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Detecting hydrologic responses of land use change at the river-basin scale

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Surface mining for coal, and subsequent land reclamation, is presently the dominant type of land use change in the predominantly-forested, central Appalachian region of the eastern United States. Previous studies conducted at the small catchment scale (10^0 km^2) have demonstrated significant hydrological impacts associated with these changes, including reductions in soil infiltration capacity (owing to soil compaction), increases in infiltration-excess overland flow, and increases in total storm runoff and stormflow peaks. The objective of the current study was to test the hypothesis that comparable hydrographic changes accompany mining and reclamation at the river basin scale (10^2 – 10^3 km^2). We performed two different statistical analyses that each made use of long-term daily streamflow and precipitation time series from two adjacent river basins located in western Maryland: Georges Creek (partially mined and reclaimed) and Savage River (unmined). The first analysis examined temporal changes (i.e., non-stationarity) in flood frequency distributions using a moving window approach; the second analysis examined the annual maximum series of peak runoff, causative precipitation, and peak runoff ratio for trends. A third analysis was based on a comparison of hourly streamflow and radar-derived storm precipitation data for sixteen paired warm-season events that occurred at both watersheds during the period 1999-2005. Our results suggest that even modest levels of land use change have the potential to significantly affect hydrological processes in river basins. Statistical detection of such changes in the face of relatively large climatic variations can be enhanced through the use of a second basin as an experimental control.