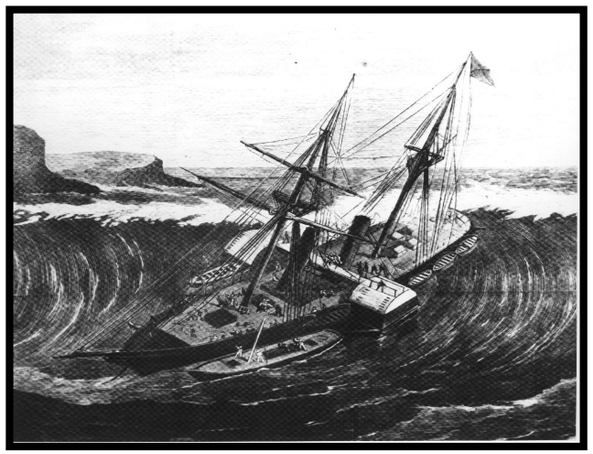
UNESCO/IOC – NOAA ITIC Training Program - International (ITP-Intl)
TSUNAMI WARNING AND EMERGENCY RESPONSE
9-12 January 2023, Rarotonga, Cook Islands

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

Dr. Laura Kong
Director, International Tsunami Information Centre

WHY IS A TSUNAMI A HAZARD?

- **WAVE HEIGHTS GROW IN SHALLOW WATER**
  - **Best Case: Quickly Rising Tide**
  - **Worst Case: Wall of water with rocks and debris**
  - **Runups > 30 m**



Nov 18, 1867, USVI

Feb 6, 2013
Santa Cruz Islands, Solomons

8 February 2013, West Santa Cruz Island
Courtesy Solomons Islands National Disaster Management Office, Royal Australian Air Force

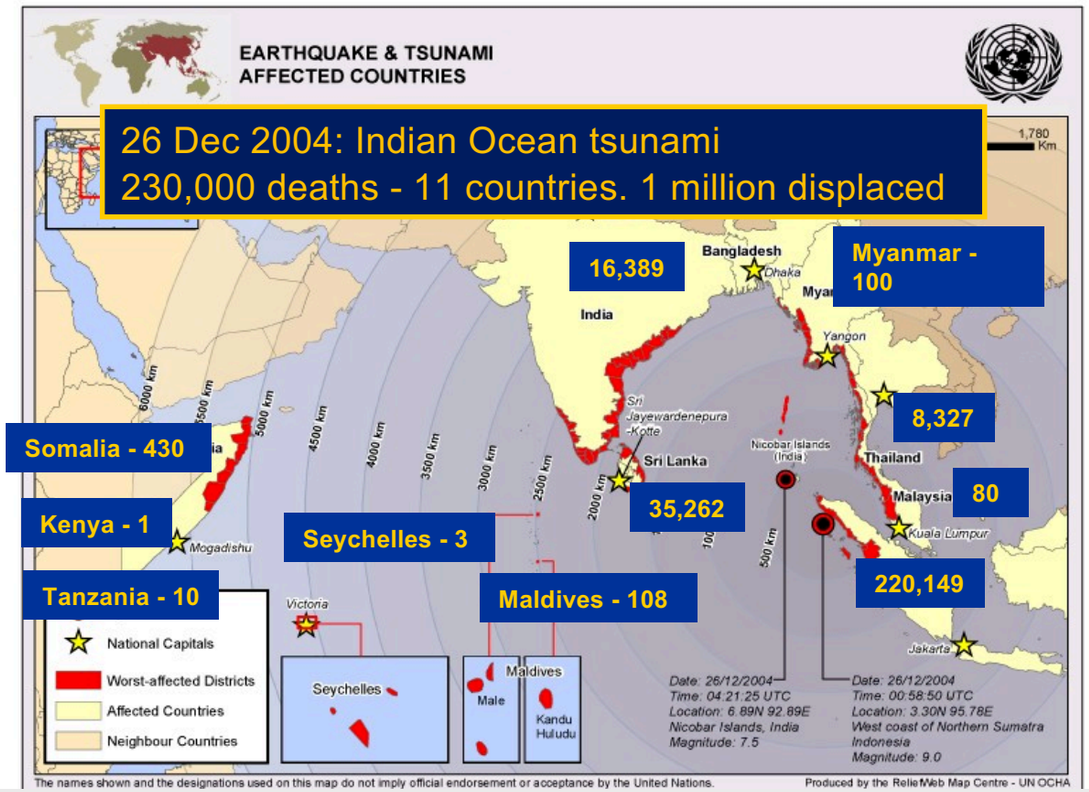
April 1, 1946 Aleutian Islands earthquake Hilo, Hawaii

WHY IS A TSUNAMI A HAZARD?

- **DANGER CONTINUES FOR MANY HOURS**
- **HIGH FATALITY HAZARD**
- **GLOBAL IMPACT –**

  blind to political boundaries

  - ***Locally, arrives in minutes***
  - ***Distant, travels hours across ocean basin***



Casualties Data source: International Federation of Red Cross and Red Crescent Societies, 9 March 2005

TSUNAMI WARNING – 2 THREATS

LOCAL / REGIONAL:

- Generated nearby
- Strikes shore quickly (in minutes)
  => NO TIME for official evacuation

➢ Education, Awareness, Preparedness

➢ Every person recognizes / acts immediately

February 27,2010, Chile

DISTANT / OCEAN-WIDE:

- Generated far away, instr detection
- Strikes shore later (2+ hours)
  => TIME for official evacuation
- Widespread Damage

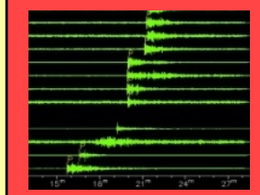
➢ Tsunami Warning Centre, then

➢ People know what to do and where to go - evacuate

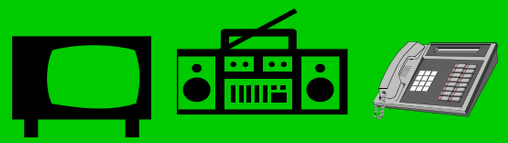
May 22, 1960, Chile tsunami in Hilo

ITIC

End-to-End Tsunami Warning



Country Alert System



Emergency Alert System & Mass Media

TWC

Intl / Natl

Natl / Provincial /Local Govt

Public

Race against Time

LIVES SAVED

ITIC, SeismicReady 2009, after Japan Cabinet Office 2005

Effective Tsunami Warning

- **2 Key Stakeholders – work closely together**
  Warning, Response, Awareness, Preparedness

- **NATIONAL TSUNAMI WARNING CENTER**
  - Assess and confirm dangerous tsunami

- **NATIONAL / LOCAL DISASTER MANAGEMENT**
  - Assess threat to coastal community
  - Inform community/public what to do
    (Evacuate, All-Clear safe-to-return)

- **COMMUNITIES ACT**
  - Aware and prepared
  - How to receive warning, what to do, where to go

Taking Action – Timely Warnings

- **Goal**:
  Act fast
  w/o confusion

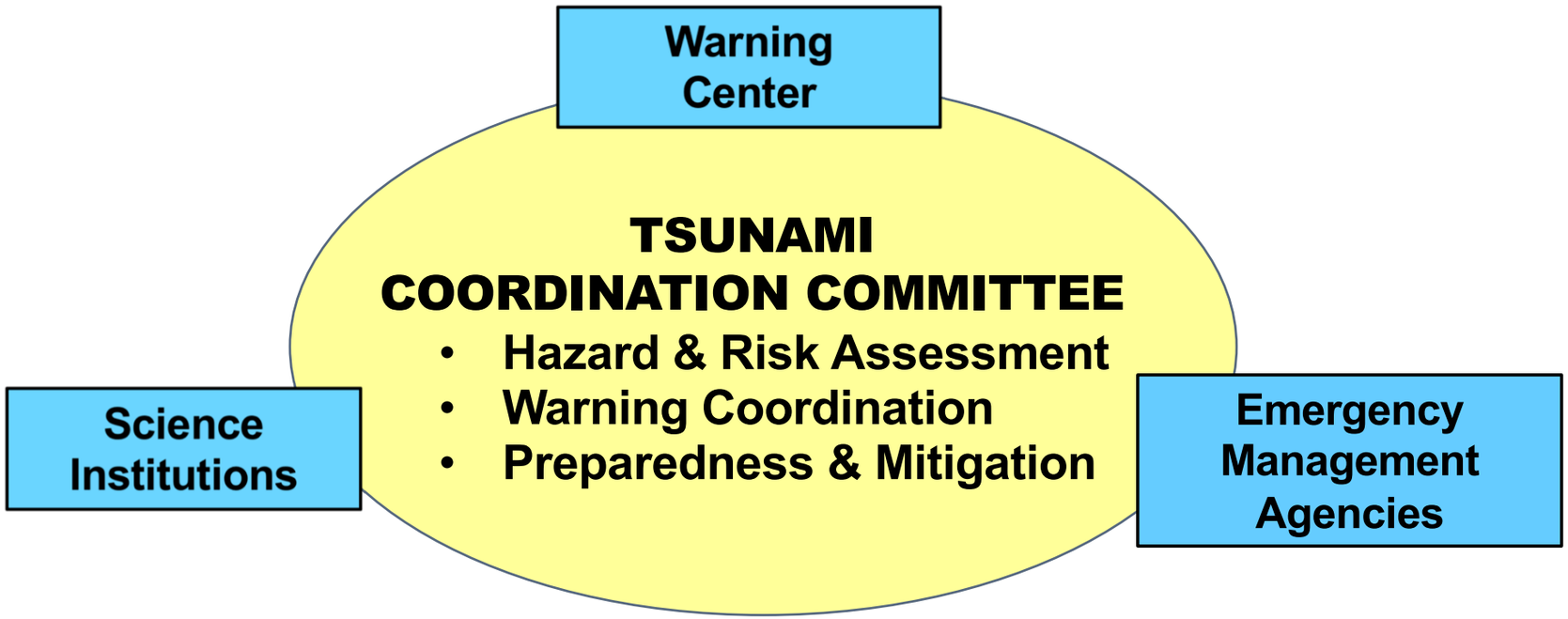
- **Requirements**:
  - Know what to do
    - Develop TWC and TER / DMO SOPs
  - Practice
    - Test Communications end-to-end
    - Conduct Drills since tsunamis are infrequent

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:

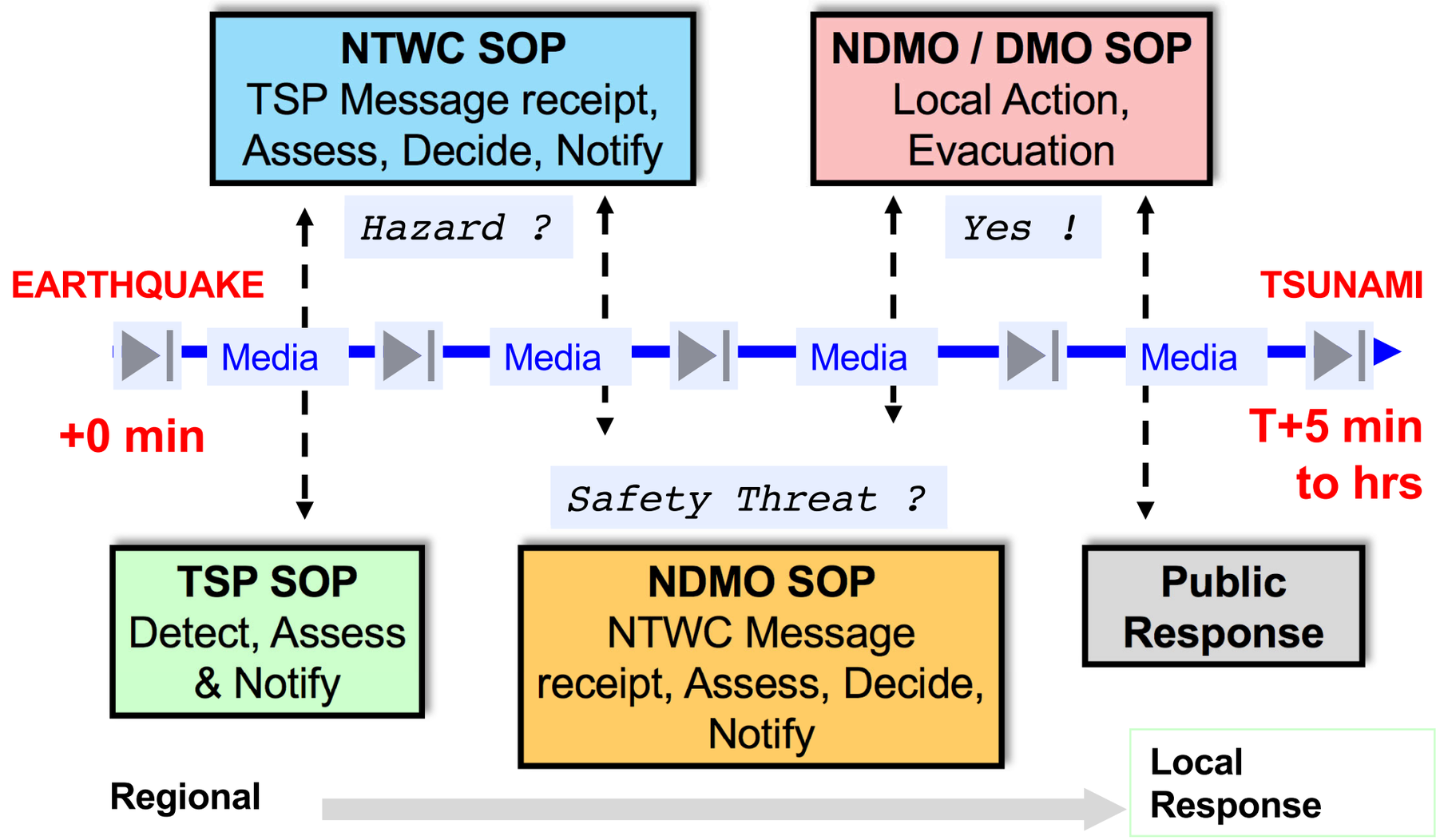
- Planning & Development
- Transportation
- Health & Education
- Coastal Management
- Social Services

Other:

- Media
- Utilities
- Tourism
- International Agencies

ITIC, NZ, IOC, SeismicReady Consulting, 2009-2015

End-to-End Warning and Response



Build Strong, Reliable Systems
Science & Technology

- Earthquake Monitoring and Analysis
- Tsunami Monitoring and Detection
- Forecast Modeling
- Warning Communications
- Hazard Risk Assess – Paleotsunami history
- Hazard Risk Assess – Engineer Strong Structures
- Hazard Risk Assess – Ports and Harbors Policy

Tsunami Early Warning: What needs to be in place to save lives - warn, respond

- **Warn.** Early Detection, Assess, Rapid Alerting

  Earthquake triggers. Forecast gives threat.
  Sea Level Monitoring confirms tsunami

- **Respond.** Community at risk, Evacuate, Safe Return

  Pre-event planning, maps, and practice exercises
  Hazard Risk assessment – vulnerable communities

➢ ***Ready, Rapid, Reliable***

Credibility requires same-quality response (SOPs)

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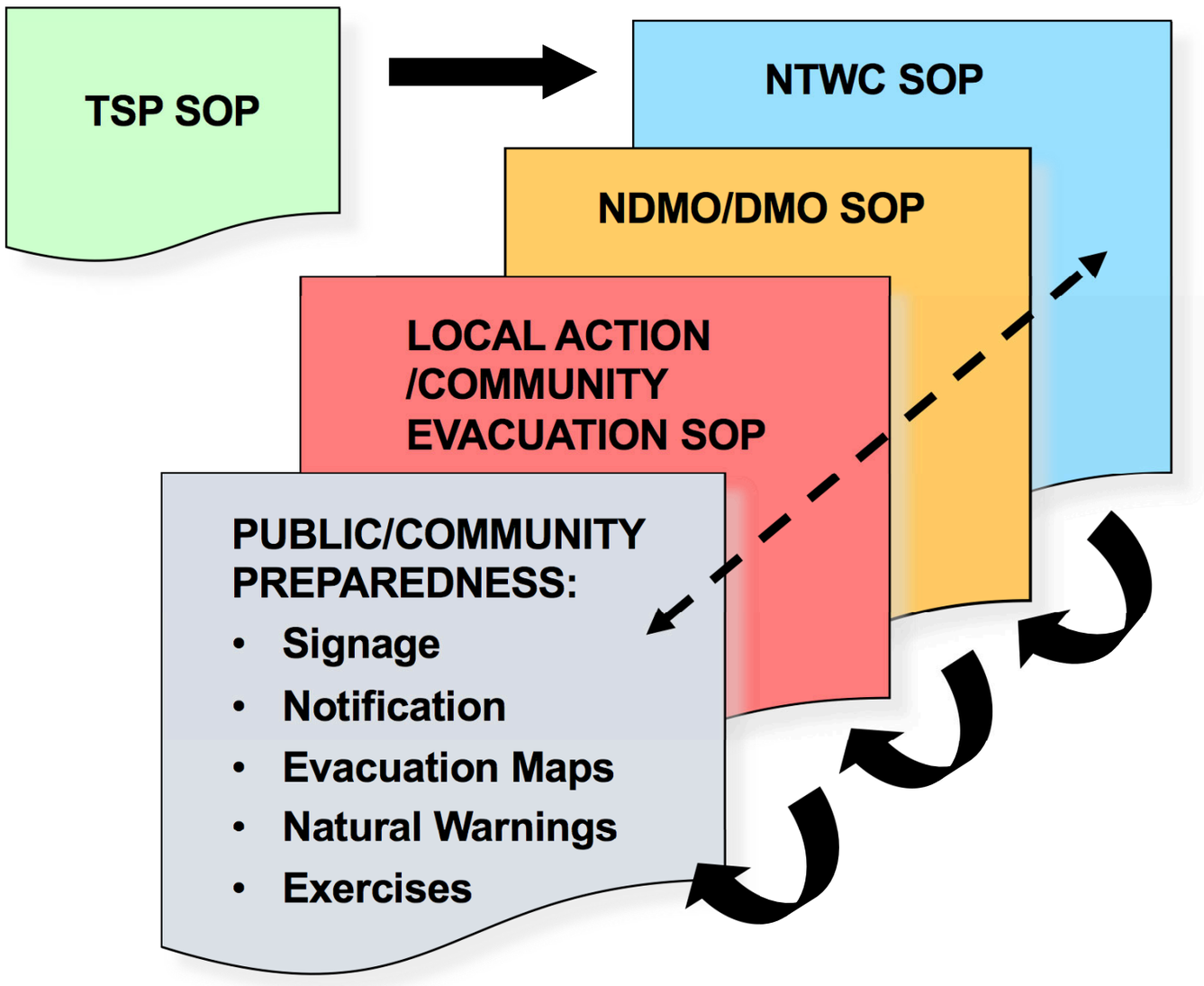
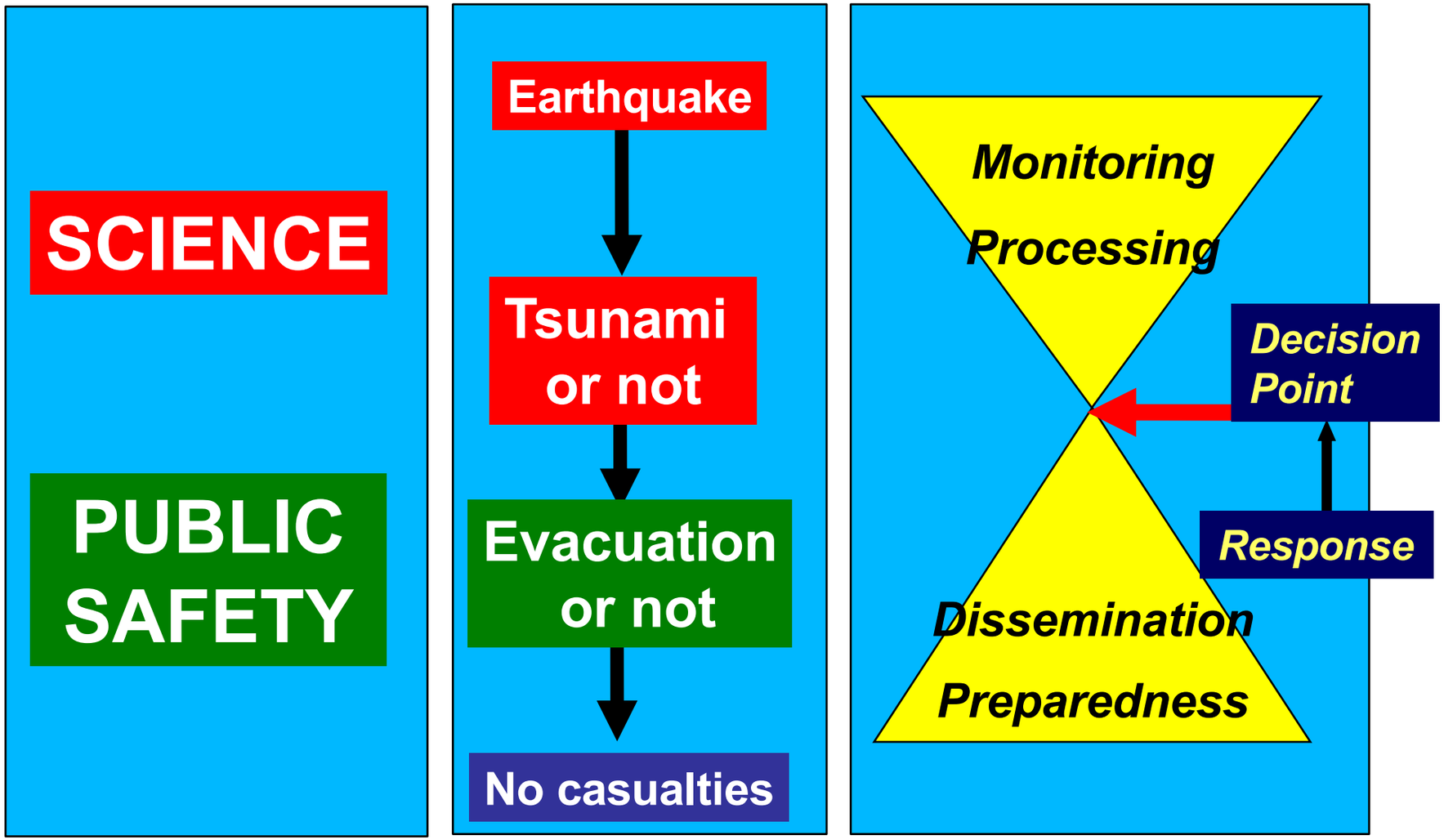
Warning Chain – set of linked SOPs



Plans & Procedures (SOPs): Practice

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

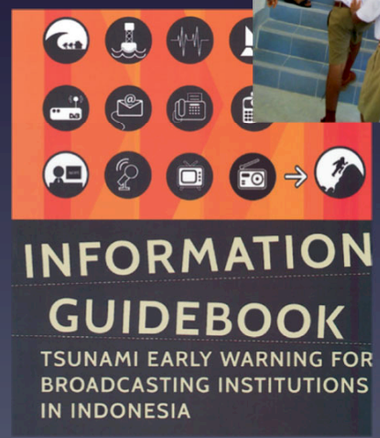
Tsunami Early Warning: Science and Public Safety



ITIC, BMKG, 2009

Build Strong & Reliable Systems Preparedness

- Education and Awareness
- Indigenous Knowledge
- Evacuation
- Exercises
- Training

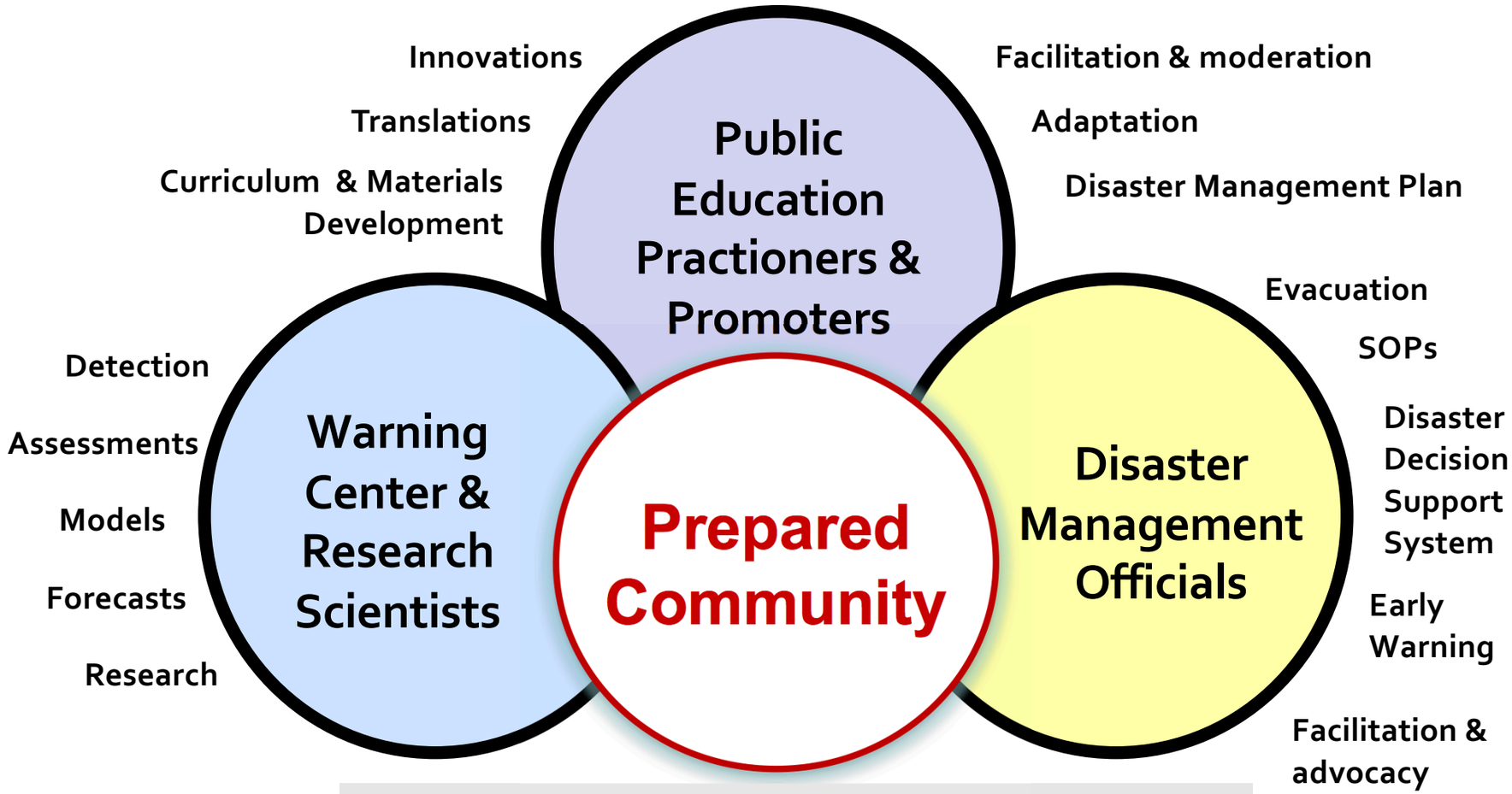


Tsunami Emergency Response:

Alerting a Prepared Public to Evacuate Beaches

- Early and Sustained Education and Awareness
- How will Alerts be quickly disseminated?
- What to expect? Which communities?
- Evacuation - What to do? Where to go?
  - 1st choice: Inland to higher ground
  - Last choice: vertical evacuation

Community Preparedness is collaborative



GOAL: Disaster-resilient community "TSUNAMI READY"

Indonesia, I. Rafliana, 2008
ITIC, L. Kong 2013

Tsunami Evacuation Maps, Plans, and Procedures (TEMPPs)

… communities knowing what to do and where to go

ITIC Essential Community Preparedness
Capacity Building, Honduras, Central America, 2015-16

Great East Japan Tsunami

Warning decision point, Evacuation, and Human Response

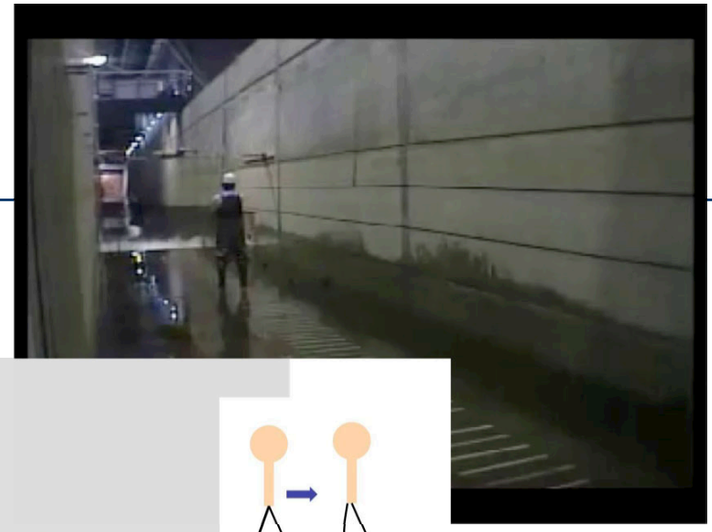
Deciding to issue warnings – Facts

- **JMA Warning timely,** incl wave forecast 3+ m
  (but was underestimate)
- **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

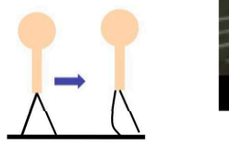
⇒ **NTWC DECISIONS MUST BE CONSERVATIVE (ENSURE SAFETY)**

⇒ **FOR LOCAL, PUBLIC SELF-EVACUATES - DO NOT WAIT FOR NTWC**

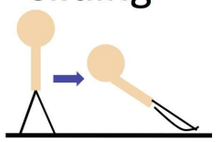
Flow Depth – Humans



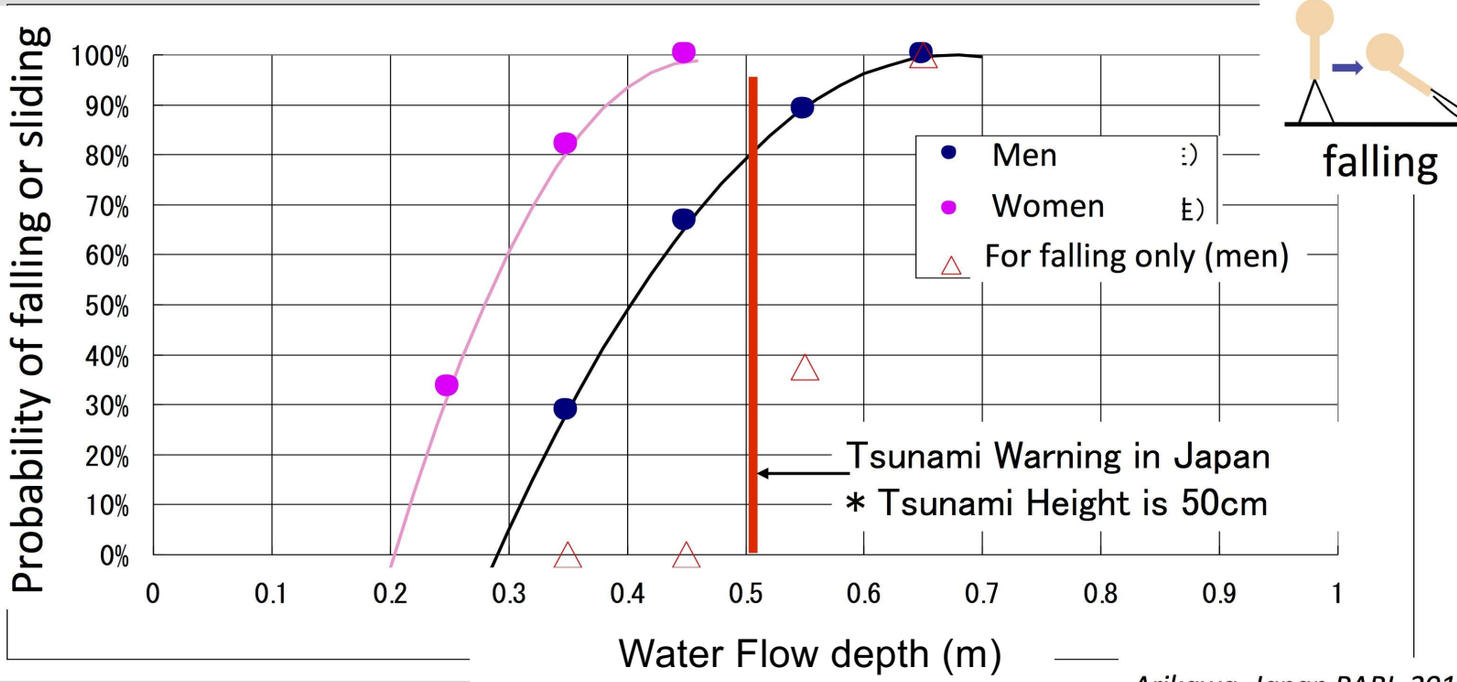
Preliminary Results:
Probability of falling or sliding
=> lose balance at 0.3 m (1 ft) depth



sliding



falling



Arikawa, Japan PARI, 2010

Velocity > 2-3 m/s (7-11 km/hr, 4-7 mph, 4-6 kts)

Onagawa, Miyagi Pref.

PASCO
World's Leading Geospatial Group

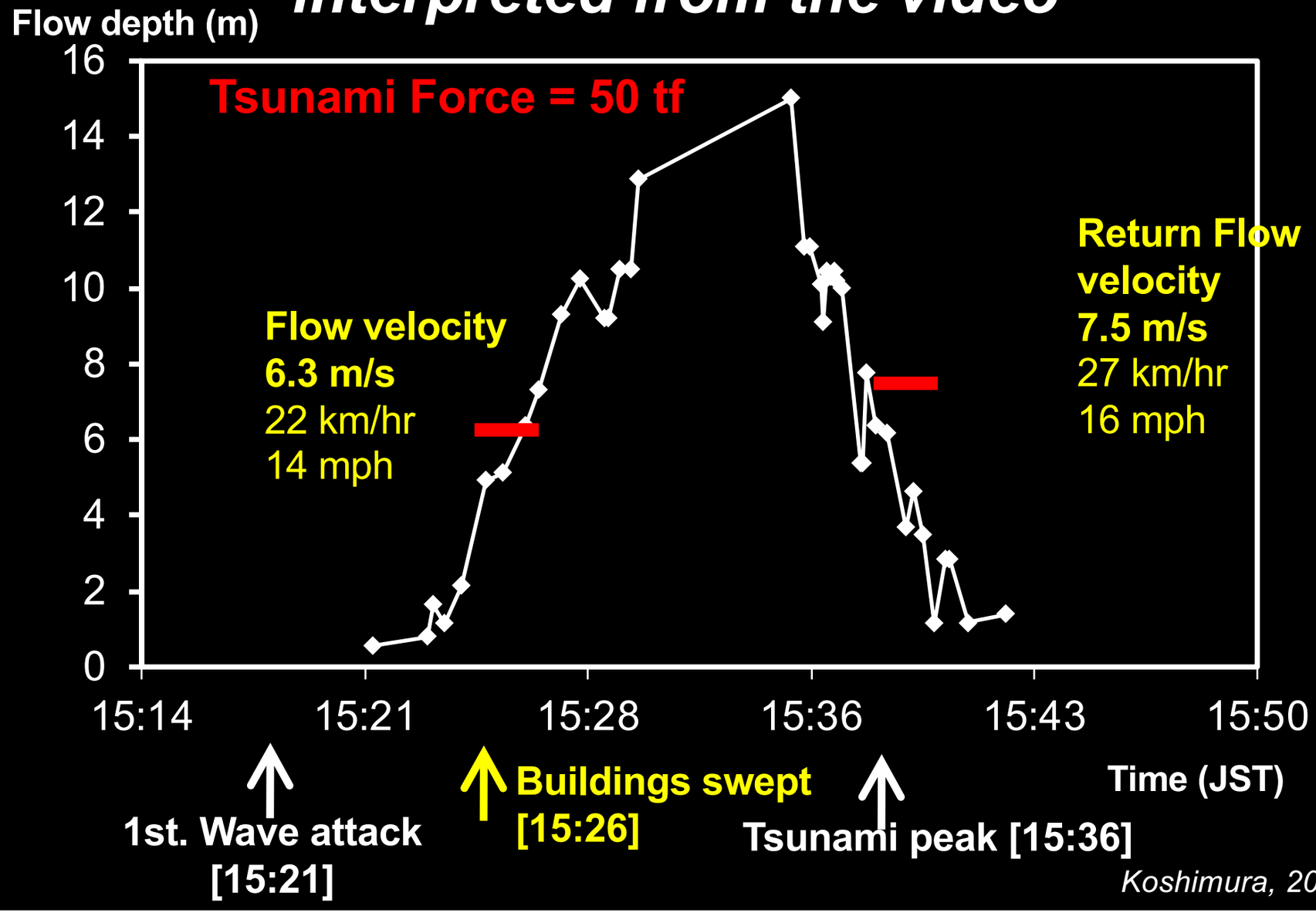
www.town.onagawa.miyagi.jp：
Fatality：455， Missing：739 (Pop.10,010). 12% of population were killed or missing.
Destroyed houses/buildings： 4432. 70% of houses in town was severely damaged.

Koshimura, 2011

Koshimura, 2011


Koshimura, 2011

Time series of tsunami inundation interpreted from the video



Koshimura, 2011

Onagawa, Japan

Koshimura, 2011

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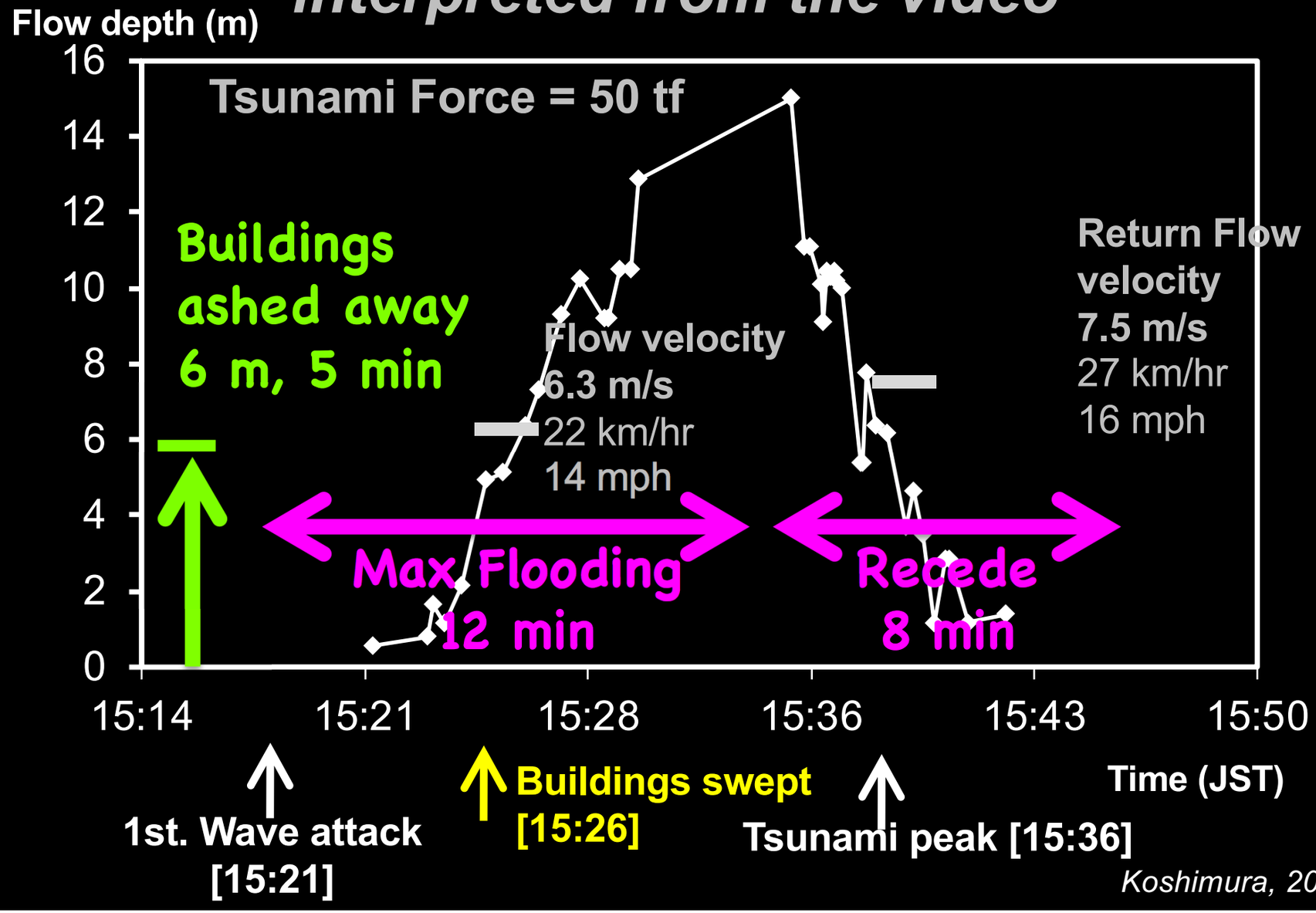
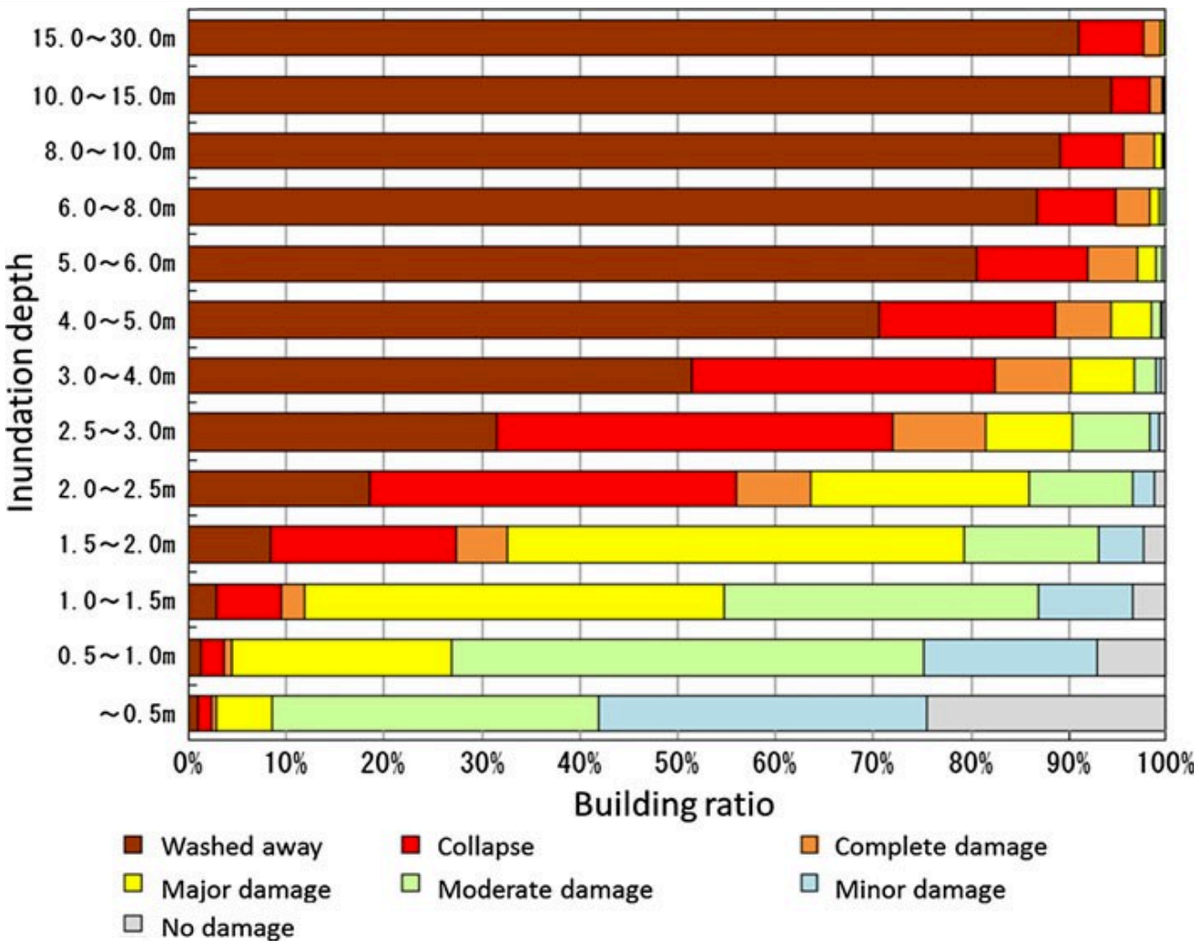


Koshimura, 2011

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

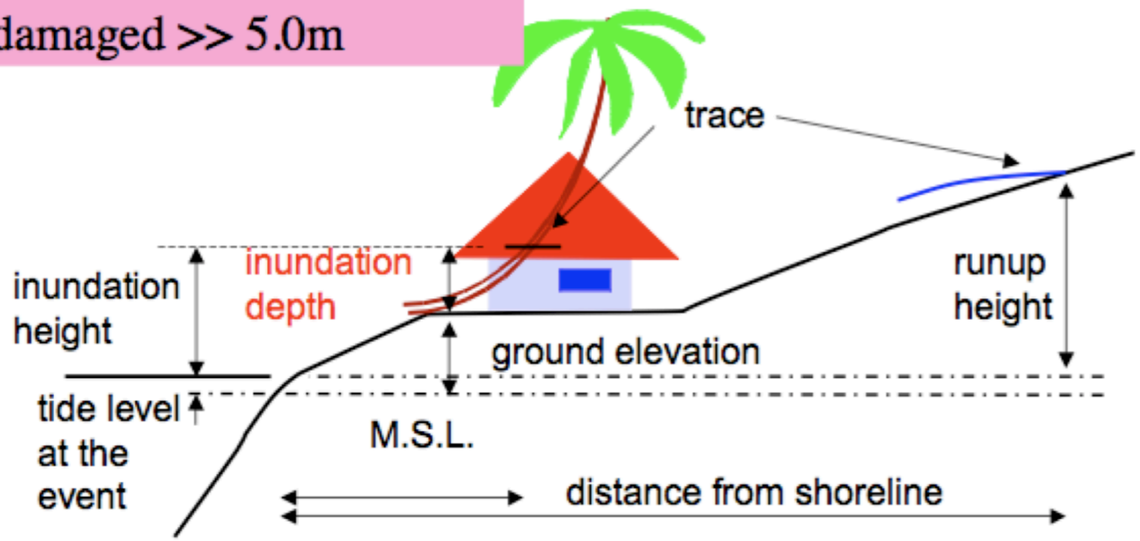
Inundation depth

Human: killed >> 50cm

House: partially damaged >> 1.0m

totally damaged >> 2-3.0m

Building: damaged >> 5.0m



Expect Fast Flooding - Have a Personal Plan

Sendai, Japan, March 11, 2011

Thank You

Dr. Laura Kong
Director, International Tsunami Information Centre