Feasibility of Estimating Relative Nutrient Contributions of Agriculture and Forests Using MODIS Time Series

Abstract

Around the Gulf of Mexico, high-input crops in several regions make a significant contribution to nutrient loading of estuaries to medium estuaries and to the near-shore Gulf. These crops include sugarcane in Texas, rice in Texas and Louisiana, sugarcane in Florida and Louisiana, citrus orchards in Florida, pecan orchards in Mississippi and Alabama, and heavy use of ornamental and vegetable crops along Mobile and Tampa Bay. In addition to crops, management of leafmold in proximity to the coasts also plays a role in nutrient loading. In the summer of 2008, a feasibility project is planned to explore the use of NASA data to enhance the spatial and temporal resolution of near-coast nutrient source information available to the coastal community. The purpose of this project is to demonstrate the viability of near-coast nutrient information products applicable to small to medium watersheds surrounding the Gulf of Mexico. Conceptually, these products are intended to complement estuarine nutrient monitoring.

Introduction

This project seeks to use NASA data to enhance the spatial and temporal resolution of near-coast nutrient information available to the coastal community. In doing so, we hope to contribute to an improved understanding of nutrient loading and nutrient sources for sensitive water bodies around the Gulf of Mexico.

Remote sensing can be effectively applied to determining the distribution of the crops. LULC (Land Use/Land Cover) information is a well-established part of modeling nutrient flux at the watershed level. LULC is often produced through classification of multispectral remote sensing data, but this effort proposes to derive the land cover information for crops through time series analysis of multi-temporal data from the MODIS (Moderate Resolution Imaging Spectroradiometer) sensor. Additionally, we hope to provide information relevant to intra-annual variations in nutrient flux, such as:

- The presence or absence of canopy to intercept precipitation,
- The timing of fertilization based on ancillary information regarding the crop phenology and management practices.

After producing the crop information, we propose to demonstrate its usefulness by showing how the information might be input into one or more nutrient loading models.

Potential Products

- Provide near real-time Land Use/Land Cover Information
- Utilize phenology products to infer application dates for fertilizer
- Provide near real-time Land Use/Land Cover Information
- Identify periods when precipitation need is most likely using phenology parameters to assess the prevalence of vegetation

Proposed Flow from NASA Remote Sensing Observations to Watershed Model Input

Typical MODIS Input Datasets

- MOD03 Planetary Reflectance (Swath)
- MOD03-48-bit Cloud Mask
- MOD08 Sensor Zenith Angle

Phenological Parameters Estimation Tool (PPET)

PPET Processing Overview

1. Extract the TSPT-filtered time series data for each year
2. Identify growing seasons via threshold curve fitting
3. Locate targeted data points within the growing season
4. Calculate the NDVI data value and day of year for each phenological parameter
5. Compute cumulative integral of integrals over each 16-day period within the NDVI time series per year
6. Generate MODIS NDVI time series products

Time Series Product Tool (TSPT)

TSPT Overview

The TSPT software is custom-designed for NASA to rapidly create and display single-band and band-combination time series, such as NDVI (Normalized Difference Vegetation Index) images, for vital- and crop surveillance, forest health, disturbance detection, and other time-critical applications. The TSPT, developed in MATLAB®, allows users to create and display various MODIS products as single images, as time series plots at a selected location, or as temporally processed image videos. The TSPT has been used to generate NDVI time series to monitor crop phenology in California and Argentina and to monitor forest health in an area of southeast Mississippi following Hurricane Katrina.

Targeted Phenological Data Points

- Sheely Farm (2003): Color-coded Sheely Farm Crop Map
- St. Louis (2005): NDVI plot at St. Louis
- Sheely Farm (2005): Fused and temporally processed NDVI from MODIS (Moderate Resolution Imaging Spectroradiometer) sensor
- Sheely Farm (2006): Fused and temporally processed NDVI image from MODIS sensor

Example Phenological Parameter: Start of Season for Mobile Bay Area for 2005 Season

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