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A framework for evaluating regional hydrologic sensitivity to climate change using archetypal watershed modeling

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ABSTRACT

The current study focuses on the development of a regional framework to evaluate hydrologic and sediment sensitivity due to predicted future climate variability using developed archetypal watersheds. The developed archetypes are quasi-synthetic watersheds that integrate observed regional physiographic features (i.e., geomorphology, land cover patterns, etc.) with synthetic derivation of basin and reach networks. Each of the three regional archetypes (urban, vegetated and mixed land covers) simulates satisfactory hydrologic and sediment behavior compared to historical observations (flow and sediment) prior to the climate sensitivity analysis. Climate scenarios considered increasing temperature estimated from the IPCC and precipitation variability based on historical observations and expectations. Archetypal watersheds are modeled using the Environmental Protection Agency's Hydrologic Simulation Program–Fortran model (EPA HSPF) and relative changes to streamflow and sediment flux are evaluated. Results indicate that the variability and extent of vegetation play a key role in watershed sensitivity to predicted climate change. Temperature increase alone causes a decrease in annual flow and an increase in sediment flux within the vegetated archetypal watershed only, and these effects are partially mitigated by the presence of impervious surfaces within the urban and mixed archetypal watersheds. Depending on extent of precipitation variability, urban and moderately urban systems can expect the largest alteration to flow regimes where high flow events are expected to become more frequent. As a result, enhanced wash-off of suspended-sediments from available pervious surfaces is expected.