Distributed Hydrology Soil Vegetation Model (DHSVM) and Sediment Loading in a Small, Timber Production Watershed, Humboldt County, California

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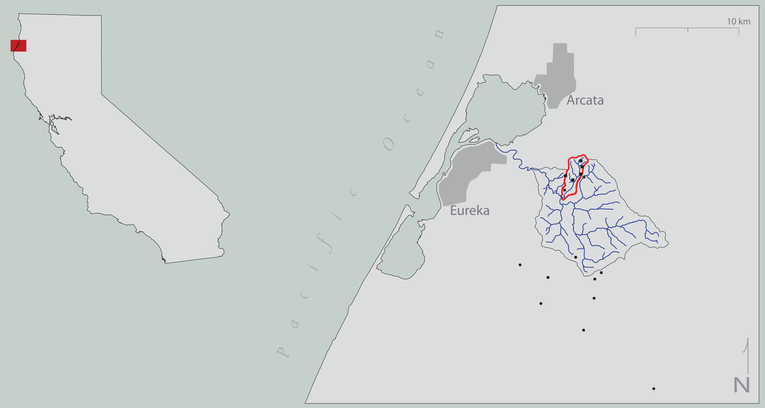
Abstract:

With the majority of small watersheds worldwide ungaged, water and natural resource managers need tools that are capable of predicting hydrologic changes at both broad and site specific scales. The Distributed Hydrology Soil Vegetation Model (DHSVM) is examined here for the ability to predict stream and sediment discharge in a small sub-basin under timber harvest management.

Sediment production and transport are natural phenomena in forested basins. The tectonic, geologic, lithic, and physiographic setting of the study area serve to set the stage for management activities that can increase sediment loading within the watershed. Investigations in the McReady sub-basin of Freshwater Creek will apply the DHSVM at a much smaller scale than previous studies, and importantly, validate the sediment production element of the model with continuous data collected by automated instrumentation located on McReady Creek.

Study Area:



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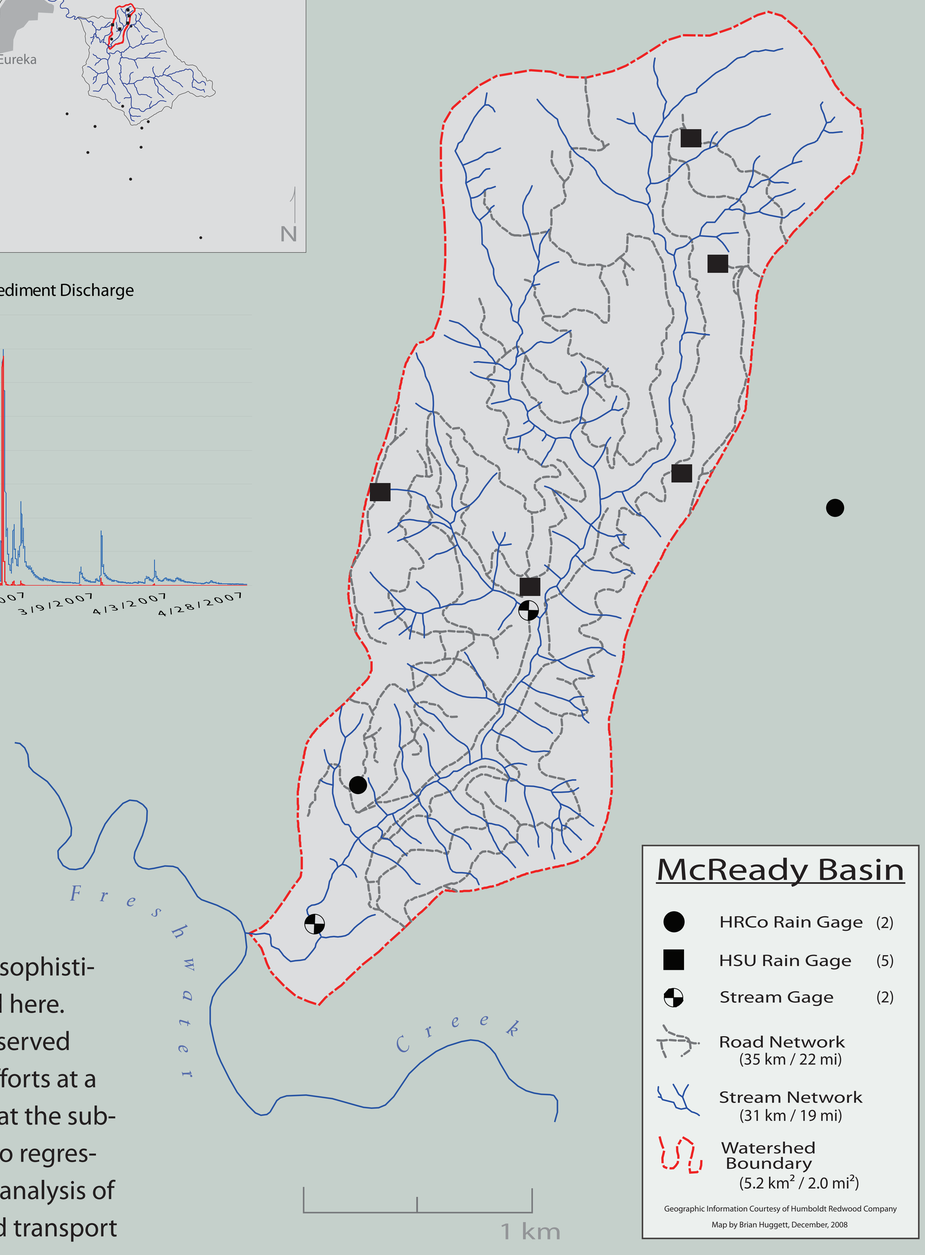

Model:

DHSVM is a physically based distributed model that simulates watershed processes across a grid on a cell-by-cell basis, at the scale of digital elevation data (10 meters for this analysis). Meteorological data, such as precipitation and incoming solar radiation, are topographically controlled. The channel network, and subsequent channel routing, is defined by the digital elevation data. Evapotranspiration is modeled by a Modified Penman-Monteith equation, while the accumulation, ablation and melt of snowpack is calculated with an energy and mass balance approach. Runoff is determined on a cell by cell basis via saturation excess.

Sediment production and transport include mass wasting processes and surface erosion. Road surface erosion is calculated as a function of both rain splash and detachment from overland flow. Sediment that is eroded from the road will enter a roadside ditch, where it will enter the stream network or be routed to the hillslope. Once sediment has entered the stream channel it is routed based on a mass balance equation.

Methods:

The McReady catchment is small (5.2 km^2) compared to other basins modeled by DHSVM. Also dissimilar is the road network density (6.7 km/km^2). This density is approximately 6 times that compared to published accounts of sediment modeling with DHSVM. Continuous stream and sediment discharge have been collected by a Turbidity Threshold Station (TTS) in the McReady sub-basin by Humboldt Redwood Company since 2004. Previous evaluations of sediment production of forest roads, and a detailed sediment source inventory proximal to the stream network will test the model's representation of sediment production. Further characterization of the road network will seek to classify segments of road by width, usage (seasonal, main, decommissioned), surface (dirt, paved,unpaved) and road type (in-, out-sloped, crowned) as required by the model.

Validation:

The sophisticated nature of distributed models argue for a similarly sophisticated validation of outputs. A multi-scale, multi-criteria validation of DHSVM is proposed here. Multi-criteria: Modeled stream and sediment discharge will be compared against the observed event, weekly, and monthly totals by statistical regression. Multi-scale: Stream gaging efforts at a major tributary to McReady Creek will help determine if simulated processes happening at the sub-sub-basin scale are supported by observed data. This output will similarly be subjected to regression analysis to determine if the sub-basin processes are properly simulated. Regression analysis of the timing of storm runoff peaks will test hypotheses regarding sediment production and transport within the basin.