

National Report to GLOSS GE XII

Indonesia Sea Level Monitoring

Khafid

National Coordinating Agency for Surveys and Mapping (BAKOSURTANAL),
Jl. Raya Jakarta-Bogor Km 46 Cibinong INDONESIA.

Email: khafid@bakosurtanal.go.id

Introduction

Since 1984, National Coordinating Agency for Surveys and Mapping of Indonesia (BAKOSURTANAL) has been developing and operating the National Permanent Sea Level Monitoring Network. Initially, the equipments were developed using graphic/analog system and it is intended to support the determination of vertical datum for surveying and mapping purposes, navigation and coastal management that do not require data in real time. The number of tide gauges is increased from year to year in line with the increasing needs of reference vertical datum for levelling networks to support surveying and mapping activities. The early implementation was started by BAKOSURTANAL with 8 analogue stations. The number of new stations increased by about 2 per year, except for a significant increase of 25 digital stations in 1998 to support the bathymetric mapping of the Exclusive Economic Zone (EEZ) and Sea Line Passages in Indonesian waters. The Indonesian Sea Level Monitoring Network before the 2004 Sumatra Tsunami consisted of 60 stations, of which 35 stations were using analogue graphical chart recorders and 25 stations were using digital recorders with Public Switch Telephone Node (PSTN) data connection.



Figure 1. Recent Status of Indonesia Sea Level Monitoring Network, purely financed by Indonesian Government (Red), in cooperation with USA (yellow), with Germany (Cyan)

The demand for permanent sea level monitoring has been increasing after the tragedy of the 2004 Sumatra Tsunami. The tsunami was the most catastrophic in recorded history, causing great loss of lives with more than 120,000 fatalities in Indonesia and thousands more over 9 countries in Asia. If an early warning system were available in the region, many lives could have been saved.

Realizing the great loss in the tragedy and in support of the early warning system in Indian Ocean initiated by the United Nations, Indonesia has allocated national funding for establishing the Indonesian Tsunami Early Warning System (InaTEWS). As sea level monitoring is an important component of TEWS

with its role for confirming the arrival time and height of the waves. Indonesia in joint efforts with international partners under the coordination of IOC/UNESCO has established real or near real time sea level monitoring stations.

Current status (April 2011), BAKOSURTANAL manage 113 stations comprising (see Figure 1):

- 10 tide gauges in cooperation with Germany
- 10 tide gauges in cooperation with IOC/UHSLC
- 93 tide gauges purely financed by Indonesian Government (remain 1 station using analogue graphical chart recorders)

2. Recent Status of BAKOSURTANAL Sea Level Monitoring

The 26th December 2004 Sumatra Tsunami, which devastated the coastal area of Aceh and the surrounding countries in the Indian Ocean, can be claimed as a turning point in the development of sea level monitoring in Indonesia. Since then, the appreciation of the importance of sea level monitoring has been increasing, resulting in funding by the Indonesian Government for 2006 - 2008 fiscal years for modernizing the network with new instrumentation and real time communication tools. In fiscal year 2010, BAKOSURTANAL got an additional funding to built 20 stations, and further three tide gauges are installed on March 2011.

The current status (April 2011), BAKOSURTANAL maintain in total 93 tide gauges purely finance by Indonesian Government.

New 20 Tide Gauges in 2010

Grand design of Indonesia Tsunami Early Warning System (InaTEWS) is to build 80 tide gauges in real time in Indonesian waters. Until the end of 2009, BAKOSURTANAL maintains 60 real time tide gauges, therefore BAKOSURTANAL for Expenditure Budget Amendment (APBN-P) in 2010 proposed to build new 20 real time tide gauges to complete the grand design. The works are completed at the end of 2010 and operate at begin of 2011. The distribution of the new 20 tide gauges is shown in figure 2.



Figure 2. Distribution of the new 23 tide gauges (20 stations built in 2010 and 3 stations in 2011),

The purposes of the new tide gauge installations are as follows:

- To complete the grand design InaTEWS for supporting Indonesia Tsunami Early Warning System (InaTEWS),

- To determine mean sea level, Lowest Astronomical Tide and Highest Water Level for Surveys and Mapping,
- To monitor the effect of Global Climate Changes into Indonesian waters,
- As fundamental data for the development of National Spatial Data Infrastructure (NSDI)

To provide back-up and redundancy, each field unit consists of three types of water level sensors capable of providing continuous observations during extreme water levels and long term satisfactory performance for at least 12 months. The three types of level sensors are as follows:

- Float gauge digital recording with one minute data sampling rate, allowing real time monitoring that can cover extreme sea level changes for relatively short time durations.
- Pressure gauge digital recording with one minute data sampling rate and high capability in detecting quick changes of water pressure caused by tsunami.
- Radar gauge tidal recording with 10 second data sampling rate enabling monitoring of sea level with high time resolution recording.
- The three types of sensors should be capable of operating independently and have a 0.5 millimeter height resolution over a range of 0 to 15 meters.

New 3 Tide Gauges in 2011

Besides the construction of 20 new tide gauges financed through Expenditure Budget Amendment in fiscal year 2010, BAKOSURTANAL build also 3 tidal stations in Tuban, Jambi and Dumai. The last three stations are not dedicated for InaTEWS but for other purposes like Monitoring Sea Level Rise, and Surveys/Mapping. The equipments are installed on March 2011, see figure 2.

GITEWS Sea Level Monitoring

German-Indonesia Tsunami Early Warning System (GITEWS) program supports 10 sea level stations. Each station consists of continuous GPS monitoring, a ground meteorological sensor and VSAT communication. In February 2006, Geoforschung Zentrum (GFZ) carried out site surveys to plan the construction of tide gauges. The first installation is in Sadeng Gunungkidul, Yogyakarta that is equipped with sea level, GPS and ground meteorological sensors, installed on September 2006. At present, all of the 10 planned tide gauges are installed, see figure 3. The last construction is in Rote installed on February 2011. Data communication for tide gauge in Sadeng is facilitated with VSAT, on the other tide gauges are with Meteosat, BGAN and PASTI, enabling data stream in real time mode to InaTEWS. All of the GITEWS raw numerical data are pushed to DSS of InaTEWS.

USA-Indonesia Sea Level Monitoring Networks

BAKOSURTANAL and the UHSLC, with financial support from the IOC and USAID, have installed 7 real time tide gauges facing to Indian Ocean and 3 tide gauges around Banda Sea. The first installation was built in April 2005 in Sibolga on the western coast of North Sumatra Province. The next installation was carried out in Sabang and Padang on December 2005. The installations were continued in January 2006 at Benoa (Bali) and further in early February 2007 the tide gauges in Cilacap and Prigi were installed. Four additional stations, i.e. Lembar, Bitung, Ambon and Saumlaki were installed in 2008. All the stations are equipped for 15 minute data transmission using

GTS/Meteosat. Later, BGAN communication capability will be added to the stations. The data can be accessed via <http://www.ioc-sealevelmonitoring.org/>, see figure 4.



Figure 3. Distribution of German-Indonesia (GITEWS) and USA-Indonesia Sea Level Monitoring

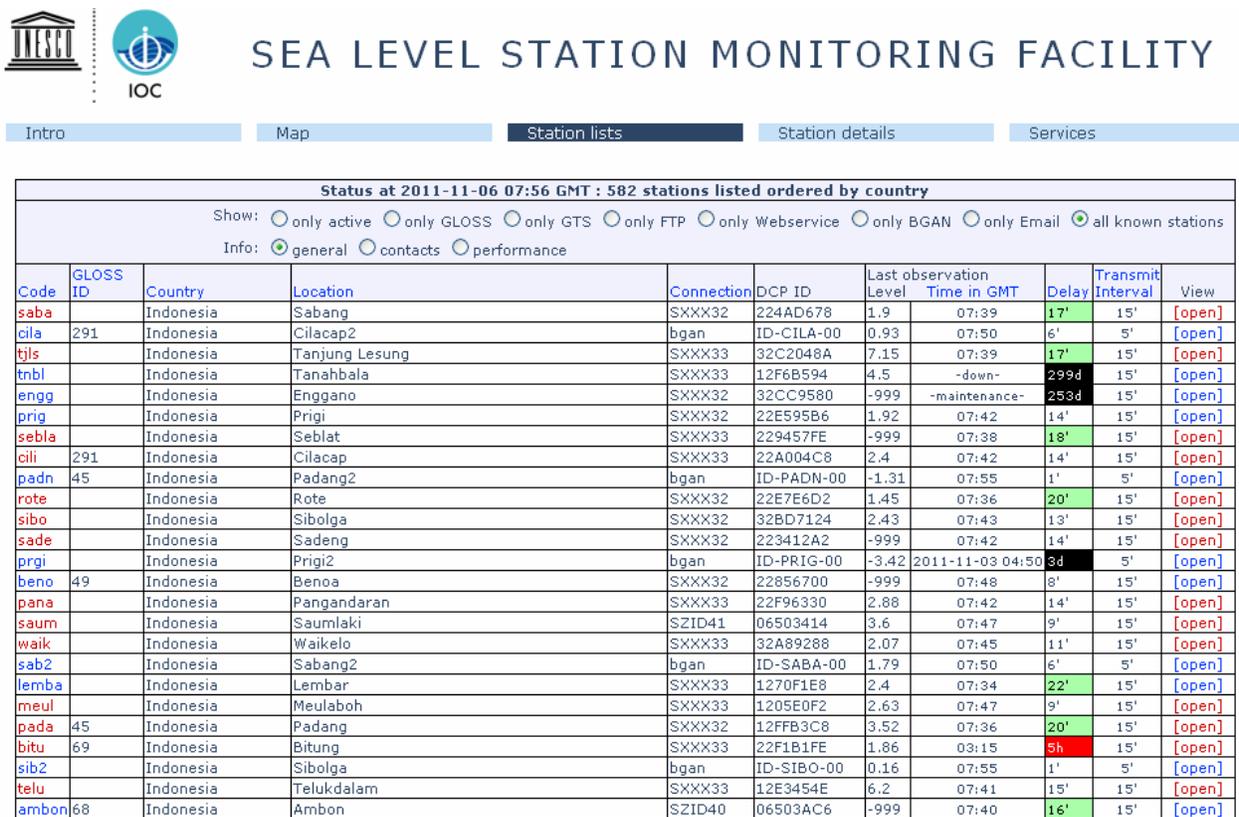


Figure 4. Website to access German/USA-Indonesia Sea Level Data in near real time

Summary

The progress on development of the Indonesian Indonesia Sea Level Network is completed in total 113 stations where 6 tide gauges are still analog system. The purposes are not only for Tsunami Early Warning, but also for other purposes. In 2012 is planned to build 2 new stations, further the activities will be focused to maintain the tide gauges. Table 1. shows a summary of National Sea Level Network up to now.

Table 1. National Sea Level Monitoring Network up to November 2011

Source	<2005	2005	2006	2007	2008	2009	2010	2011	Total
USA/NOAA/UHSLC	-	-	-	3	4	-	-	-	7
IOC/Unesco	-	2	1	-	-	-	-	-	3
Germany	-	-	2	2	3	1	1	1	10
Indonesia	53	-	2	14	-	1	20	3	93
Total	53	2	5	19	7	2	21	4	113

References

- Intergovernmental Oceanographic Commission, 1985. Manual on sea-level measurement and interpretation. Volume 1 - Basic procedures. Intergovernmental Oceanographic Commission Manuals and Guides No. 14. IOC, Paris, 83pp.
- Khafid et. Al. 2010, Laporan Kegiatan: Inventarisasi Data Pemetaan Geoid dan Operasionalisasi Stasiun Pasang Surut, BAKOSURTANAL, Cibinong Indonesia
- Manurung, P. et al, 2007. Tide Prediction Book 2009 BAKOSURTANAL, Cibinong Indonesia.
- Manurung, P. et al, 2009. Tide Prediction Book 2007. BAKOSURTANAL, Cibinong Indonesia.
- The State Ministry of Research and Technology, 2006. Grand Design of Indonesia Tsunami Early Warning System. The Republic Indonesia State Ministry of Research and Technology Office, Jakarta.