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Stream channel classification and mapping systems: Implications for assessing susceptibility to hydromodification effects in southern California

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ABSTRACT

There is growing recognition that contemporary land use changes associated with urbanization are altering channels and accelerating erosion processes in many southern California watersheds. Such changes are referred to as "hydromodification". Hydromodification can be defined as changes in watershed hydrologic processes associated with change in land use, often accompanied by increased imperviousness, which result in increased surface runoff and higher flow magnitudes and durations for equivalent rainfalls relative to the undeveloped setting. Some of the effects of hydromodification include an altered sediment delivery from the watershed, increased sediment transport within channels, and changes in channel forms.

Streams in arid/semiarid climates are perhaps most vulnerable to morphologic adjustment associated with changes in runoff because of the prevalence of channels that actively transport bedload sediment (i.e., live-bed channels), historical incision, and lack of stabilizing vegetation. Conventional theories developed for humid-temperate environments, such as dominant/channel forming discharge, hydraulic geometry relationships, and the concept of equilibrium must be reconsidered in arid/semiarid environments (Graf 1988a). It is well known that streams in arid regions can exhibit radical morphologic responses to urbanization (Trimble 1997). Adjustments can also be relatively subtle and spatially discontinuous because of the influence of urban infrastructure (e.g., culverts and pipelines acting as grade control; Chin and Gregory (2001)). Recent associative studies of watershed impervious area versus channel enlargement suggest that urban streams in the southwestern US may detectably enlarge at lower levels of watershed urbanization than streams in the eastern US (Coleman *et al*., 2005). Such studies are at least partially confounded, however, by watershed-specific patterns of impervious connectivity and drainage infrastructure, stream boundary materials, temporal lags, and legacy effects (Bledsoe and Watson 2001a, Jacobson et al. 2001).

Significant impacts to wetland, riparian, and stream habitats (Allen 1993, Allen and Feddema 1996, Stein and Ambrose 2001), as well as infrastructure and property losses, point to a need for improved hydromodification management strategies and tools. Rapid urbanization, legacy effects from past land-uses, and lags in channel response create challenges for the regulatory and management community in addressing proximate and cumulative effects of hydromodification. An important early step in managing hydromodification effects is to be able to rate streams in terms of their potential susceptibility of response to planned changes in watershed lands use, hydrology, and sediment yield. Past research in fluvial geomorphology and river mechanics provides a rich source of conceptual, qualitative, and quantitative tools relevant to arid/semiarid streams.

As a first step toward assessing the potential utility or modification of existing tools and previous research for managing hydromodification in southern CA, we performed a literature review of existing geomorphic mapping and classification schemes. The classification systems included in this summary are pertinent to assessing relative susceptibility to hydromodification effects and channel stability in southern California. For the purposes of this review, we define stream stability following Biedenharn *et al*. (1997): "*In summary, a stable river, from a geomorphic perspective, is one that has adjusted its width, depth, and slope such that there is no significant aggradation or degradation of the stream bed or significant planform changes (meandering to braided, etc.) within the engineering time frame (generally less than about 50 years).*" Although decadal time scales have practical limits for long-term planning, they are valuable in that water and sediment discharge are both primary independent variables (Schumm and Lichty 1965, Schumm 1991). Channel responses to changes in these variables occur at spatial scales that range from drainage networks to reaches to streambed patches. We focus primarily on the reach scale (e.g., on the order of 10^1 – 10^2 m or 10 - 20 bankfull channel widths), where geomorphic adjustments to altered water and sediment regimes have immediate consequences for stream ecosystems via changes in channel morphology, habitat structure, and disturbance dynamics (Poff *et al.* 2006).

Full Text

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