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Assessment of disaster resilience capacity of hillslope communities with high risk for geological hazards

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Abstract

This study presents a novel preparedness assessment method for assessing hazard mitigation and environmental planning of hillslope communities. A professional questionnaire was utilized to weight each indicator. Communities in Hsinchu, Taichung and Nantou counties with debris flow hazards were taken as study samples. Debris flow risk and landslide susceptibility for each community were determined using Geographic Information System (GIS) technology and logistic regression analysis. Thus, a novel risk assessment method for evaluating disaster resilience capacity of hillslope communities was established. This method was then applied to assess casualties caused by Typhoon Herb in 1996 and Typhoon Mindulle in 2004. Additionally, the analytical results generated by this assessment method were discussed with the aim of developing references for implementation of risk analysis, increasing the effectiveness of disaster mitigation, and reducing future loss of life and property.

Keywords: Debris flow; Landslide susceptibility; Disaster resilience capacity; Logistic

1. Introduction

Mountainous areas in Taiwan typically have steep topographies, and are therefore vulnerable to landslides and debris flows. For instance, in 1990, Typhoon Offelia caused countless casualties to the Tongmen Community, Hualian; Typhoon Herb in 1996 and typhoons Toraji and Nari in 2001 also caused numerous causalities and landslides (Chen, 2002a,b). Thereafter, residents in hillside areas began paying attention to natural disasters. In response to the public's growing concerns over landslides and debris flows, governments at both the national and county levels launched many programs aimed at disaster mitigation.

Risk perception is a necessity for hazard mitigation. By understanding risk, disaster and vulnerability can be analyzed, the experiences can be examined, the current situation can be monitored and the future predicted. Furthermore, with appropriate strategies, hazard susceptibility in certain areas can be reduced. Unfortunately, as government funds have fallen short, mobilizing communities from disasters preparedness is necessary. This study establishes a set of methods for assessing community performance in hazard mitigation, identifying the organizational and environmental structures in communities and assessing their capabilities for hazard mitigation and disaster resilience. All these processes are the base for identifying the designated soil and water conservation areas and planning for the future conservation of national lands in Taiwan (Ko and Chen, 2004a,b).

Geis (2000) and Chen (2002a,b) define the "disaster resistance" as the ability to resist, and "disaster resilience" as the capability of recovering from or adjusting easily to a disaster. These two capabilities are both aimed at reducing possible loss from disasters. Consequently, Disaster Resilience Capacity (DRC) is defined as the capability of a community to survive following a disaster.

Three counties in Taiwan, Hsinchu, Taichung and Nantou, which experience frequent geological disasters, were chosen as sample areas. Aerial photographs were used in analyzing community environments for further assessment of risk of debris

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flow torrents and landslide susceptibility. The DRC index for hazard mitigation work and natural environments was established.

2. Description of study areas

The highest relief in the area in western Taiwan home to Hsinchu, Taichung and Nantou counties Mt. Morrison (3952 m). The overall area is 7585 km^2 (Fig. 1).

2.1. Geological setting

The study area consists of 16 geological units (Fig. 2). The oldest unit is the Tananao Schist, which is composed of a wide assortment of metasediments and metavolcanics in addition to other metaigneous rocks.

The Hsitsun Formation is composed of well-foliated dark-gray slate and phyllitic slate. Interbeds of dark-colored, fine-grained, hard quartzose sandstone can be 600 m thick. Szeleng Sandstone is about 350 m thick and composed predominantly of white quartzitic sandstone. The Kankou Formation is composed of black-to-dark-gray shaly sediments that have been indurated into argillite or metamorphosed into slate or phyllitic slate, while the Tatungshan Formation sits on abundant sandstone or siltstone interbeds. The Aoti Formation is a carbonaceous unit and is slightly indurated. The Lushan Formation consists largely of black-to-dark-gray argillite, slate, and phyllite with occasional interbeds of dark-gray compact sandstone and disseminated marl nodules.

The Yehliu Group (Early Miocene), Juifang Group (Middle Miocene), and Sanhsia Group (Late Miocene) are the three Miocene stratigraphic units in Taiwan. Miocene rocks are mainly

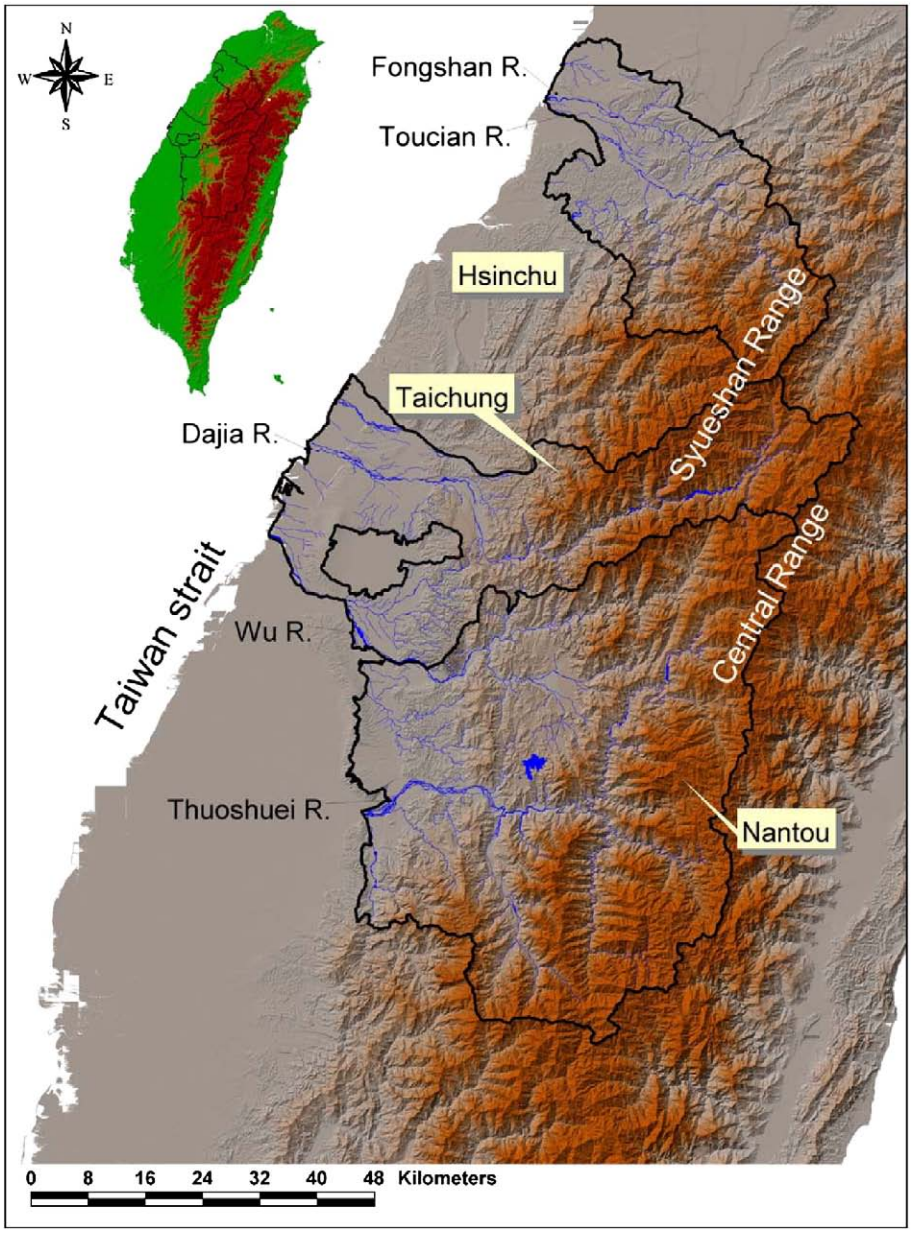

Fig. 1. Location of the study area.