

Distribution of the Engineering Water Levels along the Coast of China Seas under Sea Level Variation

Meixiang Chen^{1,2}, Juncheng Zuo², Ling Du¹, Peiliang Li¹, Lei Li¹

¹ College of Physical and Environmental Oceanography, Ocean University of China
Qingdao, Shandong, P.R.China

²Key Laboratory of Coastal Disaster and Defence, Ministry of Education, Hohai University
Nanjing, Jiangsu, P.R.China

ABSTRACT

Hourly water level records of 27 tide stations along the coast of China sea including 5 of Japan are analyzed and the design and check water levels are calculated considering the impact of sea level variability. Monthly mean sea level of the stations shows prominent seasonal variability and the stations in the north area mainly present a semiannual period and in the south area the period is mainly shorter than half a year. The months of highest sea level at the southern stations lags the northern ones and the time interval from the highest to the lowest sea level is not exactly 6 months especially at the stations on the north coast of the South China Sea. The seasonal sea level variability mainly affects the magnitude of the design water level and maximum difference between the results from the data of 3 months of highest sea level and the whole year can be 24.9cm. Stochastic Dynamical analysis shows sea levels of all the 27 stations are varying at a mean linear rate of 2.2mm/a with a maximum of 9.3mm/a and the long term sea level trend mainly affects the magnitude of check water level and the occurrence frequency of the extreme sea level, maximum differences between the extreme water levels of 100 years' recurrence with and without considering sea level trend reaches 92.7cm and the high check water level of 100 years' recurrence at the stations with the largest rising rate will change to be 21 years' recurrence. Corrected to the National Vertical Datum 1985, the mean sea level of the stations in the south is higher than the north while both the design water level and check water level have larger values along the coast of south Yellow Sea and East China Sea.

KEY WORDS

Design water level; check water level; sea level trend; seasonal variability; recurrence period

INTRODUCTION

In the past 20th century, the global mean sea level has risen 10-25cm with a most likely value of 18cm (Gornitz, 1995; Warrick et al., 1996), corresponding to a rate of about 2mm/a. The thermal expansion of the upper ocean and the melting of mountain glaciers associated with global mean surface temperature rising is attributed as the most important reasons. For the low-lying coastal areas, a small rising rate of

the sea level may cause profound economic and social burden, as sea level rise will significantly aggravate the disaster of storms and marine erosions. It has been found that open-ocean sandy beaches on the U.S. east coast not affected by inlets or engineering modifications erode at a rate that averages about 150 times the rate sea level rises (Zhang, 1998; Leatherman et al., 2000). And for the coastal areas, it is not the absolute but the relative sea level that is concerned most. On the one hand, it is directly related with the cost people have to pay to keep the place they live avoid of flooding or migrate due to sea level rise; on the other, a rise of sea level will enhance the criterion of marine engineering, the impact of the sea level rise must be considered in the design and constructions of dock and groyne.

A coarse estimation of the relative sea level rate along the coast of China seas in the last century is 2.2mm/a with a trend of acceleration. For the coastal cities, ground subsidence caused by the over-mining of the groundwater and construction of large buildings will accelerate the rise of the local relative sea level and the forthcoming disaster of aggravated storm surge and flood will severely affect the economy and life of the citizens of the nation.

In the traditional marine engineering constructions, both the design water level and check water level are calculated according to the Technological Standard of Harbor Engineering in which the high (low) design water level takes the value at 1% (98%) on the cumulative frequency curve of hourly water level and the check water level is the extreme value of different recurrence periods calculated using the distribution of Gumbel I based on a successive time series of annual extreme water level of more than 20 years. Calculation of both the design water level and check water level requests a stationary and random time series of hourly water level data satisfying the normal distribution with a length of more than 18.61 years at best in order to eliminate the impact of the motion of celestial bodies like sun and moon on the water level.

As sea level rises, the observed hourly water level from the tide gauge will not be stationary and will not satisfy normal distribution and there will be an excursion of the water level at peak frequency to the larger