**NASA DEVELOP National Program**

****USGS at Colorado State University

*Summer 2017*

**Short Title: Colorado River Basin Water Resources**

**Subtitle:** Utilizing NASA Earth Observations to Evaluate Invasive Species Cover in Riparian Areas of the Colorado River Basin

**VPS Title:** It’s Not Easy Being the Green: Quantifying Invasive Species Cover in the Green River Watershed

**Project Team**

**Project Team:**

Megan Vahsen (Project Lead), mlvahsen@gmail.com

Emily Campbell

Daniel Carver

Julia Sullivan

Chanin Tilakamonkul

Brian Woodward

**Advisors & Mentors:**

Dr. Paul Evangelista (Colorado State University)

Dr. Amanda West (Colorado State University)

Nicholas Young (Colorado State University)

Anthony Vorster (Colorado State University)

**Past or Other Contributors:**

Sarah Carroll

Amandeep Vashisht

Leana Schwartz

**Project Overview**

**80-100 Word Objectives Overview:**

The objectives of this project were to quantify the percent area inhabited by the invasive plant species *Tamarix* spp. (tamarisk) in riparian corridors of the Green River watershed within the greater Colorado River Basin, and to evaluate changes in their distribution between 2006 and 2016. Riparian corridors are essential to maintaining the overall health of the river and providing habitat for wildlife, yet these ecosystems are impacted by the proliferation of invasive plant species. The mapping of riparian corridors and tamarisk will aid the Walton Family Foundation in evaluating previous management efforts and informing future management strategies.

**Abstract:**

Riparian corridors are inhabited by unique and biodiverse plant communities that control erosion, manage sediment loads, and filter pollutants. These ecosystems are transitional zones between terrestrial and aquatic systems that provide important wildlife habitat and maintain the overall health of rivers. The Colorado River Basin not only serves as an important ecological system, but also provides a water supply to more than 40 million people in the western United States. However, the spread of invasive species such as tamarisk (*Tamarix* spp.) impacts the ecosystem functionality of this river basin by altering flow regimes, sediment loads, and evapotranspiration rates. This project utilized Shuttle Radar Topography Mission (SRTM) topographic data, Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS), Landsat 7 Enhanced Thematic Mapper Plus (ETM+), and Landsat 5 Thematic Mapper (TM) to map and distinguish tamarisk cover from that of riparian species in 2006 and 2016 in the Green River watershed of the Colorado River Basin. Further, for 2016 tamarisk cover maps, we compared Landsat 8 to Sentinel-2 Multispectral Instrument (MSI) in a cross-platform analysis. Invasive species cover maps and an in-depth tutorial allow partners at the Walton Family Foundation to create effective management plans and to reproduce this methodology for future planning.

**Keywords:** Remote sensing, riparian corridor, habitat suitability modeling, invasive species, tamarisk

**Partner Organizations:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| Walton Family Foundation | Peter Skidmore, Program Officer | End User | No |
| USGS, Fort Collins Science Center | Dr. Catherine Jarnevich, Research Ecologist | Collaborator | No |
| USGS, North Central Climate Science Center | Dr. Gabriel Senay, Research Physical Scientist | Collaborator | No |

**Community Concerns:**

* The Colorado River supplies water to 40 million people in the western United States, irrigates 5.5 million acres of crops, and is a major source of recreation for the surrounding population.
* Riparian areas contained in the Colorado River Basin are important to maintaining the overall health of the river and provide irreplaceable habitat for wildlife.
* Invasive species such as tamarisk affect riparian ecosystem structure and function, alter flow regimes and sediment loads, and change evapotranspiration rates.
* Quantifying riparian areas threatened by invasive species is a major concern for farmers, land managers, and the public at large.

**Current Decision-Making Practices & Policies**:

The Walton Family Foundation has supported and continues to promote the management of invasive plants such as tamarisk in order to preserve invaluable riparian habitat in the Colorado River Basin. Past management practices were informed by publically available, yet limited, data on riparian area and invasive species cover. Intensive removal of tamarisk and release of the biocontrol agent, *Diorhabda carinulata* (tamarisk leaf beetle), was initiated in 2007 for a limited number of locations across the basin. However, the efficacy of these management practices has yet to be quantitatively assessed.

**Decision Support Tools & Benefits:**

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Earth Observations Used** | **Partner Benefit & Use** | **Software**  **Release** |
| Expanded Riparian Vegetation Cover Map | SRTM, Landsat 8 OLI & TIRS, Landsat 7 ETM+, Landsat 5 TM, Sentinel-2 MSI | Creating a riparian area map for a tributary of the Colorado River using methodologies developed in Arizona Water Resources will aid in developing methodology to map riparian cover across the greater Colorado River Basin. | N/A |
| Expanded Tamarisk Cover Maps for 2006 and 2016 | SRTM, Landsat 8 OLI & TIRS, Landsat 7 ETM+, Landsat 5 TM, Sentinel-2 MSI | Species cover maps for *Tamarix* spp. will help inform future management prioritization and evaluate the efficacy of previous management efforts. | N/A |
| Species Modeling Tutorial | N/A | The tutorial will cover collection and processing of data from Earth observations, statistical model fitting, and will guide interpretation of model outputs. A detailed modeling tutorial will enable end users to replicate methods for future years and study areas. | N/A |

**Project Benefit to End User**:

This project will provide the Walton Family Foundation with maps to evaluate the extent of tamarisk cover in riparian zones of the Green River watershed to inform future management decisions and enhance efforts in outreach and planning of environmental programs in the greater Colorado River Basin. Evaluations of predicted change in tamarisk cover between 2006 and 2016 will serve as a quantitative assessment of past management efforts in our study area. Importantly, the tutorial created for species cover modeling will provide the Walton Family Foundation with the tools necessary to replicate our methods to assess invasive species extent and management efficacy across other regions in the Colorado River Basin.

**Project Details**

**Applied Sciences National Application Addressed:** Water Resources

**Study Area:** Green River watershed, CO, UT

**Study Period:** 2006 – 2016 (April – November)

**Earth Observations & Parameters:**

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| SRTM V2 | Elevation, slope, compound topographic index, integrated moisture index | This sensor was used to develop topographic indices related to hydrology for potential riparian areas mapping. |
| Landsat 8 OLI | Surface reflectance, NDVI, EVI, SAVI, tasseled cap components, Chlorophyll-a | This sensor was used to map riparian vegetation and to distinguish tamarisk from other riparian species in 2016. |
| Landsat 8 TIRS | Thermal bands | This sensor was used to map riparian vegetation and to distinguish tamarisk from other riparian species in 2016. |
| Landsat 7 ETM+ | Surface reflectance, NDVI, EVI, SAVI, tasseled cap brightness, greenness, and wetness | This sensor was used to map riparian vegetation and to distinguish tamarisk from other riparian species in 2006. |
| Landsat 5 TM | Surface reflectance, NDVI, EVI, SAVI, tasseled cap brightness, greenness, and wetness | This sensor was used to map riparian vegetation and to distinguish tamarisk from other riparian species in 2006 and 2016. |
| Sentinel-2 MSI | NDVI, red-edge band | This satellite was used to conduct a cross-platform analysis with Landsat of riparian areas and tamarisk cover in 2016. |

**Ancillary Datasets Utilized:**

* USGS – partner *in situ* data of tamarisk presence
* Global Biodiversity Information Facility (GBIF) Open Access Biodiversity Data – georeferenced presence data of tamarisk
* Tamarisk Coalition – partner *in situ* data of tamarisk cover
* National Institute of Invasive Species (niiss) Invasive Species Database – georeferenced presence data of tamarisk
* Early Detection & Distribution Mapping System (EDDMapS) Distribution Maps – georeferenced presence data of tamarisk
* International Biological Information System (IBIS) Non-Native Species Datasets – georeferenced presence data of tamarisk
* Colorado State University, Natural Resource Ecology Laboratory – partner *in situ* data of tamarisk presence and absence
* USFWS – field surveys of riparian areas and invasive species
* USGS National Hydrography Dataset (NHD) – flowlines and waterbodies
* USGS National Elevation Dataset (NED) – 10 m DEM

**Models Utilized:**

* USGS Random Forest
* USGS Boosted Regression Trees

**Software Utilized:**

* Software for Assisted Habitat Modeling (SAHM) – model utilization
* Esri ArcGIS – data processing and analysis; map creation
* Exelis ENVI – raster processing
* R – index calculation and model utilization

**Project Handoff Package**

**Transition Plan:**

We plan to videoconference with our partners at the Walton Family Foundation multiple times throughout the term. We will conduct a webinar at the end of the term to present general methodology and to explain products in the handoff package (as listed below).

*Project Continuation Plan*: In addition to the handoff package, the following term will be given all the project planning materials, reviewed literature, and relevant raw and processed data used for modeling. The future term will hand off evaluations of potential evapotranspiration differences between tamarisk and native vegetation to the partners at the end of their term.

**Team POC:** Megan Vahsen (Project Lead), mlvahsen@gmail.com

**Partner POC**: Peter Skidmore, peter@peterskidmore.com

**Handoff Package:**

* Riparian areas map
* Riparian vegetation percent coverage map for 2006 and 2016
* Tamarisk cover maps for 2006 and 2016
* Tamarisk cover modeling tutorial
* Final copies of deliverables