Detection of the 26 December 2004 “Sumatra Tsunami” on the Eastern Atlantic Coast

By

Antony Joseph, Joseph T. Odametey, Emmanuel K. Nkebi, Ehrlich Desa, Arvind Pereira, R. G. Prabhudesai, Prakash Mehra, Alexander B. Rabinovich, Vijaykumar, Shivanand Prabhudesai, and Philip Woodworth

Tidal measurement:

- Tidal measurement began in the then Gold Coast in 1927 at the Takoradi Harbour. Main aim then was to control movement of ships in and out of the harbour. This makes Takoradi harbour one of the oldest in Africa and most reliable for sea level measurement. In view of this Takoradi was designated as a Global Sea Level Observation System (GLOSS) station.

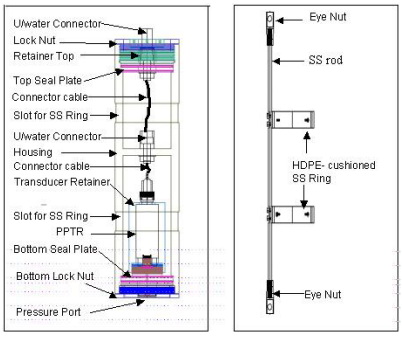
SURVEY DEPARTMENT

- The Survey Department has been the main agency for tidal data collection at Takoradi and later (1961) at Tema harbours.
- The data collected in raw form are sent to the Permanent Service for the Mean Sea level (PSMSL) at the Proudman Oceanographic Laboratory (POL) in the United Kingdom for analysis.

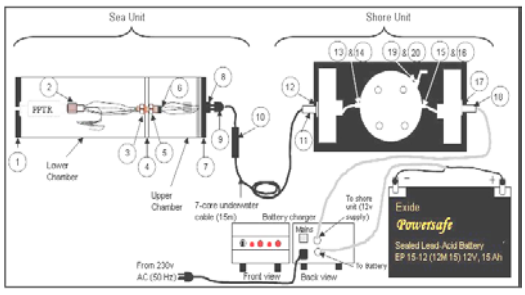
INDO-GHANA COOPERATION

- The Government and People of India through the National Institution of Oceanography (NIO) – Goa presented two Precision Pressure Transducer Tide Gauges and a Weather station to the Government and People of Ghana on south – south cooperation. The gauges presented were the first of its kind in the country and are purely digital.

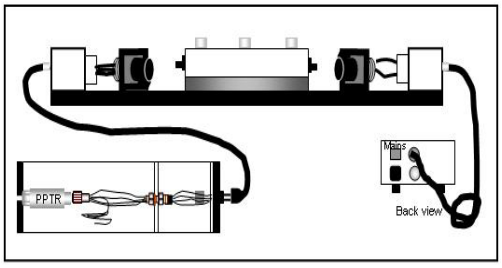
Cross-sectional View Of Pressure Proof Housing Of NIO Sea Level Gauge’s Sea-unit.



Schematic Layout Of Mechanical Assembly Of NIO Sea Level Gauge (Plan View).



Schematic Layout Of Mechanical Assembly Of NIO Sea Level Gauge



Map Indicating The Measurement Site (Takoradi Harbor), Ghana

Schematic Diagram Of The GLOSS Sea Level Station At Takoradi Harbour

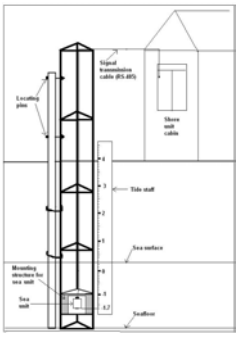
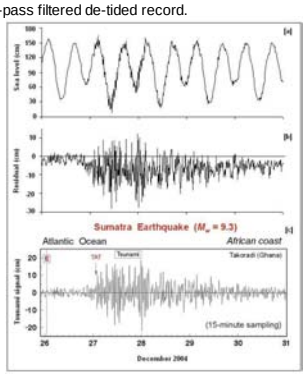


Illustration Of Sea Level Gauge Installation Details At Takoradi GLOSS Station

Tsunami (2004) signal at Takoradi

- In an attempt to examine the global reach of the December 26th 2004 tsunami signal, as a result of the Sumatra earthquake the only available sea level data from the Central West African coast, namely the GLOSS sea level station at Takoradi, was examined

Tsunami signal at Takoradi harbour subsequent to the 26 December 2004 Sumatra earthquake; (a) Time-series sea level record, (b) De-tided sea level record, (c) High-pass filtered de-tided record.



Data quality

- The data were free from erroneous spikes and gaps.
- While the sea level record on 26 December is remarkably smooth, the record from 27 December clearly shows the presence of some disturbances.

Methodology

- To examine the possible presence of a tsunami signal, the astronomical tides were removed from the tide gauge data by calculating the tides from the sea level measurements for the period from 1 July 2004 to 31 June 2005 using the TASK software package.
- The de-tided record (Fig. b) shows the presence of a residual lowering of the water level. This signal was removed by high-pass filtering the de-tided sea level record.
- The resulting series (Fig. c) was used for analysis of tsunami waves. Figures 4b and 4c clearly depict a discernible tsunami signal which started at about the predicted tsunami arrival time (TAT) and continued up to 31 December 2004. The predicted TAT was computed using a simple ocean model (West Coast/Alaska Tsunami Warning Center (WC/ATWC) 2005).

Observations

- From spectral analysis of the time series the tsunami had a mean period of 45 minutes.
- A small residual lowering of sea level (up to 10 cm) observed in Fig. b for a period of approximately 4 days, during which the tsunami signal was present in varying energy levels, could be due to the passage of internal waves through the Gulf of Guinea in association with the passage of tsunami waves.
- This observation is consistent with theoretically feasible lowering of sea level along with a tsunami wave.

Observations

- Another observation is the presence of two distinct bursts at discrete times — the peaks of whose envelopes are separated by 13.68 h, and the second burst is larger in height by several cm.
- The observed second burst at Takoradi is interpreted to be evidence of reflected tsunami waves. The reason for larger height to the second burst could be focusing of tsunami waves from certain regions of the continental shelves or from the Mid-Atlantic Ridge

Observation

- The continuous presence of tsunami wave-field (signal) at Takoradi up to 31 December with gradually reducing energy levels (as evidenced from the sea level data) could be attributed to dispersed secondary- scattered/reflected signals arriving from far-off continental shelf or mid-ocean ridges.

Observations

- Analysis of sea level data from the Takoradi station clearly reveals a tsunami signal at about the expected time of arrival.
- The tsunami arrived at this location after traveling for about 24 hours and 39 minutes.
- The first wave was negative (trough), and the observed period was about 45 minutes. The maximum trough-to-crest wave height was 39.6 cm.
- The presence of two distinct bursts separated in time by 13.68 h

Conclusion

- The prominent signal found in the Takoradi sea level record indicates that tsunami waves could be traced also at other regions of the West African coast.
- Considering the fact that this is the only measurements in the entire long stretch of the West African coast (except those from South Africa), the data obtained from Ghana is invaluable for understanding the global character of this tsunami and also for the verification of numerical models.
- Along the Atlantic coast of Africa and South America, very few sea level data are available, and therefore, had it not been for the presence of the GLOSS gauge at Takoradi, model verification of the propagation characteristics of tsunami waves in the Atlantic Ocean with adequate precision would have been greatly hampered.

Special Acknowledgement

- The authors gratefully acknowledge the support rendered by the ff.
- Council of Scientific & Industrial Research (CSIR) of India
- Ocean Data in Africa Project of Intergovernmental Oceanographic Commission of UNESCO
- The Survey Department
- The Hydrological Services Department
- The Ghana Ports and Harbour Authority
- The Meteorological Services Department
- They are thankful to:

  Mr. Jean Dotse (Director of Surveys, Ghana)

  Mr. Julius Wellens-Mensah (Director, Hydrological Services Department, Ghana), for their support during various phases of the project implementation.

- Thank you