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Sea level analysis using tide gauge observations at the northern delta coast, Egypt

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ABSTRACT

The current study focuses on the analysis of observed sea level in the northern delta coast, which is considered the most important region in Egypt. The used sea-level data are records of three tide gauge stations located on the north of the delta, on Alexandria, Damietta, and Port Said. Different periods of sea-level records had been used to be analyzed to get the astronomical tide and surge heights. Geotid software had been used to obtain the tidal harmonic constituents. The tidal cycle sort at the three locations of the tide gauges had been calculated and the results were as follows: a mixed semidiurnal tidal type in Alexandria and Damietta, and a semidiurnal tidal type in Port Said. The Mean Sea Level (MSL), referred to the Egyptian Survey Authority datum (ESA-1906), had been calculated, and the tidal datums of each station referred to the International Terrestrial Reference Frame (ITRF-2014) had been calculated also. Ten groups of tidal constituents had been obtained and two of them have the largest amplitudes and they are M₂ (Principal lunar), S₂ (Principal solar). The amplitudes and percentages of astronomical tide and surge, in the observed sea level data, will be shown in the results section.

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Sea level; tide gauge; harmonic analysis; northern delta coast; Egypt

1. Introduction

There is a great interest of sea-level change for many reasons. The most important two reasons are as follows: the change in the Earth's climate and the social economic outcomes for populations who live near the sea coast (Antonov, J. I., Levitus, S., & Boyer, T. P., 2002; Gornitz 1995).

Variation of the observed sea level at any place in the world depends on numbers of factors such as astronomical components, surge, interannual to secular variability, the seasonal cycle, and variations at interglacial and geological scales (Pugh 1987; Jorda et al., 2012).

Absolute sea level change is difficult to measure. However, relative sea-level changes have been derived mainly from tide-gauge data relative to fixed tide-gauge benchmarks. This relative sea level (RSL) is referred to as sum of changes in sea level and local uplift and subsidence changes in the land.

In the Mediterranean basin, variation of the observed sea level in the northern delta coast results principally from the combination of two heights: astronomical tide which has a minor effect, being about 20 cm, and the surge, which has a major effect, being about 1.00 m under the effect of meteorological factors. These factors are the atmospheric pressure, the air temperature, the wind framework, and the steric impact (Sharaf El-Din 1975; Eid 1990; Saad et al.

2011). Many authors made studies on these meteorological factors, which are affected on the variation of the sea level in the Mediterranean area and throughout the length of the Mediterranean coast of Egypt, e.g. Mosetti and Purga (1990), Tsimplis et al. (2005), Gomis et al. (2008), Hussein et al. (2010), Said et al. (2012).

The main objective of this research is the analysis of the observed sea level data around the northern delta coast in Egypt to investigate the characteristics of its components, obtain the astronomical tidal constituents, surge heights, and the patterns of sea level.

2. Data and methods of analysis

Different periods of sea-level records, of the northern delta coast in Egypt, have been used in this study. The sea-level data are records of three tide gauge stations located on the north of the delta coast. Figure 1(a) shows the distribution of the three tide gauges. The first set of data belongs to the tide gauge station, which is located on the west of the delta in Alexandria Western Harbour (AWH). This data is divided into two groups, the first group is a continuous half an hour data in the period from 01/01/2009 to 02/11/2010, and the second one is a continuous half an hour

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