**NASA DEVELOP National Program**

NASA Langley Research Center

*Summer 2017*

**Short Title: Colorado National Monument Ecological Forecasting**

**Subtitle:** Identifying Early Season Invasives for Monitoring and Management in the Colorado National Monument

**VPS Title:** Catching the Cheatgrass in the Act: Identifying the Movement of Cheatgrass in the Colorado National Monument

**Project Team & Advisors**

**Project Team:**

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**Advisor:**

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**Project Overview**

**80-100 Word Objectives Overview:**

Cheatgrass is an invasive species that blooms early in the spring, dies in mid-summer, and leaves behind highly flammable remains. The goal of this project was to identify cheatgrass distribution and areas at risk for cheatgrass invasion within Colorado National Monument by using Landsat 5 TM, Landsat 8 OLI and TIRS, Terra MODIS, and Sentinel-2 imagery. Maps depicting current and historical locations of cheatgrass were produced, in addition to maps forecasting where cheatgrass is likely to expand in the future. Analyzing these vulnerable areas will allow staff at Colorado National Monument to make efforts to prevent future invasion into the park.

**Abstract:**

*Bromus tectorum*, otherwise known as cheatgrass, is an invasive grass from Europe that has increased its presence all over the world by out-competing native grasses due to its adaptability and lifecycle. During the end of its life cycle, typically occurring in the summer, its flammable remains often create the conditions for forest fires to start early in the season. This alters native wildlife’s previous response to wildfires and increases the overall frequency of fires. As a result, cheatgrass often disrupts the necessary recovery time for native wildlife after habitat destruction. This NASA DEVELOP project utilized Landsat 5 TM, Landsat 8 OLI and TIRS, Terra MODIS, and Sentinel-2 MSI data to study the spread of cheatgrass throughout the Colorado National Monument and the surrounding area to determine locations at risk of being invaded by cheatgrass. The results of the study included historical and current cheatgrass population maps, multi-criteria evaluation (MCE), MCE analysis, and forecasted cheatgrass spread. The MCE analysis assessed the factors and constraints that contribute to the vulnerability to cheatgrass invasion. The results from this project will assist the National Park Service in improving their monitoring and management efforts and help contribute to the prevention of cheatgrass in Colorado National Monument.

**Keywords:**

National Park Service, remote sensing, invasive species containment, wildfire prevention, Colorado National Monument

**Partner Organizations:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| National Park Service, Colorado National Monument | Ann Rodman, Chief of Cultural and Natural Resources; Molly Murphy, Biological Science Technician | End User | No |
| Colorado Mesa University | Dr. Deborah Kennard, Associate Professor | Collaborator | No |

**Community Concerns:**

* Invasive species can dramatically alter the function of natural ecosystems, so monitoring them is essential to ecosystem stability.
* It is not feasible to monitor the growth and movement of invasive species by hand due to the size and elevation ranges of the park.
* Cheatgrass is especially impactful to the Colorado National Monument because of the area’s abundance of old-growth pinyon-juniper woodlands, which are very vulnerable to wildfire.
* The park is located directly next to a large amount of unincorporated land owned by the Bureau of Land Management. Due to the differences in management policies between agencies, understanding how cheatgrass may be spreading into the park from other areas.

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

Colorado National Monument is actively managing and monitoring the cheatgrass stands within the park; however the park is very large, making field observations difficult due to the manpower required. Park officials have employed herbicides to prevent the crop from spreading in the past when it was in its early stage, which proved to be effective. They have also tested remote sensing techniques in partnership with Colorado Mesa University and the United States Geological Survey to detect cheatgrass; however, they lack the manpower to fully utilize this technology. Because Colorado National Monument is a national park, officials have to be careful where they apply herbicide and need to be certain about the location of the cheatgrass before applying it. Additionally, the park regularly sends teams into the land directly west and south of the park to explore and monitor the presence of cheatgrass.

**Decision Support Tools & Benefits:**

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Earth Observations Used** | **Partner Benefit & Use** | **Software****Release** |
| Current Cheatgrass Distribution Map | Landsat 5 TMLandsat 8 OLI and TIRSSentinel-2 MSI | Current distributions of cheatgrass will be used to influence management and monitoring efforts within the monument by allowing park officials to focus herbicide efforts in the affected areas. | I |
| Forecasted Cheatgrass Distribution Map | Landsat 5 TMLandsat 8 OLI and TIRSSentinel-2 MSI | Forecasted distributions of cheatgrass will be used to influence management and will enhance monitoring efforts around the affected area by allowing park officials to focus efforts on preventing the spread of cheatgrass in those areas. | I |
| Cheatgrass Coverage Time Series | Landsat 5 TMLandsat 8 OLI and TIRSSentinel-2 MSITerra MODIS | A map depicting the previous movements of cheatgrass will allow them to assess potential movements and determine appropriate prevention techniques. This will also allow for the assessment of changing cheatgrass coverage patterns.  | I |

**Project Benefit to End User**:

After receiving the end products, the National Park Service will be able to better determine areas of concern in the park and will be able to better manage and prevent the spread of the cheatgrass. Both the Landsat and Sentinel-2 data will allow the end-user to determine areas historically occupied by cheatgrass. The trend maps will allow the end-user to see how the patterns of cheatgrass distribution have changed over the study period. Terra MODIS images will allow the end user to examine cheatgrass phenology. These results will aid Colorado National Monument in monitoring and evaluating the areas at risk of cheatgrass invasion. These maps will give them additional information on cheatgrass movement and show both its present location and likely future extent.

**Project Details**

**Applied Sciences National Application Addressed:** Ecological Forecasting

**Study Area:** Colorado National Monument, CO

**Study Period:** 2008-2017 (February – September); Forecasting to 2020 and 2025

**Earth Observations & Parameters:**

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| Landsat 5 TM | Spectral vegetation indices for 2003-2011 | The scenes will be used as the primary method of classification and vegetation indices. |
| Landsat 8 OLI  | Spectral vegetation indices for 2013-2016 | The scenes will be used as the primary method of classification and vegetation indices. |
| Landsat 8 TIRS | Spectral vegetation indices for 2013-2016 | The scenes will be used as the primary method of classification and vegetation indices. |
| Sentinel-2 MSI | Spectral vegetation indices for 2016-2017 | This will provide higher resolution imagery for the spectral indices.  |
| Terra MODIS | Spectral vegetation indices | MODIS collects daily data, this will allow for the identification of daily peak greenness in each year. |

**Ancillary Datasets Utilized:**

* National Park Service, Colorado National Monument – Vegetation Type and presence.
* United States Census Bureau TIGER dataset – roads and census data
* United States Geological Survey National Land Cover Database (NLCD) – land cover
* United States Geological Survey National Hydrography Dataset (NHD) – hydrographic channels

**Models Utilized:**

* TerrSet Land Change Modeler (LCM)

**Software Utilized:**

* TerrSet – land change modeling and multi-criteria evaluation.
* Esri ArcGIS – raster manipulation and analysis, image enhancement & map creation of Landsat, Terra MODIS, and Sentinel-2

**Project Handoff Package**

**Transition Plan:**

We will send all the desired deliverables to the partners a week before the handoff and conduct an interactive session where we will go over each of the deliverables provided to the partners. This session will allow partners to ask any questions regarding end products or deliverables from this term.

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**Partner POC**: Ann Rodman, ann\_rodman@nps.gov; Deborah Kennard, dkennard@coloradomesa.edu; Molly Murphy, molly\_murphy@nps.gov

**Handoff Package:**

* Technical paper describing the process that was used
* Current Cheatgrass Distribution Map
* Forecasted Cheatgrass Distribution Map
* Cheatgrass Coverage Time Series
* An analysis of when the peak greenness is occurring in the area