unesco

Intergovernmental
Oceanographic
Commission

Tsunami Warning Centre SOPs – Concept of Operations, Overview of Routine and Event Operations

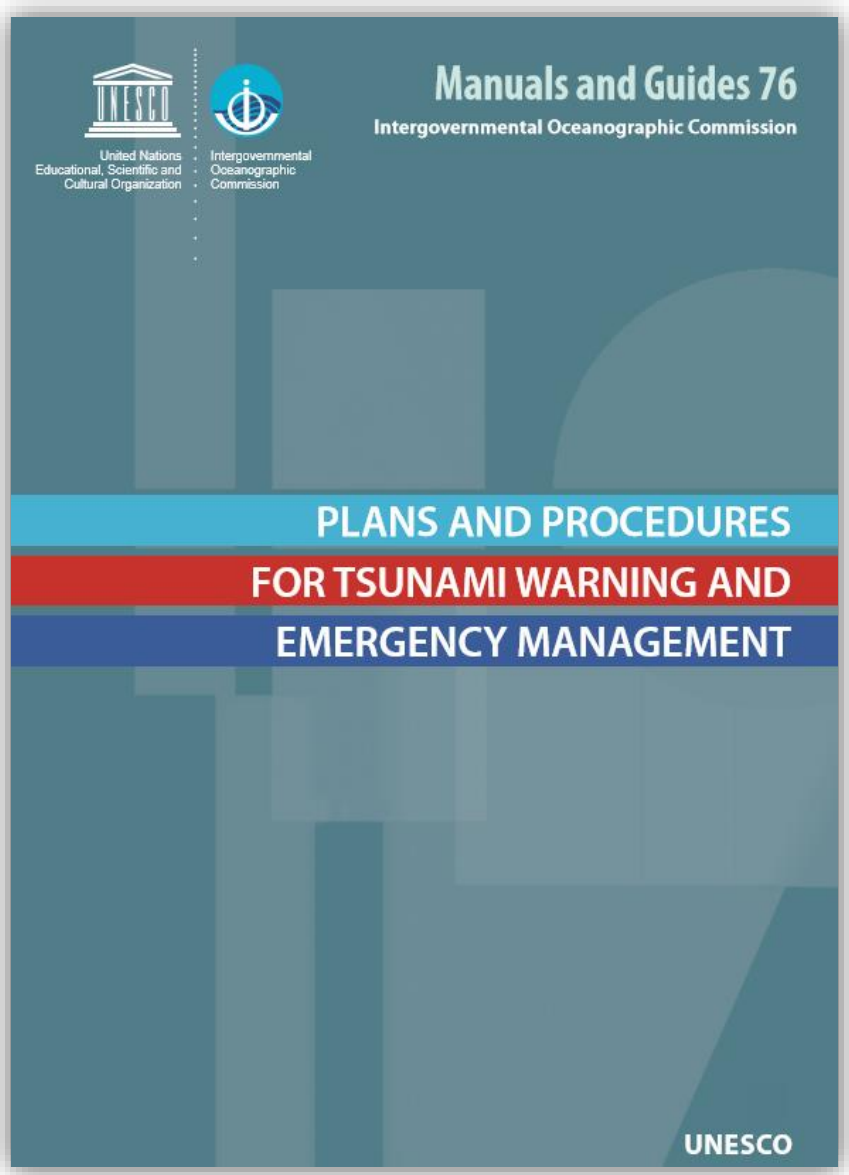
Rick Bailey and Nora Gale
UNESCO-IOC Secretariat for ICG/IOTWMS

ICG Indian Ocean Tsunami Warning & Mitigation System SOP Workshops July 2023:
Standard Operating Procedures (SOPs) for National Tsunami Warning Centres (NTWCs) and Disaster Management Organisations (DMOs)

Outline

A. Types of Standard Operating Procedure (SOP) Related Documents
B. Competency Training
C. Summary

Reference



unesco
Intergovernmental Oceanographic Commission

www.ioc-tsunami.org

A: Types of SOP Related Documents

unesco
Intergovernmental
Oceanographic
Commission

1. High-level documents to establish policy guidelines
2. Comprehensive TWC operations SOP document with details for study and reference during non-crisis
3. Quick-Reference SOP documents for reference during crisis
4. User Guides so recipients understand TWC/TER SOPs and what to expect

CONOPS and SOPs

unesco
Intergovernmental Oceanographic Commission

Concept of Operations (CONOPS)
- High level document
- Describes system components
- Assigns responsibilities

Standard Operating Procedures
- Each system component and responsibility requires an SOP
- Each SOP separate but synchronised

Without CONOPS, SOPs may be unaligned or uncoordinated activities and actions.

Concept of Operations – Typical contents

unesco
Intergovernmental Oceanographic Commission

1. **Purpose of Concept of Operations**
2. **Roles and Responsibilities for**

- ❑ Tsunami risk assessment
- ❑ Receipt and assessment of TSP bulletins and monitoring data
- ❑ Threat assessment
- ❑ Creation and dissemination of warnings (to public, DMOs, and other response agencies)
- ❑ Call for evacuations
- ❑ Media management
- ❑ Public Education

3. **Warning Concept** (thresholds, threat levels, etc.)
4. **Types of Warnings** (including when each will be used)
5. **Glossary**

Policy Guidelines

unesco
Intergovernmental
Oceanographic
Commission

Directives

- TWC Performance Expectations
- Roles & Responsibilities / Concept of Operations
- Maintained by Parent Organisation
- Formal Periodical Review / Change Process with Organisational Stakeholders

Station Duty Manual

- Duty Staff Performance Expectations
- Maintained by TWC Management
- Includes tasks outside Crisis Operations
- Formal Periodical Review / Change Process with Staff

A: Types of SOP Related Documents

unesco
Intergovernmental Oceanographic Commission

1. High-level documents to establish policy guidelines
2. Comprehensive TWC operations manual and SOP document with details for study and reference during non-crisis
3. Quick-Reference SOP documents for reference during crisis
4. User Guides so recipients understand TWC/TER SOPs and what to expect

Comprehensive TWC Operations Manual and SOPs

unesco
Intergovernmental Oceanographic Commission

Should cover:

Details on the main TWC Activities

- Seismic Data Monitoring and Analysis
- Sea Level Data Monitoring and Analysis
- Warning Decision Tools and Procedures
- Warning Dissemination
- Stakeholder Engagement

Emphasise main TWC Characteristics

- Fast
- Accurate
- Reliable
- Effective

SOPs are Living Documents

SOPs are not just about what to do in an Earthquake

unesco
Intergovernmental Oceanographic Commission

They should also be geared to maintaining:

100% Operational Reliability

1. Data availability monitoring
2. Data quality monitoring
3. Maintenance and repair priorities
4. System Alteration Procedures
5. System Failure Procedures

Long Term Readiness

1. Communication Tests
2. Table-top and Live Exercises

Preparedness for other sources of tsunamis

eg Volcanoes, Landslides

TWC Operations Manual (for reference during non-crisis)

unesco
Intergovernmental Oceanographic Commission

Details on Steps to Carry Out

- How ? Why ?

Logical Flow

- Flow Charts, Timelines

Background Information

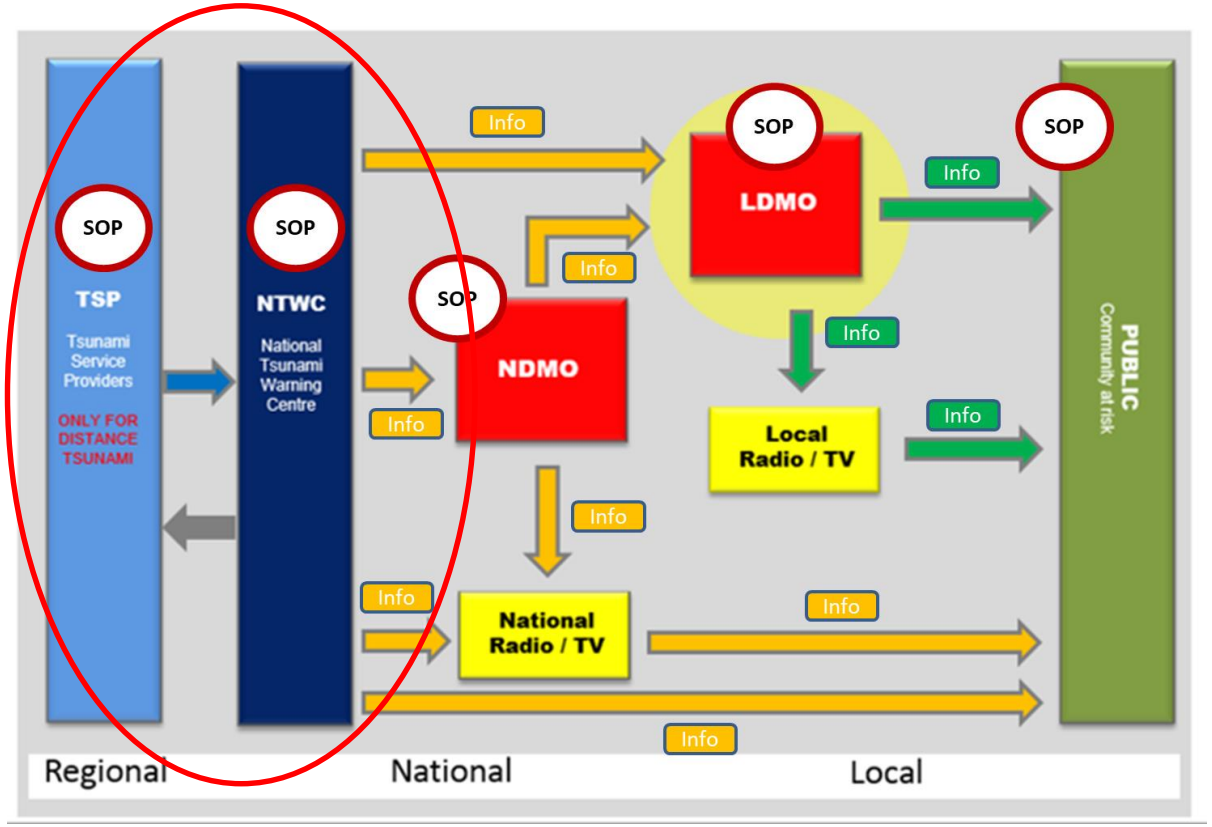
- Scientific Basis
- Organisational Basis
- Definitions

Format

- Paper, Electronic (Web Based)

The logic of SOPs

Information products are distributed and processed along the warning chain



The logic of NTWC SOPs in the warning chain

Input			Proceeding	Output		
What	From whom	How received	Processing the input, decision making and generating the output	What	To whom	How disseminated
Info				Info		
Time in: EQ + x min			**Timeline**			Time out: EQ + x min

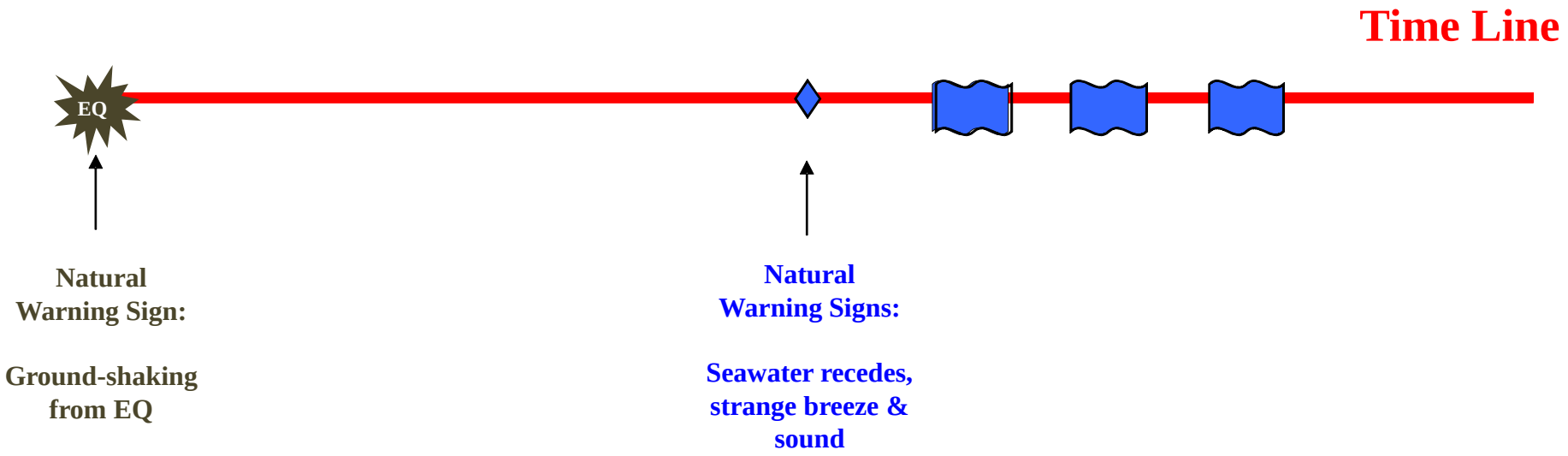
Issues to consider

Decision-making

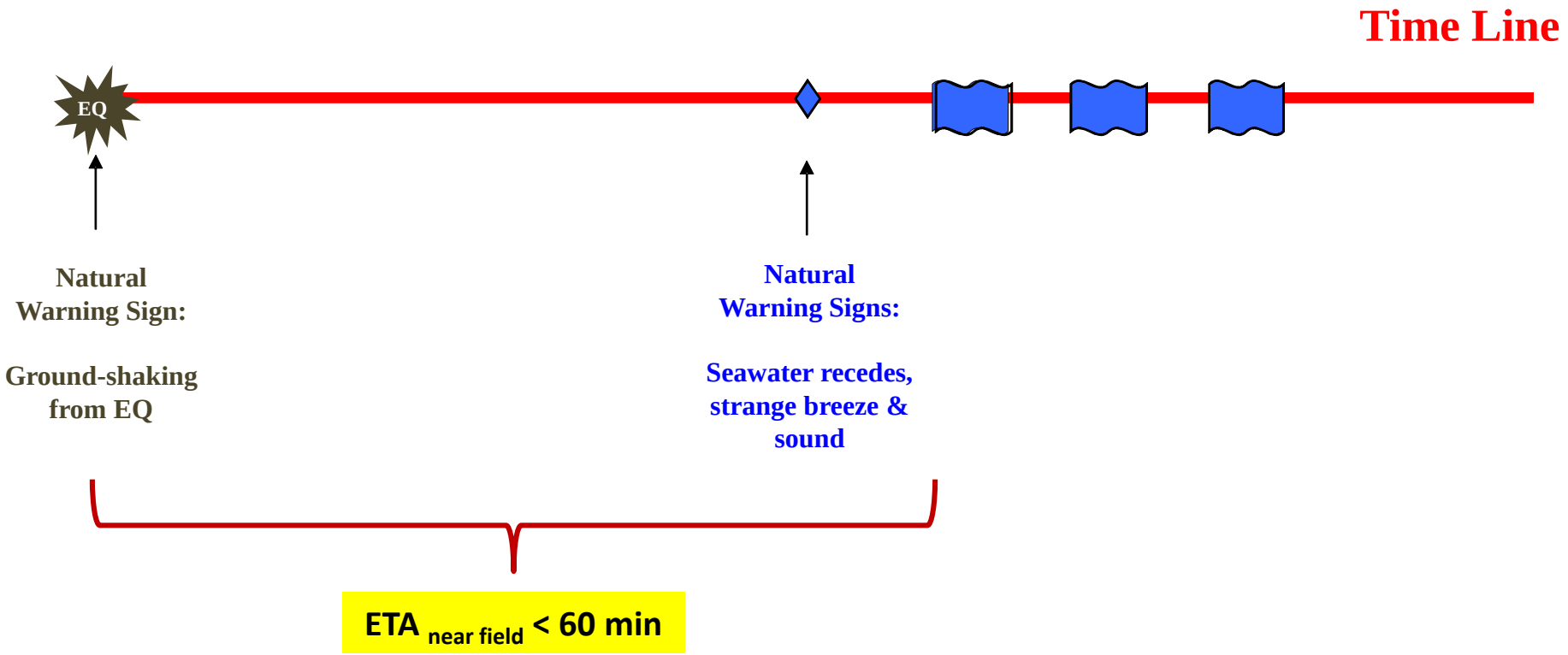
- High level of uncertainty in the case of near-field tsunamis
- Tsunami arrival times, determine critical decision point for each source / source region
- Use a Map & Table for easy reference
- Use Warning Message templates for consistency and easy fill-in
- If issuing warnings to the public with action statements, it’s necessary beforehand to decide when authorisation is required and by who for evacuations.
- Essential to delegate authority for quick response

Warning for near-field tsunamis
Time is the most critical factor

Understanding the time-line for near-field tsunamis

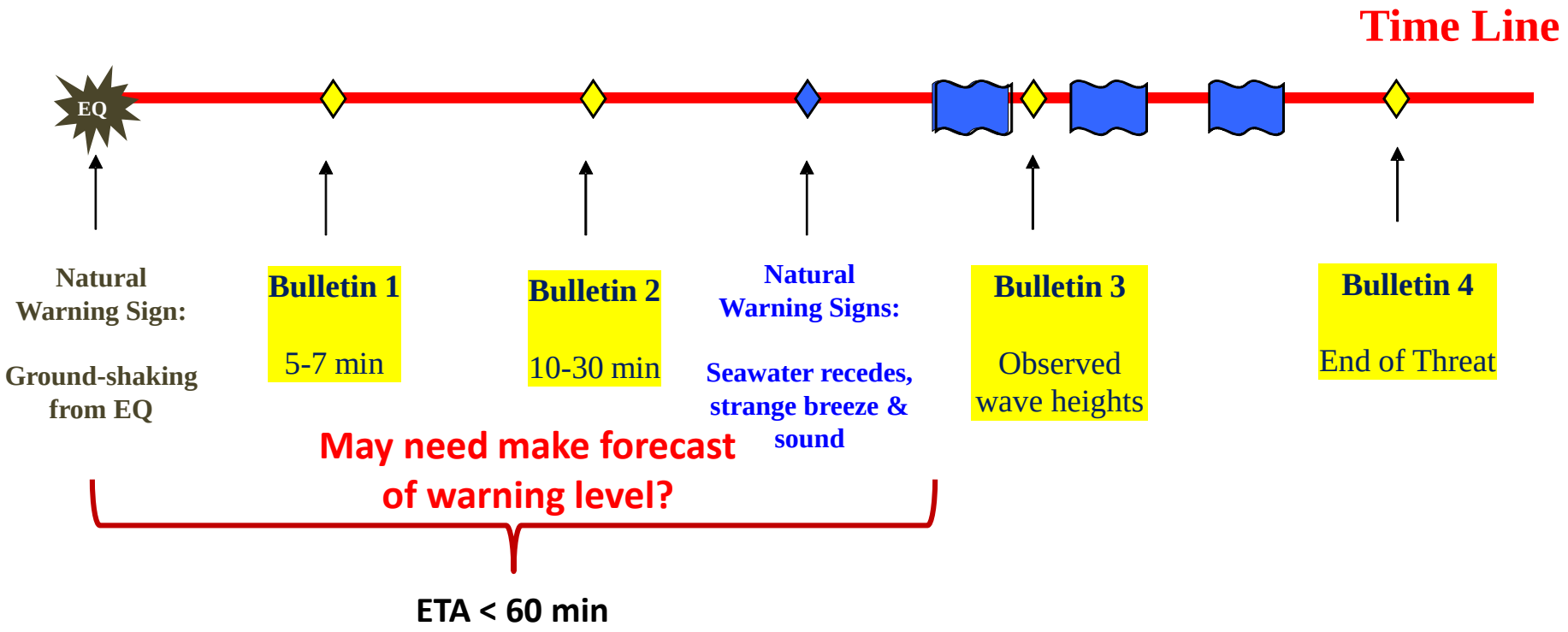


Understanding the time-line for near-field tsunamis

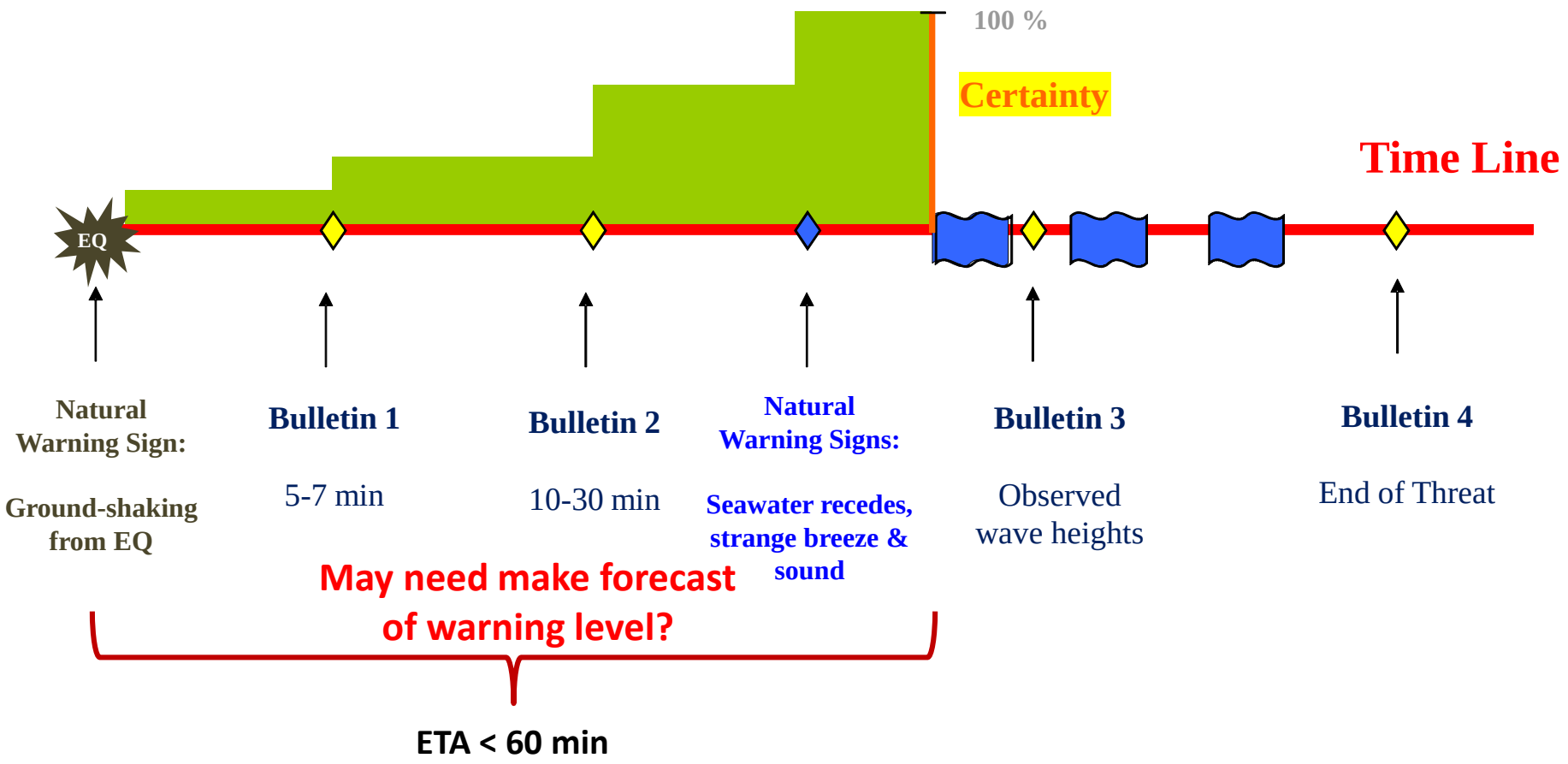


Understanding the time-line for near-field tsunamis

Exemple warning sequence

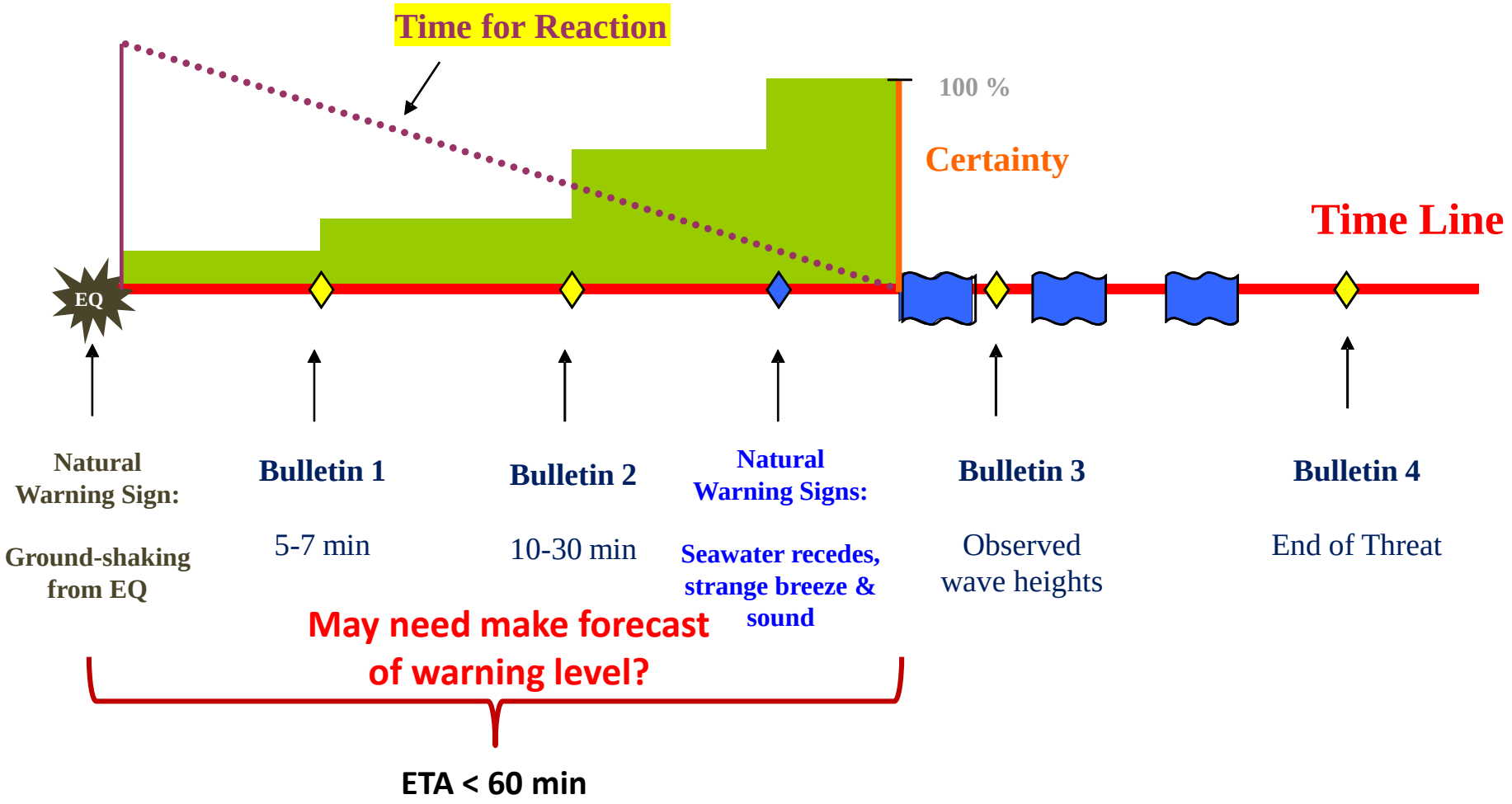


Understanding the time-line for near-field tsunamis
The dilemma of uncertainty



Understanding the time-line for near-field tsunamis

Challenge: decision-making under uncertainty



A: Types of SOP Related Documents

unesco
Intergovernmental Oceanographic Commission

1. High-level documents to establish policy guidelines
2. Comprehensive TWC operations SOP document with details for study and reference during non-crisis
3. Quick-Reference SOP documents for reference during crisis
4. User Guides so recipients understand TWC/TER SOPs and what to expect

C: Quick Reference SOPs – Crisis mode

unesco
Intergovernmental Oceanographic Commission

Timelines & Flow Charts

- Timelines identify need to act rapidly (minutes)
  >> How much time do you have? What information is wanted?
- Flow Charts describe overall flow

Criteria Tables & Checklists

- There is no time to read a detailed manual!
- Allow faster response and help take the pressure off the on-duty staff.
- What to use / What to look at
- What is the action required
- When is the action needed by
- What are the steps/procedures not to forget
- Who to notify (with phone numbers, etc)

Timelines & Flow Charts

- Describe the actions (what will be done)
- Describe the responsibilities (who will do it)
- Are useful as control tools
- Help define processes
- Reality check if timelines meet required deadlines
- Help with SOP development

Timelines & Flowcharts do not:

- Describe how to do the actions
- (Role of SOPs)

Timeline driven SOPs (1)

STEP	TIME since EQ*	ACTIVITY	ACTION AND PROCEDURES
1	1 min	Seismic Alarm Trigger	• Alarm sounds from automated seismic processing system • Feel earthquake and respond, receive phone call or other • For a strongly felt earthquake (greater than Modified Mercalli Intensity Scale VI), alert should be issued immediately to the public and EMA EOC advising to clear the beach
2	2 min	Earthquake Monitoring and Analysis	• Monitor RTED/CISN and other information tools • Receive Information provided by TSP/other Centres • Review/update automatic phase picks and solution. Perform Interactive analysis if required. Highest priority for review is earthquake magnitude and focal depth
3	3 min	Tsunami Threat Assessment	• Obtain ETA by look up in TSP Message • Obtain threat by look up in TSP Message • Calculate tsunami travel times/ETA to nearest coasts or refer to pre-calculated reverse tsunami travel time map ('bullseye' with country as centre • Estimate Threat by o Tsunami Scenario Database look up o Earthquake location, depth, magnitude as proxy for tsunami threat height and area
4	5 min	Issuance of warning and related information	• Use Country Criteria Table to decide on Alert Level. If warning thresholds (for earthquake magnitude or expected tsunami amplitude) are exceeded, issue warning to tsunami-threatened areas immediately. For warning, issue ETAs at forecast points.

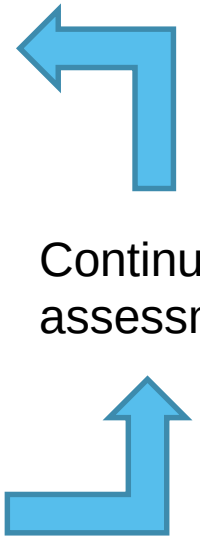
Assuming NTWC has ability to undertake own data analysis and threat assessment

Otherwise… utilise TSP products and bulletins

Timeline driven SOPs (2)

5	7 min	Re-analysis, Tsunami monitoring	• Monitor for updates to earthquake parameters by TSP/other Centres
			• Obtain tsunami observations by loop up in TSP Message
			• Monitor sea level stations near the epicentre
			• Re-evaluation of focal parameters obtained using additional data.
			• Estimate Threat by
			  o Tsunami Scenario Database look up
			  o Real-time Tsunami Forecast modeling
			  o Earthquake location, depth, magnitude as proxy for tsunami threat height and area.

6	10 min	Re-assessment and issuance of new information	• Upgrade warning if observed tsunami higher than expected at Step 3 • Issue tsunami arrival and height observations (Downgrade or Cancel if tsunami is smaller or no tsunami is observed.)
7	10 min to hours	Information	• If tsunami is generated, tsunami information regularly issued until no tsunami threat exists. Neighboring and TSP information should be considered in evaluation.
8	Hours	Cancellation	• If tsunami threat no longer exists, tsunami warning cancellation is issued.
9	Days to weeks	Tsunami science survey	• Survey of tsunami run-up, inundation, and eyewitness observation along coastal area. • Survey of tsunami disaster on people, structures, geology, and social impact and early warning response
10	Week to months	Summary report	• Analysis of the warning centre and emergency response operational procedures • Revision and update of SOP as required



Continuing assessment

Flow Charts

unesco
Intergovernmental
Oceanographic
Commission

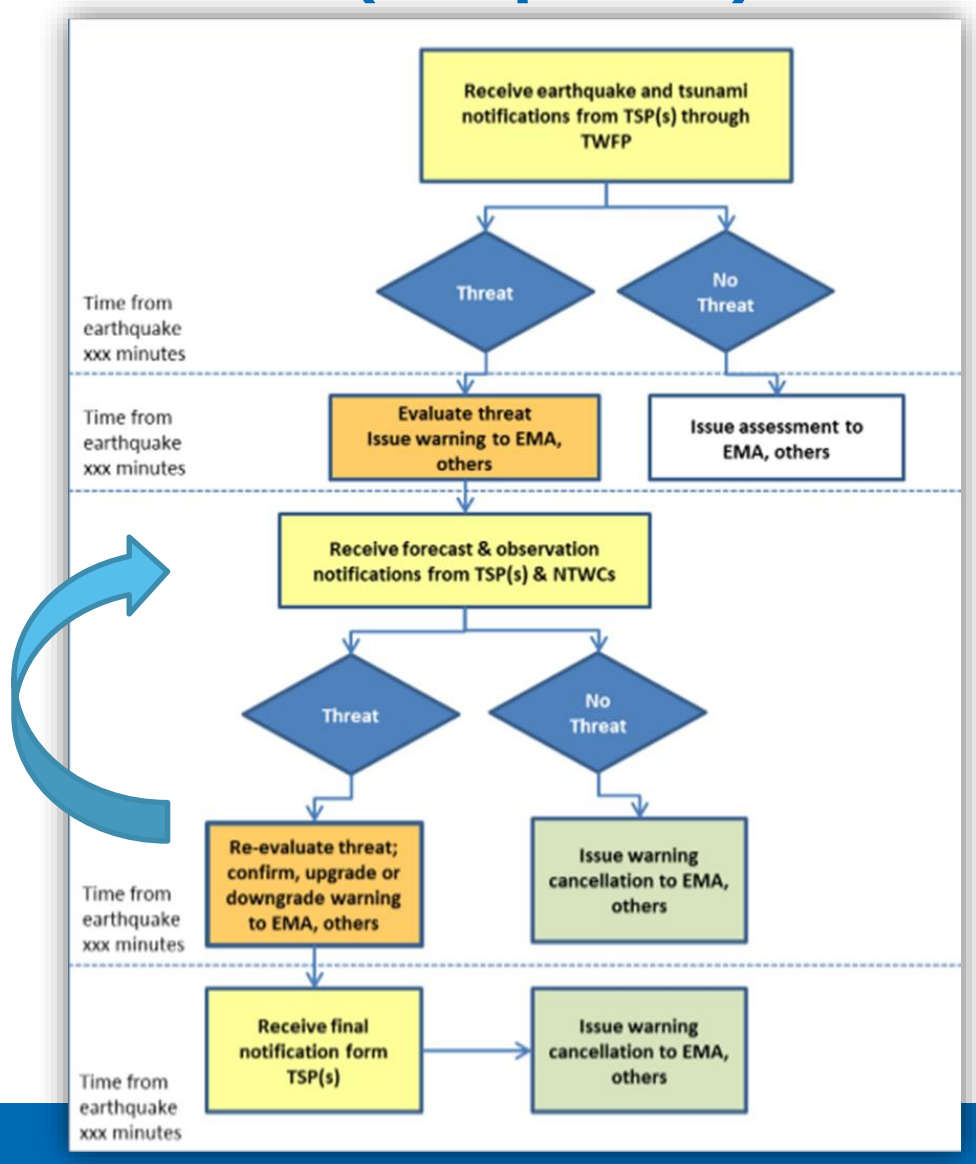
Flow Charts Indicate:

- Steps to be followed
- Decision Tree
- System or subsystems involved

Flow Charts can be nestled

- BUT, often not useful in real event
- Cannot give answer when there is uncertainty or data lacking
- Experience is most important

Event flow chart for NTWC (Simplified)



Criteria Table

Review thresholds to meet national requirements

TSP Message	Earthquake Parameters	Maximum Tsunami Wave Amplitude Indicated	Threatened Coast	Time left to Initial Wave Arrival	NTWC Alert Level for Threatened Coast	Emergency Response Action
Tsunami Threat	Magnitude 7.1 or greater, undersea or very near the sea, and < 100 km depth	≥ 1 m	Sections of coast with forecast amplitudes ≥ 1 m	< 3 hrs	WARNING	Evacuate xxx zones
				3 to 6 hrs	WATCH	Standby, Prepare to evacuate
				> 6 hrs	INFORMATION	Monitor for subsequent forecasts
		0.3 to 1 m	Sections of coast with forecast amplitudes 0.3 to 1 m	< 3 hrs	WARNING	Evacuate beaches and harbours
				3-6 hrs	WATCH	Standby, Prepare to evacuate
				> 6 hrs	INFORMATION	Monitor for subsequent forecasts
		< 0.3 m	None		INFORMATION	Monitor for subsequent forecasts

LAND THREAT:
Threat of
land inundation

MARINE THREAT:
Threat of dangerous currents, etc, only within marine environment

NTWC checklist for issuing a tsunami message

unesco
Intergovernmental Oceanographic Commission

- Send Message ☐
- Read Message on telephone hotline (voice alert) ☐
- Check that all messages transmitted and resend if necessary:
  - GTS ☐
  - SMS / RSS ☐
  - Fax ☐
  - Web site ☐
  - Email ☐
  - EMWIN ☐
- Call persons on Telephone Call Down List ☐

Continuing activities

- Call closest affected provinces / communities:
  - Confirm message received ☐
  - Ask if they have any eyewitness reports ☐
- Display marigrams and monitor nearest sea-level gauges for tsunamis ☐
  - (Tide Tool, IOC SL Monitoring Site, other national sources) ☐
- Measure tsunami wave amplitudes and arrival time on sea-level gauges ☐
  - (Tide Tool, other national sources) ☐
- Run Tsunami Forecast Model software or look up in Tsunami Scenario Database ☐
- Review historical information ☐
- Check for Tsunami or Slow Earthquake (Mw vs Ms, Theta) ☐
- Monitor for updated EQ parameters and CMTs, or compute CMTs (email, other) ☐
- Appoint and deploy a tsunami advisor to the EMA ☐

A: Types of SOP Related Documents

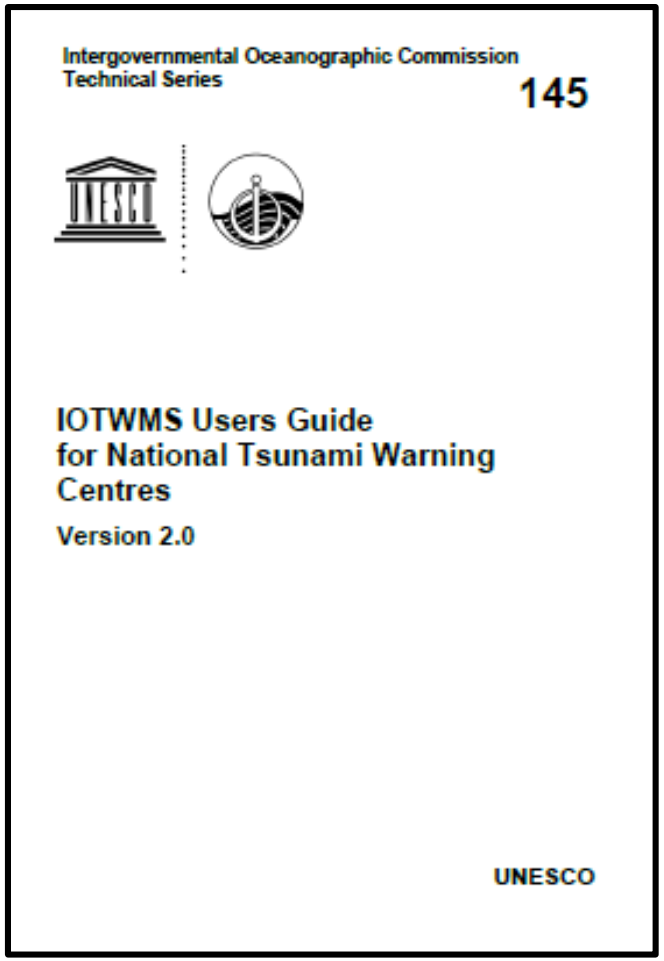
unesco
Intergovernmental Oceanographic Commission

1. High-level documents to establish policy guidelines
2. Comprehensive TWC operations SOP document with details for study and reference during non-crisis
3. Quick-Reference SOP documents for reference during crisis
4. User Guides so recipients understand TWC/TER SOPs and what to expect

IOTWMS TSPs User Guide

Describes for NTWCs:

1. What products they may receive
2. When they may receive the products
3. Uncertainties in the threat assessment
4. Contact information



IOTWMS TSP User Guide is available from:

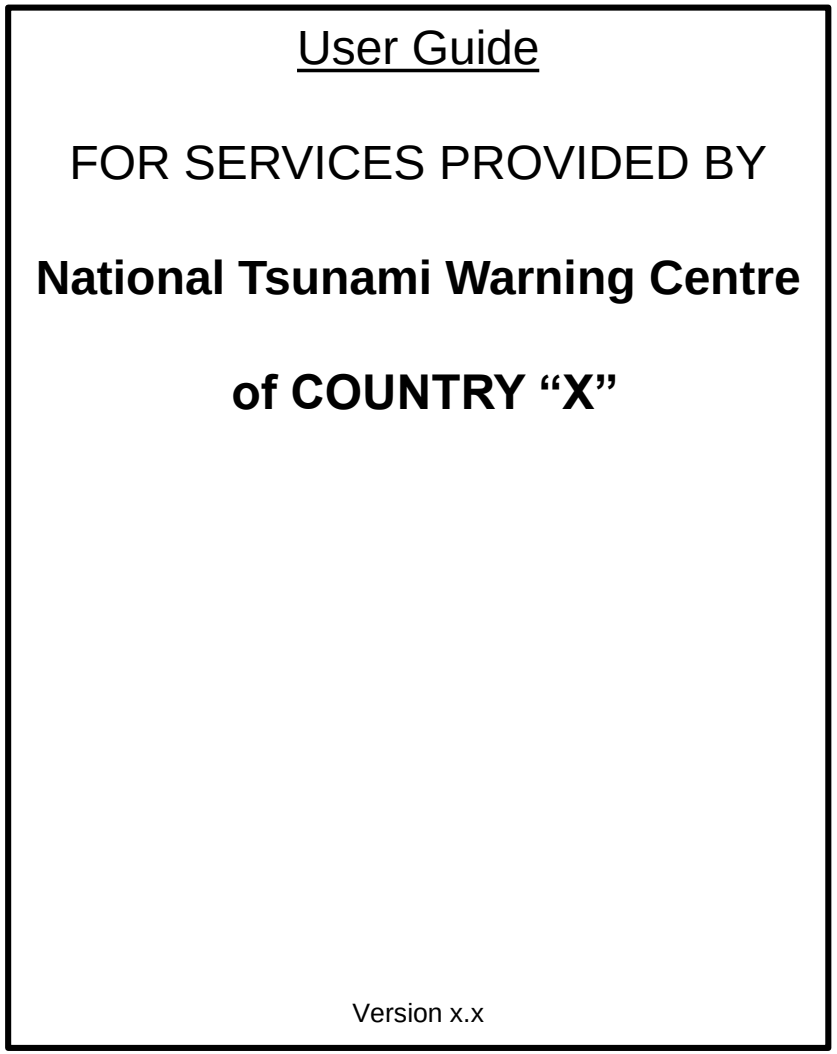
http://ioc-tsunami.org/

unesco
Intergovernmental
Oceanographic
Commission

NTWC User Guide

Describes for users/stakeholders:

1. Awareness information on the threat
2. What products they may receive
3. When they may receive the products
4. Uncertainties in the threat assessment
5. Contact information



unesco
Intergovernmental Oceanographic Commission

B: Competency Training

Competency is defined as “the ability to do something successfully or efficiently”

In time-critical, emergency situations, on-duty staff must competently:

- ❑ Understand the Warning Process
- ❑ Know their and other’s roles and responsibilities
- ❑ Be proficient in the use of the required tools and procedures
- ❑ Apply the relevant skills and expertise for their position
- ❑ Undertake their duties within the timelines
- ❑ Not develop and introduce untested new procedures on the fly

Competency training for each staff member must be conducted regularly

C: Summary

unesco
Intergovernmental Oceanographic Commission

- ✓ National Tsunami Warning System requires Concept of Operations and set of linked, integrated SOPs
- ✓ SOPs required for non-crisis and crisis operations
- ✓ Timeline-drive SOPs required for local source/tsunami and distant source/tsunami events
- ✓ Flow charts show overall flow of information, but checklists allow for guided and faster response
- ✓ TWC SOPs should be strictly followed in an event, then reviewed and revised after the event if necessary.
- ✓ TWC SOPs should be linked to SOPs of DMOs, Broadcast Media, and other response agencies and regularly exercised
- ✓ Staff should be trained and competencies assessed regularly

unesco
Intergovernmental
Oceanographic
Commission

THANK YOU