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National-scale assessment of river migration at critical bridge infrastructure in the Philippines using Google Earth Engine

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River migration represents a geomorphic hazard at sites of critical bridge infrastructure, particularly in rivers where migration rates are high, as in the tropics. In the Philippines, where exposure to flooding and geomorphic risk are considerable, the recent expansion of infrastructural developments warrants quantification of river migration in the vicinity of bridge assets. We analysed publicly available bridge inventory data from the Philippines Department of Public Works and Highways (DPWH) and leveraged freely available satellite imagery in Google Earth Engine (GEE) to assess river migration. Specifically, we extracted active river channel masks of the bankfull extent (including the wetted channel and unvegetated, alluvial deposits) from Landsat products (Landsat 5, 7 and 8) using multi-spectral indices, before identifying river planform adjustments over decadal and engineering (30-year) timescales. For 74 bridges, we calculated similarity coefficients (Jaccard index) to indicate planform (dis)similarity and quantified changes in river channel width using RivWidthCloud.

Monitoring revealed the diversity of river planform adjustment at bridges in the Philippines (including channel migration, contraction, expansion and avulsion). The mean Jaccard index over decadal (0.65) and engineering (0.50) timescales indicated considerable planform adjustment throughout the national-scale inventory. However, planform adjustment and morphological behaviour varied between bridges. Some inventoried bridges were characterised by substantial planform adjustment and river migration, with maximum active channel contraction and expansion over decadal timescales equal to approximately 25% of the active channel width. This represents considerable lateral adjustment and when left unmanaged could pose a substantial geomorphic hazard. However, for other inventoried bridges the planform remained approximately stable and changes in channel width were limited. We suggest that multi-temporal analysis from satellite remote sensing offers a low-cost approach for monitoring the relative risk of river migration at critical bridge infrastructure; the approach can be extended to include other critical infrastructure adjacent to rivers (e.g., road, rail pipelines) and extended elsewhere to other dynamic riverine settings.

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