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Modelling the interaction between natural hazards and socioeconomic systems in city-regions

Qiang Dai (1), Dawei Han (1), Ningsheng Chen (2), and Anna Jacomo (1)

(1) University of Bristol, Department of Civil Engineering, Bristol, United Kingdom (qd_gis@163.com), (2) Chinese Academy of Sciences, Key Laboratory of Mountain Hazards and Surface Processes, Institute of Mountain Hazards and Environment, Chengdu, China

There is a growing intensity and frequency of natural hazards in many cities around the world due to the changing climate and anthropogenic activities. The negative effects of natural hazards on human society are usually amplified due to the compounding interactions from multi-hazard chains, such as earthquake, flood, typhoon, etc. To date, there has been little work on the socioeconomic impact simulation from multi-hazard events and even fewer studies on the dynamic intersection between human behavior and natural hazards. Considering the complicated interactions of natural hazards and socioeconomic systems, a holistic, systematic and integrated city model with a diverse range of natural hazards in a multi-hazard context is required.

To tackle the aforementioned issues, this study proposes a hazard-oriented city model to describe how people behave in multi-hazard events within an agent-based framework with a specific reference to the dynamics of the hazards and human environment. The city model includes the following key components: 1) a GIS module that provides a spatial expression and analysis framework; 2) a social process simulation module covering a human activity model, a city network model, an information diffusion model, etc.; 3) an economy simulation module that analyzes the interactions between different industries and their input-output ratios; 4) a hazard module that models the dynamic process of individual and integrated hazards; 5) an assessment module that estimates the social impact factor of hazards such as exposure, vulnerability, risk and damage.

Based on this model, two initial examples are carried out in Dechang city in China as part of the RESIST Project funded by NERC of UK and NSFC of China. The first one lies in simulating the dynamic vulnerability of storm-trigged multi-hazards (urban flood, fluvial flood and landslide), which aims to provide an assessment of human vulnerability to multi-hazards by considering the human daily-activity behaviors and mobility adaptation with respect to weather disruptions and hazard warning. The second case study lies in simulating the indirect damage of tourism by multi-hazards (including primary hazards and induced secondary hazards). The sudden and long-term indirect damage of hazards on the hospitality, catering, entertainment industries will be investigated. The ultimate goal of this work is to offer an innovative solution for integrated collective hazard-impact assessment.