Uncertainties in DEM data crucial in assessing population exposure to coastal flooding

Nan Xu[1,2], Qihao Weng[1,2,3] *

[1] JC STEM Lab of Earth Observations, Department of Land Surveying and Geo-Informatics, The Hong Kong Polytechnic University, Hung Hom, Hong Kong

[2] Research Centre for Artificial Intelligence in Geomatics, The Hong Kong Polytechnic University, Hung Hom, Hong Kong

[3] Research Institute for Land and Space, The Hong Kong Polytechnic University, Hung Hom, Hong Kong

*Corresponding authors. Email: qihao.weng@polyu.edu.hk

Main Text:

Since the 1980s, China has witnessed a rapid and extensive urban expansion, which has caused concerns over land subsidence across its major cities. Human activities, such as building and infrastructure construction, groundwater extraction, land reclamation, hydrocarbon extraction, and underground mining, can all induce land subsidence. In conjunction with sea level rise, land subsidence can increase population exposure to coastal flooding, threatening the livability of coastal cities and well-being of their residents.

In Ao et al. study (1), they combined land subsidence and digital elevation model (DEM) data to estimate the exposure of urban populations in Chinese coastal cities to flooding with a relative elevation lower than sea level. It should be noted that uncertainties of DEM data can substantially influence the estimation of population exposure to coastal flooding. Satellite observations, in-situ measurement and future projections suggest that both land subsidence and sea level rise vary within one meter (1, 2, 3). However, in general, the existing global-scale coastal DEM datasets exhibit an elevational accuracy worse than 1m, making it difficult to accurately estimate population exposure to coastal flooding (4). Although Ao et al.'s study averaged nine coastal DEM data products for analysis, it is necessary to quantify the impact of coastal DEM's uncertainties on population exposure estimation.

High accurate DEM data are urgently need for accurate estimation of population exposure to coastal flooding. Recently released satellite Lidar data, such as ICESat-2 (The Ice, Cloud, and land Elevation Satellite-2 launched in 2018), can provide high-accurate satellite measurements for elevations of the Earth's surface with accuracy of about 10 cm (5, 6). It is hoped that these high-accurate, global-scale coastal DEM datasets will improve the estimation of population exposure to coastal flooding and deepen our understanding of coastal vulnerability, and thus guiding policy-making on coastal management and sustainable development (7, 8).

References:

(1) Ao, Z., Hu, X., Tao, S., Hu, X., Wang, G., Li, M., Wang, F., Hu, L., Liang, X., Xiao, J. and Yusup, A., 2024. A national-scale assessment of land subsidence in China's major cities. Science, 384(6693), pp.301-306.
(2) Kulp, S.A. and Strauss, B.H., 2019. New elevation data triple estimates of global vulnerability to sea-level rise and coastal flooding. Nature Communications, 10(1), pp.1-12.
(3) Hooijer, A. and Vernimmen, R., 2021. Global LiDAR land elevation data reveal greatest sea-level rise vulnerability in the tropics. Nature Communications, 12(1), p.3592.
(4) Kulp, S. and Strauss, B.H., 2016. Global DEM errors underpredict coastal vulnerability to sea level rise and flooding. Frontiers in Earth Science, 4, p.36.
(5) Wang, C., Zhu, X., Nie, S., Xi, X., Li, D., Zheng, W. and Chen, S., 2019. Ground elevation accuracy verification of ICESat-2 data: A case study in Alaska, USA. Optics Express, 27(26), pp.38168-38179.
(6) Magruder, L., Brunt, K., Neumann, T., Klotz, B. and Alonzo, M., 2021. Passive ground-based optical techniques for monitoring the on-orbit ICESat-2 altimeter geolocation and footprint diameter. Earth and Space Science, 8(10), p.e2020EA001414.
(7) Nicholls, R.J., Lincke, D., Hinkel, J., Brown, S., Vafeidis, A.T., Meyssignac, B., Hanson, S.E., Merkens, J.L. and Fang, J., 2021. A global analysis of subsidence, relative sea-level change and coastal flood exposure. Nature Climate Change, 11(4), pp.338-342.
(8) Hinkel, J., Aerts, J.C., Brown, S., Jiménez, J.A., Lincke, D., Nicholls, R.J., Scussolini, P., Sanchez-Arcilla, A., Vafeidis, A. and Addo, K.A., 2018. The ability of societies to adapt to twenty-first-century sea-level rise. Nature Climate Change, 8(7), pp.570-578.