SCCWRP # 1019

Tools for managing hydrologic alteration on a regional scale: Estimating changes in flow characteristics at ungauged sites

Ashmita Sengupta[1], Stephen K. Adams[2], Brian P. Bledsoe[3], Eric D. Stein[1], Kenneth S. McCune[1], Raphael D. Mazor[1,4]

[1]Southern California Coastal Water Research Project Authority, Costa Mesa, CA

[2]Colorado State University, Fort Collins, CO

[3]University of Georgia, College of Engineering, Athens, GA

[4]California Department of Fish and Wildlife, Rancho Cordova, CA

ABSTRACT

1. Hydrologic alteration is a predominant stressor for biological resources in streams. This stress is further aggravated by competing human and ecological demands for limited water resources. Understanding flow–ecology relationships and establishing relevant and implementable flow targets are essential to protect biological communities.

2. Estimating degree of ecologically relevant hydrologic alteration depends on the availability of long-term flow data at sites with biological information. However, measured flow data are seldom available at sufficient density to support largescale analyses of the biological effects of hydrologic alterations. The ability to accurately simulate flows and estimate flow metrics at many ungauged locations across a broad geographical area remains a fundamental challenge.

3. We address this challenge by applying a novel technique to simulate flow regimes at any stream reach of interest by first developing an ensemble of regionally calibrated and validated hydrological models, and then using a selection tool to match the "best-fit" model to ungauged stream reaches. An ensemble of 26 HEC-HMS rainfall–runoff models were calibrated to represent the range of catchment conditions in the southern California region.

4. We developed current and historical flow regimes and a suite of flow metrics at 572 ungauged sites in southern California with bioassessment monitoring data. The flow metrics represent hydrograph characteristics of magnitude, timing, frequency, duration and variability. The flow metrics were estimated under three precipitation conditions—dry, wet and average. In addition, we estimated aggregated flow metrics for (dry + wet + average) condition. Hydrologic alteration was estimated as the deviation between the modelled current and historical flow metrics.

5. Approximately 79% of the region shows some degree of hydrologic alteration, and approximately 40% of the sites are estimated to be severely altered. Magnitude metrics tend to increase in response to urban and agricultural land uses, whereas the timing and duration metrics are mostly unchanged.

6. This mechanistic modelling approach demonstrates the feasibility of estimating flow alterations for ungauged catchments with relative ease of transferability over a broad geographical region. The continuous granular flow data allow for computation and consideration of metrics that may be applicable to a variety of ecological endpoints and consideration of a range of management trade-offs.

Full Text

Due to distribution restrictions, the full-text version of this article is available by request only.

Please contact pubrequest@sccwrp.org to request a copy.