

Category I: Hydrology, Climatology & Hydraulics

Predicting the Impacts of Urbanization on Basin-scale Runoff and Infiltration in Semi-arid Regions

PRINCIPAL INVESTIGATOR

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EXECUTIVE SUMMARY

The Santa Clara River, located 30 miles north of the city of Los Angeles, flows 116 miles from its eastern headwaters in the Santa Susana Mountains to the outlet at the Pacific Ocean near Ventura, California. Although the population of southern California is growing dramatically, the Santa Clara region has escaped much of the urbanization pressures and remains in a mostly natural, free-flowing state. However, the northward expansion of urban development in Los Angeles County is approaching the Santa Clara and major land-cover change is starting to occur. The recent rainfall events (winter of 2004-2005) in southern California reminded communities of the destructiveness that extreme precipitation can have on local communities and ecosystems. Increasing urbanization in regions such as Santa Clarita, which is heavily impacted by periodic floods, will create even more uncertainty in prediction and management of large-scale runoff events. This increased urbanization also results in a loss of the infiltration (and subsequent recharge to the aquifer) due to the increase in impervious surface that accompanies urbanization.

California is expected to grow by 20 million inhabitants by 2050 and urban areas will continue to encroach on wildland regions. Understanding the short and long-term effects of these drastic land-cover changes on regional water supplies will become increasingly important. The proposed research will help develop a better understanding of the impacts of urbanization on hydrologic processes, but will also provide a platform for the discussion of alternative urban forms and development locations to mitigate some of the anticipated deleterious impact. This study will address several key science questions, including: What are the current dynamics in the upper portion of the Santa Clara watershed (runoff, streamflow patterns and infiltration rates)? Can a semi-distributed, basin-scale model, using high-resolution satellite-based products, adequately simulate current watershed dynamics? Can this detailed basin-scale model predict the impacts of the proposed urban developments and reduce the uncertainty in the quantity and frequency of future flows in the Upper Santa Clara River? In addition to changes in surface flow, what are the potential infiltration losses to the groundwater system (and valuable recharge) in the basin? And finally, can results from this study be used by decision-makers as they proceed with development in the region?

The Santa Clara River offers a unique opportunity to study a semi-arid watershed in transition from a natural to an urbanized state. Both surface water and groundwater flow regimes are expected to be severely altered by the development in the basin, and quantification of potential changes in these fluxes will be critical to local water resource managers. The proposed research will focus on the development of a physically-based, semi-distributed model specifically for the upper Santa Clara River basin, using existing in situ data (land cover, soils data, gauge-based precipitation, streamflow data, etc.) and satellite-based products (potential evapotranspiration, solar radiation, land surface temperature, etc.). The modeling framework will provide an effective tool for evaluating development scenarios and predicting the impacts of urbanization on basin-scale runoff and infiltration rates. Although the proposed research focuses on the Santa Clara River, this work is readily transferable, and highly relevant, to other regions in California undergoing urbanization.