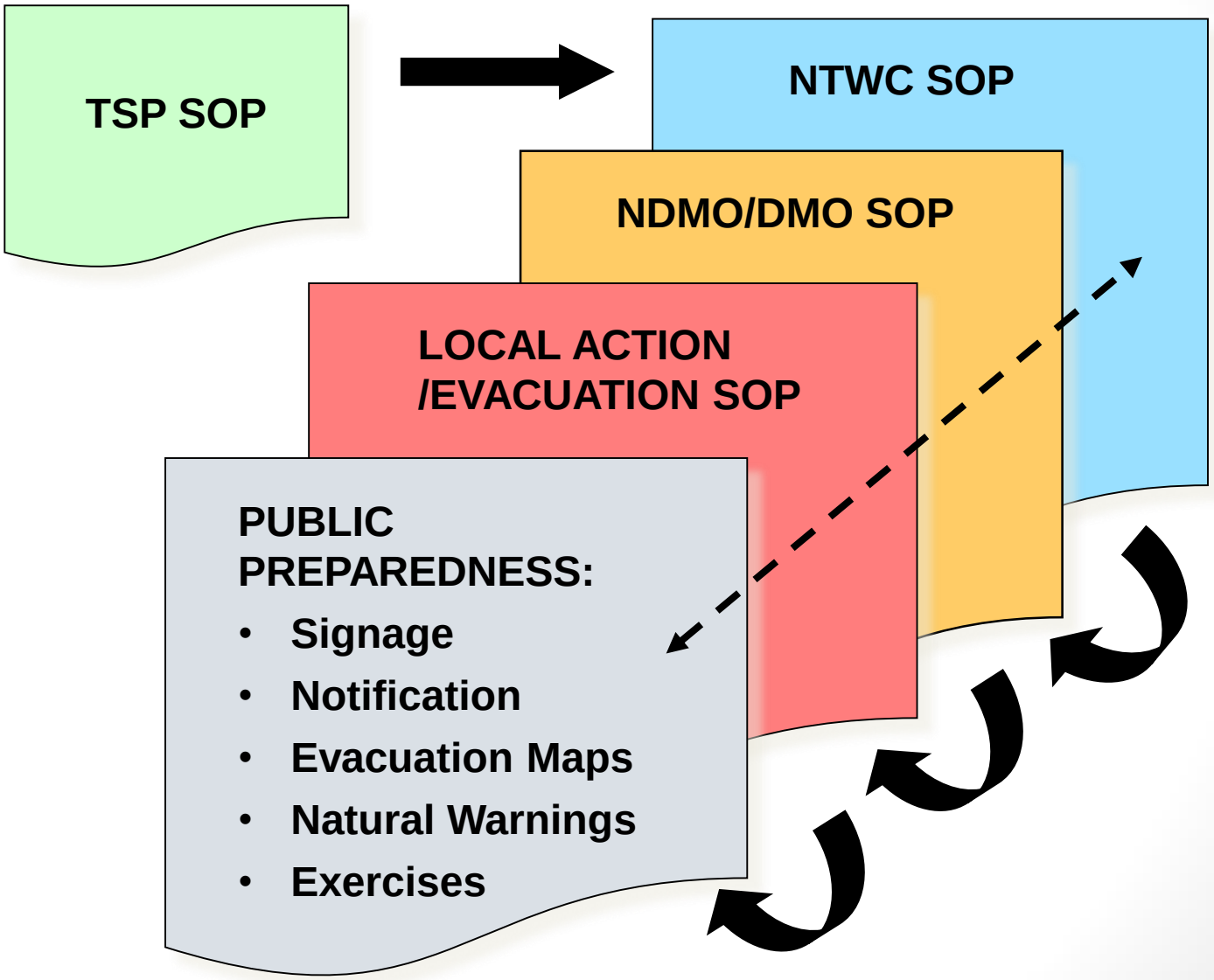
Other:

- Media
- Utilities
- Tourism
- International Agencies

End-to-End Warning and Response



Tsunami Warning SOPs are coherent



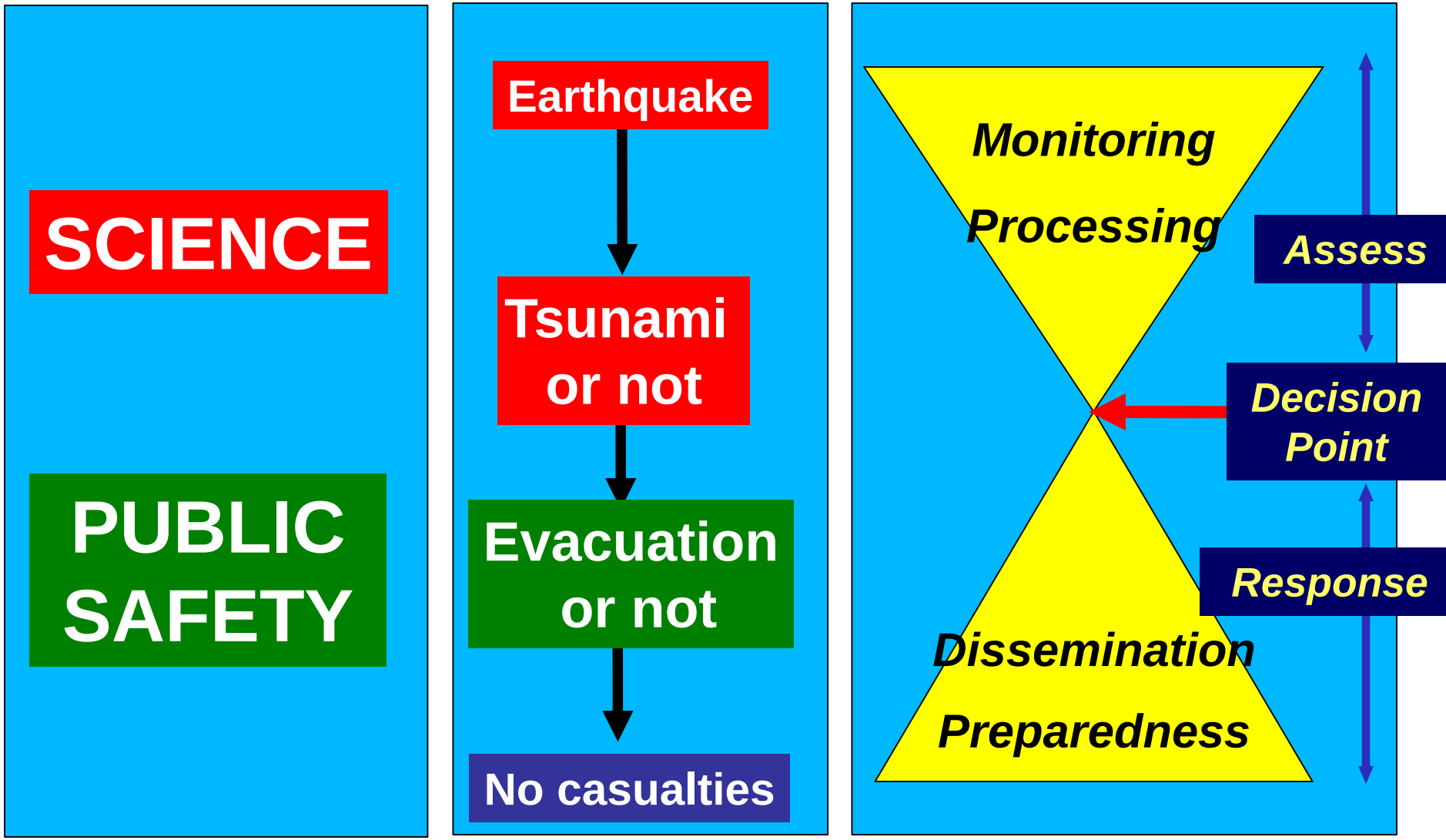
Tsunami Warning SOPs are timeline-driven

TSUNAMI ACTION TIME LINE	TIME min after EQ	OBSERVATION	ACTION PTWC	ACTION NTWC	ACTION NDMO / Local Auth
	0	Strong ground shaking locally			
	1-5		Alarm triggers		
	5-15	Tsunami might come	Msg 1	Alarm CISN triggers	
	15-30		Msg 2 Forecast	WARNING	EVACUATION
	30-60	Tsunami confirmed	Msg 3 SL obs	Confirm Dangerous Tsunami	
	1-2+ hrs		Msg 4+ SL obs	Monitor and report SL obs	
	2-8+ hrs	Dangerous waves stop	Msg 5+ Last Msg	CANCEL WARNING	Search and Rescue
	3+ hrs	Safe to Return			ALL-CLEAR

Effective Warnings: Practice SOPs

A perfect warning will be useless if people do not know what to do in case of an emergency

Tsunami Early Warning: Science and Public Safety



ITIC, BMKG, 2009

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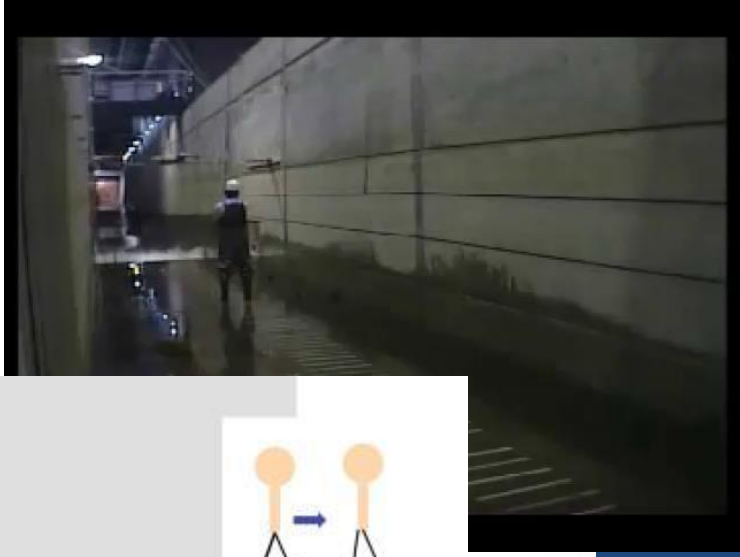
2011 Great East Japan Tsunami Warning and Human Response

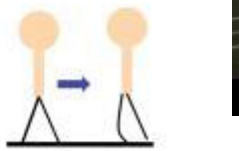
Facts

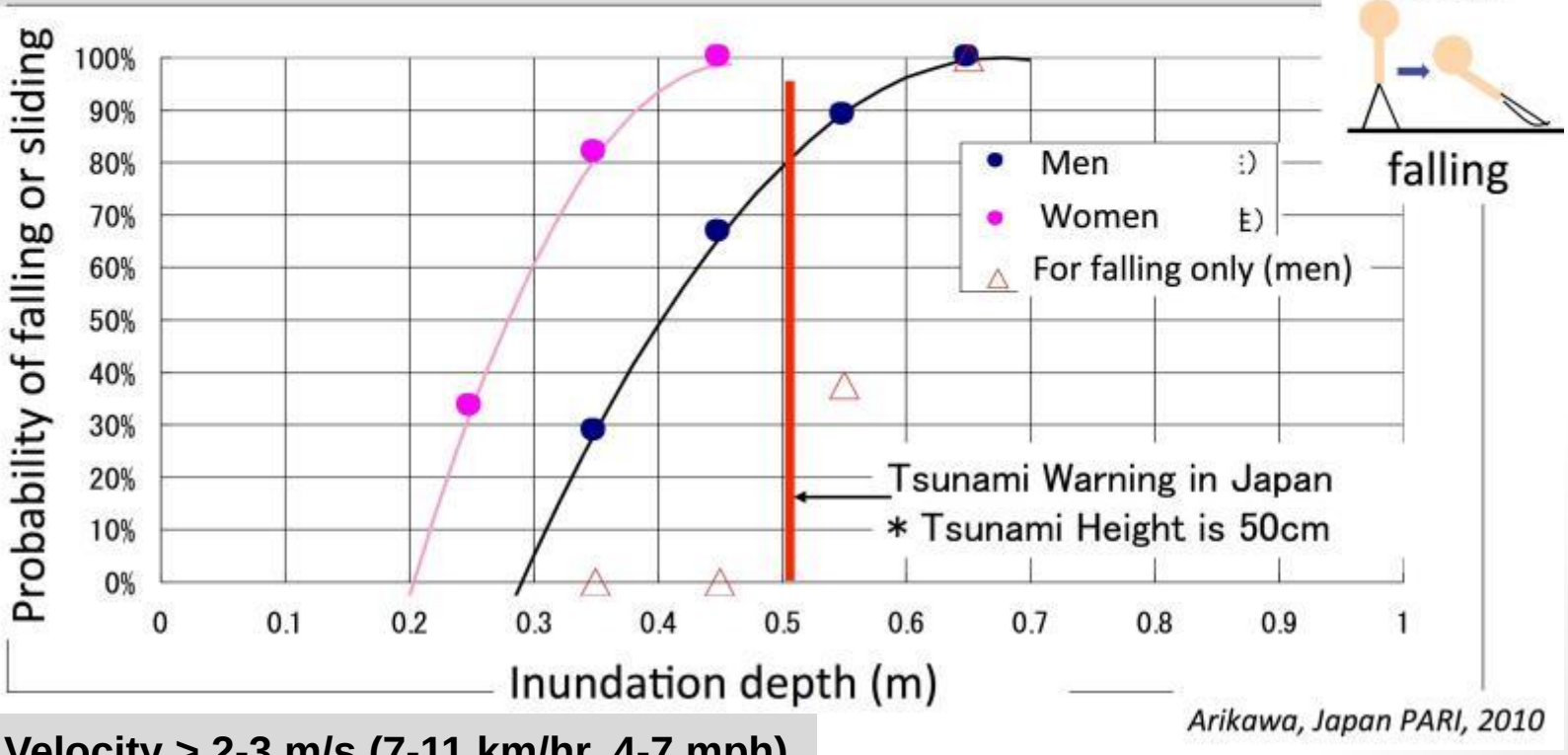
- **Timely NTWC Warning,** incl wave forecast 3+ m but was underestimate => 1st message most critical
- **Small waves can be dangerous** Laboratory expts show waves 30 cm flow depth cause people to lose balance / cars to float
- **Swift-moving waves are dangerous** especially later waves as debris-laden rivers and/or walls of water.
- **Most people evacuated. Some did not.** Only 5% died, nonetheless, it was ~18,000

Flow Depth – Human



Preliminary Results:
Probability of falling or sliding
=> lose balance at 0.3 m (1 ft) depth





Arikawa, Japan PARI, 2010

Velocity > 2-3 m/s (7-11 km/hr, 4-7 mph)

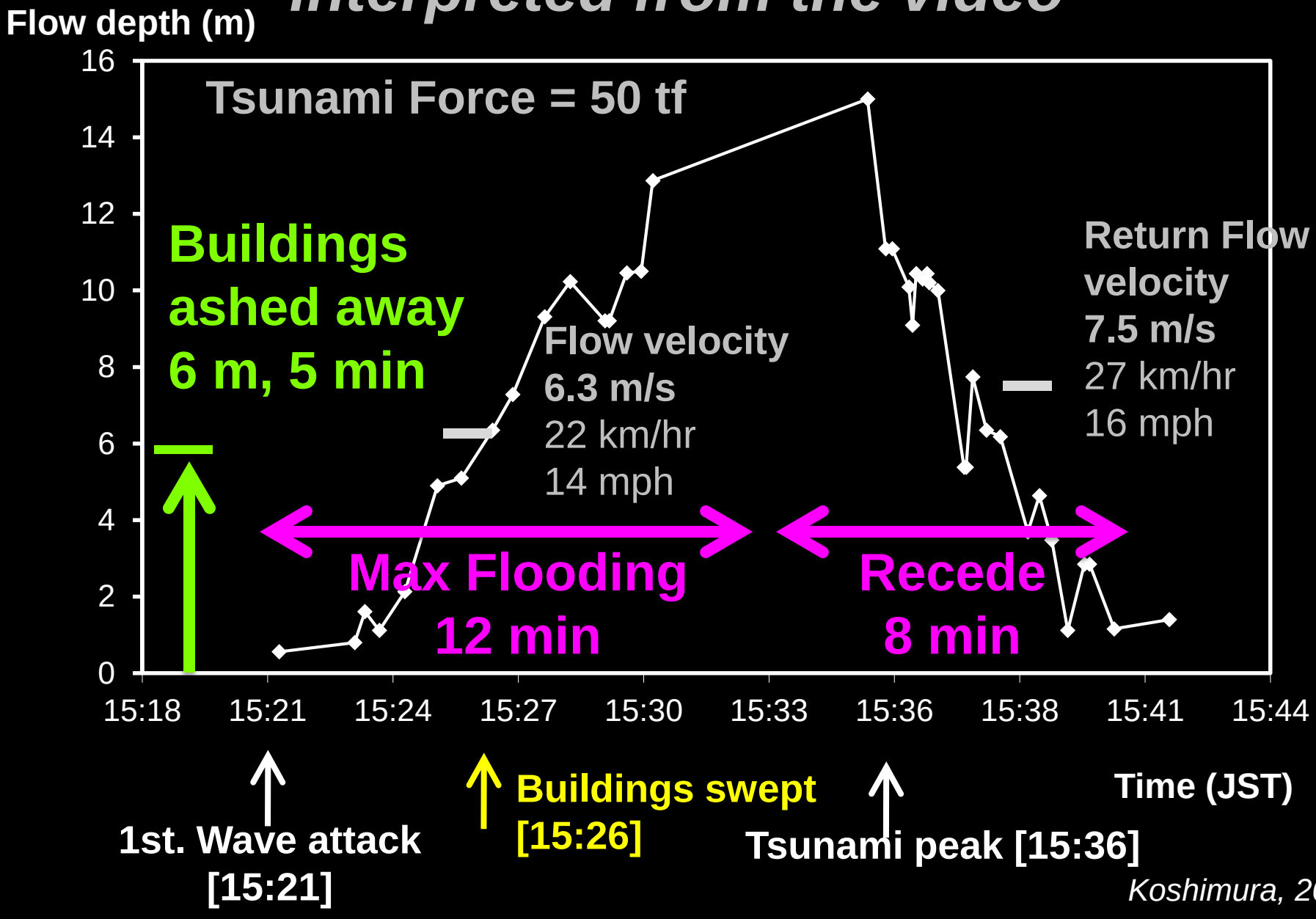
Onagawa, Miyagi Pref.

www.town.onagawa.miyagi.jp：
Fatality：455, Missing：739 (Pop.10,010). 12% of population were killed or missing.
Destroyed houses/buildings： 4432. 70% of houses in town was severely damaged.

Koshimura, 2011

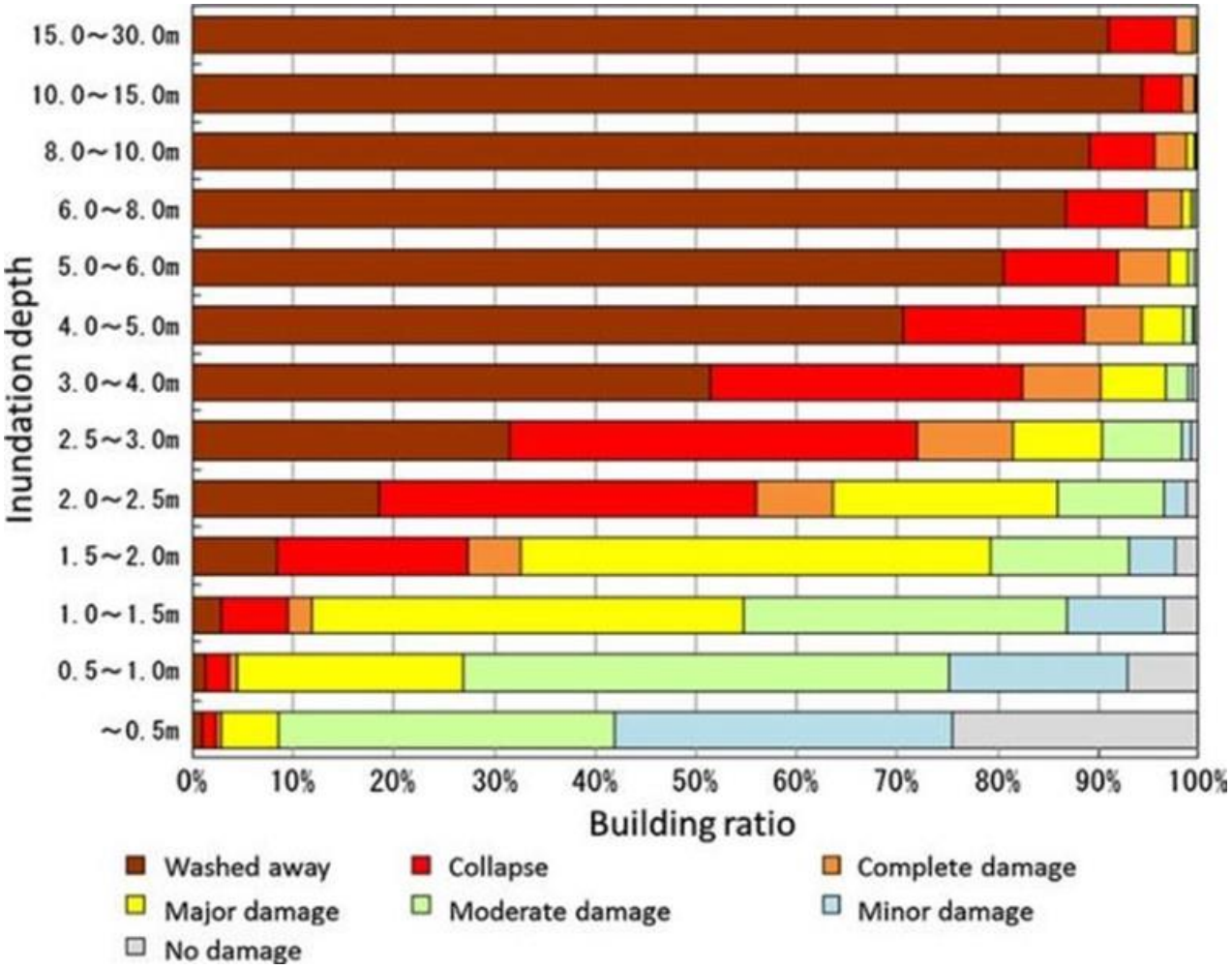

Koshimura, 2011

Time series of tsunami inundation interpreted from the video



Koshimura, 2011

Flow Depth - Building Damage



11 March 2011 Data: Fig. 2 Distribution of the total 251,301 building data surveyed by MLIT (2012) Ministry of Land, Infrastructure and transportation (MLIT): Survey of tsunami damage condition: http://www.mlit.go.jp/toshi/toshi-hukkou-arkaibu.html. Accessed 4 July 2012

Suppasri et al., 2013

Tsunami Impact - summary

Criteria to estimate damage by tsunamis

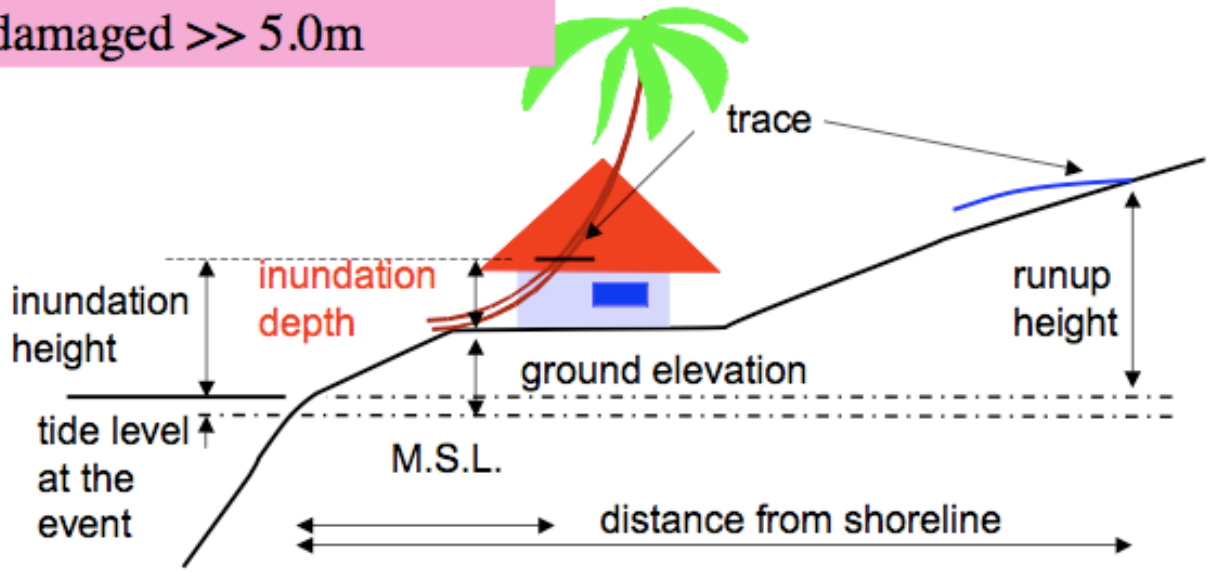
Inundation depth

Human: killed >> 50cm

House: partially damaged >> 1.0m

totally damaged >> 2-3.0m

Building: damaged >> 5.0m



Expect Fast Flooding - Have a Plan

Sendai, Japan, March 11, 2011

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Thank You

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