**NASA DEVELOP National Program**

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NASA Langley Research Center

**Fall 2015**

**Short Title: North Carolina Ecological Forecasting**

**Subtitle:** Update of NOAA C-CAP Wetland Delineation and Further Disaggregation of Land Use Classes using Remote Sensing

**VPS Title:** Remote Sensing for the Wetlands: Landsat 8, LiDAR, and Soil for Land-Use in the Albemarle-Pamlico Watershed

**Project Team & Partners**

**Project Team:**

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**Past or Other Contributors:**

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**Partner Organizations:**

Albamerle-Pamlico National Estuary Partnership (APNEP) (End-User), POC: Bill Crowell and Dean Carpenter

**Project Details**

**Applied Sciences National Applications Addressed:** Ecological Forecasting, Water Resources

**Study Area:** Albemarle-Pamlico Watershed (NC, VA)

**Study Period:** May 2000 - Nov 2015

**Earth Observations & Parameters:**

Landsat 8, OLI – land cover

Terra (MODIS) - Land Cover and Normalized Difference Vegetation Index (NDVI)

**Ancillary Datasets Utilized:**

* USGS National Land Cover Dataset (NLCD) - land cover
* NOAA Coastal Change Analysis Program (C-CAP) - regional land cover
* USGS National Hydrological Dataset (NHD)
* USGS Digital Elevation Model
* Soil Survey Geographic Database (SSURGO)

**Models Utilized:**

* Remote Sensing for Biodiversity and Conservation, R Random Forest Model

**Software Utilized:**

ERDAS IMAGINE – supervised land classification of Landsat imagery

ArcGIS – raster manipulation/analysis, image enhancement & map creation of Landsat 8. Selection of Training sites for supervised land-use classification in R random forest model.

Google Earth Engine – exploring other tools for land use and land cover classifications (LULC).

**Project Overview**

Landsat 8 imagery, in consort with LiDAR, DEMs, soil, and ground truth data provided powerful tools for this land classification project. Data were used to classify land use types, update NOAA’s C-CAP program, and identify additional land cover categories, such as areas impacted by the invasive species, *Phragmites australis*. The project aims to provide updated LULC maps to the partner organization as well as a usable methodology that would allow APNEP to update the imagery on an annual or biannual basis.

**Abstract:**

This project focused on ecological forecasting of wetlands in the Albemarle-Pamlico watershed in Northeastern North Carolina and Southeastern Virginia. The Albemarle-Pamlico watershed encompasses the second largest estuary system in the United States. Understanding land cover types and uses is incredibly important in managing the myriad of uses for, and stressors on, this valuable resource.  In partnership with the Albemarle-Pamlico National Estuary Partnership (APNEP), this project aimed to provide an updated version of NOAA’s Coastal Change Analysis Program (C-CAP) land-use classification, with a specific focus on delineation of wetland types within this watershed. The project also further disaggregated land cover types such as crop varieties and the invasive species, *Phragmites australis*. The team utilized a supervised land classification methodology and cross-referenced Landsat 8 imagery with ground truth, LiDAR or DEMs, NHD, and soil datasets to create inputs for the R classifying model. The end goal of the project was to produce maps and a methodology by which APNEP can continually update wetland types and *Phragmites* extent within the watershed to better inform policy and management decisions.

**Community Concerns:**

* Data and resources limitations
  + Personnel and extent of C-CAP
  + Ability to ground truth is limited
  + Use of remote sensing and GIS knowledge is limited
* Existing active wetland monitoring programs are limited in their utility for ecosystem-based management because of some of the resource limitations listed above and their scalability.
* C-CAP is helpful but does not cover the entire Albemarle-Pamlico basin and it is only updated on approximately a five year cycle.
* Wetlands within the Albemarle-Pamlico basin provide a breadth of positive benefits for people and ecosystems. Beyond the obvious economic benefits of tourism and fishing, wetlands provide extensive flood control, water filtration (removal of excess nutrients and other pollutants) and extensive habitat for a range of flora and fauna. All of these aspects are integral to people living within the basin and APNEP strives to incorporate this consideration into their work wherever possible.

**Current Management Practices & Policies**:

APNEP relies on an ecosystem-based approach to watershed management. The overall plan is laid out in their extensive “Comprehensive Conservation and Management Plan: 2012-2022” (CCMP). In this document, APNEP outlines their five main guiding principles: to identify, protect, restore, engage and monitor trends in the basin. Much of the identify stage is based on field science in consort with a host of partner organizations for data collection with the goal of better quantifying and qualifying specific threats and challenges within the basin. This project aimed to make a contribution to this ‘identify’ phase. While the organization utilizes NOAA’s C-CAP data, use of remote sensing data remains fairly limited. A majority of their research and data relies on field work and partner-organizations, The ‘protect’ and ‘restore’ phases are influenced by the particular aspect of the watershed that is being addressed. In a given estuary for example, a ‘pristine’ state would ideally be protected, while a judgement that it was in a degraded state would require restoration. The ‘engage’ pillar is one place where the ecosystem and adaptive approaches to management are obvious. This covers APNEP’s objective to incorporate a broad range of actors. This could range from government scientists to commercial fishermen to farmers to the general public. APNEP utilizes citizen monitoring programs and outreach/education programs, amongst other strategies to include input from many different user groups within the basin. Finally, the ‘monitor’ stage is necessary for any well-planned and comprehensive management strategy. In any approach billed as adaptive, one must gather information, make decisions and implement policies and then monitor impact, and adjust as necessary.

As APNEP advocates this holistic approach to ecosystem/basin management, the policies they advance are varied. Because they have the dual management directive of human use and ecosystems, they must pursue policy options which aim to protect and restore ecosystem resources while also preserving human use in the area. This is apparent in their CCMP where they extol the virtues of a rich culture anchored in a long connection with the area, the fisheries and natural environment, as well as the importance of protecting habitats and restoring ecosystems to a more pristine state

**Decision Support Tools & Benefits:**

|  |  |  |
| --- | --- | --- |
| **End-Product** | **Earth Observations Used** | **Benefit & Impact** |
| Land use classification and wetland type map | Landsat 8 OLI  Terra MODIS | Aid in describing focus areas and wetland types for protection/conservation or remediation efforts |
| Methodology for continuously updating C-CAP | Landsat 8 OLI  Terra MODIS | C-CAP is only updated by NOAA once every 5 years so this would enable APNEP to update wetland types and other classifications such as *Phragmites* more regularly |

**Project Imagery**

**[Insert image here]**

**Caption:** [Insert Caption Here. Max of 25 words.] Image Credit: [Insert project short title] Team.

**Image:** File Name (Please submit your image as a separate .jpeg as well as inserting it in this document)

**Software Release Requirements**

What category do the tools your project is creating fall within? [Category I to V]

If your decision support tools fall within Category IV, fill out this section:

**Software Title:** Insert here (ex. DEVELOP National Program Python Package)

**Software Abbreviation:** Insert here (ex. dnppy)

**Technical Point of Contact:** Insert full name, permanent email, and node here. Also include whether employed through SSAI or Wise County. (Team member who knows the most about the software.)

**Brief Description of the Software:** Insert here (ex. The dnppy package will be used to functionalize common programming tasks in the geospatial community, specifically for working with NASA data products. It will include functions for processing satellite data and assist in structuring analysis to reduce the startup time for DEVELOP teams to learn programming and create tools for end users.)

**Type of Code:** *Executable Code* and/or *Source Code* (Select one or both)

**Will the software include any embedded computer databases?** *Yes* or *No* (Select one)

**Does the software use or call any open software or libraries?** *Open Source* and/or *Proprietary/Commercial* (Select one or both)

**List the software or libraries used, under what license they were obtained, and the URL for the license in the table below:**

|  |  |  |
| --- | --- | --- |
| **Name** | **License** | **License URL** |
| Ex. Arcpy module | Ex. group license through ArcGIS | http://www.esri.com/software/arcgis |
| Ex. Python | Ex. Open source license | http://opensource.org/licenses/Python-2.0 |
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**Full Software Description and Plan**

**Introduction/Objective:**

What motivated the creation of this software, what problem does it address?

**Applications and Scope:**

Where and how will this software be used to influence decisions?

**Capabilities:**

What can it do better than what was previously available?

**Interfaces:**

How is one expected to use the software? For example, command line, GUI, script execution, etc.

**Assumptions, limitations, & Errors:**

What areas that the software could be improved upon in the future? This is where limitations of the theory, model, science, etc should be briefly documented. If the tools only work for a specific scenario, say so.

**Testing:**

What validation techniques and testing strategy will be used to build confidence in the software?