Inundation Pattern Measurements of Tropical Wetland Ecosystems with Remote Sensing

Carlos Alvarez, Ilana Price, Jessika Alvarez, Kat Jensen, Dr. Kyle McDonald
The City College of New York Department of Earth and Atmospheric Science

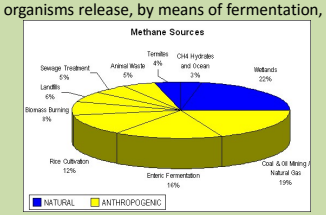
NOAA-CREST

Abstract

The Pacaya-Samiria National Reserve in Peru is one of the largest wetland regions in existence. Surrounding this region is a vast number of meteorological and hydrological weather stations that measure a variety of temperatures, precipitation, wind speed, velocity and river levels at different times throughout the day. The use of the Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR), which collects high quality images of the Pacaya-Samiria region every 12 days, allows us to classify multiple areas throughout the wetland into four sections: No Data, Inundated Vegetation, Open- Water and Non-Inundated Vegetation. The classification of these wetland areas enable the ability to observe the percentage of open water and inundated vegetation in a 5 kilometer radius across multiple points, along one of the main rivers in the Pacaya-Samaria. The combination of the information from the weather stations and the satellite data helps us understand the seasonality of inundation patterns through means of direct comparison.

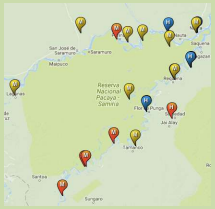
Introduction

Wetlands, areas where water covers the soil, play a major role in our environment affecting biodiversity, hydrology, and meteorology. Pacaya-Samiria is a national park in Peru that houses one of the largest wetland ecosystems in the world. Since this wetland ecosystem is located in a tropical environment where the rainfall is constant, the soil is perpetually inundated. The continually saturated soil lacks oxygen for aerobic organisms to perform cellular respiration letting the anaerobic organisms release, by means of fermentation, large amounts of methane gas into the atmosphere.

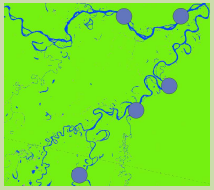


Methane is a green house gas that has been proven to be more threatening to our environment than carbon dioxide due to it's high heat absorbency. Through remote satellite sensing and GIS (Geographic Information Systems), we can graph seasonal rainfall and compare it to the actual wetland flooding to find areas where higher levels of methane gas are released into the atmosphere. This information will provide a better understanding of the role and impact of wetlands on global climate change.

Methods



- Collected data from Senahmi, a Peruvian national weather service organization, which provides daily measurements of meteorological and hydrological data.
- Formatted data in order to be read by programming languages. Filled in empty data slots with NaN values and edited erroneous values.
- Data was then imported into a python code which displayed a clear graph of the seasonality of inundation patterns that occurs in the national park.
- The seasonality of inundation patterns graph was then compared with the data that was received from the UAVSAR.

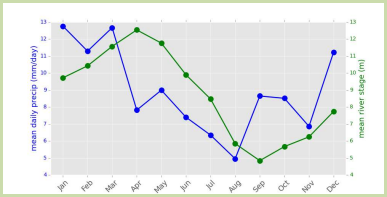


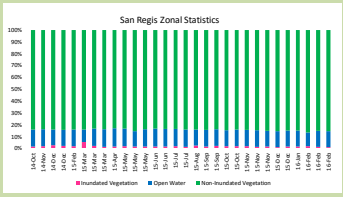
- The UAVSAR provided radar imaging measurements which explained what each portion of the land classifies under.
- The land was classified as No Data, Non-Inundated Vegetation, Open Water and Inundated Vegetation.
- This data calculated the percentage of those classifications on the region.
- These two sets of data were then compared to make a final visual representation, which portrayed the results of the research.

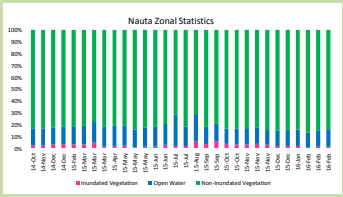
Discussion and Conclusions

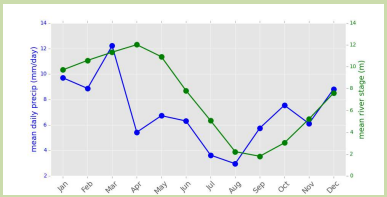
- Data from Senahmi might slightly differ from data from the UAVSAR since Senahmi is over a five year span, whereas the UAVSAR data is over a one year span.
- The precipitation and the river depth data from Senahmi have a direct relationship.
- Future goals consist of increasing the radius of observation, and comparing more regions down the river.
- Future research will involve concentrated interest of methane release in these regions.

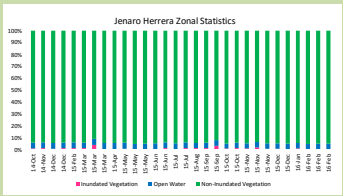
Results

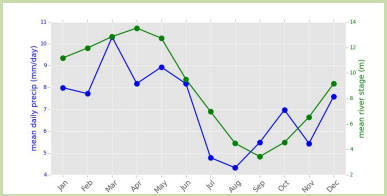


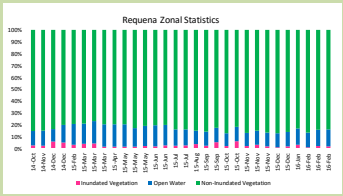


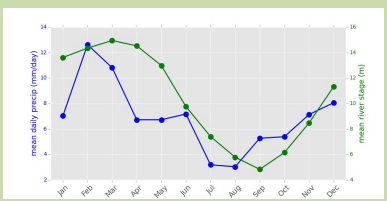


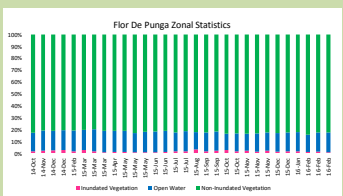












- Through the graphs of the seasonality of inundation patterns, it can be noted that the increase of rainfall usually increases the river depth. There is an increased amount of rainfall and river depth around the months of December to March.
- By comparing the graphs of the seasonality of inundation patterns and the data from the UAVSAR, it is noted that increased rainfall and river depth generally leads to an increased amount of Open Water or Inundated Vegetation.

Acknowledgements

This project is supported by the National Science Foundation Research Experiences for Undergraduates Grants #1560060, under the direction of Dr. Reginald A. Blake, Dr. Janet Liou-Mark, and Ms. Laura Yuen-Lau, the NOAA-CREST CURE program under the direction of Dr. Reza Khanvilbardi and Dr. Shakila Merchant, and the High School Initiative in Remote Sensing of the Earth Systems Science and Engineering program under the direction of Dr. Shakila Merchant. The authors are solely responsible for the content of this article, and it does not necessarily represent the views of the NSF or of NOAA-CREST.

References

Environmental Protection Agency. Overview of Greenhouse Gases.
Retrieved August 02, 2016, from https://www3.epa.gov/climatechange/ghgemissions/gases/ch4.html
Schmunk B. Robert, Goddard Institute for Space Studies Institute on Climate and Planets.
Retrieved August 2, 2016 from http://icp.giss.nasa.gov/education/methane/intro/cycle.html
SENAMHI, Peruvian National Meteorological and Hydrological Service.
Retrieved August 02, 2016, from http://www.senamhi.gob.pe/main_mapa.php?t=dHi