

The flash floods in Lambaré, Paraguay, on November 2, 2023: a simulation study

Eduardo Ojeda, Marcelo Castier, Christian E. Schaerer & Liz Báez

Abstract

This paper is framed against a dramatic rain-caused flash flood event in the municipality of Lambaré, Paraguay, on November 2, 2023, in which two sergeants of the Paraguayan Army lost their lives when their vehicle was swept away by the torrents. This work pursues four objectives: (i) to develop a methodology for the rapid generation of digital elevation models (DEMs) incorporating urban features; (ii) to simulate the flood conditions associated with the event using HEC-RAS; (iii) to identify and map areas of high risk to vehicles and people based on the simulated flood characteristics; and (iv) to develop and implement a flood-aware vehicle routing procedure capable of generating safer origin-to-destination routes that avoid hazardous zones. To achieve these objectives, the circumstances of this event are considered. The watershed basin where it occurred is identified, and the digital elevation model of the terrain is modified by considering the presence of built structures, such as houses and residential buildings. The depressions in the terrain elevation due to the presence of water streams are also considered. Rainfall data for the occasion is retrieved from the Paraguayan National Meteorological Center. The simulated results are generally consistent with the published accounts of the event. Also, some of the locations with the most severe floods, according to the simulation, coincide with published information about previous floods in Lambaré. In addition, this work presents a new and practical methodology for flood-aware vehicle routing, that is, the automatic generation of origin-to-destination routes that avoid hazardous zones. The results show how the safest route dynamically changes, depending on the extent of the hazardous zones.