Hydrologic Modeling at Ucross

UCROSS HIGH PLAINS STEWARDSHIP INITIATIVE

Yale School of Forestry and Environmental Studies

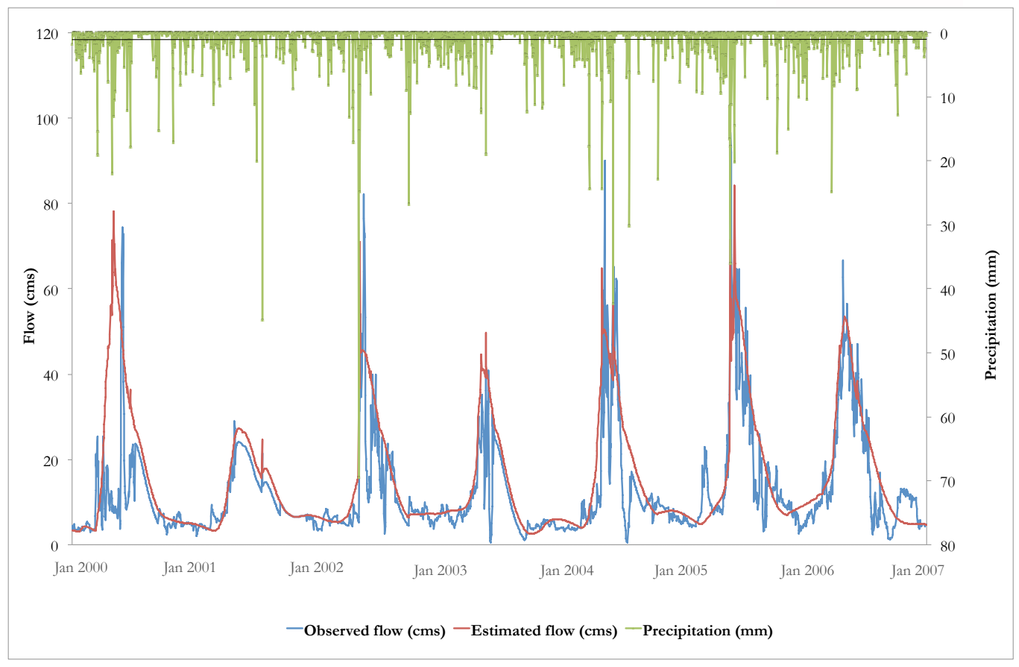
UCROSS FOUNDATION

Hydrology

Hydrology is the study of the distribution and movement of water on, and below the surface of the earth. Hydrologic modeling is a process of quantifying and correctly representing the existing hydrology as a model, which can in turn be used to understand the impacts of environmental changes, such as those associated with land-use and climate.

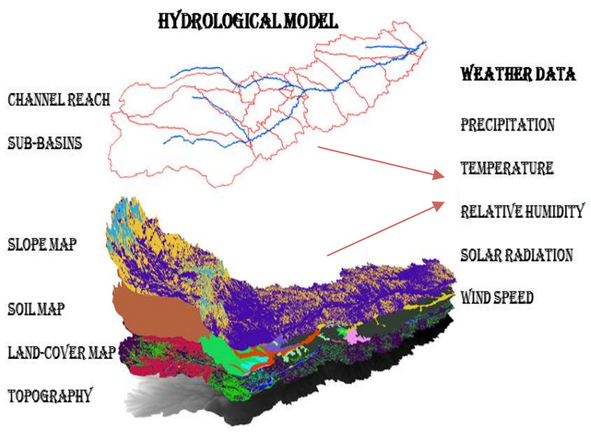
UHPSI, led by hydrologist Ambika Khadka, has represented and quantified the 1,110 square-mile watershed extending from the Bighorn Mountains to Clear Creek in Arvada, Wyoming. This was accomplished by creating a model using the Soil and Water Assessment tool (SWAT). The accuracy of the model was measured by comparing the modeled output for a number of landscape parameters with eight years worth of daily discharge records from a USGS stream gauge in Arvada. In its current state, the model is approximately 80% accurate.

The SWAT model is critical to our understanding of the current hydrology of the ranch, and in predicting hydrologic response to changes in vegetative cover, grazing regimes, and riparian area management.

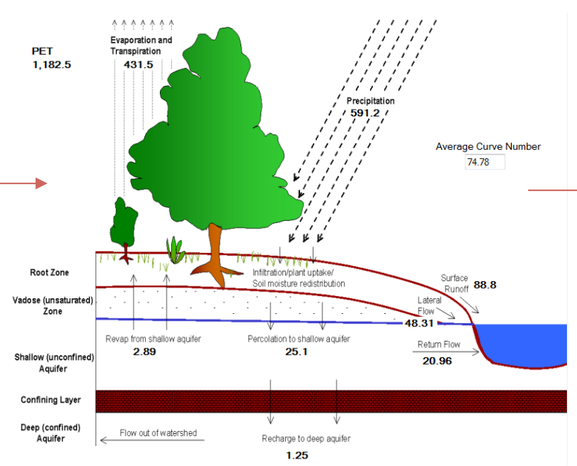


Accuracy assessment of the SWAT model against observed data for the Clear Creek Watershed

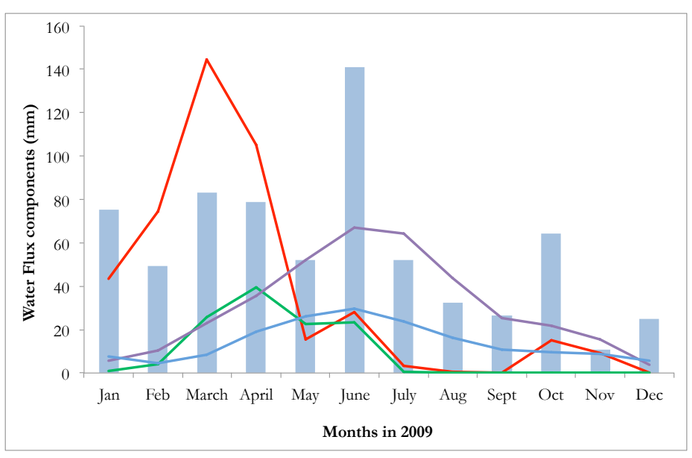
SWAT Model Inputs



SWAT Model Outputs



Clear Creek Basin Hydrology



Precipitation (mm)

Quickflow (mm) (immediate flow into Creek)

Delayed Flow (mm) (slow return flow to Creek)

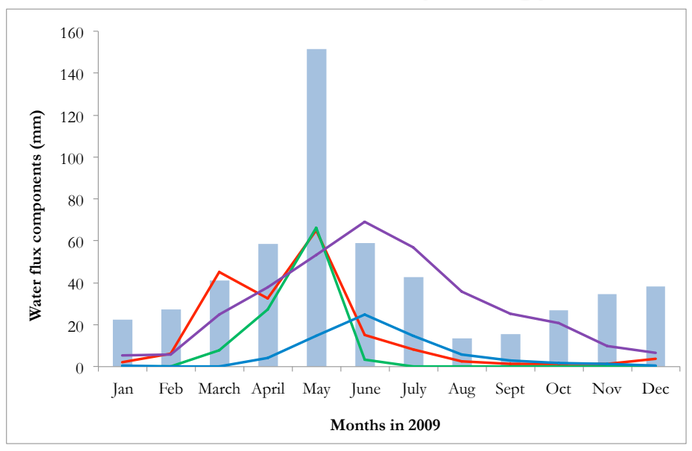
Evapotranspiration (mm)

Infiltration (mm)

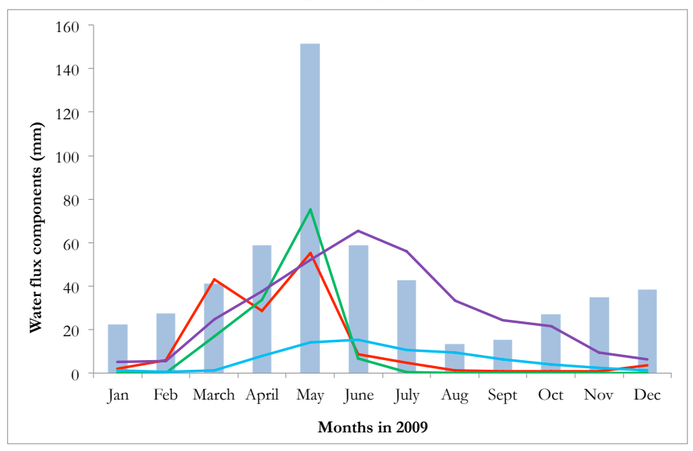
Riparian Buffer Scenario Analysis

- Scenario analysis allows the modeler to play around with different land-use and management scenarios to come up with an optimal scenario for water conservation and utilization.
- 16 parameters applied in accuracy assessment of the Clear Creek watershed model were used to mimic scenarios across the Ucross ranch.
- **Baseline Ucross Hydrology:** Ranch-scale hydrology was quantified by limiting the 1,110 square-mile Clear Creek watershed model to the Ucross ranch, using the 16 corrected parameters.
- **Scenario 1:** Three riparian buffer strips were placed adjacent to all draws, including 9m of evergreen trees, followed by 21m of shrubby vegetation, followed by 20m of pasture. This effectively limits grazing within 30m of all streams.
- **Scenario 2:** Two riparian buffer strips were placed adjacent to all draws, including 30m of shrubby vegetation and 20m of pasture. Here grazing is limited within 30m of all streams.
- **Scenario 3:** Three riparian buffer strips were placed adjacent to all draws, including 9m of evergreen trees, 41m of shrubby vegetation, and 20m of pasture. Here grazing is limited within 50m of the streams.

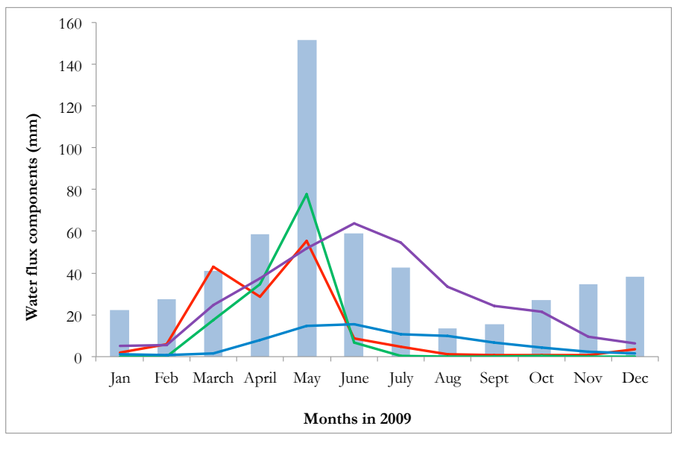
Baseline Ucross Hydrology



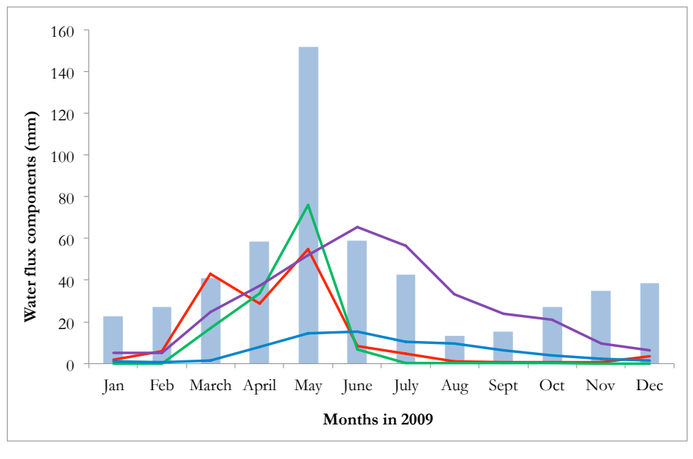
Scenario 1



Scenario 2



Scenario 3



Scenarios	Stream flow/ Precipitation	Percolation/Precipitation	Surface runoff/Total flow	Base flow/Total flow	ET/Precipitation	Deep recharge/Precipitation
Baseline	0.39	0.20	0.43	0.57	0.57	0.02
Scenario 1	0.34	0.26	0.43	0.57	0.56	0.01
Scenario 2	0.35	0.26	0.42	0.58	0.55	0.01
Scenario 3	0.35	0.26	0.42	0.58	0.55	0.01