Integrated Analysis of the Combined Risk of Ground Subsidence, Sea Level Rise, and Natural Hazards in Coastal and Delta River Regions

Qing Zhao [1,2,3], Jiayi Pan[4,5,6], Adam Devlin [4,5,6], Qing Xu [7], Maochuan Tang [1,2,3], Zhengjie Li [1,2,3], Virginia Zamparelli [8], Francesco Falabella [8,9,10], Pietro Mastro [9], Antonio Pepe [8]

[1] Key Laboratory of Geographical Information Science, Ministry of Education, East China Normal University, Shanghai 200062, China; qzhao@geo.ecnu.edu.cn (Q.Z., M.T., Z.L.)
[2] Institute of Eco-Chongming (I.E.C.), East China Normal University, Shanghai 202162 (Q.Z., M.T., Z.L.);
[3] School of Geographic Sciences, East China Normal University, Shanghai 200241, China (Q.Z., M.T., Z.L.);
[4] Key Lab of Poyang Lake Wetland and Watershed Research of Ministry of Education, Nanchang 330022, China (J.P., A.D.);
[5] School of Geography and Environment, Jiangxi Normal University, Nanchang 330022, Jiangxi, China (J.P., A.D.);
[6] Institute of Space and Earth Information Science, The Chinese University of Hong Kong, Shatin, Hong Kong, China (J.P., A.D.);
[7] College of Oceanography, Hohai University, Nanjing 210098, China (Q.X.);
[8] Institute for Electromagnetic Sensing of the Environment (IREA), Italian National Research Council, 328, Diocleziano, 80124 Napoli, Italy (A.P., V.Z., F.F.);
[9] Institute of Methodologies for Environmental Analysis (IMAA), Italian National Research Council, Tito Scalo, 85050 Potenza, Italy (F.F.);
[10] School of Engineering, The University of Basilicata, 85100 Potenza, Italy (P.M., F.F.).
* Correspondence: qzhao@geo.ecnu.edu.cn; Tel.: +86-21-62224459

Abstract: Non-climate-related anthropogenic processes and frequently encountered natural hazards exacerbate the risk in coastal zones and megacities and amplify local vulnerability. Coastal risk is amplified by the combination of sea level rise (SLR) resulting from climate change, associated tidal evolution, and the local sinking of land resulting from anthropogenic and natural hazards. In this framework, the authors of this investigation have actively contributed to the joint European Space Agency (ESA) and the Chinese Ministry of Science and Technology (MOST) Dragon IV initiative through a project (ID. 32294) that was explicitly designed to address the issue of monitoring coastal and delta river regions through Earth Observation (EO) technologies. The project's primary goals were to provide a complete characterization of the changes in target scenes over time and provide estimates of future regional sea level changes to derive submerged coastal areas and wave fields. It also provided suggestions for implementing coastal protection measures to adapt and mitigate the multifactor coastal vulnerability. To achieve these tasks, well-established remote sensing technologies, based on the joint exploitation of multi-spectral information gathered at different spectral wavelengths, the exploitation of advanced Differential Interferometric Synthetic Aperture Radar (DInSAR) techniques for the retrieval of ground deformations, the realization of geophysical analyses, and the use of satellite altimeters and tide gauge data, have effectively been employed. The achieved results, which mainly focus on selected sensitive regions including the city of Shanghai, the Pearl River Delta in China, and the coastal city of Saint Petersburg in Europe, provide essential assets for planning present and future scientific activities devoted to monitoring such fragile environments. These analyses are crucial to assess the factors that will amplify the vulnerability of low-elevation coastal zones.

Keywords: Ground Subsidence; Sea Level Rise (SLR); Flooding Risk; Delta Regions.