Impact of Land Subsidence and Sea-level Rise on Coastal Cities in China

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Land subsidence (LS) caused by groundwater overly exploitation has been severe in China, since it was firstly observed in Shanghai in 1921, and is still ongoing. The subsidence-affected area with a cumulative lowering greater than or equal to 200 mm is more than 90,000 km2 and encompasses 50 cities, 25 of which are located on the coastland (Ye et al., 2016). Land subsidence contributes to the loss of elevation, which is usually relatively low in the coastal cities. Shanghai, on the coast of East China Sea, is an exemplificative case study. The maximum cumulative LS amounted to about 2 m since 1921 and the average elevation of the city ranges from 2 to 4 m above msl. In addition to LS, sea-level rise (SLR) due to climate changes is another process threating the coastal cities in China. The mean SLR rate along the China coast amounted to 1.5 mm/a over the 20th century (Ren, 1993). Therefore, relative sea level rise (RSLR), i.e. the superposition of LS and SLR, in the coastal cities has been generally much greater than the mean SLR rate. Wusong tide-gauge station in Shanghai recorded a cumulative RSLR of 1.175 m between 1923 and 1966. Land subsidence average rate at the tide gauge was 25.2 mm/a, which accounted for 94% of the RSLR rate. With an efficient control of groundwater pumping, average LS rate in Shanghai is recently decreased to 6 mm/a. Conversely, SLR rate is increasing because of climate changes and has reached 2 mm/a (Chen et al, 2015), which accounts for 25% of the 8 mm/a RSLR rate. Similar variations of the RSLR trend are occurring in other subsidence-affected coastal cities. RSLR prediction is important for flood control, risk assessment, and engineering design of tide/wave protections in these areas. Reliable predictions of land subsidence and ESLR are required. A numerical model of regional land subsidence, including a three-dimensional groundwater flow model and a one-dimensional deformation model, has been developed to predict the loss of land elevation in the cities along the coast of East China Sea over the next 30 years. The potentially flooded areas as of 2050 are preliminary assessed by combing the predicted LS and the ESLR.

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