Application of LiDAR-derived DTM to analysis of drainage morphometry and flood modeling in the Jinshan area

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Abstract

Drainage morphometry is a method of the measurement and mathematical analysis of the configuration of the earth’s surface and of the shape and dimensions of its landforms. Drainage network analysis is commonly used to shed light on the evolution, organization, and flow pattern. Moreover, geomorphologic quantitative methods can be applied to evaluated tectonic activities because they respond sensitively to the relationship between surface features and fluvial landscapes. In the past decade, digital terrain models (DTM) have been used intensively for observing and mapping landforms and structures because of its power for displaying spatial relations in active structures. However, more precise and higher resolution DTMs are needed to improve our understanding of minor ground changes induced by single faulting events. Since 2005, airborne LiDAR mapping is carried out and provided high resolution DTM with accuracy ~ 15 cm in northern Taiwan. Historical records show that severe earthquakes may have triggered significant surface ruptures and caused flood damage around the Jinshan delta area. Our work applies the newly LiDAR-derived DTM to pinpoint the locations of active faulting which is not well observed and documented in the study area. Furthermore, quantifiable sets of geometric properties were defined that described the linear, areal, and relief characteristics of the Peihuanghsi watershed. Based on the analysis of river profiles, locations of normal faulting with 3 m offset were recognized in the northwestern side of the Jinshan delta area. The overall river pattern also displays a left-lateral strike-slip component in addition to the normal slip component. The DTM analysis and field observations indicate that the normal fault system is possibly active due to the well preserved fault scarp in the highly erosional environment on Taiwan. Considering such normal faulting event may occur in the future, we thus model possible earthquake induced flooding effects for the Jinshan delta area. Flooding areas can be determined by the LiDAR topography in conjunction with high resolution digital aerial photographs. Finally, a subsidence modeling due to normal faulting demonstrates how topographic information produced by the LiDAR technique can be accurately used for predicting future flooding hazards.