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# Linking local vulnerability to climatic hazard damage assessment for integrated river basin management

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1. Background
Major portions of areas in Asia are expected to increase exposure and vulnerability to climate change and weather extremes due to rapid urbanization and overdevelopment in hazard-prone areas. To prepare and confront the potential impacts of climate change and related hazard risk, many countries have implemented programs of integrated river basin management. This has led to an impending challenge for the police-makers in many developing countries to build effective mechanism to assess how the vulnerability distributes over river basins, and to understand how the local vulnerability links to climatic (climate-related) hazard damages and risks. However, the related studies have received relatively little attention. This study aims to examine whether geographic localities characterized by high vulnerability experience significantly more damages owing to onset weather extreme events at the river basin level, and to explain what vulnerability factors influence these damages or losses.

2. Methods and data
An indicator-based assessment framework is constructed with the goal of identifying composite indicators (including exposure, biophysical, socioeconomic, land-use and adaptive capacity factors) that could serve as proxies for attributes of local vulnerability. This framework is applied by combining geographical information system (GIS) techniques with multicriteria decision analysis (MCDA) to evaluate and map integrated vulnerability to climatic hazards across river basins. Furthermore, to explain the relationship between vulnerability factors and disaster damages, we develop a disaster damage model (DDM) based on existing disaster impact theory. We then synthesize a Zero-Inflated Poisson regression model with a Tobit regression analysis to identify and examine how the disaster impacts and vulnerability factors connect to typhoon disaster damages and losses. To illustrate the proposed methodology, the study collects data on the vulnerability attributes of the Kaoping, Tsengwen, and Taimali River basins in southern Taiwan, and on the disaster impacts and damages in these river basins due to Typhoon Morakot in 2009. The data was offered by the National Science and Technology Center for Disaster Reduction, Taiwan, as well as collected from the National Land Use Investigation, official census statistics and questionnaire surveys.

3. Results
We use an MCDA to create a composite vulnerability index, and this index is incorporated into a GIS analysis to demonstrate the results of integrated vulnerability assessment throughout the river basins. Results of the vulnerability assessment indicate that the most vulnerable areas are almost all situated in the regions of middle and upper reaches of the river basins. Through the examining of DDM, it shows that the vulnerability factors play a critical role in determining disaster damages. Findings also present that the losses and casualties caused by Typhoon Morakot increase with elevation, urban and agricultural developments, proximity to rivers, and decrease with levels of income and adaptive capacity. Finally, we propose the adaptive options for minimizing vulnerability and risk, as well as for integrated river basin governance.