GLOSS Training Course, Malaysia Feb 2004

Indonesia

Nice report

PERMANENT SEA LEVEL MONITORING IN INDONESIA

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Background

Indonesia is an archipelagic country consisting of nearly 17,000 islands with a total coast line length exceeding of 81,000 km. The country borders two oceans with the sea water flows from Pacific to Indian Ocean passing the archipelago via the so called Indonesian water through flow. Indonesia waters have large variations of tidal regime and strong tides in some parts, resulting in the demand for tidal monitoring shows a large increase in support of survey and mapping, navigation, marine transportation, and climate research. However, the distribution of the existing National Tide Gauge Network (NTGN) consisting of 54 stations is considered less adequate to represent a better understanding of tidal characteristics along its coast line. Assuming one tidal station represent for a tidal regime of 100 km coast line area, an idealistic number of permanent tidal stations for the whole country should be simply of about 810 stations. Therefore, efforts should be made to provide a better distribution of permanent tide gauges in the country's coast line. Considering the vast region of Indonesia and some difficulties in transportation to the remote area, this task would be hardly possible to be achieved under the responsibility of one central government institution such as the National Coordinating Agency for Survey and Mapping (BAKOSURTANAL). However, it should be through joint efforts amongst related institutions and local district governments and participation from international bodies for technical assistance and development should also be encouraged.

Station Maintenance and Monitoring

As the implementation of national program in tidal data monitoring, BAKOSURTANAL established the network in stages. The early implementation was started in 1984 with eight tide gauges located in the main harbours.

The daily operation of NTGN is fully centralized under the responsibility of Bakosurtanal. The stations equipped with two types of tidal recording namely analog graphical chart and digital recording instruments. The

former consists of 29 tidal recording type chart manufactured by Kempton OTT version R20 and two old type punched chart recording manufactured by Steven Leopold and Fisher. The latter consists of 25 digital on-line tide gauges with instrument Scanmatic version SM 5075 established in 1998 under the Digital Marine Resource Mapping Project. The stations were aimed at determination of chart datum for bathymetric mapping exclusive economic zone and sea line passages in Indonesian waters. Unexpectedly, the whole stations were no longer in operational at the time of the project was terminated by the end of 2000. After a long effort had been made to put the stations into operational, it was decided to replace the idle with new instruments. Extra budget was provided by the end of fiscal year 2003 to purchase 25 units of Thalimedes digital recording and 25 units of Kempton chart recording type R20. The whole instruments will be installed in the early of 2004.

It is possible to up-grade and modernize some of the stations with the new purchased instruments, in particular those located in the busy harbours of the provincial capitals. These are classified as the main stations which capable of providing a fast and near real time delivery data to users mainly using electronic chart navigation. Therefore it is agreed to equip the main station with both digital and chart recordings. The on-line data communication from the central processing unit in Cibinong (a suburb of Jakarta) to the remote stations is via telephone line.

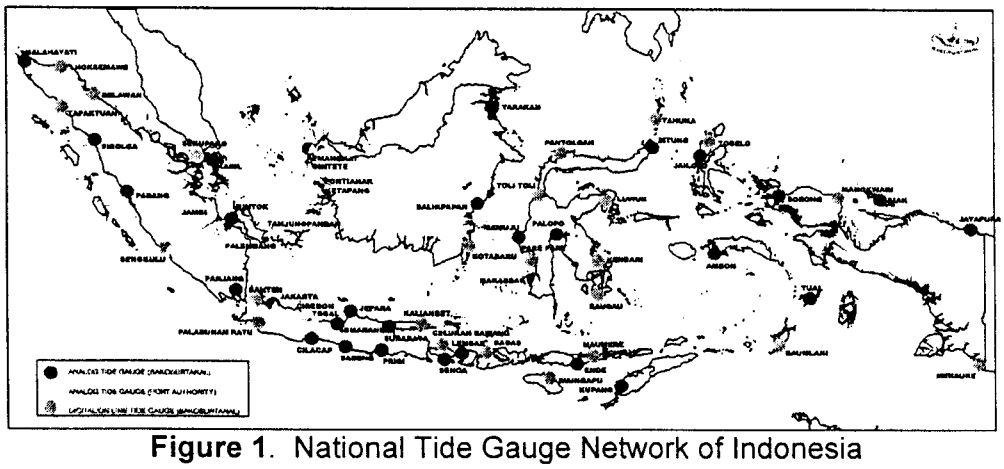

Figure 1. National Tide Gauge Network of Indonesia

The operators play an important role for maintaining the stations fully operational from day to day. This is due to the technology of tidal recording used in the network is not fully automated and the stations are mostly located in busy harbours which is proned to destructions by such as trucks on the harbour, ships and vandalism. As the result, Bakosurtanal hire a number of 85 local staffs recruited from the local port authority office where the stations are located to do part time jobs such as to operate and maintain the stations. The number of operator for each station is not similar of which the stations equipped with an analog graphical chart is operated by two local staffs and that of digital by one local staff.

Bench Mark Connection

Each of the NTGN stations has its owned Bench Mark with standard specification similar to that of first order national levelling network. The tidal staff of each station is carefully referred to its Bench Mark by precise levelling measurements carried out regularly once in a year. The regular measurements have been carried out in the whole station after the requirements for mean sea level rise study due to global change effects have becoming of increasingly importance issue nowadays. Evaluating the mean sea level (MSL) time series of stations observed more than a decade, it was found that some stations shows lack of consistency to its MSL trend. As an example, the monthly MSL of Jakarta stations as shown in Figure 2 shows a significant jump at some epochs. It is suspected that there should be an alteration of the tide staff zero stetting which is not well documented leading to incorrect zero scale of the chart recording.

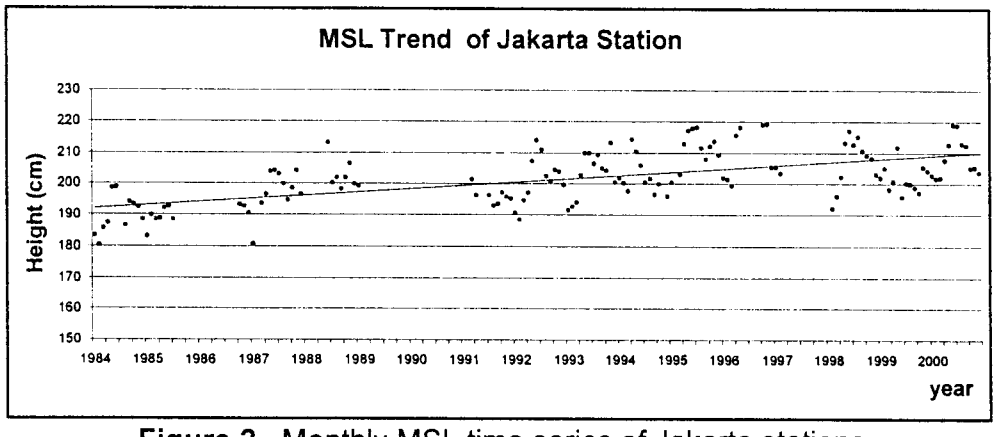

Figure 2. Monthly MSL time series of Jakarta stations

It is realized that further improvement should be made to the existing tidal station building, which are varies in size and structure as shown in Figure 3. An ideal tidal house should be built in a permanent and strong structure which is capable of against destruction caused by an extreme weather and tidal wave conditions. The tide staff and BM should also be located at a stable plat form with possible minimum local ground displacement.

Monitoring of BM and tide staff with space techniques could solve the ambiguity of the computed MSL rises in many stations. Since the sea level gauges measure the relative motion between the sea surface and the land, and the records can be possibly contaminated by land vertical movements at individual tide gauges. The use of GPS has led to an opportunity to link a network of tide gauges to more highly accurate global reference system. This technique would provide a better understanding of mean sea level change by its capability to unify local to global reference

frame. Bakosurtanal has been performing precise GPS measurements at a selected set of BMs of the tide gauge network, started in 2002. The selected BM's were connected to the National Geodetic Control Network and the Indonesian Permanent GPS Station Network and therefore to the International Terrestrial Reference Frame.

Figure 3. The existing tidal stations are still in different type of buildings. In the future the building should be standardized like the left hand building.

Data Processing

A modification was made to convert the DOS-based TOGA software created by the University of Hawaii Sea Level Centre into Windows-based. The main purpose of performing the modification is that to make the software become more users friendly. There are many advantageous of windows that could be optimally utilized with the modification such as a capability of providing processing options in a pull down menu, compatibility to windows-based commercial software used for data analysis and quality control and possible connectivity of the software to a web-based data base.

The content of data base is mainly consists of such as meta data, raw data, monthly and yearly harmonic constants, monthly and yearly MSL trends and a description of station maintenance. Online data service via internet for commercial would be available in the near future to provide services to users with various requirements such as fast hour data and harmonic constants. As the demand from users mainly from the field of coastal management and fisheries shows a significant increase, Bakosurtanal started to publish tidal prediction of 5 stations in both tabular and graphical format.

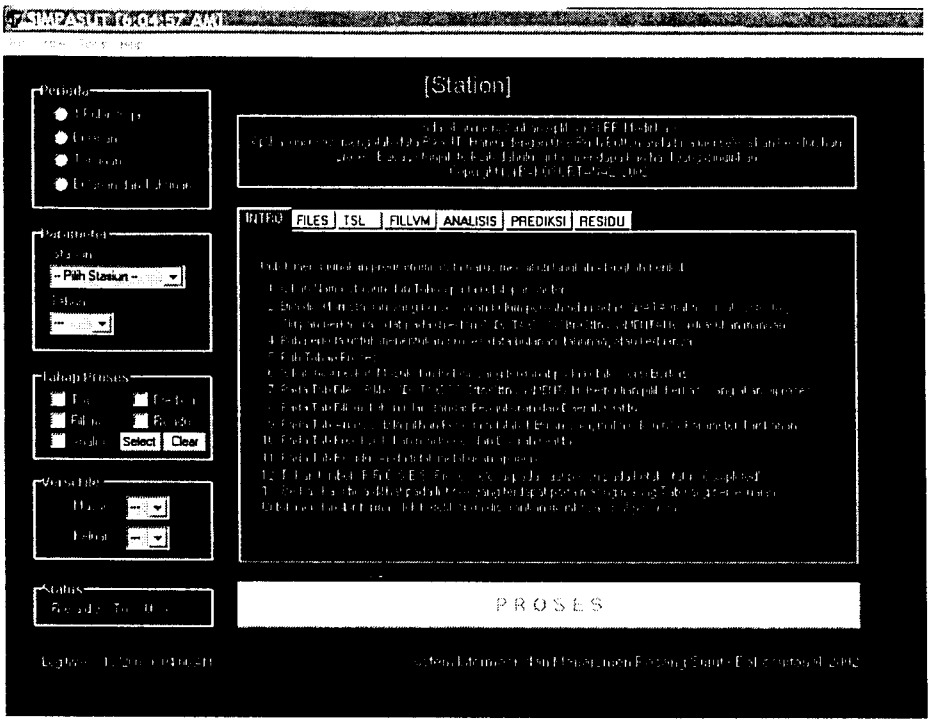

Figure 4: An in-housed windows-based tidal processing software used in Bakosurtanal. The software originally developed from the DOS-based SLPR2 tidal processing software, written by the University of Hawaii Sea Level Centre.

Data Submission to GLOSS

The Indonesian waters play such an important region for climate studies and it is realised that to have a better understanding on the regional climate of the region, global data should be incorporated in the studies. Therefore it is of great importance to collaborate with international experts by taking part in data exchange to international communities. Action has been made to convince decision makers at higher level to provide a consistent support to the GLOSS programme. There are 8 stations committed as part of the GLOSS network, namely Ambon, Benoa (Bali), Cilacap, Kupang, Bitung, Padang, Sorong, and Surabaya. All of the stations are equipped with punched and graphical recording systems and the stations have been in full operation for more than a decade.

Conclusions

To provide a high quality data with a fast delivery mode, most of the buildings and instrumentations of stations dedicated to GLOSS should be improved. Considering the growth of national funds allocated for maintaining the operation of the tidal network remains not significantly increasing, efforts have been made to seek for other support to improve the system. There is also national security and cost recovery concerns which inhibit data exchange. It is expected that the GLOSS program should be capable of convincing decision makers of the value of ongoing measurements and it should improve the operational status of GLOSS data delivery available in 'fast' mode allowing the international community will gain access to information.