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Implications of subsidence for coastal flood risk and adaptation in China

Robert Nicholls[1] and Jiayi Fang[2]
[1]Tyndall Centre for Climate Change Research, University of East Anglia, Norwich, UK (robert.nicholls@uea.ac.uk)
[2]Key Laboratory of Geographic Information Science, Ministry of Education, School of Geographic Sciences, East China Normal University, Shanghai 200241, China

Land subsidence is impacting large populations in coastal Asia via relative sea-level rise. This paper quantitatively assesses the risks and possible response strategies for China from 2020 to 2050, focusing on observed changes in urban and delta areas where subsidence is largest. Using observed subsidence rates as scenarios, flood impacts are assessed with the Dynamic and Interactive Vulnerability Assessment (DIVA) model framework. Land area, population and assets exposed to the 100-year coastal flood event by 2050 are approximately 20%-39%, 17%-37% and 18%-39% higher than assuming climate change only scenarios. Realistic subsidence control measures can reduce this growth in exposure, leading to 7% more exposed land, 6% more population and 7% more assets than due to climate change alone. This emphasizes that subsidence control, combined with upgraded coastal protection, is a plausible and desirable adaptation response for coastal China.

Our results emphasise that subsidence is degrading China's coastal environment quality and well-being. Subsidence is nationally significant as people preferentially live in the subsiding areas. Compared with natural subsidence occurring and accumulating over centuries and longer, human-induced subsidence is more local and is usually much more rapid. The effects of human-induced subsidence are visible over relatively shorter timescales (i.e., decades). It reduces the effective protection levels of dikes and amplifies the consequences of failure of flood protection infrastructure. For example, subsidence in Shanghai, has required the flood defence walls to be raised four times since 1959, amounting to more than a three metre raise, requiring large expenditure and also enhancing residual risk.

Subsidence can also lead to saline intrusion and water logging thus affecting water quality, ecosystem service and agriculture. In urban areas, subsidence is greater than in rural environments, due to greater groundwater withdrawal and lowering of water tables enhancing consolidation in geologically young sediments. Significant land subsidence and deformation is also observed in new coastal reclamations such as Hong Kong, Shenzhen, Shanghai, Tianjin, where critical infrastructure is often located, such as airports. New reclamations should expect subsidence and design for it.

In conclusion, this research shows it is essential to understand and address subsidence and

resulting relative sea-level rise across coastal China. Traditionally, subsidence is considered a local problem. This study demonstrates subsidence has national implications and there is a need for a national policy response: a combination of subsidence control and adaptation (e.g. higher dikes). More detailed national and regional assessments of flooding and subsidence are recommended include the costs and benefits of management in the context of climate-induced sea-level rise. The issues raised in this paper have global significance, particularly in south, south-east and east Asia. Similar assessments across these Asian nations and more systematic collection of subsidence data would facilitate improved responses to this issue.