**NASA DEVELOP National Program**

**2019 Spring Project Proposal**

**Virginia – Langley**

**Patuxent Water Resources**

*Assessing Land Cover and Land Use Change to Inform Watershed Resource Management*

**Project Overview**

***Project Synopsis*:** The Patuxent Reservoirs Watershed Protection Group (PRWPG) is a multi-jurisdictional government cooperative focused on preserving water quality and supply, habitat, and landscape characteristics within the 132 mi2 Patuxent Reservoirs Watershed in Maryland. The group’s Technical Advisory Committee (TAC) collects and aggregates data related to watershed characteristics and recommends courses of action to government officials. This project will generate a consistent and reproducible set of land cover maps for the entire extent of the watershed, which will allow the team to analyze spatial and temporal changes in land cover and land use to aid TAC officials in their management of the watershed and supplement their *in situ* water quality metrics.

***Community Concern:*** The Triadelphia and Rocky Gorge reservoirs supply drinking water to about 1.8 million residents of the greater Washington, DC metropolitan area in Montgomery, Prince George’s, and Howard Counties, MD. The PRWPG TAC includes representatives from all three county governments, the Maryland state government, and the Washington Suburban Sanitary Commission. The TAC is tasked with monitoring the watershed and relaying metrics to government policy makers. It publishes a publicly available annual report on watershed health and recommends government actions through a coordinated multi-jurisdictional approach. TAC officials currently evaluate numerous *in situ* water quality measurements but are interested in how changes in land cover and land use might drive the changes they have observed in water quality. They are particularly interested in changes in forests, croplands, wetlands, and impervious surfaces. Currently, information on land use and land cover is inconsistent across the three counties. The TAC desires a reproducible land cover and land use mapping methodology that can be consistently applied across the entire watershed and provide an analysis of changes in the watershed since the establishment of the TAC in 1996.

***Source of Project Idea:*** The former Virginia – Langley Center Lead initially spoke to Dr. Paul Koch, a Prince George’s County representative on the PRWPG TAC and its 2018 Chair, who expressed an interest in incorporating Earth observation data into the organization’s current mapping efforts. Further communication with Dr. Koch, Susan Overstreet, and Jean Kapusnick, all of whom serve on the TAC, eventually led to the proposal herein.

***National Application Area Addressed:*** Water Resources

***Study Location:*** MD

***Study Period:*** July 1996 – July 2018

***Advisor:*** Dr. Kenton Ross (NASA Langley Research Center)

**Partner Overview**

***Partner Organization:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **Patuxent Reservoirs Watershed Protection Group, Technical Advisory Committee** | Paul Koch, TAC Representative of Prince George’s County; Susan Overstreet, TAC Representative of Howard County; Jean Kapusnick, TAC Representative of Montgomery County | End User | Yes |

***End-User Overview***

***End User’s Current Decision-Making Process:***The PRWPG TAC currently maintains a recurring regimen of *in situ* water quality measurements as the primary data source used to set recommendations for policy makers. These water quality parameters include chlorophyll-a, dissolved oxygen, and total organic carbon. Current land cover mapping of the Watershed is conducted on a county-by-county basis, which presents difficulties for producing a coherent picture of conditions in the Watershed at selected intervals. Furthermore, state map data are available only for particular years, and the mapping procedure involved has not been consistent over the period of interest. No current standardized mapping procedure currently exists for the entirety of the Watershed.

***End User’s Capacity to Use NASA Earth Observations:***

*Patuxent Reservoirs Watershed Protection Group, Technical Advisory Committee* – The PRWPG TAC consists of government officials, scientists, engineers and land managers who are very familiar with GIS in general and have good awareness and understanding of remote sensing. However, they do not currently incorporate NASA Earth observations into their decision-making process. Some TAC members have access to other remotely sensed datasets and are therefore familiar with the use of such data, but these datasets do not cover the entirety of the watershed and only exist on a county-by-county basis. The outputs of this project will build the TAC’s capacity to apply a consistent watershed wide methodology for mapping land use and land cover.

***Collaborator & Boundary Organization Overview***

***Dissemination by Boundary Organizations*:**

*Patuxent Reservoirs Watershed Protection Group, Technical Advisory Committee* – TAC officials publish a publicly available annual report that will allow them to easily disseminate the results of this DEVELOP project to other county government officials and residents of the Patuxent watershed. They are also well situated to ensure that the results of this project are accessible to stakeholders and decision makers from each of the three county governments associated with the PRWPG.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The DEVELOP team will communicate with the partners weekly or biweekly throughout the project term. Regular partner meetings will be held via teleconference and the Project Lead and Center Lead will conduct recurring email correspondence with partners. Thus far, the primary end user POC has been Paul Koch.

***Transition Plan*:** Transition to the end user will be conducted via teleconference or WebEx. The team will hand off final project deliverables via NASA Large File Transfer. The team will provide all final maps and data products as well as a tutorial on the classification methodology and tips for how to assess and analyze change between the various classified images. The project methodology tutorial is of particular importance because the partner intends to replicate the approach in future years.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter** | **Use** |
| **Landsat 8 OLI** | Surface reflectance | Landsat 8 OLI data will serve as the primary underpinning of the 2018 land cover classification. |
| **Landsat 5 TM** | Surface reflectance | Landsat 5 TM data will serve as the primary underpinning of the 1997 land cover classification. |
| **Sentinel-2 MSI** | Surface reflectance | Sentinel-2 will supplement as an additional optical data source for the 2018 land cover classification. |
| **Sentinel-1 C-SAR** | Backscatter values | Sentinel-1 C-SAR data will be used, particularly in wetland areas, to aid in the 2018 land cover classification. |

***Ancillary Datasets:***

USGS National Land Cover Database (NLCD) – As of December 2018, NLCD data are available for 2001, 2006, 2011, and 2016, and will be used as points of comparison to the team’s 2018 and 1997 land cover classifications.

NOAA Coastal Change Analysis Program (C-CAP) – The coastal land cover and land use dataset will be used as a point of comparison to the team’s 2018 and 1997 land cover classifications.

USDA National Agricultural Statistics Service Cropland Data Layer – The land cover dataset tailored to agricultural regions will be used as a point of comparison to the team’s 2018 and 1997 land cover classifications.

Patuxent Reservoirs Watershed Protection Group, Technical Advisory Committee *in situ* water quality measurements, disparate fine resolution commercial remote sensing data, and previous mapping efforts – These partner-provided resources will be used as points of comparison and a source of some ground truth information.

***Software & Scripting:***

ERDAS Imagine – Land cover classification of Landsat and Sentinel imagery

Esri ArcGIS Pro – Land cover classification of Landsat and Sentinel imagery

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **2018 Land Cover Map** | This will allow the TAC to assess current land cover distributions by providing the most up to date information on the distribution of forests, agricultural land, wetlands, and impervious surfaces within the watershed. | The team will create a refined classified land cover map for the entire extent of the Patuxent Reservoirs Watershed based on 2018 Landsat 8 OLI, Sentinel-2 MSI, and Sentinel-1 C-SAR imagery. | N/A |
| **1997 Land Cover Map** | This will allow the TAC to assess the historical distribution of forests, agricultural land, wetlands, and impervious surfaces within the Watershed. | The team will create a refined classified land cover map for the entire extent of the Patuxent Reservoirs Watershed based on 1997 Landsat 5 TM imagery. | N/A |
| **2001, 2006, 2011, and 2016 Change Detection / Change Analysis Maps** | The partner will be able to visualize and identify spatial and temporal trends in wetlands, forests, agricultural land, and impervious surface distributions. | The team will analyze the spatial and temporal changes in land cover by comparing their own classified images from 1997 and 2018 to C-CAL, NLCD, and CDL maps from 2001, 2006, 2011, and 2016. | N/A |
| **Land Cover Mapping Tutorial** | This tutorial/standard operating procedure for land cover mapping will allow the partners to replicate mapping efforts in the future. | N/A | N/A |

***End-User Benefit*:** The results of this work will allow TAC members to incorporate changes in land cover and land use into their assessment of what drives the changes they observe in various *in situ* water quality measurements. They hope to incorporate watershed-wide land cover analyses into their understanding of the Watershed, with a particular focus on forests, agricultural land, wetlands, and impervious surfaces. The project end products will allow them to do this and also give them the ability to replicate the analysis in the future.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: 2019 Spring

***Related DEVELOP Work:***

2016 Summer (LaRC) – Everglades Ecological Forecasting: Examining the Applicability of NASA Earth observations and Google Earth Engine to Monitor and Forecast Mangrove Health and Extent in the Florida Everglades

2016 Summer (GSFC) – Northern Great Plains Ecological Forecasting: Utilizing NASA Earth Observations to Map Temporal and Spatial Patterns of Annual Bromes for Prairie Management and Invasive Species Control in the Northern Great Plains

**Notes & References:**

***Notes*:** The PRWPG TAC Annual Report is an ideal and comprehensive resource for obtaining information on the partner’s ongoing goals and initiatives. We have access to partner-provided *in situ* data analysis as well. In order to draw comparisons and analyze spatial and temporal trends year-to-year, the team will need to maintain consistency and compatibility with the NLCD, CDL, and C-CAP datasets. The spatial analysis and change assessments are predicated upon this consistency.

The following are links to the ancillary datasets that the team will utilize to produce the project end products:

* NOAA C-CAP

<https://www.coast.noaa.gov/ccapatlas>

* USDA Cropland Data Layer

<https://www.nass.usda.gov/Research_and_Science/Cropland/SARS1a.php>

* USGS NLCD

<https://www.mrlc.gov/data>

***References:***

Patuxent Reservoirs Watershed Protection Group. (2011). *Supplementary Documentation in Support of the Patuxent Reservoirs Technical Advisory Committee’s 2011 Annual Report*. Laurel, MD: WSSC. Retrieved from https://www.wsscwater.com/files/live/sites/wssc/files/PDFs%206/2011TechnicalSupplement-FINAL\_13401285.pdf

Patuxent River Commission. (2017). *2015-2016 Biennial Report: Implementation of the Patuxent River Policy Plan.* Baltimore, MD: Maryland Department of Planning. Retrieved from https://planning.maryland.gov/Documents/OurWork/PRC/prc-2015-2016-biennial-rpt-web.pdf