Estuarine, Coastal and Shelf Science xxx (2016) 1–10

Contents lists available at ScienceDirect

Estuarine, Coastal and Shelf Science

journal homepage: www.elsevier.com/locate/ecss

Tidal regime deformation by sea level rise along the coast of the Mekong Delta

Nguyen Huu Nhan

Vietnam Academy for Water Resources, Viet Nam

ARTICLE INFO

Article history:
Received 14 January 2016
Received in revised form
14 July 2016
Accepted 14 July 2016
Available online xxx

Keywords:
Mekong Delta
Sea level rise
Deformation of tidal regime
Harmonic analysis
Model

ABSTRACT

The future of river deltas is believed to depend mainly on sea level rise (SLR) and on the processes controlling the adaptation of the substrate to human impacts. The deltas are increasingly deprived of riverine sediment by river diversion, dams, dykes and the destruction of wetlands, and they are often sinking due to mining for groundwater, gas and petroleum. The relative sea level rise is causing severe negative impacts in many river deltas worldwide. With continuously rising sea levels, this impact is expected to increase over time. The increased risk of delta flooding caused by tidal deformation associated with SLR in shallow coastal waters has received less attention. In this study, we demonstrate this effect for the case of the Mekong Delta where this study suggests that the maximum tidal water level and the tidal amplitude are increasing while the tidal phase at the coast is decreasing. In addition, the maximum water levels is rising faster than SLR because the tides themselves are modified by SLR. This effect is particularly pronounced for semi-diurnal tides and less so for diurnal tides. Similar effects may prevail for river deltas with extensive shallow coastal waters elsewhere in the world and deserve further investigation.

1. Introduction

About 500 million people live near or in deltas in the world. Many of these deltas are not keeping up with sea level rise (SLR) and are actually sinking; this sinking increases the risk of flooding from river floods and storm surges (Syvitski et al., 2009; Wolanski and Elliott, 2015). The main causes of sinking deltas are (1) being deprived of riverine sediment by river diversion and dams, (2) sinking due to mining for groundwater, gas and petroleum, and (3) construction of coastal structures and the destruction of wetlands (see examples in Hoa et al., 2007; Syvitski and Higgins, 2012; Rao et al., 2010; Naeije et al., 2012; Van Wesenbeeck et al., 2014; Erban et al., 2014; Day et al., 2014; Schmidt, 2015a,b; Tessler et al., 2015; Day et al., 2016 and references within).

The Mekong River delta (MD; Fig. 1) is the outcome of the Holocene evolution of the delta from the initiation of delta progradation around 8.0 ka BP to the present (Nguyen et al., 2000; Xue et al., 2010). During its development, the character of the delta changed from tide-dominated into a wave- and tide-dominated, and its shape and the orientation of the coastline changed through time (Ta et al., 2002). The MD is influenced by various factors including tides (meso-tidal system), waves, coastal currents, monsoon-driven river discharge and human impact (agriculture, fishing, sand dredging, tourism, power dams, local infrastructure, urbanization, etc.). It is already vulnerable as exemplified by inundation induced by both Mekong River floods and marine spring tides (from September to December) and droughts resulting in salinity intrusion (from February to May). The main reason of this vulnerability are the large East Asian Monsoon seasonal climatic variations (Xue et al., 2010). At present time, this vulnerability is already very severe and it will be increasingly so because the impacts of climate change and Sea Level Rise (SLR) are already affecting the MD and because of natural and human-driven global changes such as the relentless and on-going reduction of sediment input to the MD by the Mekong River from 160 million tons per year in 1993 to 75 million tons per year in 2009 (Kummu et al., 2010). In future these processes will intensify and therefore the MD is becoming less and less resilient (Albers and Schmitt, 2015). Another, little studied cause for increased risk of delta flooding exists, namely the tidal deformation that comes with SLR because the tides over large, shallow coastal waters may change with SLR (Clara et al., 2015). In deep waters where the depth $D \gg$ SLR, the tides remain unaffected. However where deltas are fronted by

E-mail address: nhan_vktb@yahoo.com.

http://dx.doi.org/10.1016/j.ecss.2016.07.004
0272-7714/

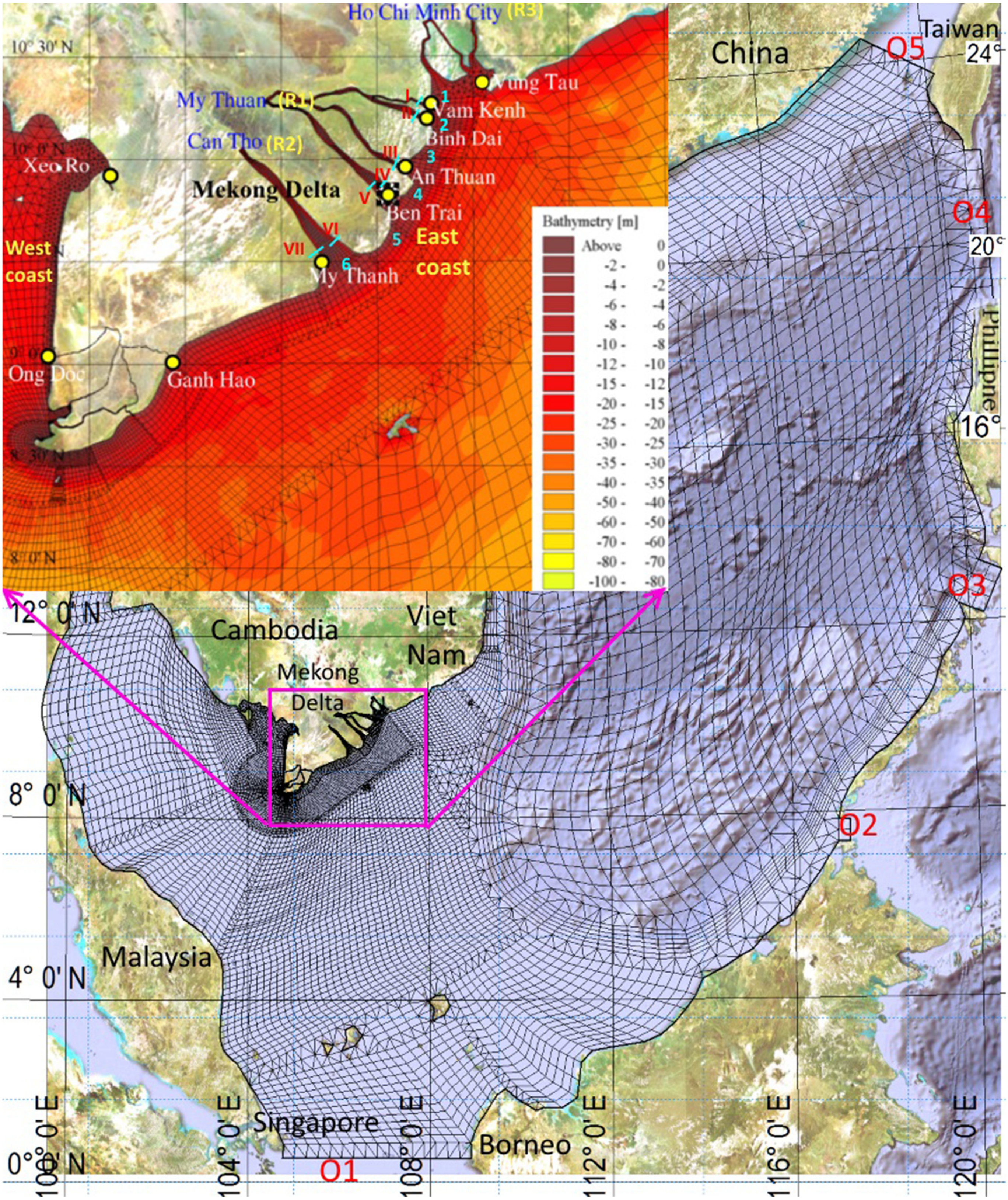

Fig. 1. A map showing the location of water level measurement stations along the coast of the Mekong Delta, the model domain, the bathymetry, the non-structured mesh and the location of the open boundaries.

extensive areas of shallow coastal waters, SLR may modify the tides impacts by a number of mechanisms, namely (1) increasing the phase speed of the tidal wave, (2) changing its direction, (3) decreasing tidal friction, (4) causing more frequent flooding in

Please cite this article in press as: Nhan, N.H., Tidal regime deformation by sea level rise along the coast of the Mekong Delta, Estuarine, Coastal and Shelf Science (2016), http://dx.doi.org/10.1016/j.ecss.2016.07.004