TWC Operations: Sea Level Monitoring
- Use, Instruments, Limitations, Challenges

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Why Sea Level Gauges are Needed

- To verify if a tsunami exists or not
- To measure tsunami size for decision-making
  - Compare with historical data
  - Constrain forecast model
- To aid in response
  - How bad was it?
  - Is it safe to go in?
Rarotonga (float)
Two Basic Types of Sea Level Gauges

- **Coastal**
  - Good for comparison with historic events
  - Observation at coast
    - Used to authoritatively cancel events
  - Heights sensitive to local effects (coastal shape, bathymetry, etc)

- **Deep Ocean**
  - Best for constraining forecast models. Heights not affected by local effects – ‘pure’ tsunami signal
  - Observations in deep water. Not likely to be destroyed by wave
  - Forecast models required to interpret deep-ocean observations
Typical Coastal Gauge

- Mechanical level
- Acoustic sensor
- Pressure sensor
- Radar
Tidal observation equipment in JMA

- Tsunami Gauge
- Transmitter/Receiver
- Supersonic waves

Acoustic gauge in the Open Air

Float gauge in the Stilling Well

Acoustic gauge with Sounding Tube
Instruments

Fuess type gauge  Acoustic gauge  Pressure sensor
Miyako: Observed Maximum height is 8.5 m at 06:26Z

Ofunato: Observed Maximum height is 8.0 m at 06:18Z
The tsunami signal is detected by a pressure sensor on the ocean floor. That signal is relayed by acoustic telemetry to the buoy. The buoy in turn transmits the signal via satellite back to the warning centers.
In case of big Tsunami?
Sea Level Gauge Data Streams

- **Sample Rates**
  - 15s: Optimal For TWS
  - 1 minute: Good For TWS
  - 2 minute: OK For TWS
  - 6 minute: Can be Used
  - 15 minute: Not useful for TWS

- **Transmission Rates**
  - Real-time: Optimal
  - 3-6 minute: Very Good
  - 15 minute: Good
  - 1 hour: Poor
  - 3 hours: Not useful
Concept of the Tidal Data Collection System using the Geostationary Meteorological Satellite of Japan

Acquisition of Tidal Data
1.6 GHz band

Acoustic gauge
Pressure sensor

Report of Tidal Data
402 MHz band

Transmission of Data
• Transmission Interval: 6 min., 12 min. or 15 min.
• Transmission Period: Within 1 min

Global Telecommunication System (GTS)

PTWC

National Meteorological Services (NMS)

JMA HQ

CDAS

MSC

Pressure sensor

Acoustic gauge

Tidal Observatory
November 4, 1952 Tsunami Recorded at Port Hueneme, CA Tide Gage
Start Time - 2339 11/04/1952 (UTC)

Tide Gage Record Showing Tsunami
PAGO PAGO, SAMOA
November 5, 1952
2 days tsunami records (Western part of Japan)
Limitations of Sea Level Data Analysis

- **Type of Sea Level Measurements**
  - **Coastal Gauge**
    - Most common
    - Signal highly modified by coastal effects
    - May be destroyed by large tsunami
  - **Deep Ocean Gauge**
    - Less common
    - Most expensive
    - Pure tsunami signal to constrain forecast
  - **Wet Sensor**
    - On land
    - Less expensive
    - Only indicate if flooding has occurred
Limitations of Tsunami Forecasting

- **Estimated Arrival Time Forecast**
  - Based on initial seismic analysis
  - Point source or assumed finite fault

- **Initial Threat Level Forecast**
  - Based only on initial seismic analysis and general geophysical/oceanographic constraints
  - Least accurate

- **Sea Level Constrained Forecast**
  - Too late for local tsunami
  - Deep ocean measurements best constraint
  - More accurate
Tsunami Travel Times from Small Source
Tsunami Travel Times from Large Source
Limitations of Tsunami Forecasting

- **Historical Comparisons**
  - Historical record is very short and incomplete in most areas
  - No repeat events
  - May be okay to identify coastal sensitivities
Limitations of Messages / Dissemination

- **Message Content**
  - Should be simple and to the point
  - Should contain key information
    - Situation Evaluation and Summary
    - Seismic Parameters
    - Predicted Threat Level
    - Estimated Tsunami Wave Arrival Times
    - Key Tsunami Wave Measurements
    - **Recommended Actions**
  - Tied to SOPs and trigger SOP actions
Thank You

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