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Hazard assessment of landslide and debris flow in the Rječina river valley, Croatia

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The Rječina River extends approximately 18.7km long and flows into the Adriatic Sea at the center of Rijeka City, Croatia. Landslide, debris flow and rockfall are main geohazards in the middle part of the Rječina river basin. The zone between the Valići reservoir dam and the Pasac Bridge is particularly the most unstable and hazardous area in the river basin. The Grohovo landslide in the middle part of the river basin is located on the valley's slope facing southwest and situated at just downstream of the Valići dam. This landslide is the largest active landslide along the Adriatic Sea coast in Croatia. Assuming that serious heavy rainfall or earthquake occurs, it is most likely to occur two types of geohazard event. One scenario is that the debris deposited on the Grohovo landslide will move down to the channel of the Rječina River and dam up the river course. Another scenario is that the slope deposits on the landslide will be mixed with water and subsequently turn into a debris flow reaching to Rijeka City. We simulate both two cases of the formation of landslide-dam and the occurrence of debris-flow by two integrated models using GIS to represent the dynamic process across 3D terrains. In the case of the formation of landslide-dam, it is assumed that slope deposits will move downhill after failing along a shear zone. GIS-based revised Hovland's 3D limit equilibrium model is used to simulate the movement and stoppage of the slope deposits to form landslide-dam. The 3D factor of safety will be calculated step by step during the sliding process simulation. Stoppage is defined by the factor of safety much greater than one and the velocity equal to zero. The simulation result shows that the height of the landslide-dam will be nine meters. In case of debris flow, the mixture of slope deposits and water will be differentiated from landslide by fluid-like deformation of the mobilized material. GIS-based depth-averaged 2D numerical model is used to predict the runout distance and inundated area of the debris flow. The simulation result displays the propagation and deposition of the debris flow across the complex topography and shows that the debris flow takes about 16 minutes to travel about 6 km along the Rječina River and consequently reaches to Rijeka City.