Assessment of Annual Snowpack and Its Effect on Water Availability in the Fremont River Basin

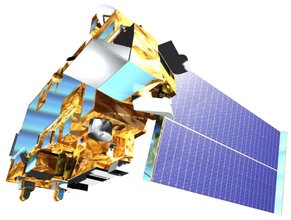
Abstract

The Fremont River in Utah provides water for wildlife, riparian habitats, and irrigation for approximately 16,000 acres of agricultural lands, which includes the historic orchards and pastures maintained by Capitol Reef National Park. Annual snowmelt is recognized as the primary water source within the Fremont River Basin. However, the predictions of seasonal water availability within the basin from in situ snowpack measurements have proven unreliable in the past. For this reason, a more robust method was required to provide accurate estimates. For better predictions of annual water resources from snowmelt, the team utilized daily Normalized Difference Snow Index (NDSI) snow cover data and daily Land Surface Temperature (LST) data from the Terra Moderate Resolution Imaging Spectroradiometer (MODIS). The team also integrated daily precipitation data from the Precipitation Estimation from Remotely Sensed Information using Artificial Neural Networks - Climate Data Record (PERSIANN - CDR). These datasets were incorporated into the SNowmelt Observational Watershed Model (SNOW-M) with in situ data, creating two graphical outputs that reveal the changes in snowmelt between 2000 and 2017. These graphical outputs included the actual flow versus the simulated water flow per annum and the snow covered area per annum. Furthermore, this model simulated the projected water flow for three months based on snow covered areas. Complementing the SNOW-M, monthly Terra MODIS NDSI snow cover data were utilized to produce maps displaying the change in snow cover extent. Capital Reef National Park will employ these products to further predict the seasonal water availability for irrigation.

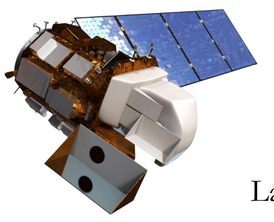
Objectives

- **Derive** the Snowmelt Observational Watershed Model **(SNOW-M)** from the Modified – Snowmelt Runoff Model **(M-SRM)**
- **Detect** snow cover from NASA Earth observations
- **Model** and **Predict** water flow

Earth Observations

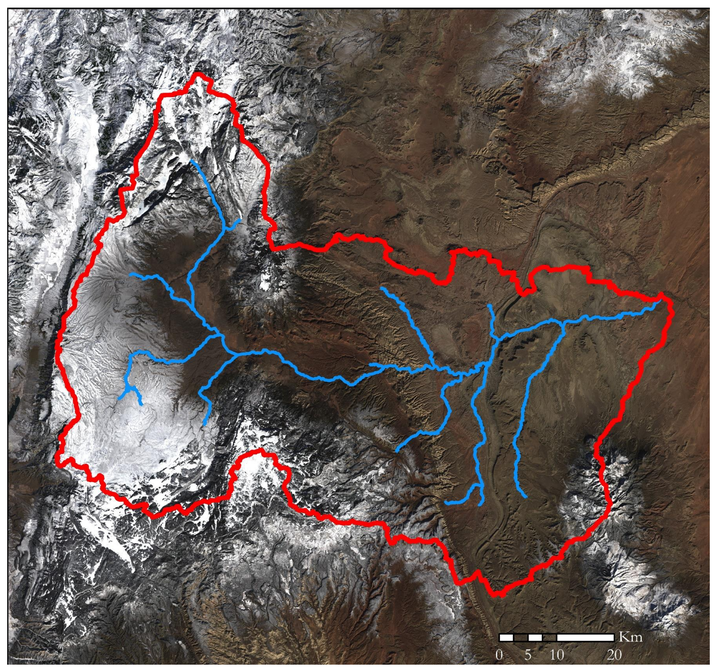


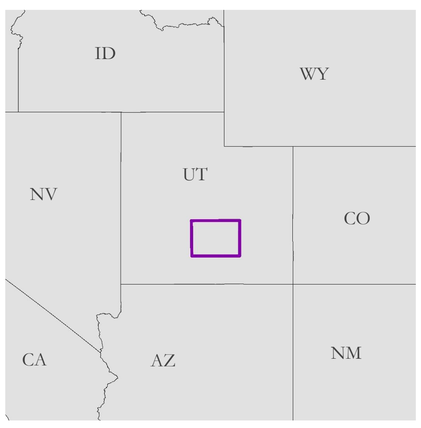
Terra MODIS



Landsat 8 OLI

Study Area

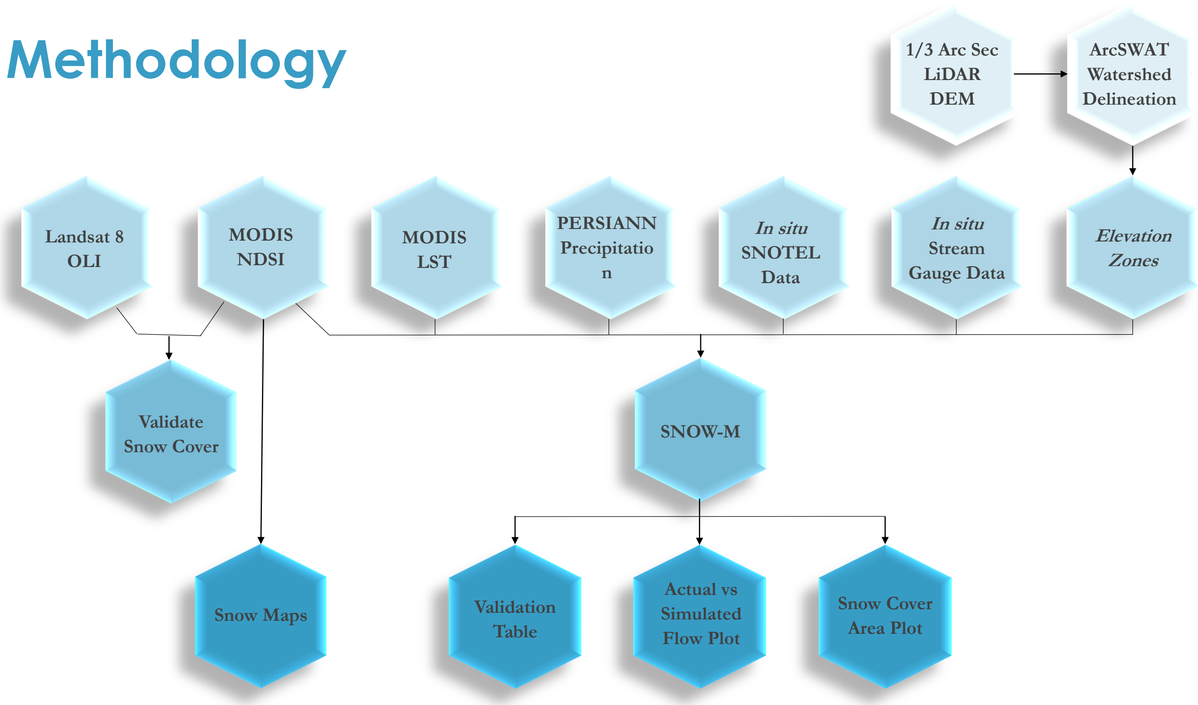




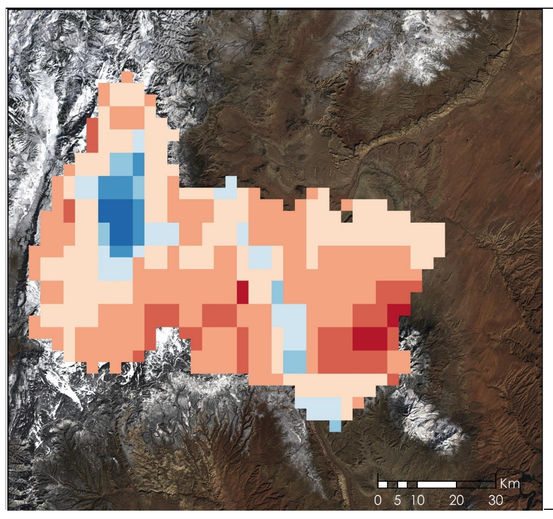
Fremont River Watershed

Fremont River & Tributaries

Methodology



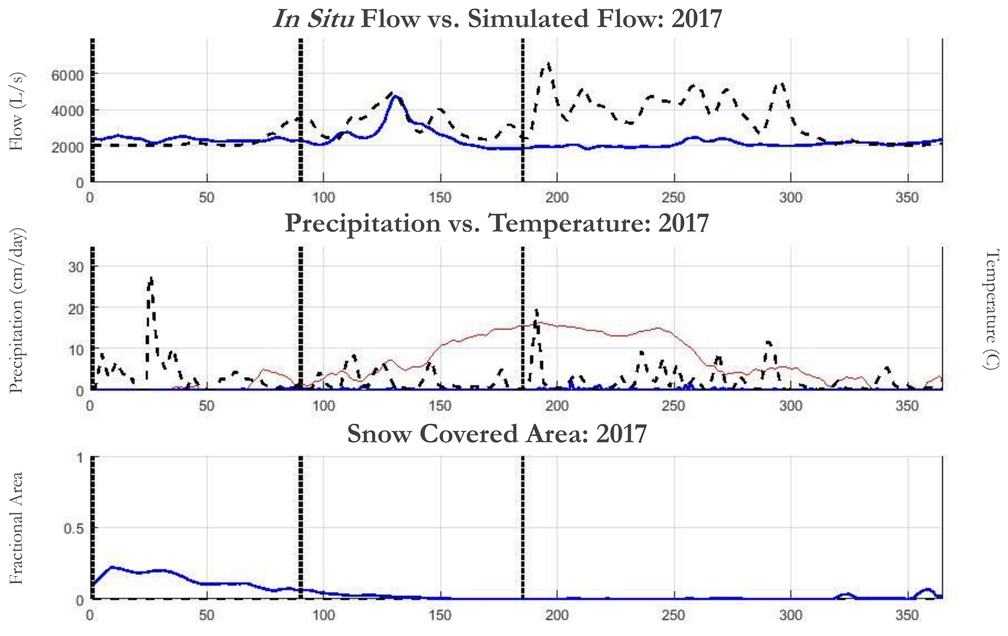
Results



Difference in 2016-2017 Snow Cover from 2000-2010 Snow Cover

% Difference

- 4.7 - 6.3
- 3.2 - 4.7
- 1.6 - 3.2
- 0 - 1.6
- -2.5 - 0
- -5.1 - -2.5
- -7.6 - -5.1
- -9.6 - -7.6



Project Partners

- National Park Service, Northern Colorado Plateau Network
- Capitol Reef National Park

Conclusions

- The preliminary snow cover change map for the 2016 to 2017 water year shows less snow cover.
- The SNOW-Model was written and adapted from M-SRM to fit the Fremont River Basin.
- The project resulted in the development of the SNOW-Model.

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