**NASA DEVELOP National Program**

**Virginia – Langley**

*Project Summary – Spring 2018*

**Amistad Ecological Forecasting**

*Using Landsat and Sentinel to Identify and Detect Giant Cane in Amistad National Recreation Area for Future Invasive Species Land Management*

**VPS Title:** Crass Grass: A pain in Amistad National Recreation Area

**Project Team**

***Project Team*:**

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***Advisors & Mentors*:**

Dr. Kenton Ross (NASA Langley Research Center)

**Project Overview**

***Project Synopsis*:** Giant cane (*Arundo donax*) is a non-native and disruptive grass species that occupies valuable riparian habitat within Amistad National Recreation Area (NRA), TX. Giant cane generates large monocultures and crowds out native riparian species. The National Park Service (NPS) requires accurate and up-to-date information on the distribution and prevalence of giant cane in order to effectively plan management and eradication practices. This project used NASA Earth observations to generate historic and current vegetation distribution maps of giant canewithin Amistad NRA.

***Abstract*:**

Portions of Amistad National Recreation Area (NRA) are threatened by the presence of an invasive grass species known as giant cane (*Arundo donax*), which drastically alters riparian habitats by out-competing native vegetation and depleting vital resources. Giant cane does notprovide viable habitat or food for native species of wildlife, making it an important eradication target of land managers at the National Park Service (NPS). The NPS requires precise distribution maps of giant caneover the entire extent of Amistad NRA for effective land management, however their typical monitoring methods are ground based, labor intensive, and limited in scope. The Amistad Ecological Forecasting team created historic and current classified species distribution maps for the entire extent of Amistad NRA using Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI, and Sentinel-2 MSI data for the years 1996 to 2018. Persistence maps were then constructed from these classified images to differentiate between long-lasting and ephemeral stands of giant cane. Finally, the team analyzed year-over-year change in the abundance of giant cane to highlight temporal trends and assess the efficacy of this classification approach. The products of this work will help the NPS prioritize their future land management efforts.

**Keywords:**

National Park Service, *Arundo donax*, Landsat, Sentinel, remote sensing, invasive species, image classification, random forests

***National Application Area Addressed:*** Ecological Forecasting

***Study Location:*** Amistad National Recreation Area; Del Rio, TX

***Study Period:*** Jan 1996 – Jan 2018

***Community Concern:***

* Giant cane (*Arundo donax*)degrades the ecosystem health in Amistad NRA by outcompeting native vegetation and destroying habitat used by native wildlife.
* The NPS requires accurate vegetation distribution maps across all of Amistad NRA to make informed management decisions and allocate scarce resources.
* Field observations of giant canedistribution across Amistad NRA are resource intensive and limited in scope. Park staff are interested in monitoring giant cane remotely using NASA Earth observations.

***Project Objectives:***

* Generate a series of current and historic classified vegetation species distribution maps for the years 1995 – 2018
* Differentiate between ephemeral and persistent stands of Giant Cane using persistence maps
* Assess year-over-year change in the abundance of giant cane

**Partner Overview**

***Partner Organization:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **National Park Service, Amistad National Recreation Area** | Sarah Howard, Biologist | End User | No |

***Decision Making Practices & Policies***:

The NPS treats giant cane within Amistad NRA using herbicides, chainsaws, biological control insects, and prescribed fire. NPS officials would like to prioritize their giant cane work areas based on distribution, abundance, and proximity of the invasive species to other park resources, but currently rely on limited distribution information exclusively from manual ground surveys.

***Project Benefit to End User***:

Officials at Amistad NRA require spatial information about giant cane in order to produce a well-informed restoration plan. This project provides historic and current species distribution maps of giant cane and a means by which to monitor park resources remotely hereafter. It will also benefit park managers by differentiating between persistent and ephemeral stands of giant cane using persistence maps. Collectively, the results of this project can be used to prioritize future land management practices at Amistad NRA.

**Earth Observations & End Products Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter** | **Use** |
| **Landsat 5 TM** | Surface reflectance | Landsat 5 TM was used to identify giant cane and assess long-term trends. |
| **Landsat 7 ETM+** | Surface reflectance | Landsat 7 ETM+ was used to identify giant cane and assess long-term trends. |
| **Landsat 8 OLI** | Surface reflectance | Landsat 8 OLI was used to identify giant cane, assess long-term trends, current distributions, and compare to Sentinel-2. |
| **Sentinel-2 MSI** | Surface reflectance | Sentinel-2 MSI was used to identify current giant cane distributions and compare to Landsat-based results. |

***Ancillary Datasets:***

National Park Service, Amistad National Recreation Area *in situ* vegetation data – validate remote sensing measurements and inform selection of training areas for classification scheme

University of Texas at Austin’s Center for Water and the Environment (CWE) and the Texas Division of Emergency Management (TDEM), Height above nearest drainage (HAND) dataset, based on United States Geologic Survey National Elevation Dataset – used as an input into the classification algorithm to differentiate land cover types based on their proximity to water

National Park Service and United States Geologic Survey, Amistad Lidar dataset, bare earth model – used to generate a new HAND model specific to Amistad NRA

***Software & Scripting:***

Esri ArcMap 10.5 – vegetation classification, map creation, and imagery analysis

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Earth Observations Used** | **Partner Benefit & Use** | **Software Release Category** |
| **Giant Cane Coverage Maps (1996-2017)** | Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI, and Sentinel-2 MSI | Amistad will use annual coverage maps to assess historic trends in giant cane distribution. | N/A |
| **Giant Cane Coverage Persistence Maps** | Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI, and Sentinel-2 MSI | Amistad will use persistence maps of giant cane to identify persistent and ephemeral stands. This will highlight long and short term spatial trends in giant cane distribution. | N/A |
| **2018 Giant Cane Coverage Map** | Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI, and Sentinel-2 MSI | Amistad will use the current coverage map to inform their management strategies. | N/A |
| **Giant Cane Mapping Tutorial & Guide** | Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI, and Sentinel-2 MSI | The giant cane tutorial will allow Amistad to reproduce the results of this study and provide a remote monitoring method that can be used hereafter. | N/A |
| **HAND Model (1 m resolution)** | N/A | Amistad will be able to replicate the results of this study with a higher resolution HAND model. This hydrogeological model will have broad applicability to other aspects of land management as well. | N/A |

**Project Handoff Package**

**Transition Plan:**

Handoff will be conducted virtually via WebEx and include a tutorial on the project methodology for our partners. All final products will be transferred directly to land managers at the NPS offices within Amistad NRA. These materials will be transferred either via email or NASA LFT as per the preference of our partners. All classified image files will be exported in GeoTIFF format to maintain compatibility with various image processing platforms.

**Team POC:** W. Patrick Frier, wpatrickfrier@gmail.com

**Partner POC**: Sarah Howard, sarah\_howard@nps.gov

**Handoff Package:**

* Historic vegetation species distribution maps for years 1996 - 2017
* Current vegetation species distribution map using 2018 Sentinel 2 imagery
* All associated Esri files compiled into geodatabases for easy access
* Accuracy assessment tables for each classified map image
* Giant cane mapping methodology guide for Esri ArcMap
* Giant cane persistence maps for each decade and for the total study period
* HAND hydrogeological model

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