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Preliminary Tectonic Geomorphology of the Opak Fault System, Java (Indonesia)

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The Island of Java is a part of the volcanic arc in the Sunda Plate adjacent to the trench where the Australian Plate is subducted. This tectonic setting is prone to geohazards such as earthquakes and volcanic eruptions and their secondary effects. Our work focuses on the earthquake geology in the Opak Fault system, an SW-NE trending normal fault with multiple minor strike-slip faults located at the southern part of central Java. Our paleoseismic work represents a challenge considering the emplacement of the study area: (a) the accommodation of tectonic strain by slow slip rate faults, (b) poor surface expression and long earthquake recurrence intervals; in addition to (c) the tropical climate and vegetation that accelerate the erosion/weathering rates and cover faults and related morphology. The Opak Fault system is close to the densely populated city of Yogyakarta (>4 M people). On the 27th of May 2006, a M 6.3 earthquake occurred in the area, causing more than 6000 fatalities and $3 billion economic loss. Although the mapped Opak Fault was initially thought to be the source of this earthquake, the epicenter and aftershocks distributions were inconsistent with the extent of the fault presented at the regional geology map. Based on the aftershock distributions, it was suggested that Opak Fault was not the causative fault for the 2006 earthquake, but another unknown fault, located 10 km to the east Opak Fault. The discrepancies remain unresolved since the fault did not rupture the surface, hence ground checking to determine the geometry of the fault was not possible. Locating and determining the geometry of the fault system is important to understand its potential to produce an earthquake in the future. Here, we present a tectono-geomorphological analysis based on morphometric indices of channel steepness index, knickpoint identification and detailed geomorphological mapping assisted by remote sensing to map the fault system as well as identifying other existing faults in the vicinity that may have potential to produce large earthquakes. Within the area that experienced most deformation during the 2006 earthquake we identify a peculiar drainage pattern of the Oyo River prior to the crossing of the Baturagung Range. Despite the fact that the lithology of calcareous sandstones and limestones does not change along the river's course and there is no dip variation of the layers, it changes its course northwards and southwards at various locations. This suggests that several NNW-SSE to N-S trending faults may have controlled the drainage evolution in this area. These faults may be the ones responsible for the 2006 earthquake.