Use of NASA Satellite Assets for Predicting Wildfire Potential for Forest Environments in Guatemala

Laura Johnson, Greg Easson, The University of Mississippi Geoinformatics Center
geasson@olemiss.edu

Goal

To assess the capability of NASA's upcoming Visible Infrared Imager / Radiometer Suite (VIIRS) satellite sensor for contributing to the development of a near real time forest fire potential decision support system in Guatemala.

Project Overview

Forest fires are an increasingly serious problem in Central America, threatening the region's rich biodiversity as well as contributing significantly to smoke-related human health concerns (Figure 1). In recent years significant advances have been made in developing and implementing near real time fire detection systems such as the SERVIR fire product. However, little progress has been made in terms of monitoring fire potential, or the susceptibility of forests to the ignition and spread of surrounding grassland fires. Regular assessment of fire potential is of critical importance for improving fire management and protection efforts in the region.

The purpose of this project is to evaluate the potential of VIIRS data for monitoring vegetation moisture in tropical forests. Vegetation moisture is a key component of fire potential models (Figure 2). VIIRS generated vegetation and drought indexes including Normalized Difference Vegetation Index (NDVI), Enhanced Vegetation Index (EVI) and Shortwave Infrared Water Stress Index (SIWSI) or Normalized Difference Moisture Index (NDMI) will be compared against weather station-generated Keetch Byram Drought Code (KBDI), an important fire weather index used extensively to predict fire potential in other parts of the tropics and North America.

Figure 1. Surface fire in tropical forest fire, Guatemala

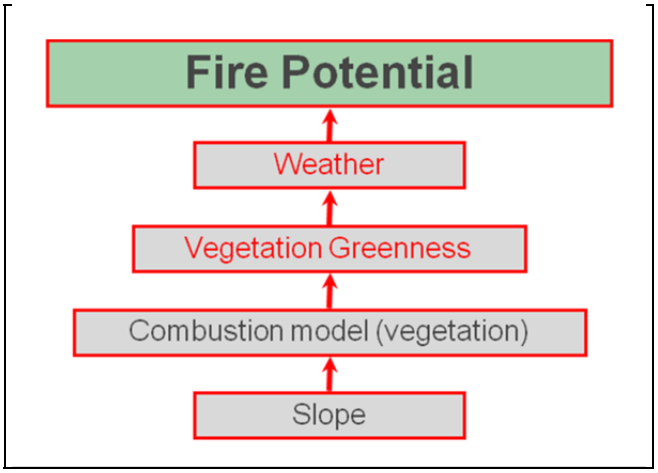

Figure 2. Fire potential model in use in Guatemala. Simulated VIIRS data may assist with vegetation greenness assessment, as well as potentially replace weather and vegetation greeeness model components with near real time vegetation moisture measurements.

Approach

The study site for the project is Tikal, which is located in the Mayan Biosphere Reserve, northern Guatemala (Figure 3). Three major tasks will be undertaken as follows:

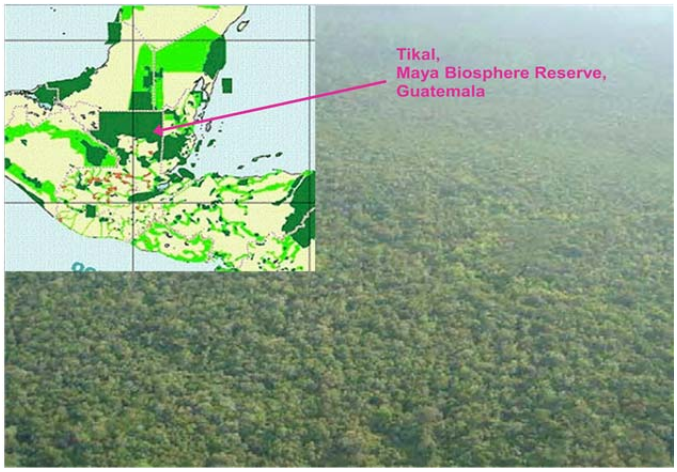

Figure 3. Fire study area, Maya Biosphere Reserve, northern Guatemala

Step 1: Keetch-Byram Drought Code

The local KBDI will be generated using daily maximum temperature and daily 24 hour rainfall values for the years 1999 until present (Figure 4). KBDI reflects long term moisture deficit in the uppermost meter of the forest floor, and is commonly used for fire prediction. Weather data from the Tikal weather station is being utilized for KBDI calculations.

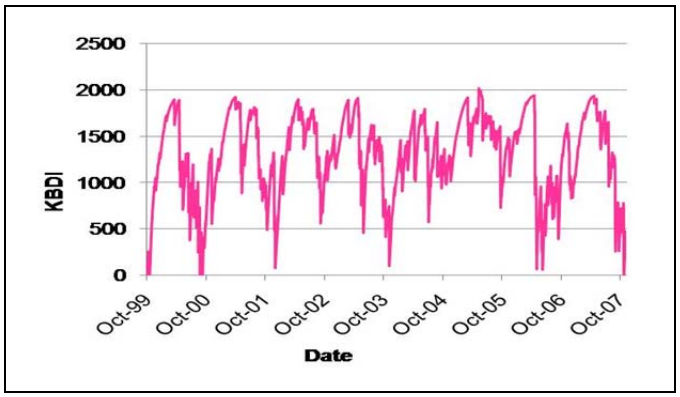

Figure 4. Keetch-Byram Drought Code for Tikal Between 1999 and 2007

Step 2: Satellite Data Acquisition

Daily MODIS and simulated VIIRS dry season vegetation and drought index (NDVI, EVI and SIWSI) image products will be obtained for 2001 to 2005. Major forest fires are known to have occurred in and around the reserve in 2003 and 2005. Vegetation and drought indices are generated by applying common mathematical ratio-based operations to multispectral image data (Figure 5). These 'accepted' operations are used to emphasize and highlight subtle variations in the actual spectral responses of various surface covers, such as vegetation greenness. Images used will be continuous 8-day composites. The spatial pixel resolution for the MODIS EVI and SIWSI products is 500 meters, while the resolution for the simulated VIIRS NDVI product is 400 meters.

Normalized Difference Vegetation Index
NDVI = NIR (band2) - Red (band1) / NIR + Red

Enhanced Vegetation Index
EVI = 2.5 x (NIR + Red) / [(NIR + 6) x (Red – 7.5) x (Blue (band3) + 1)]

Shortwave Infrared Water Stress Index
SIWSI = NIR – SWIR2 (band 6) / NIR + SWIR2

Figure 5. Equations for NDVI, EVI and SIWSI Vegetation Indices

Step 3: Image Processing and Data Analysis

Satellite image data will be processed using ENVI software. ENVI's Interactive Data Language (IDL) module will be used to extract a 5 x 5 window of pixel values over the Tikal forest area for successive scenes (Figure 6). These 'window' values will be averaged. Averaged satellite sensor NDVI, EVI and SIWSI values and weather station derived KBDI values will be graphed. Comparisons will then be made of KBDI values in significant forest fire years (2003, 2005) and non-forest fire years, and NDVI, EVI and SIWSI associated signals in these years. Statistical regression will be used to determine the correlation coefficients for the NDVI, EVI, SIWSI and KBDI, and well as provide indication which, if any, of the indices can be used to predict years when fires are likely to burn. Final results will be compared with current literature on MODIS based vegetation indices and KBDI, as well as historical fire maps.

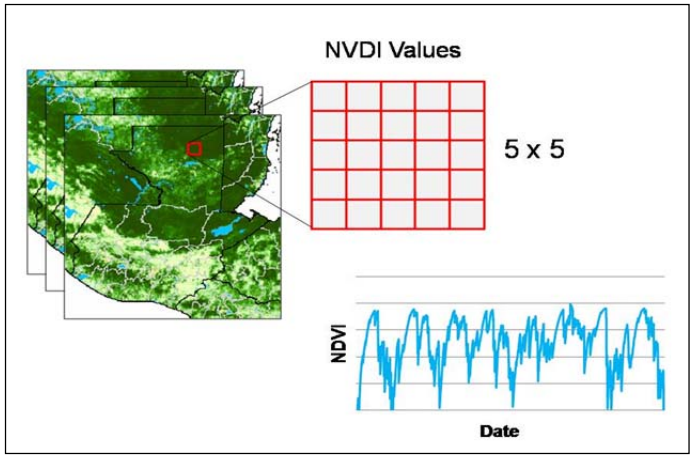

Figure 6. Keetch-Byram Drought Code for Tikal between 1999 and 2007.

EXPECTED IMPACTS

Expected impacts for the project are three-fold. First, this analysis helps assess the potential for the VIIRS sensor, when deployed, to provide data that insures the long-term continuity of drought indices that are currently calculated using MODIS data. Second, the project will give clear indication of the usefulness of VIIRS generated vegetation and drought indexes for prediction of forest fire potential in the northern Guatemala. Currently, countries such as Guatemala are without an effective spatial fire prediction system. If effective, a VIIRS generated vegetation or drought index could fill this void. Finally, the project will provide indication of the applications potential for expanding SERVIR decision support capability to include near real time fire potential products.

Collaborators

Bill Cooke & Rekha Pillai, Mississippi State University GeoResources Institute

David Lewis, Institute for Technology Development Inc. at Stennis Space Center

Victor H. Ramos, National Council for Protected Areas, Guatemala

Contact Information

For more information please contact Greg Easson.
Email: ***geasson@olemiss.edu***
Phone: (662) 915-5995
www.mmri.olemiss.edu – *umgc@olemiss.edu*