

Sea level measurement and sea level rise in Vietnam

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Vietnam has a long coast of more than 3200 km. The tide has different characters : dunnal, semi-dunnal and mixed. The tide range reaches about 4.5m in the North, and decreases to 0.5 - 0.7m in the Central area, then increases up to 4.5m in the South. In the west coast the tide range is 1m in average. The difference in tide range and character is caused by different geographical conditions. To monitor the tide, a network of tidal stations has been established along the coast and on islands. The total tidal stations are 21 (see fig.1). At six stations the tide are continuously recorded by different type of recorders. At four stations the tide is automatically measured by pressure sensors and the tidal data are transmitted via Inmarsat-C System to the Marine Hydrometeorological Center (MHC) in Hanoi, which is responsible for operation of marine hydrometeorological station network. At the rest stations the tide is measured four times per day by foot staff.

All tide data are stored at MHC and available.

The yearly mean sea level recorded at some stations (Hon Dau, 20°40'N, 106°48'E ; Da Nang, 16°06'N, 108°13'E ; Qui Nhon - GLOSS Station, 13°45'N, 109°13'E ; Vung Tau, 10°20'N, 107°04'E) along the coast are used to determine the sea level rise (SLR) in Vietnam. According the calculation, SLR changes from 1.75 to 2.56mm/year. The high value is observed in the North and in the South parts of the country. It could be said that SLR in Vietnam is in comparsion with the SLR in the region and on the world.

To be sure the SLR is due to global warming, some main factors impacted on sea level change, are considered, such as geotectonics (subsidence) El-Nino phenomena and meteorological events (typhoon, monsoon...).

Using precise leveling and GPS to examine the stability of the bench mark at the tidal stations and it was found out that the vertical movement of the land cover is 0.66mm/year up in the North and Central and 1mm/year down in the South. The vertical movement in the North and Central decreases the rate of SLR, and in the South increases it's rate, but not more than 1mm/year.

Analysing sea level change during the years of El-Nino (1965 - 1969, 1972, 1976, 1982, 1983, 1987) it was found out that the yearly mean sea level (MSL) a little decreases in comparsion with MSL in previous consecutive year. The value of the decrease is not preceed 10 cm. This confirms that the El-Nino phenomena slows the rate of SLR (see tab.1).

The meteorological events-typhoon, monsoon occurred in very short time-several hours or some days could not impact on the change of mean sea level (see tab.2). The events could only cause storm surge.

Based on the above analysis, it can come to a conclusion that due to global warming sea level rise along the Vietnam coast reaches the value of 2 - 3 mm/year in average.

If the greenhouse effect is kept in no change as at present, by the year 2100 SLR in Vietnam reaches 30cm in average. The maximum SLR can be reached 60cm if there is no active measures to low down the impact of the greenhouse effect.

Table 1. Impact of El-Nino phenomena on yearly mean sea level change Δh cm

El-Nino year	Δh (cm)			
	Hon Dau	Da Nang	Qui Nhon	Vung Tau
1957	- 2.0			
1968	- 2.0			
1969	- 5.0			
1972	- 2.0			
1976	- 5.0		- 6.0	
1982	- 4.0	- 10.0	- 4.0	- 3.0
1987	- 10.0	- 4.0	- 3.0	-1.0

Table 2. Impact of Typhoon on mean sea level (MSL) Δh max cm

Stations	Daily MSL	Monthly MSL	Yearly MSL	20 year MSL
Hon Dau	8	1	0.2	0.01
Da Nang	7	1	0.3	0.015
Qui Nhon	4	1	0.3	0.015
Vung Tau	20	1	0.5	0.025