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Editorial

# Larger Asian rivers and their interactions with estuaries and coasts

The larger Asian rivers formerly had the highest sediment loads among the large river basins worldwide (Milliman and Syvitski, 1992; Ludwig et al., 1996; Syvitski and Milliman, 2007). It was estimated that around 50% of the total sediment load transported to the ocean was generated in Asia (Ludwig et al., 1996). For example, the top five rivers with the highest sediment loads were in Asia: Brahmaputra, Huanghe (Yellow River), Ganges, Changjiang (Yangtze River) and Indus (Summerfield and Hulton, 1992). The three rivers combined, Ganges, Brahmaputra and Huanghe, carried 30% of the total fluvial sediment load (Summerfield and Hulton, 1992). The high sediment fluxes are attributed to both natural (plate margin tectonics, materials of loess and volcanic deposits, high elevations, steep slopes, high and intensive rainfall) and anthropogenic factors (high population density, deforestation, intensive agricultures and urbanization) (Gupta and Krishnan, 1994).

Rapid environmental changes in the region such as those resulting from forest conversion or driven by rapid economic development, have resulted in an increasing magnitude and extent of soil erosion and sediment increase especially in insular Southeast Asia (Syvitski et al., 2005). However, it is more common that many of the larger Asian rivers have seen dramatic decrease in both water discharge and sediment fluxes over the past decades due to environmental changes (climate and human induced changes). For example, the Ganges now has only 5% of the original discharge reaching the ocean (Wong et al., 2007). This is especially true for the large Chinese rivers, e.g. Huanghe, Changjiang and Zhujiang (Pearl River), where sediment loads have been reduced significantly due to climate change, reservoir construction, sand mining and vegetation recovery (Chen et al., 2006; Yang et al., 2006; Wang et al., 2007; Zhang et al., 2007). Such decreases have also been occurring in other Southeast Asian rivers. For example, the reduction in the sediment flux from the Mekong River has been dramatic. Milliman and Syvitski (1992) used 160 MT/a as the total annual sediment load of the Lower Mekong River, but Lu and Siew (2006) and Kummu and Varis (2007) reported an approximate 50% reduction of the load as a result of one Chinese dam (Manwan) in Yunnan. Similar dramatic trends for the Red River have been observed by Le et al. (2006).

Such dramatic reductions in water discharge and sediment load have a significant effect on broad ecological and environmental issues in the estuaries and coastal regions of these rivers and even the continental shelf areas. For example, the drastic changes in the water and sediment discharge to the South China Sea have a significant influence on the biological production on the coastal shelf, and the efficiency of the biological pump is threatened (cf. Chen, 2000). An effective means is required to predict how human activities and climate change upstream impact the coastal zone. Therefore, research linking river basin development with the coastal zone is urgent.

This special volume is a collection of the papers presented in the symposium "First International Symposium on Larger Asian Rivers: Fluvial-Coastal Zone Interactions", supported by Wong K.C. Education Foundation under the State Education Ministry of China and by Hohai University, in December 9–10, Nanjing, China. This symposium provided opportunities to exchange the latest research results in the relevant fields for worldwide academicians, scholars, engineers and decision makers. The symposium was jointly organized by the State Key Laboratory of Hydrology—Water Resource and Hydraulic Engineering at Hohai University and National University of Singapore.

The themes of this symposium included: (1) effects of land cover/land use and climatic changes in upper stream reaches on water and sediment discharge to the seas, (2) effects of reservoir construction, water diversion and sediment mining on estuarine and coastal processes, (3) effects of the upstream development on the ecological environment in the estuarine and coastal areas, and (4) water pollution in estuarine and coastal areas, salt water intrusion and mitigation, wetland and coastal protection. Invited speakers provided case studies drawn from larger Asian rivers such as the Huanghe, Changjiang, Zhujiang, Langcang/Mekong, and Irrawaddy/Salween river systems.

This special volume attempts to cover the main aspects of the papers presented in the symposium, ranging from climate changes, water and sediment/ carbon discharges, geochemistry, river channels and coastal changes. The papers cover the major larger Asian rivers such as the Huanghe, Changjiang, Zhujiang, Langcang/Mekong, Salween, Irrawaddy, and Euphrates in southeast Turkey,

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ranging from dry to humid, and from temperate to tropical environments. The special volume also has coverage of temporal scales, from Quaternary records (Cenozoic and Pleistocene) to contemporary processes.

There are 11 papers dealing with contemporary processes. The paper by Xu J.X. looked at the land accretion in the delta of the Huanghe, one of the most human and climate influenced rivers in Asia, as impacted by reduction in water discharge as a result of precipitation changes and human activities. Five papers by Gemmer et al., Su et al., Xu J.J. et al., Dai et al., and Chen X.Q. et al., are about the Changjiang, the largest river in Asia. They dealt with precipitation changes, human intervention and their impacts on water and sediment discharge changes. The papers by Sun et al. and Chen C.T.A. et al. investigated carbon and geochemistry in the Lower Zhujiang and its delta and river mouth regions, one of the fast economic development areas in China.

Three papers dealt with the rivers in Southeast Asia. Fu et al. and Kummu et al. investigated the water and sediment discharges, river channel and river bank stability, and their responses to Chinese dams. Both papers concluded that the impacts of Chinese dams on sediment and river channel changes, a controversy facing the Langcang/Mekong River, the largest river in Southeast Asia, were very limited. Bird et al. reported a preliminary investigation on carbon flux from two other larger rivers in Southeast Asia, Salween and Irrawaddy, both of which have been understudied compared with other larger Asian rivers.

In addition, there are three papers dealing with paleoenvironments. The paper by Gao et al. examined the stream response to tectonic and climate changes in the Weihe of the Upper Huanghe basin. Demir et al. summarized their work on surface uplift by river incision in the Euphrates river basin in southeast Turkey, and the paper by Zhao et al. provided marine records and relative sea level change during the late Pleistocene in the Changjiang delta and adjacent continental shelf.

This collection attempts to illustrate tectonic, climate and human impacts on larger river systems over a very long time frame and a wide range of geographic locations. The larger Asian rivers provide livelihoods to large populations and have experienced intensive human activities and rapid economic development. As such, many of the larger Asian rivers have been experiencing degradation process (Wong et al., 2007). However, the large Asian rivers, especially in Southeast Asia, have been understudied, and some of the data used often in the literature are questionable due to sporadic measurements. For example, a widely cited estimate of sediment loads for the Irrawaddy in Burma (265 MT/a) has recently been re-calculated from the original data and may be as much as 364 MT/a (Robinson et al. 2007). Similarly, the Mekong was frequently cited as transporting 150–170 MT/a of suspended sediment load, although this was based on a short period of measurements (likely less than 1 year) in the 1960s by US Land Reclamation Bureau. Therefore, there is an urgent need to further study these rivers and their interactions with estuaries and coasts in the rapid pace of global environmental changes.

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