

Preface to the Special Issue on Potential Geohazards of the Taipei Metropolitan Area

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The Taipei metropolitan area is located within a complex tectonic environment where several types of geohazards may readily occur. In order to better characterize and understand the tectonic environment and related surface processes that may threaten the residents of Taipei, the Taiwan Central Geological Survey launched a then newly integrated project a few years ago aimed at gathering up-to-date tectonic, volcanic, seismic, geologic and geochemical data in the northern and offshore Taiwan. Many new and exciting findings have arisen from such a program and have provided further insight into the overall sources of geologic and seismic hazards around the Taipei metropolitan area.

Earthquake threats for the Taipei metropolitan area come from several potential sources, including large earthquakes with epicenters located some distance from Taipei for example, the 921 Chi-Chi earthquake and earthquakes occurring offshore Hualien. If certain crustal conditions develop at the plate interface underneath the Taipei Basin and allow a reflection of seismic waves into the Taipei region, earthquakes can cause severe surface vibration resulting in serious damage. Another possible earthquake threat comes from fault activities at shallow depths such as the Shanchiao normal fault. Because most of the Taipei metropolitan area is located upon the soft Quaternary sediments of the geometrically complex Taipei Basin, it is important to better understand the physical properties of the basin sediment for seismic wave propagations. Several papers in this special issue address related issues of seismic wave properties and site responses in the Taipei metropolitan area. Furthermore, active volcanoes may also result in serious damage to society and surrounding environs as documented by numerous hazardous eruptions worldwide. Although no historical volcanic eruptions have been recorded in the Taiwan region, empirical and phenomenal evidence indicates that the Tatun volcano group and the Kueishantao volcanic island may include active volcanoes raising the critical question of how to evaluate the activities and threats of the volcanoes in Tatun and Kueishantao. Several papers address these questions in this issue to better characterize the status of volcanic activities and underlying processes. Here:

Chen et al. (2010b) examine Holocene activities of the Shanchiao Fault by compiling sedimentary records,

particularly depositional facies and available age dates of three boreholes in the Taipei Basin. The depositional history of the Taipei Basin since the Last Glacial Maximum can be quite well reconstructed using a simple back-stripping method. They point out tectonic subsidence events that may possibly be related to major earthquakes and suggest further studies of the fault activities are needed to explore other possibilities of earthquake events. Here Cheng et al. (2010) use available data to evaluate probabilistic seismic hazards including the attenuation relationship of the peak ground acceleration, fault-slip data, and seismicity. Important earthquake sources are pointed out in the metropolitan Taipei area. In addition to the long return earthquake period of active faults, the study calls for attention to the threats of high peak acceleration resulting from subduction zone earthquakes beneath the Taipei area.

Recent surface deformation and changes may be monitored by new satellite-borne and airborne remote sensing techniques, particularly InSAR and LiDAR. Chang et al. (2010a) apply DInSAR and PSInSAR techniques to analyze the general uplift and subsidence pattern in northern Taiwan and show regions of surface change of the past decade as related to fault activities. Meanwhile, Chang et al. (2010b) present the mapping results of the Nankan lineament, which is considered to be an active fault as outlined by the Taiwan Central Geologic Survey, using the newly-derived airborne LiDAR topographic data and concludes that the lineament has not been tectonically active since the deposition of the alluvial fans, thus posing less threat to the Taipei area.

Huang et al. (2010a) reconstruct two-dimensional motions of the magnitude 7.1 earthquake that occurred offshore eastern Taiwan in 2002 based on 89 free-field strong motion records in northern Taiwan. According to the study, seismic wave amplifications are obvious within the Taipei Basin, especially where the sediment is the thickest. Studying the same earthquake, Huang et al. (2010c) find that seismic waves travel within the Taipei Basin and have been reflected back from its western edge with a dominant frequency of about one Hz. Characterization of these seismic waves within the Taipei Basin should provide further information for prevention of shaking-induced hazards and importantly more realistic modeling of seismic propagation.

Chen et al. (2010c) analyze three locally felt earthquakes based on a dense broadband seismic array deployed around the Taipei area. According to relocated hypocenters, the study proposes a potential blind normal fault underneath the Taipei Basin. The tentative proposal of a blind normal fault in the region prompts for more detailed investigation of normal faulting activity within the Taipei Basin. For methodology-oriented paper, Lee et al. (2010) present an improved method to invert the moment tensor solution for local earthquakes. The paper shows that the method can gather more precise source parameters for earthquakes in a well-modeled basin such as the Taipei Basin. In a short note, Huang et al. (2010b) report seismic observations from downhole networks that certainly can assist the evaluation of seismic waves passing through the Taipei Basin.

Wang et al. (2010) discuss the problem of static stress transfer for two major faults: the Sanchiao fault and the Chinshan normal fault in the Taipei area. Here, Coulomb stress changes are computed to determine triggering of one fault resulting from the failure of another. The calculated failure mode may indicate potential areas of seismic hazard when major earthquake hitting the Taipei area. Among all the geohazards, flooding due to significant rainfall events are familiar to the residents of Taipei. However, inundation hazards resulting from potential surface faulting may not be so familiar to most people. Lai et al. (2010a) simulate an inundation scenario resulting from surface faulting of the Sanchiao normal fault. Inundation maps are created for future reference to potential flooding hazards for the Taipei region. Lo et al. (2010) present results of the talus deposit investigation and discuss a possible mechanism for its development. The study identifies many talus deposits that may pose landslide dangers near the southeastern Taipei city.

In addition to earthquake-induced geohazards, potential volcanic activities and eruptions are also investigated and presented in several papers. Chiang et al. (2010) monitor the geothermal activities of the Kueishantao volcanic island offshore northeastern Taiwan. Interestingly, they find that geothermal activity may be affected by typhoons and clearly a still unsettled question as to whether or not that earthquakes can be correlated with the measured temperature variations warranting further investigation. Chiu et al. (2010) establish a detailed geologic map of Kueishantao and divide the volcanic rocks into six lava flows that are interlayered with pyroclastic flows. Two volcanic centers are identified through experimental drilling on the island. Based on mapping and age dates, the study cannot conclude that eruption of the Kueishantao will no longer occur.

Lai et al. (2010b) survey the Chihsingshan volcano, the highest peak in the Tatun volcanic group, and recognize at least twenty lava flow layers. Similarly, Tsai et al. (2010) map the well-preserved Huangtsuishan volcano subgroup using newly-derived topography and identifies thirteen lava flow layers. Although published age dates of these volcanic

activities range from 1.5 to 0.2 Ma, a recent notable discovery by Chen et al. (2010a) indicates that the latest volcanic eruption in the Tatun volcanic group can be dated as young as 20 Ka. This brand new information further reminds us of potential volcanic hazards in the Taipei metropolitan area in addition to well-known earthquake-related geohazards.

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