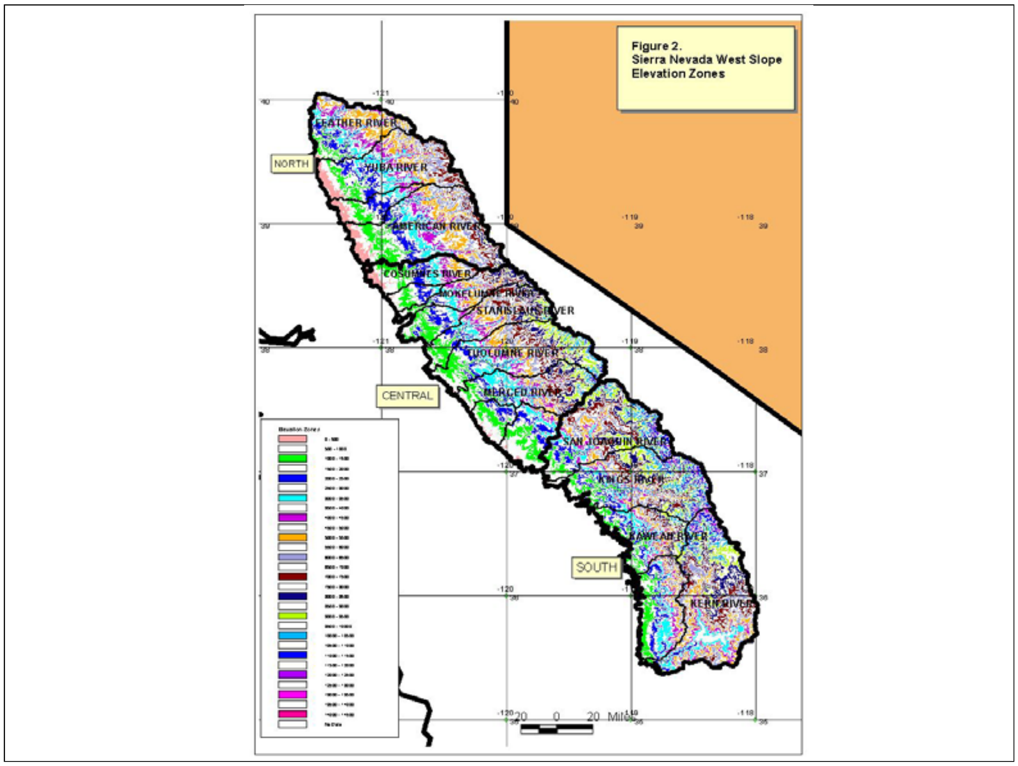
Climatic Change Implications for Hydrologic Systems in the Sierra Nevada

Part Two:

The HSPF Model: Basis For Watershed Yield Calculator

Part two presents an an overview of why the hydrologic yield calculator for the west slope Sierra Nevada was designed with the parameters that were chosen.

Part 2 Powerpoint was created by John Humphreys, PhD, who did all the HSPF modeling, converted the HSPF model output to an Excel file, and designed the Watershed Yield Calculator using MS .Net Framework software.



Geographic area of application:

The western slope of the Sierra Nevada from the crest to the margin of the Central Valley were included in the study area.

The north/northeastern boundary is an exception. The headwaters of the North Yuba, Middle Fork Feather, and North Fork Feather rivers are excluded from the study area due to the influence of a rain shadow caused by a tectonic plate shift.

[the northern extent of the eastern boundary includes exceptions. Headwater portions of the north Yuba, Middle Fork Feather, and North Fork Feather rivers are excluded from the study area due to the influence of rain shadows caused by complex faulting in this portion of the Sierra Nevada microplate.

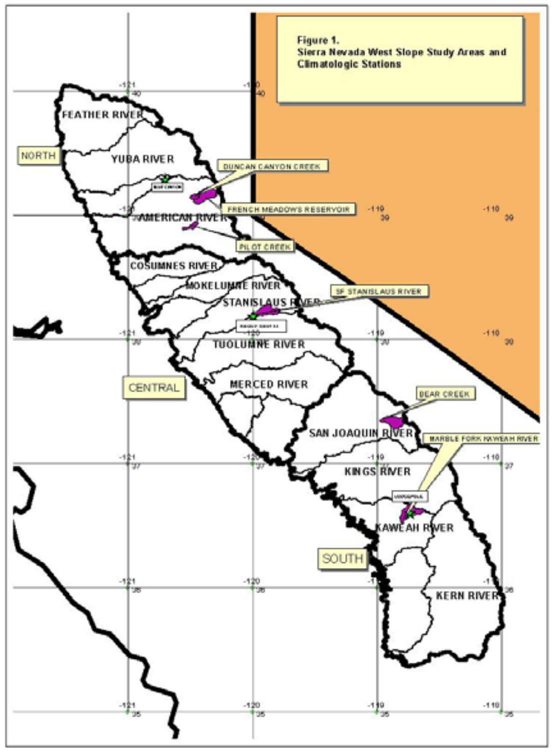
The study are is large, including 4 ½ degrees of latitude and 3 ½ of longitude. Study area is divided into three retions.

<u>Elevation</u> in 500 ft increments can be referenced on this map.

Change in temperature in latitude was one reason to do three zones;

Also south watersheds are predominantly high elevation watersheds, unlike north.

Noted: mid-elevation watersheds sensitive to temperature as much as precip



This map shows major watersheds in the Sierra Nevada range area that was modeled by HSPF for this study..

Weather data from the three stations were calibrated to calibration in each region: North= Duncan Canyon, Central=South Fork Stanislaus River, South=Bear Creek

The map also shows the three pilot watersheds, French Meadows on the Middle Fork American River and Pilot Creek in the Northern Sierra, and Marble Fork of the Kaweah in the Southern Sierra

Surprisingly, there was not an abundance of weather data from stations in the Sierra, particularly with history of 55 years of record with hourly time steps. Weather data points required for the HSPF model were:

•Hourly precipitation

•Hourly dew point

•Hourly wind speed

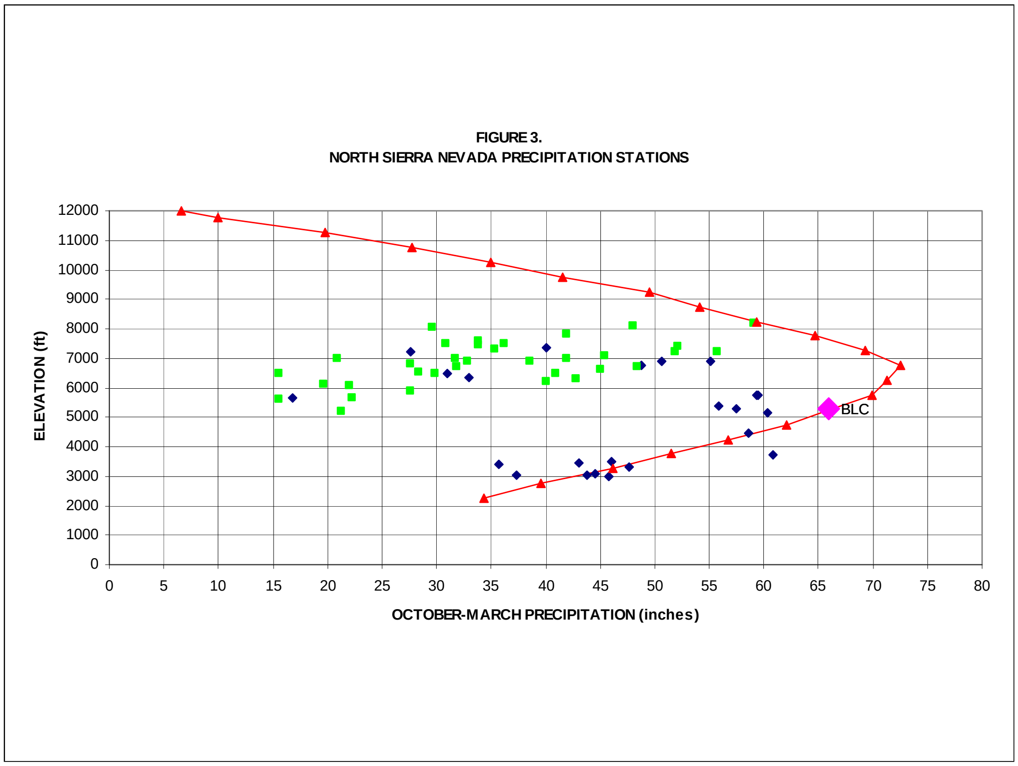
•Hourly solar radiation

•Daily pan evaporation

Today, several dozen weather stations are in place, but little complete historical weather data is available before 1991.

A weather station was picked for each of the three study regions which had the most complete record for that region. The quality of records and the period of record were the salient criteria for these choices:

North Sierra=Blue Canyon Central Sierra=Pinecrest Southern Sierra=Lodgepole



This is the precipitation curve for the Northern region.

BLC is Blue Canyon weather station.

Blue diamonds are precipitation stations, which have varying periods of record.

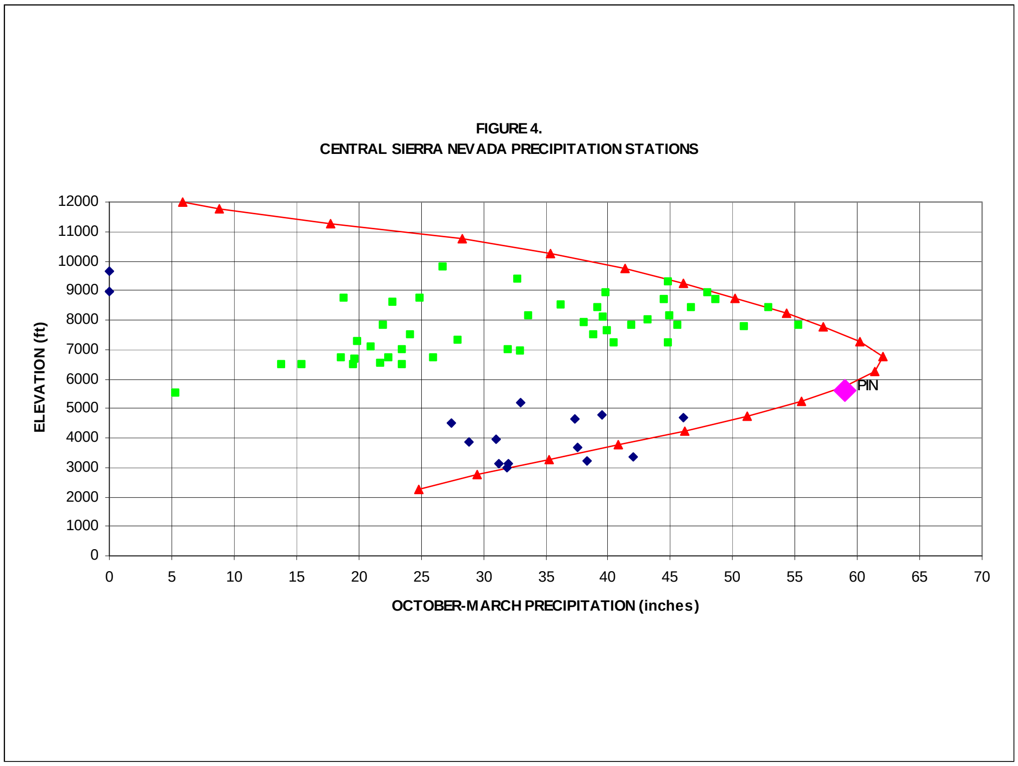
Green are snow courses records, which typically read low for a number of reasons:

•Rain, (Rain can go straight through gauge and is thus not measured)

•evaporation

•wind makes snow catch up to 50% inaccurate (Relationship of error in snow catch= 1% per one mile per hour, even if the unit is shielded.)

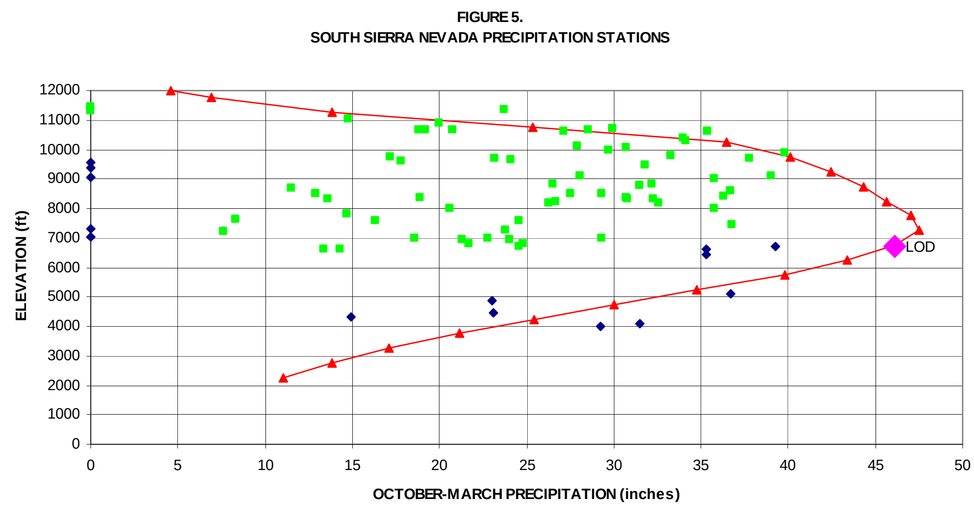
In the northern Sierra region, there is very little land area above 8000 feet, even though the HSPF model curve extends to 12000 feet elevation.



This is the precipitation curve for the Central Sierra; Pinecrest is weather station.

Accuracy of the snow course gauges is better in the Central Sierra because they are at higher elevations.

[Stations indicating zero rainfall had no reportable data/or were out of operation, as indicated by diamonds on the far left column range of zero.]



This is the precipitation curve for the Southern Sierra; Lodgepole is the weather station

At colder and higher elevations, there is less error in the snow gauge data, thus the precipitation curve plots through the high elevation snow gauge stations.

High elevations are less significant for runoff than mid-level elevations due to less precipitation and less watershed area.

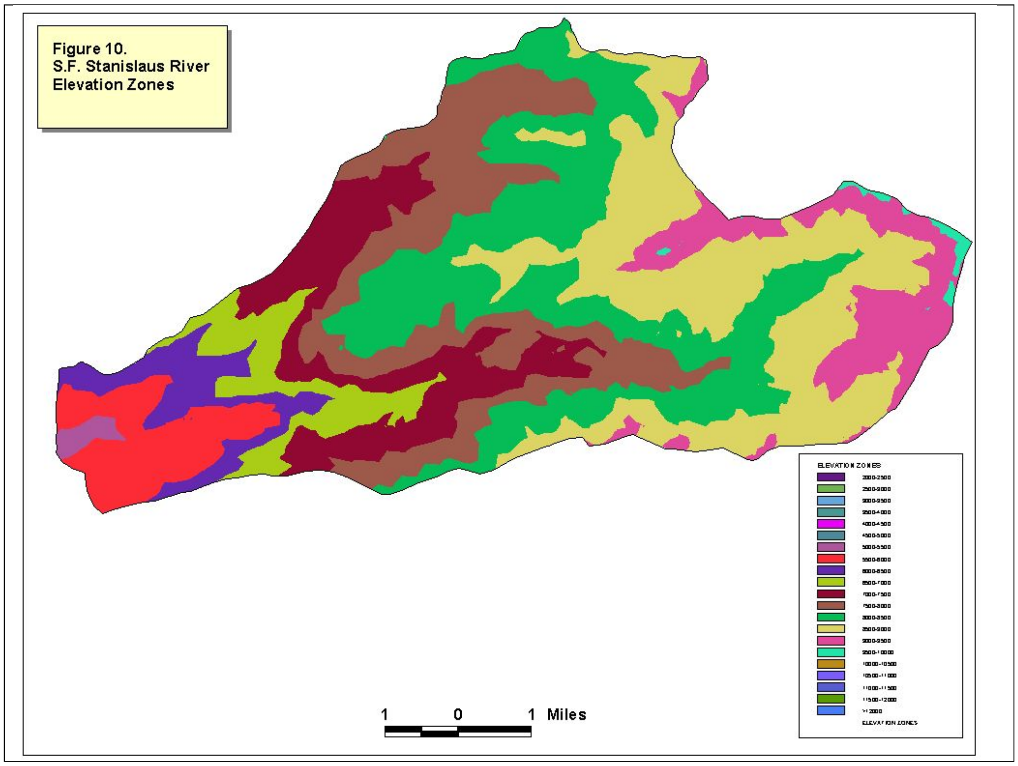
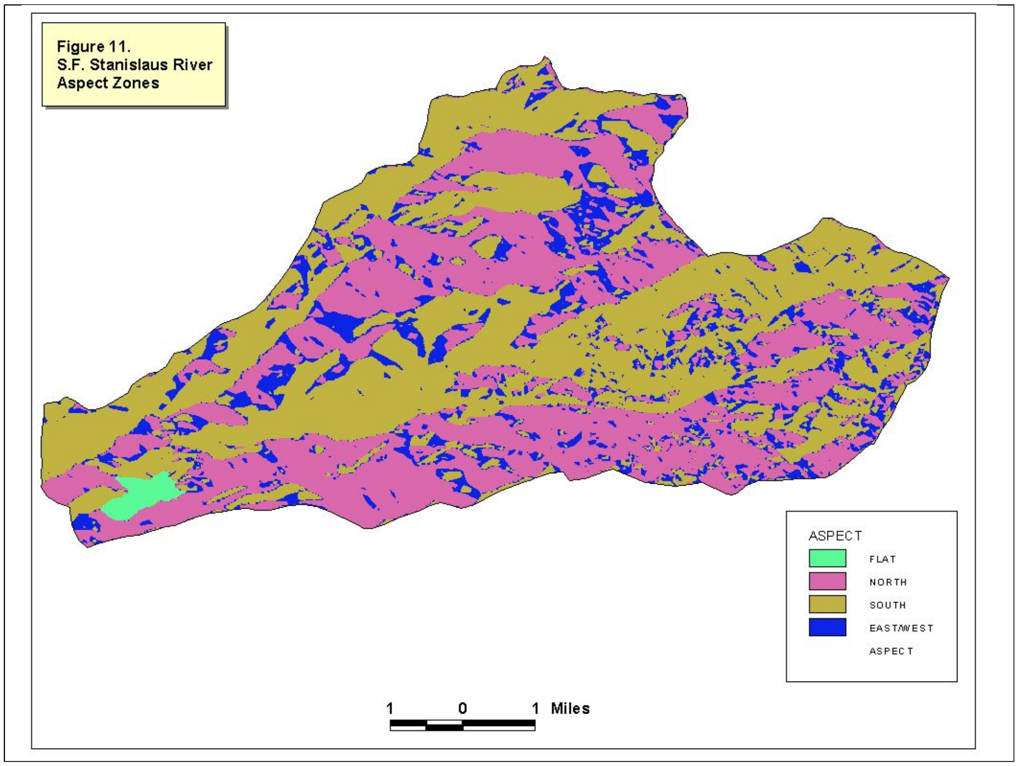


Figure 10.
S.F. Stanislaus River
Elevation Zones

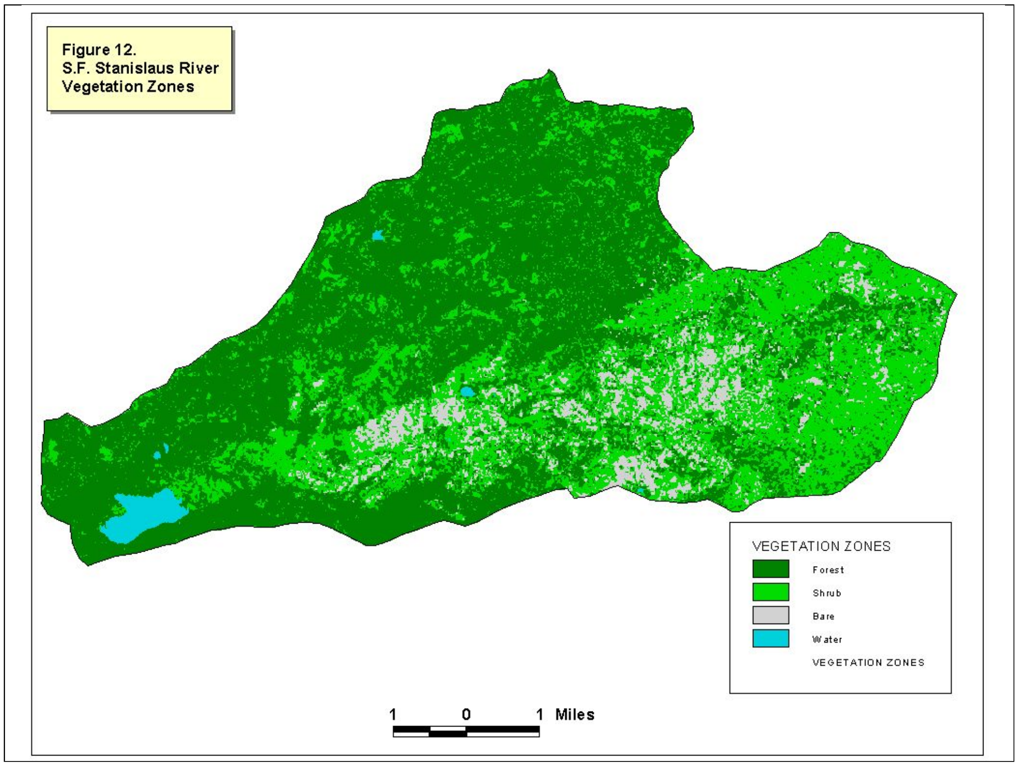
Elevations zones are shown in 500 feet increments.

The HSPF model, and the Watershed Yield Calculator, use 500 feet elevation bands. Most other climate models for the Sierra use 1000 feet elevation bands.



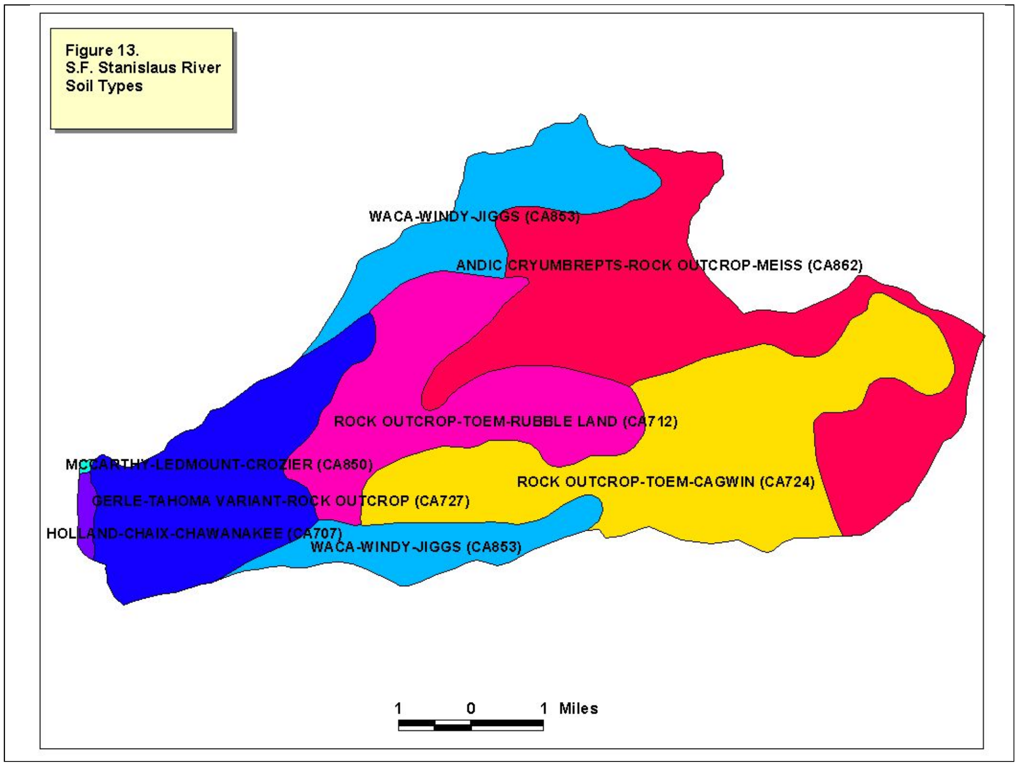
Aspect derived from DEMs.

For the purpose of the model, aspect was reduced to three variables: north facing, south facing, and the combined east/west facing and flat. Model runs showed little difference in hydrologic runoff between east facing, west facing, and flat slopes in relationship to north and south facing slopes.



Vegetative land cover data.

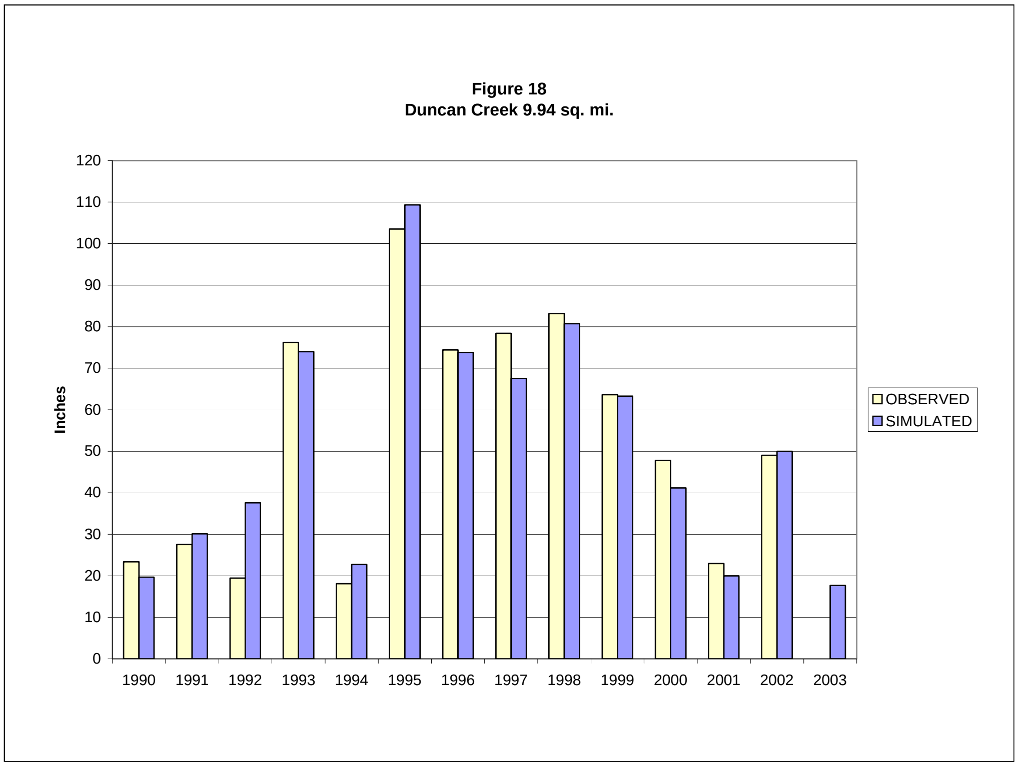
Three land cover variables were chosen for the watershed yield calculator: forest, shrub, and bare.



Soils mapping was obtained in digital form from NRCS.

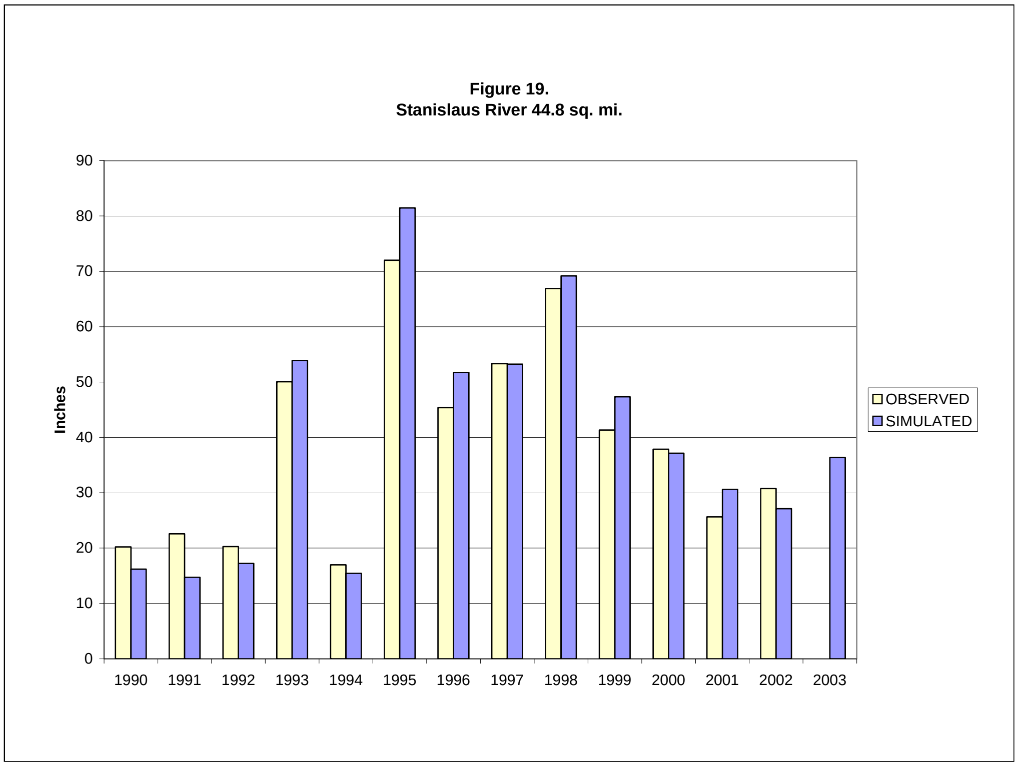
Soil and geology were evaluated as variables for use in the watershed yield calculator. After test runs, it was determined that using vegetation cover as a surrogate for soil and geology produced satisfactory simulations that calibrated closely with observed conditions. This is one of the compromises that was necessary in order to reduce the number of Hydrologic Response Unit (HRU) variables to make it feasible to run the HSPF model. The HSPF model has an imbedded limit of 200 HRU variables, thus compromises of this kind were necessary in order to model large regions.

The Watershed Yield Calculator should be not be used as a model with a level of accuracy necessary for operations and the like. This calculator has been calibrated to produce relatively accurate projections of hydrologic response to climate change scenarios. If very high level accuracy is required by the user, it is advisable to use the HSPF model directly on the watershed in question, using all variables needed to produce highly accurate model projections– like geology and soil type, a finer grain vegetation cover, differentiated aspects of east/west/flat, and the like. The Watershed Yield Calculator will be very useful to describe hydrologic response to climate change scenarios within these noted constraints.



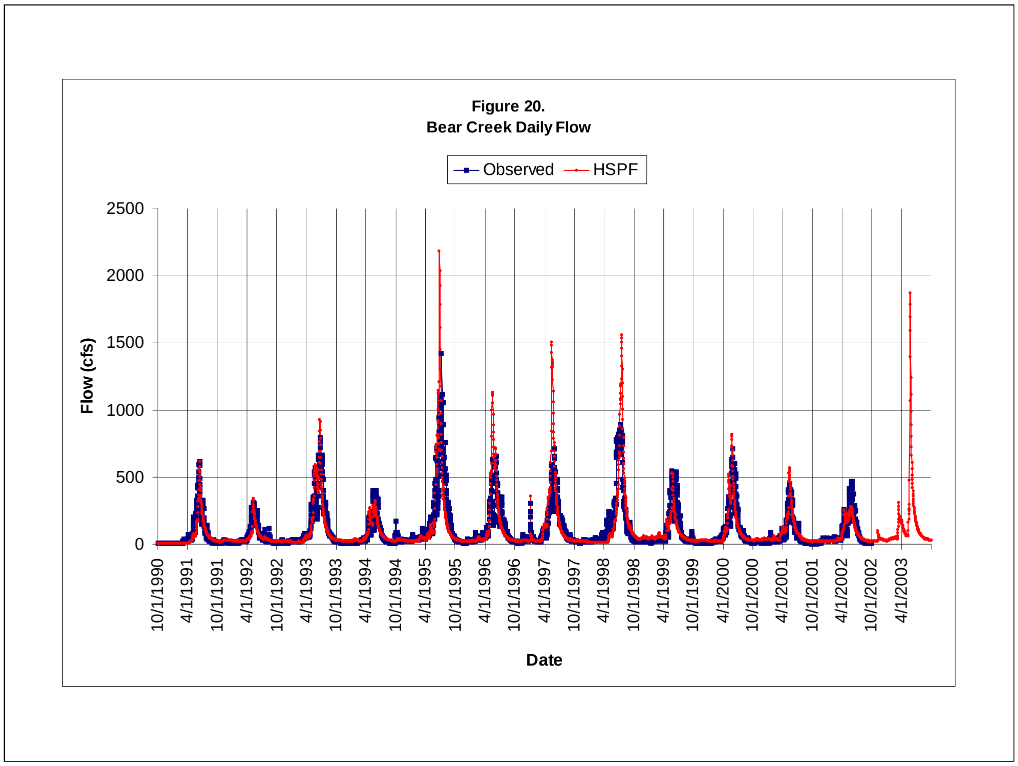
Graph shows model performance on annual yield basis for Duncan Canyon, Northern Sierra.

For the year 2003, there was no observed data from DWR available at the time the graph was generated



Graph shows model performance on annual yield basis for SF Stanislaus in Central Sierra.

For the year 2003, there was no observed data from DWR available at the time the graph was generated



Daily time step output: model performs well at low, moderate, and moderately high flows.

Peak flow events are not tracked well by the model, because routing is not built into the model, so it is not particularly good for flood peaks

The emphasis of this study is on seasonal watershed yield, not flood control events.

Snow pack attenuates peak rains and does not rout it through to stream flow, except for very large events (e.g. January 1997).

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