FNRM 5262 Project Proposal
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Mary Heise
Rui Zhou

Moisture Cycling from Marine Coast to Inland through Forests

Project Description/Objectives:

This analysis aims to better understand the relationship of moisture cycling between coastal forests and inland areas. Specifically, whether the presence of forested shorelands contribute significant moisture gains through evapotranspiration and soil moisture (SM) retention to more arid inland areas. The goal is to understand if deforestation or reforestation affects microclimates over the area of a coastal corridor, defined as a swath of land originating at an oceanic shoreline and extending inland.

Forests not only retain moisture delivered to an area by way of weather systems but they also generate humidity and precipitation through the biological process of evapotranspiration. A GIS will be used to select a suitable study site and then quantify and visualize changes in moisture variables over an extended period of time. The land cover types will include forested and deforested areas in addition to open cover types such as developed, agricultural, or semi-arid desert. This broad view of adjacent biomes is needed to understand the extent of forest moisture cycling and how exchanges occur across biomes.

A comprehensive understanding of large scale ecosystem exchanges is critical to addressing potential changes in water supply and soil quality for areas outside of deforestation zones. A quantifiable marker of how deforestation alters moisture variables in adjacent areas will assist resource managers and policy makers in prioritizing overall land use. Knowing the scale of moisture transportation from coastal areas inland through wooded cover types can significantly contribute to habitat restoration efforts or prevent degradation of inland ecosystems and the communities that rely on them.

Data Sources and Methods:

The study sites will be identified using a time-series analysis compiled from Landsat images by the Global Forest Watch group which visualizes change in global forest cover over a nineteen year period.

Additional satellite imagery will be used to identify changes in the coastal forest area as well as the non-forested inland area. These changes will be quantified visually and with software generated classification algorithms. This same data will be used to calculate a Normalized Multi-band Drought Index (NMDI) to track changes in vegetation moisture.

SM levels will be determined using a combination of satellite collected microwave and infrared spectral data and a Soil Moisture Active Passive (SMAP) dataset provided by the National Aeronautics and Space Administration (NASA) in conjunction with the United States Department of Agriculture (USDA).

Weather data will be collected from the National Oceanic and Atmospheric Administration (NOAA) and National Center for Atmospheric Research (NCAR) to assess seasonal precipitation amounts for the entire study site. Table 1 lists data needs and sources.

Table 1. Required data.

Purpose	**Data**	**Source**
Land cover imagery showing area of forest cover change	Satellite Imagery	Global Forest Watch
Top soil moisture levels	SMAP satellite L-Band microwave imagery	Earth Engine SMAP
Weather data to track relative humidity and rainfall amounts	NCAR, NOAA	NOAA, NCAR

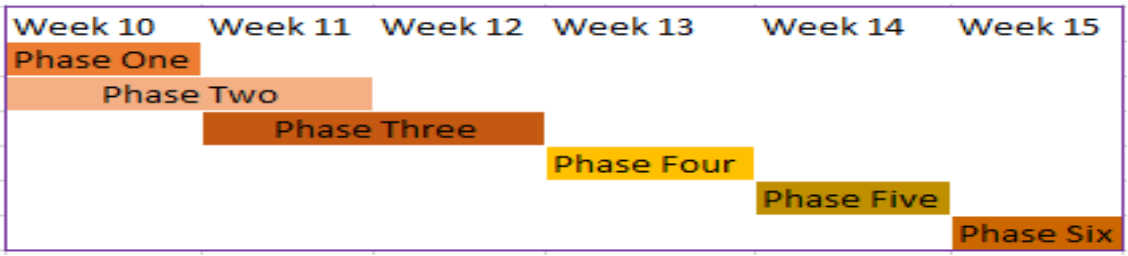
Table 2 lists out the currently planned analysis methods, which include classification of land cover types and calculations of the NMDI as well as the Normalized Difference Vegetation Index (NDVI). Changes in forest cover and respective SM levels will be mapped in a time-series animation along with seasonal precipitation and relative humidities. The final results will be compiled into a story map. There will likely be other methods performed as the data and process dictates but this is a snapshot of project needs at this time.

Table 2. Analysis methods.

Method	**Desired Results**
Land Cover Classification	Discovery of changes in forest cover & siting of adjacent non-forest inland areas.
NMDI	Soil & Vegetation Moisture Levels.
NDVI	Vegetation index.
Time Series	Visualize changes in land cover and moisture levels over time.

Project Timeline:

Table 3. Project phases and timeline.



Phase One: we have already identified the South West Coast of Portugal as one study site. We will continue to identify more areas of interest. They must satisfy such conditions: a) coastal areas, b) forest change, c) their extending inland should ideally be flat landscapes because mountain ranges also hold off moisture migration.

Phase Two: we will download satellite images from our sources (see Table 1. Data needed) in addition to the forest loss maps and weather data. We intend to collect data for a ten-year span (2010 to 2020). For each year, we plan to find data collections of at least seasonal frequency. Resolutions of the images should match that of Landsat imagery.

Phase Three: we will apply geocomputing techniques to calculate vegetation indexes and moisture indexes from our satellite imagery. We will also use mixed approaches of object-based classification and pixel-based classification on our images in eCognition. Our goal is to classify inland cover types as vegetated, developed, agricultural, or semi-arid desert, etc.

Phase Four: we will organize our results to create a time series for analysis. We should have seasonal forest loss data of the coastal areas, moisture data of soil and vegetation, plus weather data for the inland areas. We will also calculate the moisture index for each class of the land to quantify moisture variables. Our results will indicate the correlation between coastal forest change and inland moisture retention. We will make conclusions about the extent that forested shorelands help retain and cycle moisture through evapotranspiration and SM retention to more arid inland areas.

Phase Five: we will draft our story map. Our story map should include background, brief introduction, data source, methodology, results, and conclusion. At the end of our story map, we will make recommendations to resource managers and policymakers about how to improve microclimates through coastal forest enhancement.

Phase Six: we will polish our story map and submit it on time.

Table 4. Expectations and Responsibilities:

Phase One	Phase Two	Phase Three	Phased Four	Phase Five	Phase Six
Mary	Mary	Mary		Mary	Mary
Rui	Rui		Rui		Rui

Anticipated Products/Outcomes:

This analysis is expected to yield a quantitative assessment of changes in moisture levels for air, soil, and vegetation as well as any changes in rainfall over a ten-year time period for the study area. Table 5 specifies a detailed list of intermediary and final outputs.

Table 5. Project products.

Product	**Content**
Story Map	Our main presentation format.
Tables	Results of time series analysis such as time vs coastal forest change or inland moisture variables, and coastal forest change vs inland moisture variables.
Charts	Visualization of our results. We have two forms of charts in mind: scatter plot and pie chart. Scatter plots will be used for time series illustration while pie charts will help visualize the moisture variables of each class.
Screenshots of Imagery	Comparing images before and after changes can provide first-hand evidence to support our hypothesis.
Maps	Visualization of moisture and vegetation indexes for each land class in the images.
Recommendations	We will see whether or to what extent shoreland forestation can contribute to moisture gain in inland areas through evapotranspiration. We can make recommendations to policymakers and resource managers on prioritizing land use and ecosystem restoration.

Sources:

Global Forest Watch. “Tree Cover Loss (Hansen/UMD/Google/USGS/NASA).” *Data.globalforestwatch.org*, May 2020, data.globalforestwatch.org/datasets/14228e6347c44f5691572169e9e107ad. Data for forest cover change worldwide.

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National Center for Atmospheric Research Staff. “Climate Forecast System Reanalysis (CFSR) | NCAR - Climate Data Guide.” *Climatedataguide.ucar.edu*, 8 Nov. 2017, climatedataguide.ucar.edu/climate-data/climate-forecast-system-reanalysis-cfsr.

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