

Aridland Urban Hydrology in Phoenix, AZ



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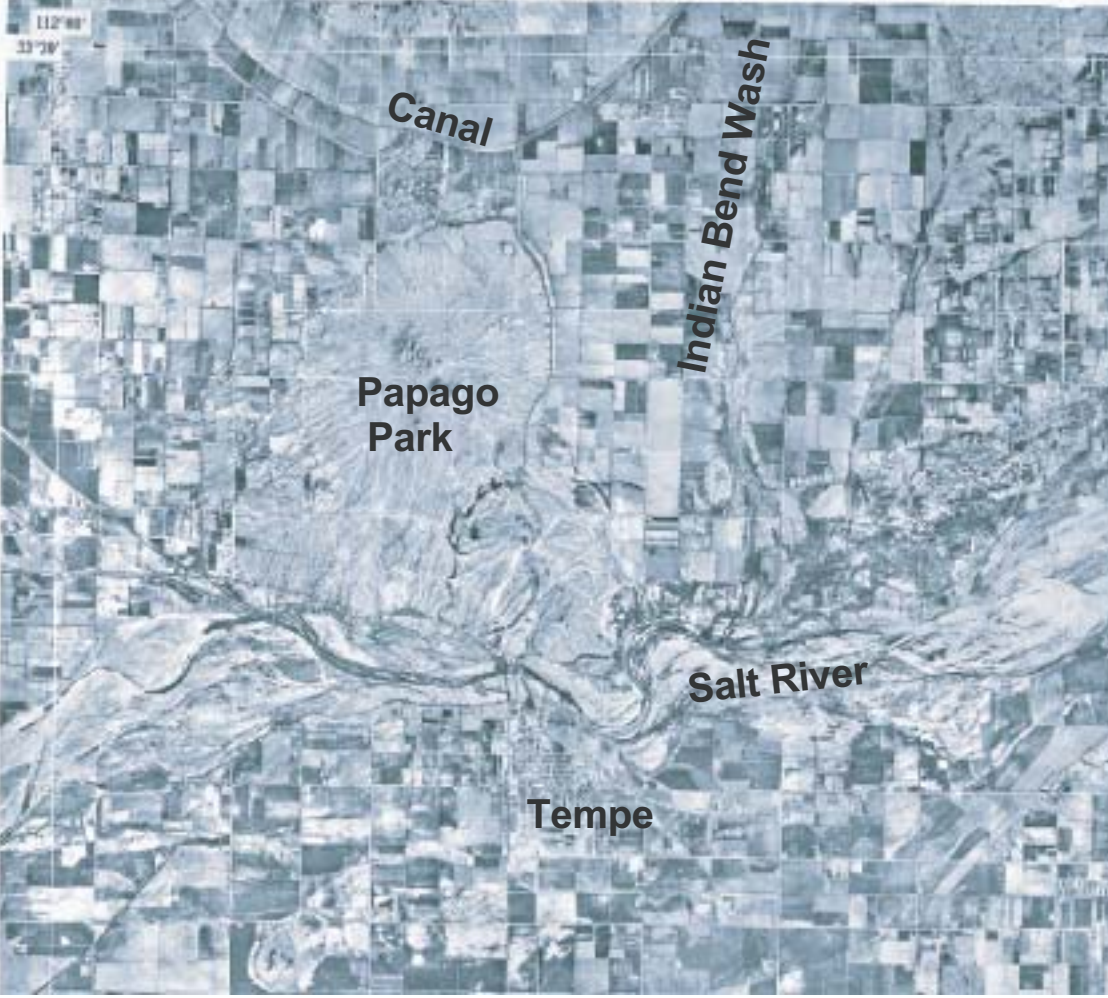
ABSTRACT

To determine the effects of urbanization on hydrology we analyzed 30-40 year trends in hydrologic parameters in Phoenix, AZ, and performed a downstream flow analysis of Indian Bend Wash (IBW) to examine factors that may explain these changes. We coupled this analysis with observations of changes in urban infrastructure and urban form.

Streams in Phoenix did not demonstrate consistent trends in runoff, peak discharge, or flashiness, nor were these trends different than non-urban streams. Frequent flood events (<2-year recurrence interval) increased in magnitude for two urban streams perhaps suggesting that urbanization leads to more runoff. However, within IBW, analyses of stormwater flow and the location of pipes, roads, and retention basins, suggest some areas of the watershed are segmented into internally drained subsystems. Other parts of the watershed are rerouted around IBW or enter the channel at locations further downstream because of street and pipe conveyance. Therefore, rerouting of surface runoff may be as important as increased runoff generation in accounting for changes in hydrologic parameters.

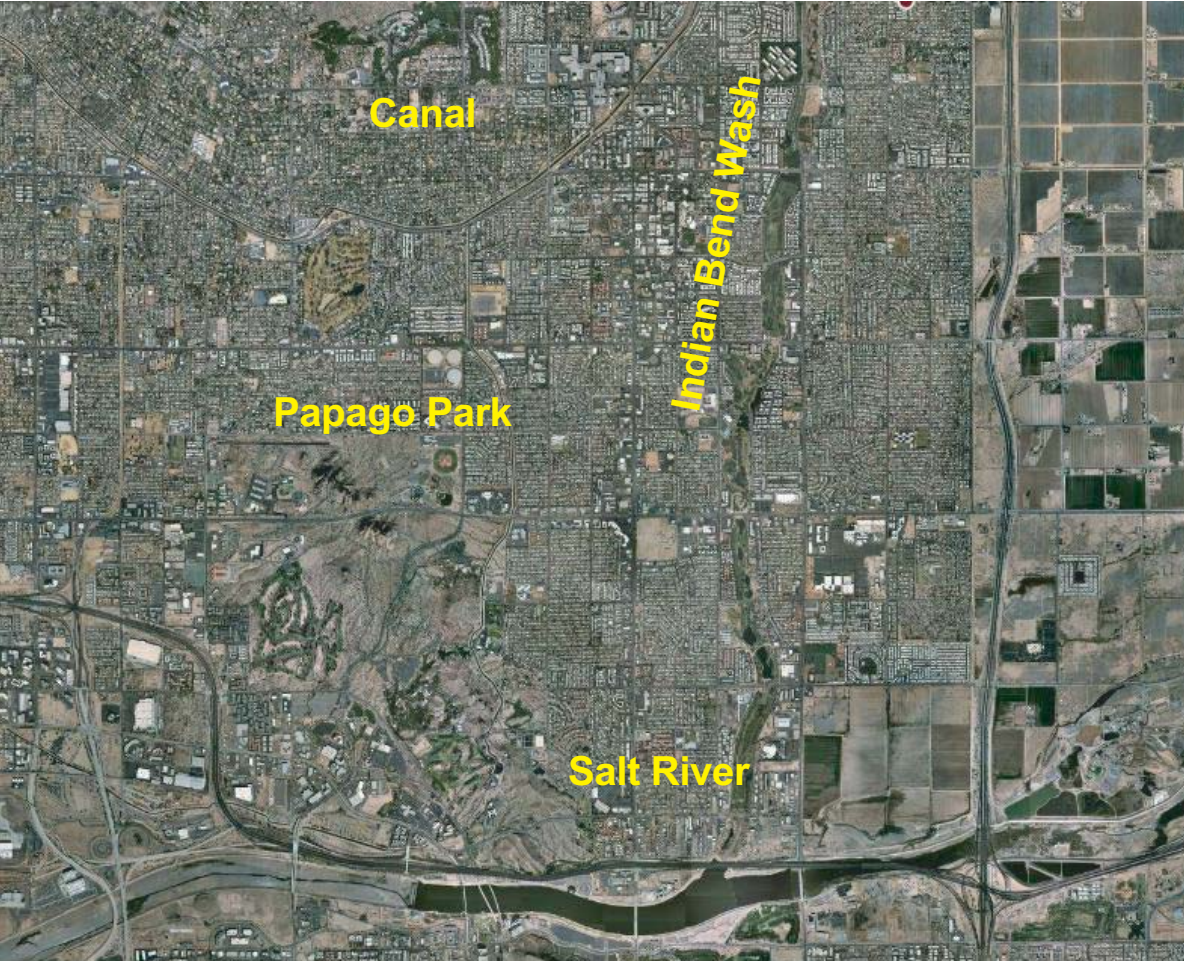
Engineering practices that are meant to prevent runoff from reaching urban channels appear to be relatively successful. However, the effects of these changes on the variability and timing of stream flows is not consistent, thus the implications for ecosystem function are varied. This suggests that detailed case studies are necessary to determine the hydrologic outcomes of urbanization. Further analysis should allow us to systematically link development choices to hydrologic and ecological outcomes; important information for informed decision making.

Development of Indian Bend Wash 1940's



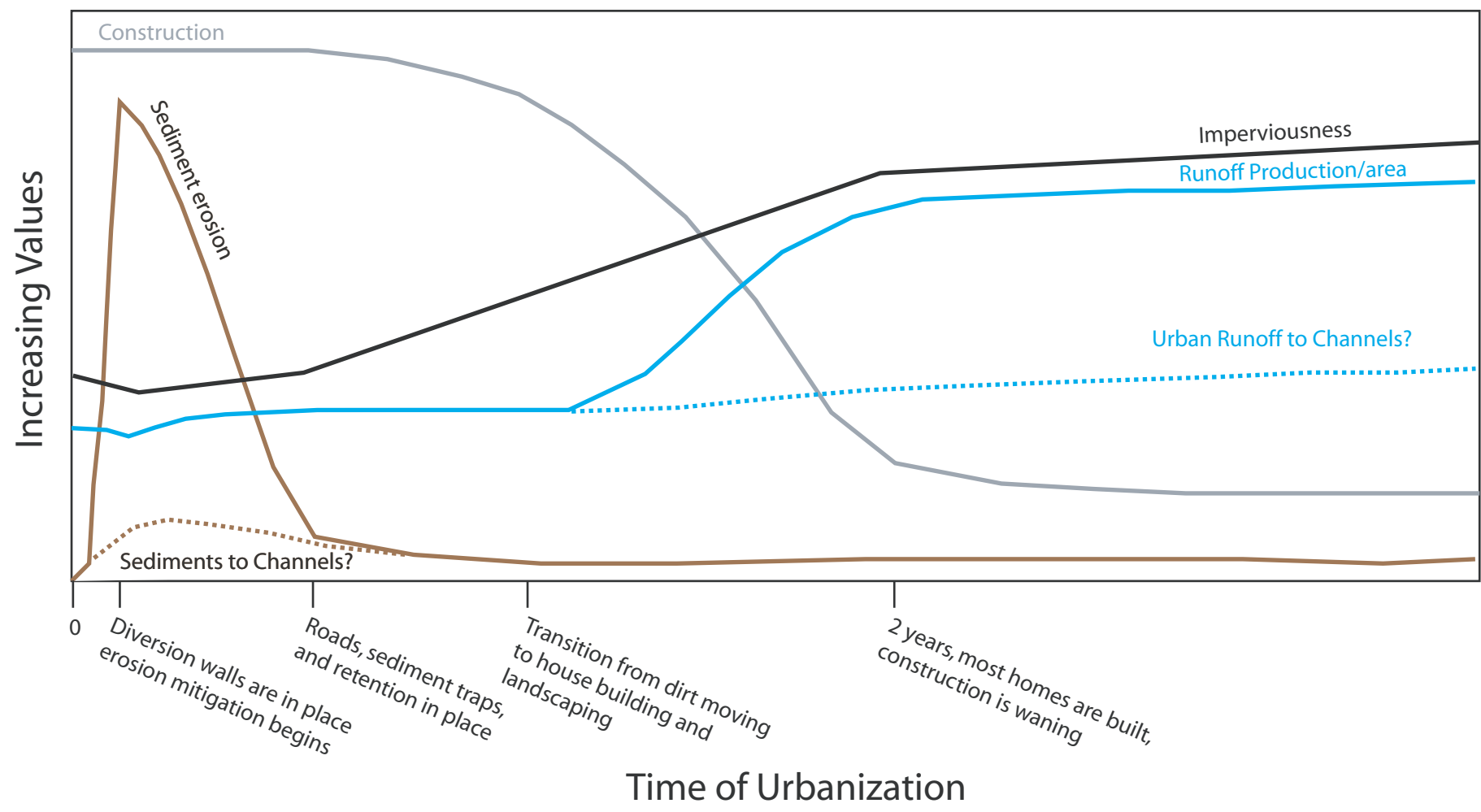
Indian Bend Wash aerial photography (Fairchild collection) from the 1940's. During this time much of the watershed's landcover was agricultural though the mile by mile grid was established and probably influencing the flow of runoff. Also many of the canals were already in place. At this time the lower Indian Bend Wash and Salt River were braided channels wider than 1 mile.

2007



Indian Bend Wash aerial photography (google earth imagery) from 2007 of the same area as above. Now much of the land around Indian Bend Wash has been developed with residential, commercial, and industrial landcover. The Salt River and Indian Bend Wash have been channelized and narrowed. The Salt River channel now holds Tempe Town Lake. Some agriculture persists on the Fort McDowell reservation.

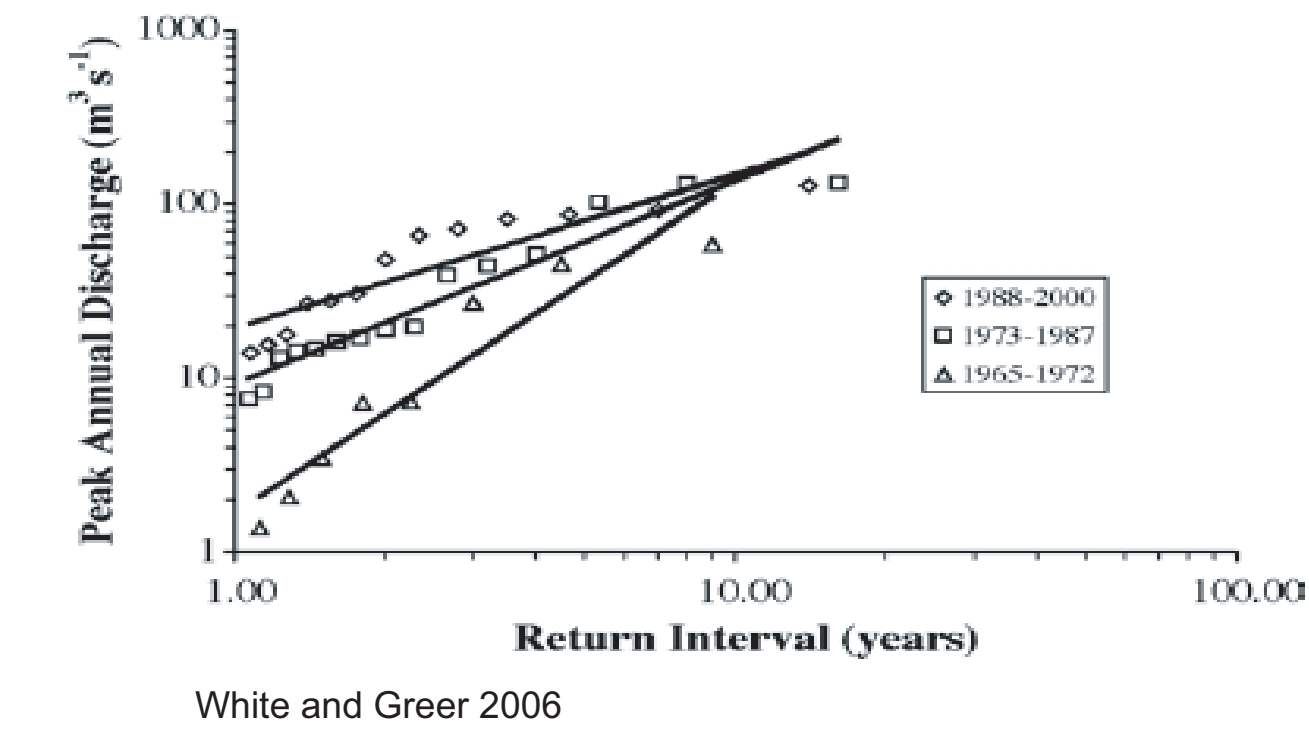
Effects of Urbanization on Hydrology



With urbanization imperviousness and runoff production increase. However, with on site retention it is unclear if runoff reaching channels also follows this pattern. (Graph modified from Chin, 2006; Wolman 1967).

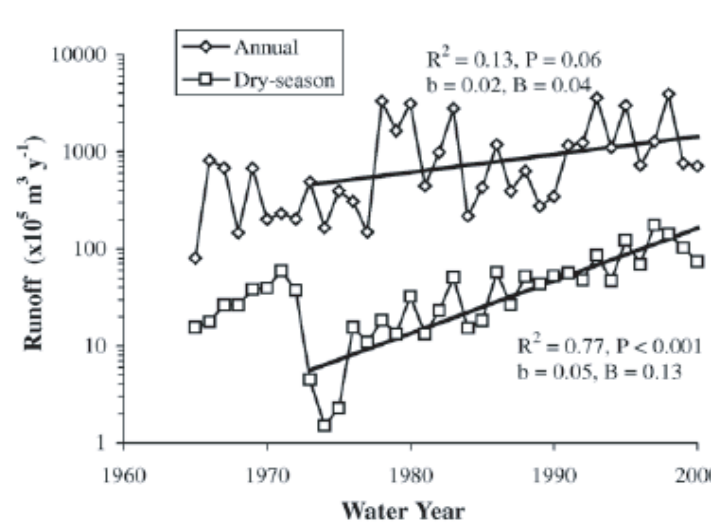
Flood Return Interval

Previous studies have found that urbanization dramatically increases the peak discharge of smaller, high frequency events, but has little effect on larger, rare events (Hollis 1975, White and Greer 2006).



White and Greer 2006

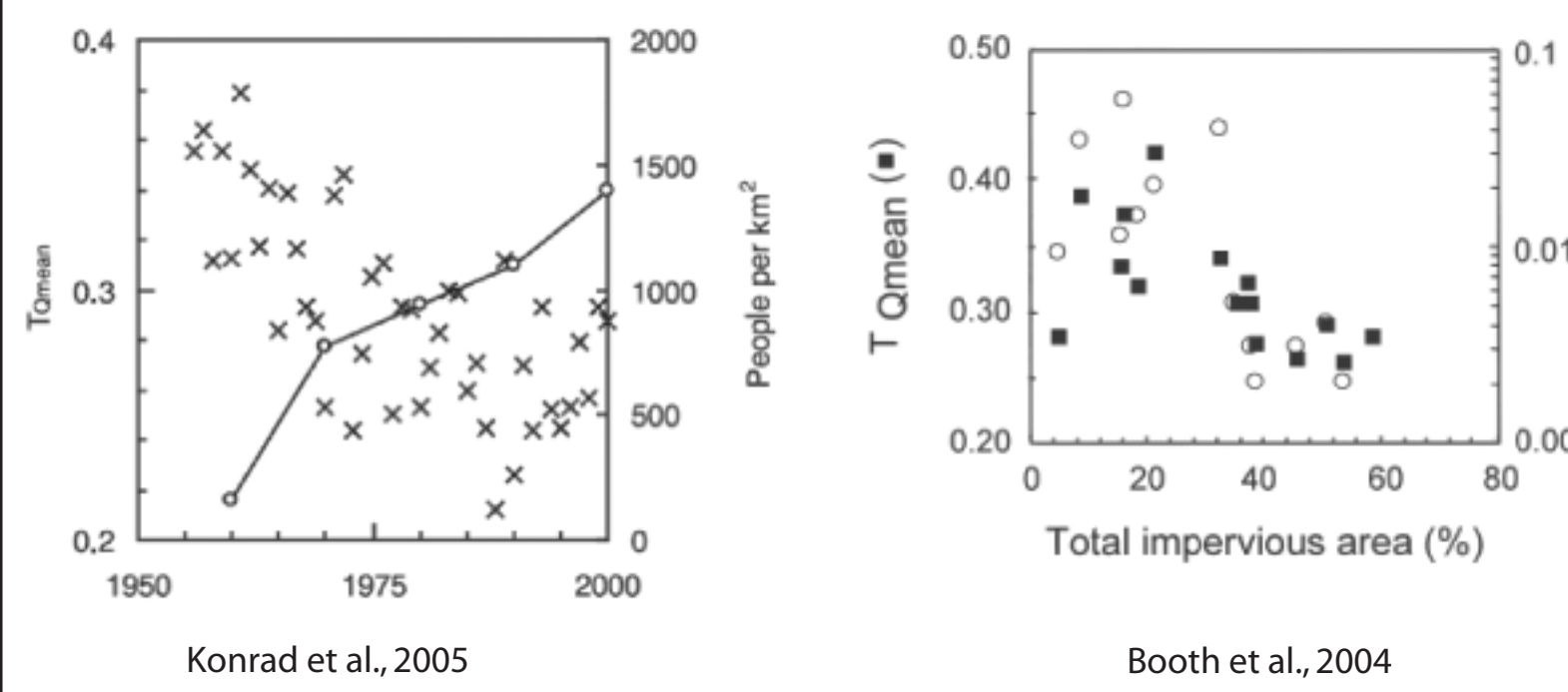
Annual and Peak Runoff increases with urbanization.



White and Greer 2006

"Flashiness"

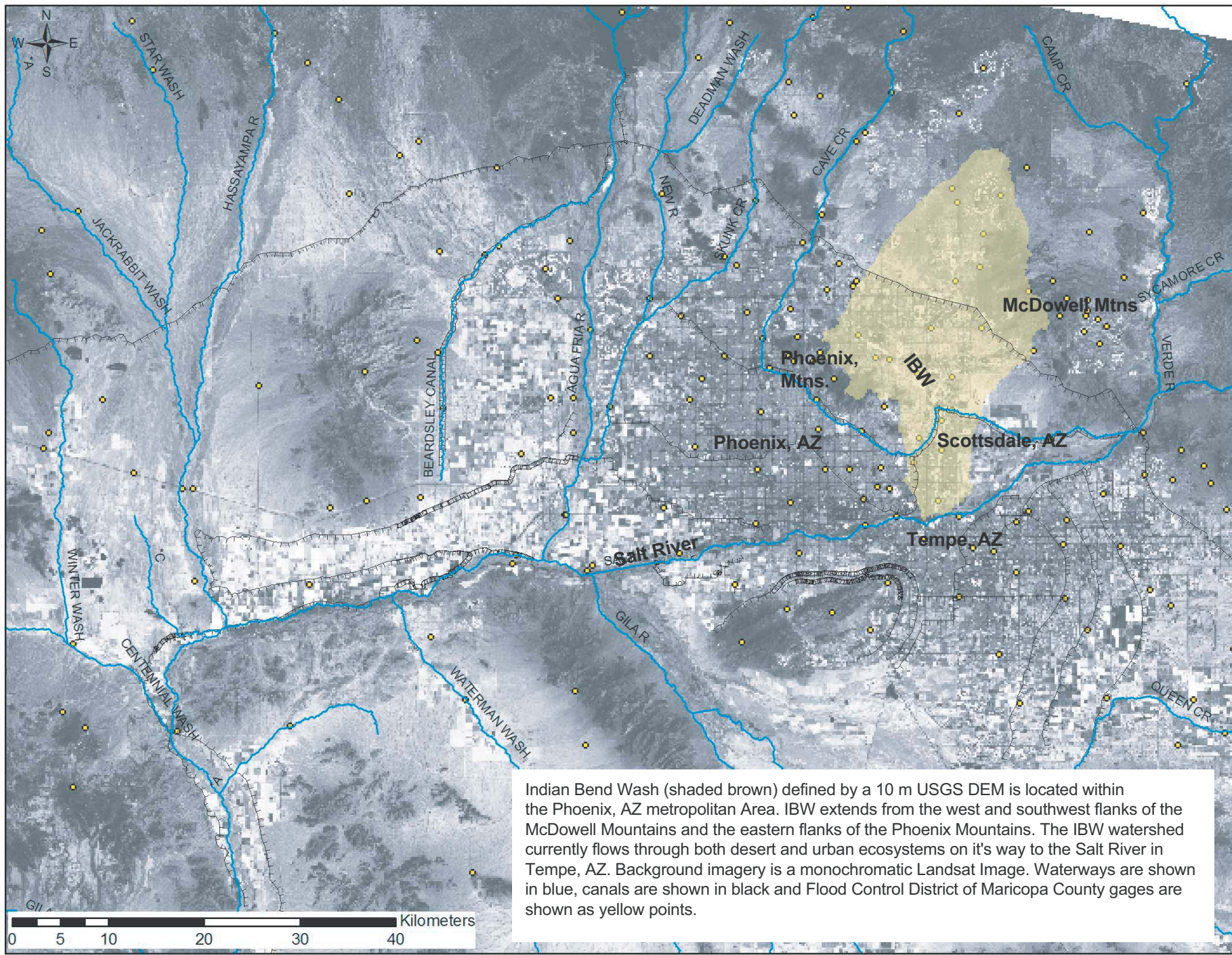
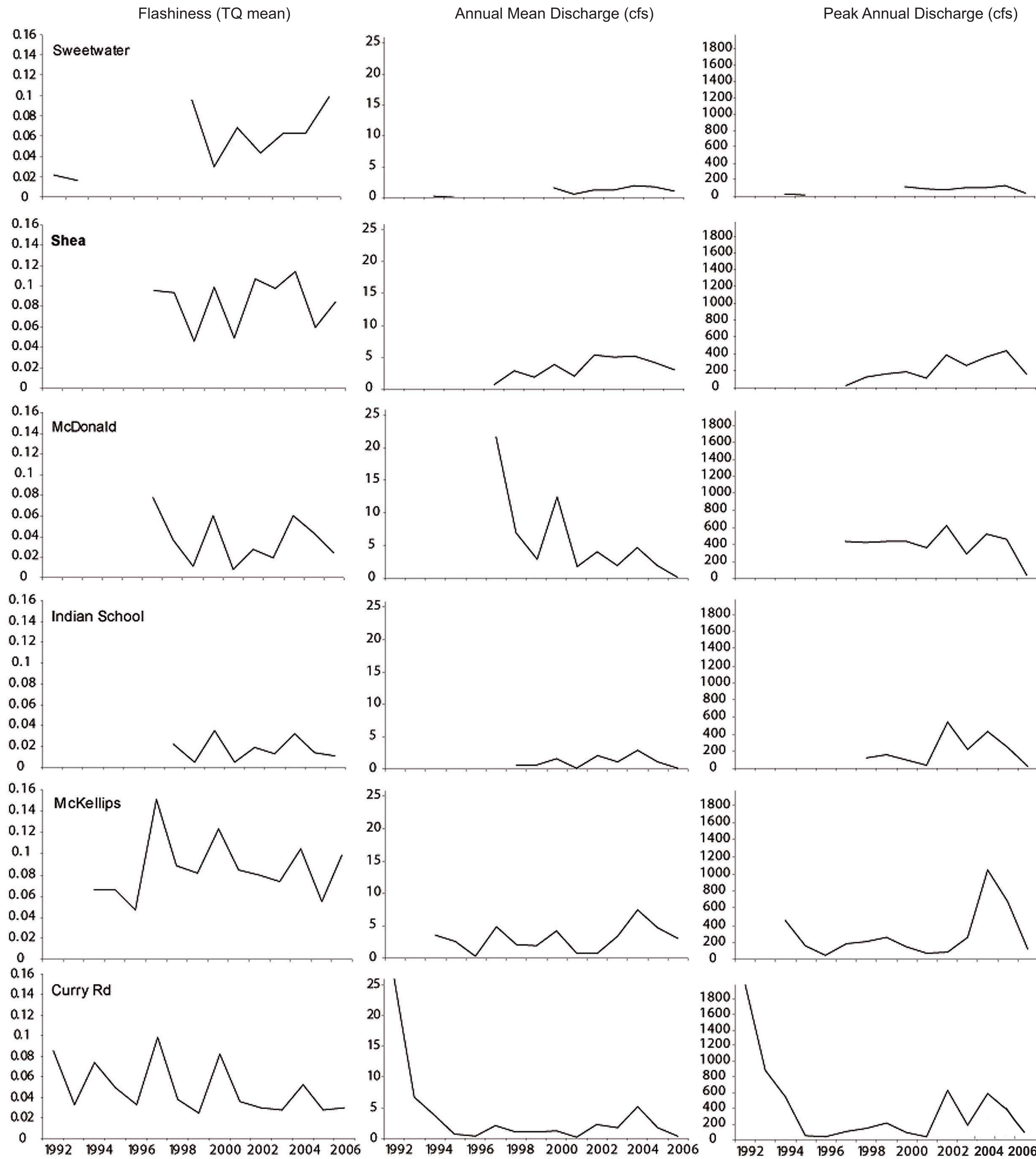
Booth et al. (2004) and Konrad et al. (2005) both found that flashiness increases with increasing urbanization. To measure flashiness in Phoenix streams, we used TQmean, the fraction of the year during which daily mean discharge exceeds annual mean discharge, where TQmean is lower for flashier regimes (Booth 2004, Konrad 2005).



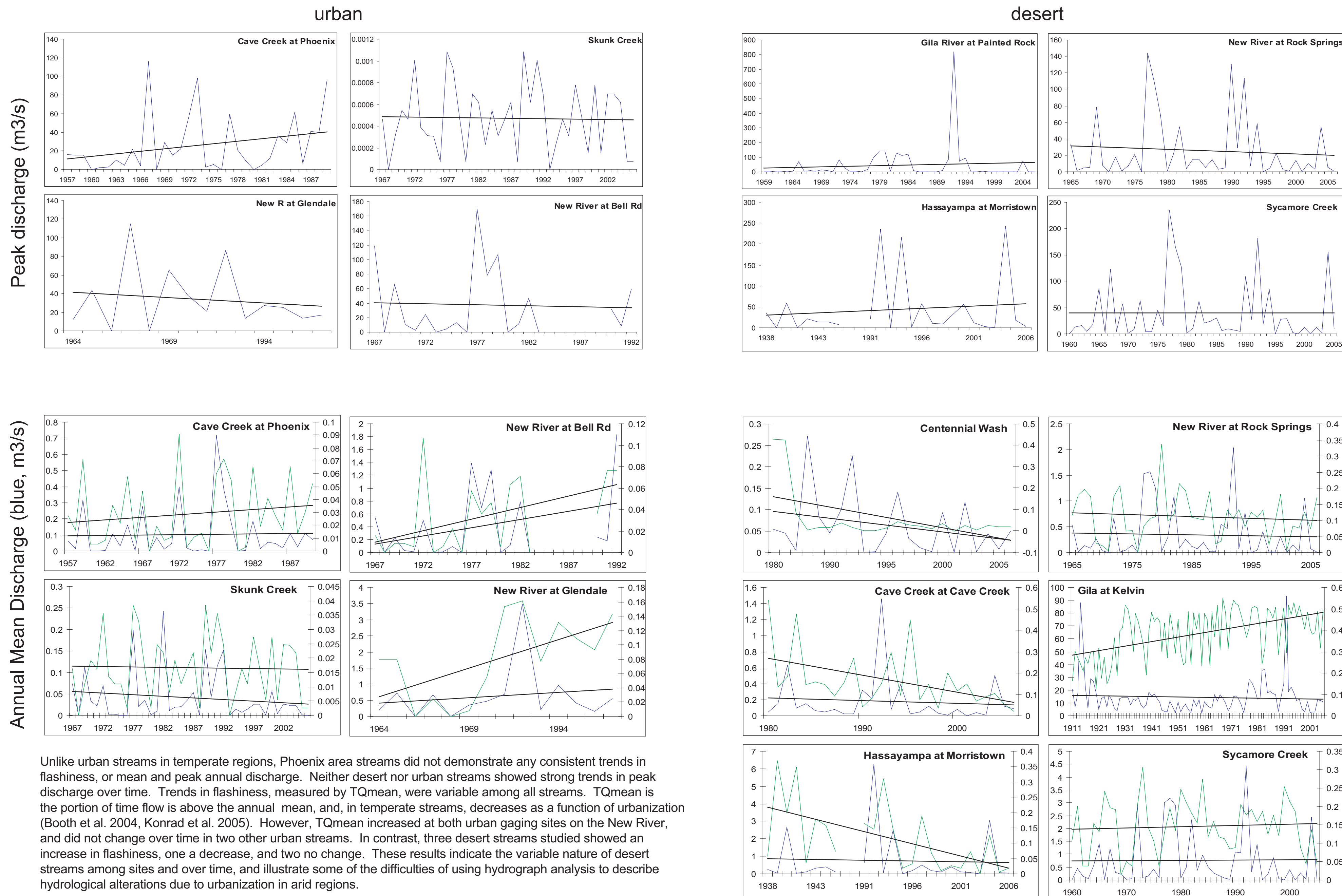
Konrad et al., 2005

Booth et al., 2004

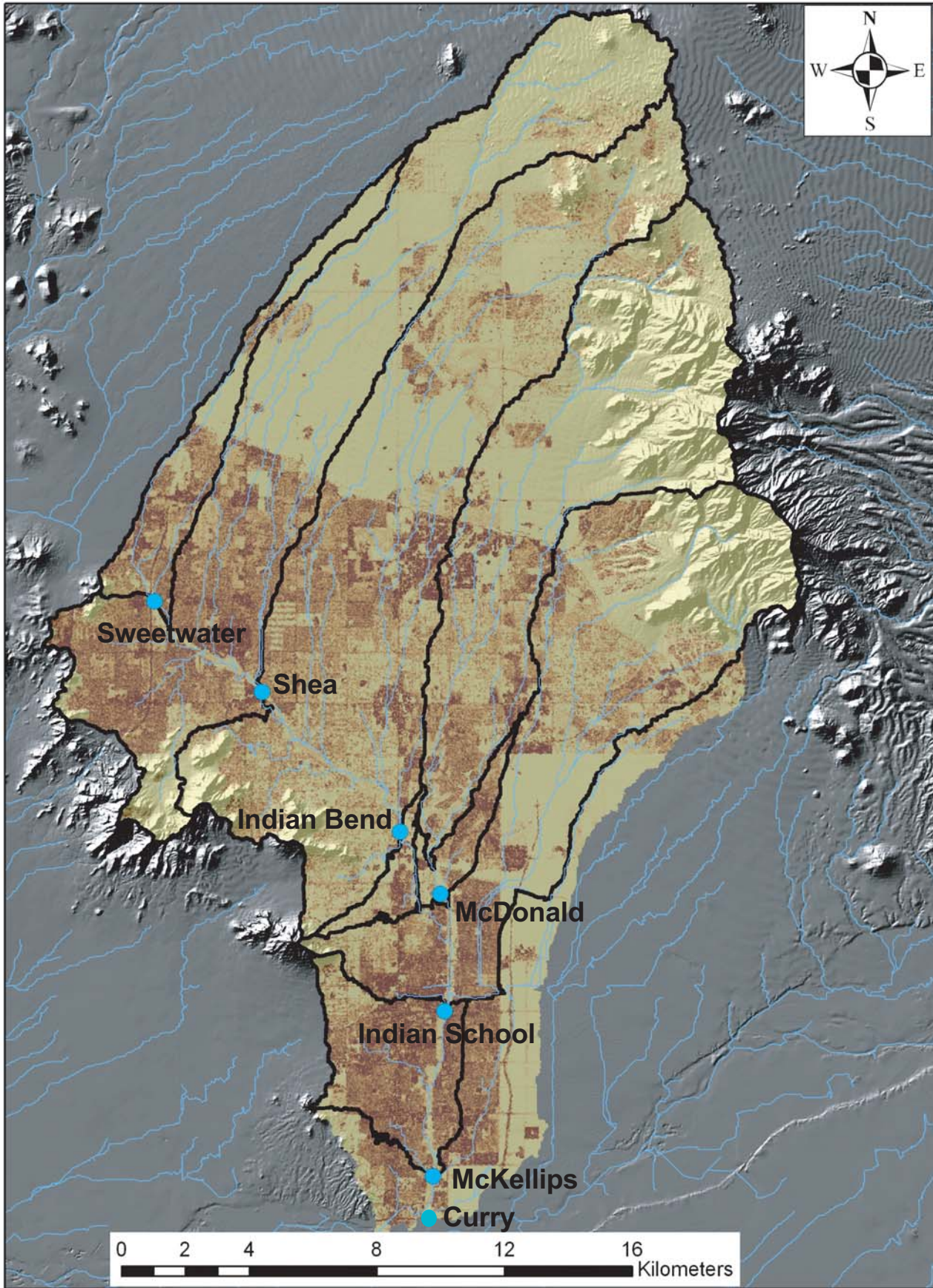
Downstream Hydrologic Metrics in Indian Bend Wash 1992-2006



Recent streamflow trends in desert and urban streams near Phoenix, AZ



Indian Bend Wash Watershed and Gageshed Runoff and Rainfall During the 2006 Monsoon



Indian Bend watershed (IBW; tan shading) and gagesheds (outlined in black) over a 10 meter hillshade model. Impermeable landcover is shaded brown (2001 National Landcover Dataset). Gage stations along IBW are shown in blue.

Table 1. Watershed rainfall vs runoff analysis above each Indian Bend Wash gage. See figures 5a. SW = sweetwater, SH = shea, IB = Indian Bend, McD = McDonald, IS = Indian School, McK=McKellips.

Station	Area (km ²)	Runoff (m ³)	Area-normalized runoff (cm)	Rainfall (cm)	% impermeable	% runoff
SW	17	9.80.E+05	5.7	11.3	27.9	49.9
SH	122	2.75.E+06	2.2	11.3	21.7	19.8
IB	327	2.81.E+06	0.9	11.3	19.0	7.6
McD	337	1.51.E+06	0.4	11.3	19.4	3.9
IS	415	8.96.E+05	0.2	10.7	19.5	1.9
McK	435	3.48.E+06	0.8	10.6	20.9	7.5

Table 2. Gageshed rainfall vs runoff analysis for each Indian Bend Wash gage. See figures 5b. SW = sweetwater, SH = shea, IB = Indian Bend, McD = McDonald, IS = Indian School, McK=McKellips.

Station	Area (km ²)	Runoff (m ³)	Area-normalized runoff (cm)	Rainfall (cm)	% impermeable	% runoff
SW	17	9.80.E+05	5.7	11.3	27.9	49.9
SH	105	1.77.E+06	1.7	11.3	20.7	14.8
IB	206	5.92.E+04	0.0	11.3	17.4	0.0
McD	10	-1.30.E+06	-13.0	11.3	32.5	-114.8
IS	78	-6.50.E+05	-0.8	8.2	20.2	-10.2
McK	20	2.63.E+06	13.1	8.1	48.6	162.7