Field-based Geomorphic Methods for Assessing the Impacts of Hydromodification on Stream Channels

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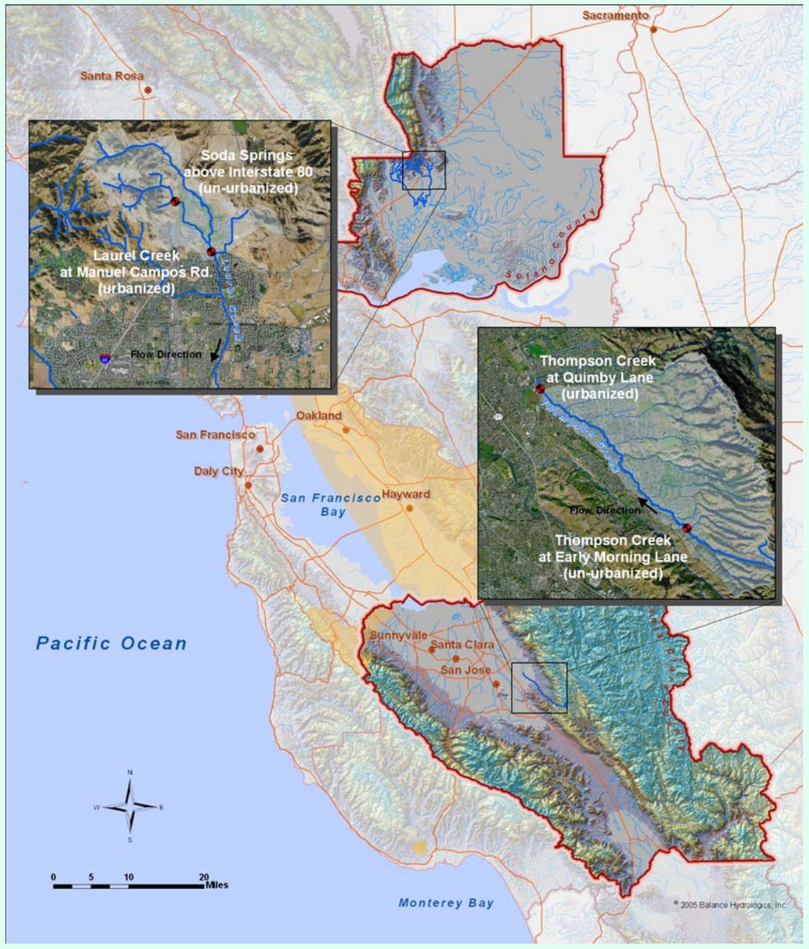
1. Introduction

Balance Hydrologics developed field-based geomorphic methods for assessing the impacts of hydromodification on stream channels that discharge to San Francisco Bay. The term "hydromodification" refers to changes to the natural streamflow hydrograph due to watershed disturbances and changes in land use, particularly urbanization. The increase in impervious area coverage and drainage density associated with urbanization reduces infiltration of rainfall and increases the peak rate and volume of runoff to local streams. These changes can disrupt stream channel morphology, including causing reach-wide incision and/or erosion of the stream banks, resulting in transport of significant volumes of sediment from upland areas downstream to the bay and estuary system.

2. Site Location

Balance Hydrologics conducted sediment transport and geomorphic studies in two San Francisco Bay watersheds: 1) the Thompson Creek subwatershed of the Coyote Creek watershed in eastern Santa Clara County; and 2) the Laurel Creek watershed in southern Solano County. The purpose of the field work was to compare sediment transport rates and channel conditions in urbanized and un-urbanized portions of the watershed.



Balance Hydrologics has conducted additional hydromodification studies in the Bay region and elsewhere in the state. Study areas (highlighted on the map in orange) include: Alameda County HMP, UCSC Stormwater Master Plan, and San Francisquito Watershed studies.

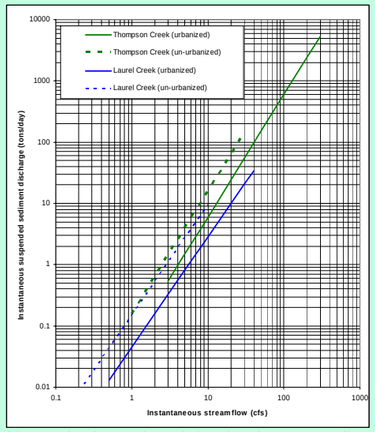
3. Methods

Laurel Creek – urbanized watershed
Q= 4.5 cfs

Thompson Creek – urbanized watershed
Q= 72.7 cfs

Balance staff installed several continuous-recording stream gages along the main stem and tributary channels of the two watersheds and conducted stream reconnaissance surveys to evaluate channel stability and identify areas of active, reach-wide erosion. During water years 2003 through 2005 (for Thompson Creek) and water year 2005 (for Laurel Creek), we measured streamflows and collected samples of suspended and bedload sediment at the stations to estimate sediment discharge rates. These data are also being used to estimate the volume and size distribution of sediment entering and passing through the watersheds, to evaluate bank stability related to sediment transport findings, and to compare sediment transport findings between the two studied watersheds.

4. Data/Results



This graph shows the relationship between sediment transport and flow. Lines were fit to a series of individual sediment transport measurements for each gage.

Gaging station	Watershed area	Period of record	Total flow per square mile (acre-feet/mi²)	**Flow Ratio***	Suspended load per square mile (tons/mi²)	**Suspended sediment ratio***
Thompson Creek – (urbanized)	17.4	10/1/02-9/30/03	72		465	
Thompson Creek – (un-urbanized)	2.3	10/1/02-9/30/03	14	**5.1**	5	**97**
Laurel Creek – (urbanized)	4.2	11/11/04-5/29/05	343		7	
Laurel Creek – (un-urbanized)	0.99	11/11/04-5/29/05	214	**1.6**	51	**0.14**

*These ratios highlight the differences between the urbanized and un-urbanized portions of the watersheds:

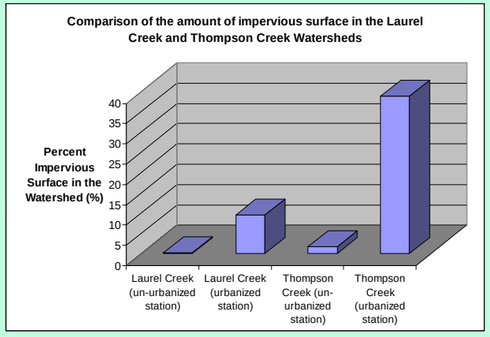
Ratio = Urbanized station (flow or suspended sediment per square mile) / Un-urbanized station (flow or suspended sediment per square mile)

Comparison of these ratios can serve as a useful tool in quantifying the effects of urbanization within watersheds of varying conditions (geology, precipitation, urbanization patterns or degree of urbanization, among other factors). Note that the data from the two watersheds was collected in different water years—the calculations flow and suspended load per square mile are not comparable between watersheds (due to varying amounts of rain), however the urban/non-urban ratios of are comparable.

The middle watershed of Laurel Creek (downstream from the un-urbanized, upper station), has much potential for sediment storage and minimal in-channel erosion.

Conversely, reach-wide bank erosion was observed along many of the urbanized portions of Thompson Creek that act as sediment sources during flow events.

The percentage of impervious surfaces in the watersheds of the urbanized stations are different for Laurel Creek (9.5%) and Thompson Creek (38.7%).



5. Summary of Conclusions

The Thompson Creek watershed shows a much higher unit ratio of urbanized to un-urbanized flow and sediment transport than the Laurel Creek watershed, which corresponds to the higher degree of urbanization within the lower Thompson Creek watershed. The higher degree of urbanization in Thompson Creek has observable effects on channel stability, with Thompson Creek exhibiting reach-wide channel instability via bank widening and incision. These areas of erosion represent large in-stream sediment sources that are not present along Laurel Creek, where the amount of urbanization does not appear to have crossed a threshold where reach-wide in-channel erosion occurs. Instead, there are still many areas within the urbanized portion of Laurel Creek where there is no defined channel and sediment is stored.