Sea level measurements by NIO tide gauge stations

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Measurement of sea level has become an essential part of global climate change studies. Global Sea level observing Systems (GLOSS) was established under the auspices of the Intergovernmental Oceanographic Commission (IOC) UNESCO in 1985 to coordinate global sea level observations in support of oceanographic and climatic research related to sea level studies. The GLOSS network includes 290 coastal and island tide gauge stations that provide research quality data sets. Survey of India, Dehra Dun, operates the sea level gauges in India. There are eight sea level gauges included in GLOSS network from India they provide l average sea level to GLOSS. Most of the GLOSS network stations from the international community provide near real time/ hourly average data from tide gauges.

GLOSS is planning to study the effect of land motion at tide gauges through collaboration with the International GPS Service for Geodynamics. Geocentric coordinates of the Tide Gauge Benchmarks (TGBMs) are required if the tide gauge measurements are to be located within the same global geodetic reference frame as e.g., altimeter data or to establish a global vertical reference frame.

As a part of institutional programme, the National Institute of Oceanography (Council of Scientific & Industrial Research) has established a network of fast-sampling and cellular-based and Internet-accessible real/near-real time reporting sea-level and surface meteorological stations (Autonomous Weather Station [AWS]) at several locations on the Indian coasts & Islands (Internet link http://inet.nio.org). Until May 2009, the network comprises of eight sea-level stations and ten AWS stations (Fig.1 and Table.1).

The sea-level stations of the network have incorporated sub-surface pressure sensor and downward-looking microwave radar based sea-level gauges, designed and developed in-house. Unlike float-driven gauges and guided air-acoustic gauges which require stilling-wells (with inherent slow response, non-linearity, and waveform distortion in the presence of short-period large-amplitude waves such as tsunami), NIO gauges have fast and linear response. The gauges are installed under “open” environments (*i.e.*, without the use of ‘tide gauge huts’), and are powered from 12-volts batteries which are charged through solar panels. Sea-level data are acquired at fast sampling intervals (5-minutes). A set of Internet-time synchronized time-tagged dataset are uploaded to an Internet server with the use of cellular modem. Our preference for cellular-based data reporting stems from the ubiquity of cellular base-stations throughout the country, relatively small size of the cellular modem, and state-of-the art information accessibility at significantly low cost. Graphical displays of the measured sea-level, astronomical tide, and the residual (*i.e.,* anomalous sea-level oscillations) can be viewed in real/near-real time from the Internet, updating at 5-minutes intervals.

Maintenance of accurate time stamp of the dataset through Internet-time synchronization of the gauges’ real time clock (RTC) twice in a day using Internet network time protocol (NTP) allows error-free estimation of the arrival times and speed of propagating oceanic events such as coastal waves, storm surges, tsunamis etc. The data is transmitted on real time basis therough cellular GPRS connectivity. Also real time data can be viewed over internet (http://www.nio.org http://inet.nio.org)

Table 1. Sea lelvel gauges operated by NIO, Goa, India

	Sea Level Gauges
WEST COAST	Ratnagiri Radar Gauge [Maharashtra]
	Verem Pressure Gauge [Goa]
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	Karwar Radar Gauge [Karnataka]
	Malpe Radar Gauge [Karnataka]
EAST COAST	Yanam Radar Gauge [Pondicherry U.T.]
ISLAND	Kavaratti Radar Gauge [Lakshadweep]
	Andrott Pressure Gauge [Lakshadweep]

Fig. 1. The locations of sea level gauges operated by NIO, Goa- INDIA