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Geomorphic covariance structures of selected channel morphological variables across the alluvial-bedrock continuum in the Upper Ogun River Basin, Southwestern Nigeria

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Bivariate relationships have been extensively researched in fluvial geomorphology. The relationship between process-process, form-form, or process-form gives great insight into the dynamics of channel morphological variables. One of the most extensively adopted concepts in bivariate relationships in fluvial geomorphology has been the use of hydraulic geometry. The hydraulic geometry despite its many advantages and applications has been identified to focus more on general trends rather than innumerable individual variations. In recent times, a growing concept on bivariate observations within fluvial systems is the geomorphic covariance structures (GCS). GCS has been defined as linked bivariate observations of any two river morphological variables along a continuum. These variables could also accommodate the abiotic and biotic variables. In its strictest sense, GCS does not necessarily connote a statistical covariance though sometimes it could, it focuses more on a complete bivariate spatial series. In this study, we investigated coherent patterns for GCS for selected morphological variables along the alluvial-bedrock continuum for 83 reaches within the Upper Ogun River Basin. In interpreting the bivariate spatial series along the alluvial-bedrock continuum, we made use of "in-phase" and "out-of-phase". In-phase signifies a positive relationship and out-of-phase signifies an inverse relationship. The morphological variables were measured using standard procedures and derived variables were determined using hydraulic equations. As the river flows from an alluvial section into a bedrock section; slope and total stream power were out of phase, hydraulic radius and velocity are in phase across the continuum, bankfull with and slope were out of phase, while slope and total stream power were more in phase within the bedrock section than in the alluvial section and finally, width and total stream power were out of phase. The alluvial section within the Upper Ogun River Basin is either unconfined or partly confined while bedrock channels are confined and underlain by migmatites. Flow within the bedrock channels is restricted while flow within the alluvial channels is more dispersed and free-flowing. The inherent dynamics operating within these two distinct channel types are capable of providing a detailed extent as to the observed bivariate relationships between these selected morphological variables using geomorphic covariance structures.