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Assessing human and natural impacts on the hydrogeomorphological trajectory of a non-equilibrium river system

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Understanding the hydrogeomorphological trajectory of a river allows us to document the impact of environmental changes on the river, but also to determine sustainable management solutions in the cases of a non-equilibrium river system. The hydrogeomorphological trajectory is obtained through the quantification of morphological and hydrological changes that have occurred in a river system over time. This paper aims at documenting the hydromorphological trajectory of the Matane River, a gravel-bed river located on the north shore of the Gaspé peninsula, Québec. This river has been highly impacted by wood rafting in the 19th century and first half of the 20th century. Since the second half of the 20th century, there has been widespread use of bank stabilization structures to protect the road, particularly in the downstream sections of the valley. In addition to these human impacts, the river is highly sensitive to environmental changes related to hydrological variability, it is partly controlled by the presence of bedrock outcrops in some reaches and it is prone to severe river ice jams. A combination of field surveys, LiDAR Digital Elevation Models (DEMs) and high-resolution imagery was used to obtain key hydrogeomorphological variables such as water surface slope, width and unit stream power for the 50-km downstream reach of the Matane River. GIS scripts developed in ArcGIS allowed us to automatically extract unit stream power from the LiDAR DEM. The comparison with a field survey of water surface slope revealed a very good agreement (correlation coefficient of 0.87). The trajectory analysis was performed from aerial photographs from 1963 to 2009. The relationship between unit stream power extracted from the LiDAR DEM and river migration rate is not very strong. This is likely due to the impact of bank stabilization and bedrock outcrops. When examining the entire 50km reach, the trajectory analysis reveals that the river width decreased, the eroded flood plain surfaces were stable and the gravel bar surfaces increased over time. However, when considering specific river sections, the hydrogeomorphological trajectory is highly contrasted. These contrasts are discussed in relation to changes in hydrology and human activity within the fluvial system.