

MODIS NEAR REAL-TIME AUTOMATIC ACTIVE FIRE MONITORING SYSTEM FOR SOUTHEAST ASIA – FROM REGIONAL TO NATIONAL SCALE

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ABSTRACT: Forest fire is an annual hazard threatening the livelihood in Asia destroying considerable amount of forest lands and polluting the environment affecting the health of inhabitants. Occurrences of forest fire vary with climatic variations of countries due to their spatial location; October-November in Indonesia, December-February in Cambodia, Thailand, Lao PDR, Myanmar and Vietnam experiencing forest fires in February-April. Geoinformatics Center of Asian Institute of Technology was involved in developing a satellite observation system using MODIS data received at the center since 2006 to capture and monitor forest fire locations, daily propagation and related them to land use. The system also provides active forest fire classified by country, which can be visualized in Google Earth. System is already in place to cover large part of Asia that is covered by the reception at the center. The system was further improved to national level to ensure more information of active fire occurrences in administrative levels. A prototype of integrating national level administrative boundaries and number of other information was developed to Lao PDR. This system provides forest fire active location with information such as provinces and districts names in tabular format and through maps showing the spatial location and distribution. The information would help the local administration locating active forest fire location either by maps or using village and district names to bring necessary counter measures more effectively and timely. The system is available through the website of the Geoinformatics Center for free access of the data.

1. INTRODUCTION

MODIS data receiving from Terra and Aqua satellites are the main data for the research on the environmental issues in global scale for Southeast Asian region such as land use and land cover change, forest cover change, atmospheric conditions, land and sea surface temperature, etc. which are useful for natural resources and environment monitoring.

Nowadays, according to the problem of the global warming, many disasters have been occurred such as flood and forest fire, which damage the natural resources and the environment, in particularly, forest fire, which is natural and man-made. The lost of the forest area affect the stability of the environment and could cause other serious natural disaster such as drought, flood and landslide. In order to protect the forest from such disaster, the application of remote sensing technology is considered to be one of the solutions to this issue. As MODIS data is receiving daily in AIT, it is used to generate the fire pixels for the region which can be viewed from the regional AIT MODIS Fire Information System which covers all of the countries in South and Southeast Asian region, and from the national level, which can monitor the fire occurrence in different administrative levels within a country, which will be helpful to understand the human activities in the area.

2. OBJECTIVES

The objective of this paper is to demonstrate the capability of the near-real time automatic fire detection systems using MODIS data receives from Terra and Aqua satellites for detecting and monitoring fire, biomass burning and thermal in regional and national level.

3. OVERVIEW OF THE FIRE INFORMATION SYSTEMS

Both regional and national fire detection systems have similar structure. The regional system is considered to

be the main system, which consist of MODIS Fire Product generation, MODIS Fire statistical analysis, MODIS fire visualization, MODIS fire archiving database, and MODIS fire validation systems,

In the main system in regional level, after the data receiving and pre-processing of the daily MODIS data from Level 0 to Level 1B, the data is sent to input to the MODIS Fire Product generation module for generating the MODIS Fire Product known as MOD14. From this product, the list of fire pixels with many fire physical parameters such as geographical location of the fire pixels, brightness temperature of the active fire, fire power, fire confidence, etc are extracted and stored into a table for further processing. In this module, the fire pixels information in the fire pixels table are sent to generate a map of fire occurrences with three types of fire pixels based on the classification of high, nominal and low fire confidence. The fire pixels information can be also used to overlay with MODIS true color of 250 meter and view on the Google Earth 3D viewer to understand the active time occurrence in near real-time with high resolution satellite image available on Google Earth. Next, the fire pixels information is sent to generate the statistical information of the distribution of active fire pixels occurrences by countries. The same fire pixels information is also sent to store into the database for multi-temporal data analysis of fire occurrence.

In case of the national system, the system is the extended sub-system from the main system in regional level, which will focus specifically to the active fire occurrence and thermal anomalies that occurs in the specific country only, and it will be benefit for better understand the fire distribution in different administrative levels that will be helpful to local officers to understand the human activities in the forestry and agricultural area and as well as to be useful for decision-makers in the forest and agricultural resources management planning. As the system in national level is a sub-system of the system in regional level, the system in national level consist only the MODIS Fire statistical analysis, MODIS fire visualization and MODIS fire archiving database. There is no MODIS Fire Product generation sub-system in the fire detection system in national level system, since the fire location data of specific country is filtered by regional level system before transferring to the national level system for further processing to generate fire information to the users online.

Presently, a prototype system of integrating national level administrative boundaries and number of other information was developed to Lao PDR. This system provides forest fire active locations with administrative information such as provinces and districts names in tabular format and through maps showing the spatial location and distribution. This sub-system will be also developed further for other countries in the region, such as Thailand, Myanmar, Vietnam and Indonesia which are the countries that have a numerous of forest fire, biomass burning in the region. The flowchart of the systems in regional and national levels is shown in Figure 1.

4. APPLICATION OF THE SYSTEMS FOR FIRE MONITORING IN REGIONAL AND NATIONAL LEVELS

4.1 MODIS Fire Archiving Database

The fire pixels which identify the active fire location stored in tabular text file are generated by the MODIS Fire Product generation sub-system. The information of fire pixels contains several physical parameters related to the fire pixels detected by MODIS sensor. In order to perform further statistical analysis using these physical parameters, it should be stored into a database, which is efficient way to archive and retrieve the data for further analysis. The system in regional level has database for fire information that distributes by countries, while the sub-system in national level has the information of the specific country in different administrative levels. The database was designed for archiving and retrieving the fire physical parameters for further processing. The archiving database is web-based processing system, which can be access through the Internet. The user interfaces of the database for both systems are shown in shown in Figure 2.

4.2 MODIS Fire Visualization and Validation using Google Earth, MODIS True and false Color 250m Images, and Ground Truth Data

In order to understand the fire phenomenon detected by MODIS sensor in different area of the country, it is necessary to have a tool that we can do visual interpretation of the MODIS image in the interested area. Therefore, a visualization module has been developed. The important component of this module is the generation of true color image with the resolution of 250m, based on the True Color 250m algorithm developed by NASA. This algorithm generates true color MODIS image of 250m resolution in jpg format from Level 1B data. This image will be used to observe the smoke plume, haze and other fire-related phenomenon. The true color MODIS image is used with high-resolution satellite images available in Google Earth to visualize the fire pixels and interpret the land cover.

The advantage of this system is the combination of near-real time true color MODIS image of 250m, which the

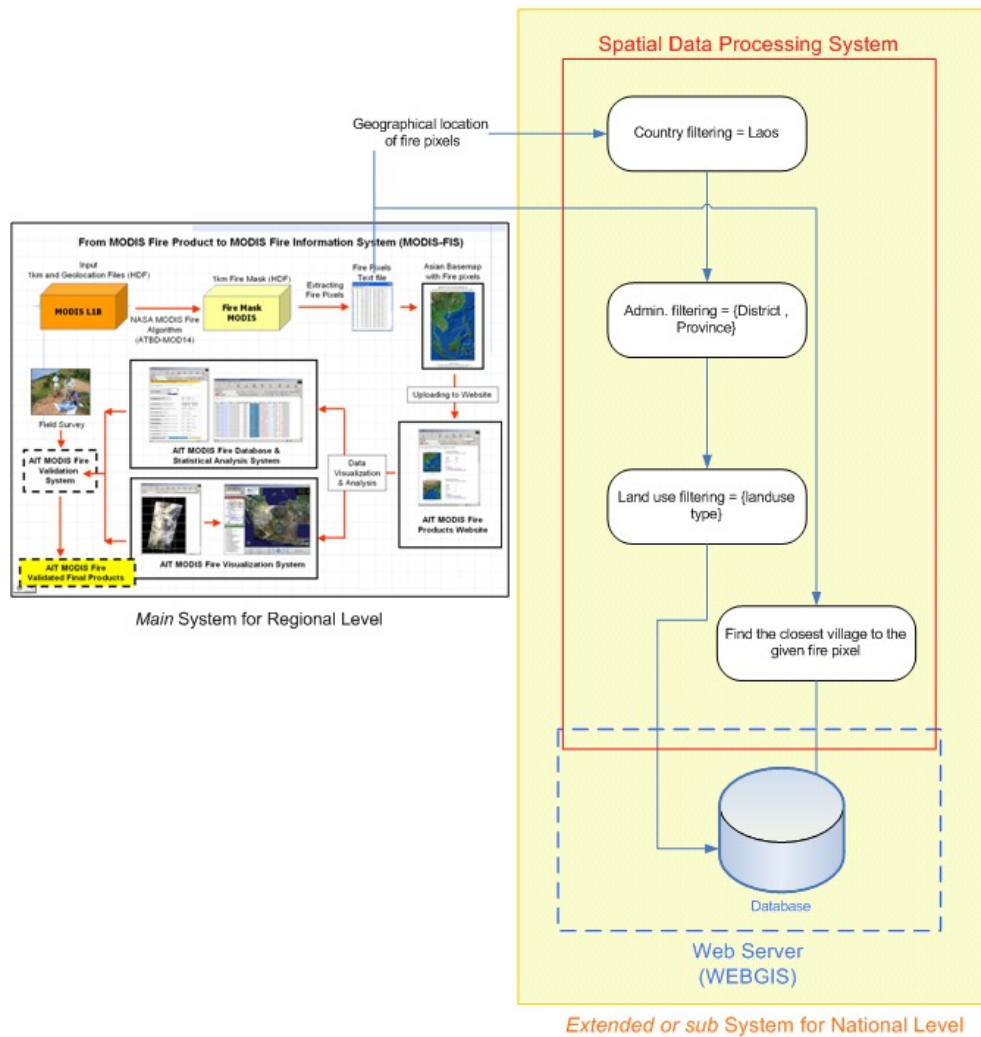


Figure 1 Flowchart of the fire detection systems in regional and national levels

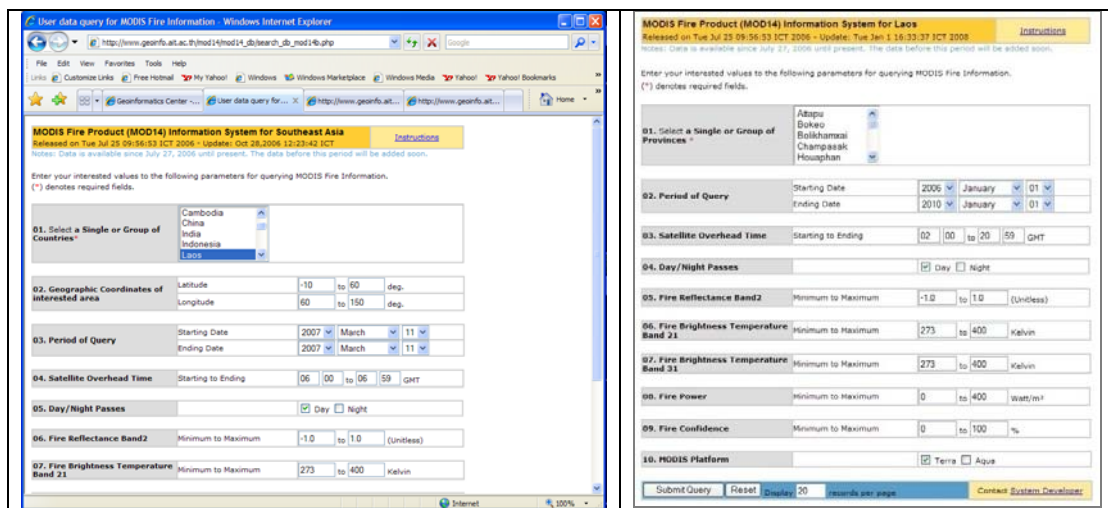


Figure 2 User interface of the MODIS Fire Archiving Database for regional and national levels

surface reflectance correction was performed, similarly to the MODIS product MOD09, except the effect of the aerosols was not removed, and the high-resolution satellites images available in Google Earth 3D viewer. The fire pixels text files are converted to kml format that can be overlay with MODIS images and high-resolution images in Google Earth as shown in Figure 2.

Using true color MODIS image of 250m resolution for visualization of the phenomenon is not efficient, as it can display only smoke and haze in the burning area which is visible in the visible wavelength. Therefore, to have better visualization of the active fire occurrence, the authors has introduced the false color MODIS image of 250m resolution which is generated by the combination of MODIS band 7(Shortwave infrared), band 2(Near-infrared) and band 1 (Red). In this band combination, the burning area can be detected and shown in red-orange color patches. Similarly, this false color MODIS image can be viewed together with true color MODIS image for better visualization of burning area, haze and smoke during active fire occurrence. The false color MODIS image of 250m also can be used together with ground truth data for land cover validation of active fire location and burning area as well. Figure 3 to Figure 8 demonstrate the usage of fire information retrieved from the online database of the fire detection system in national level for Laos, ground truth data from field survey, true and false color MODIS image of 250m resolution to indicate the fire location. In our example, the fire occurrence was detected by MODIS sensor on March 23, 2010 at 06:37GMT and the ground truth data was collected on March 25, 2010 at 03:24GMT.

This visualization system will be very helpful for the users to allocate the interested active fires which are necessary and have possibility to access, as the GIS layers such as road; land use types can be overlaid to have more detailed information.



Figure 3 Burning site in Laos, visited on March 25, 2010 at 03:24GMT



Figure 4 Burning site (marked by red icon) viewed with true color MODIS image of 250m resolution

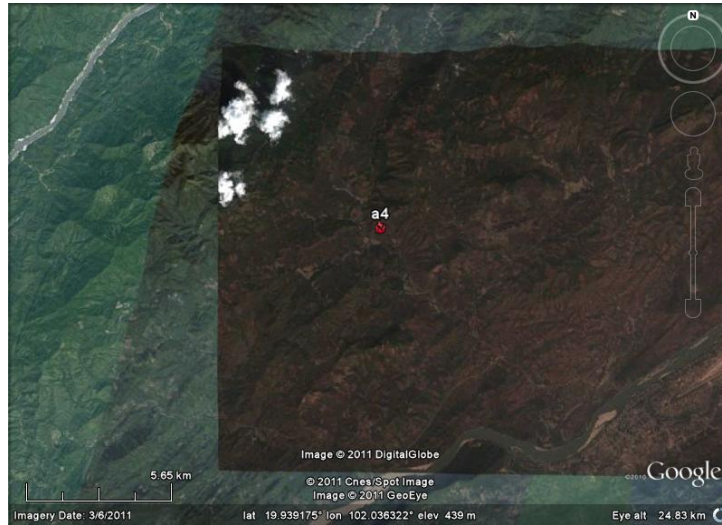


Figure 5 Burning site viewed with Google Earth background



Figure 6 Burning site location comparing with fire location by MODIS

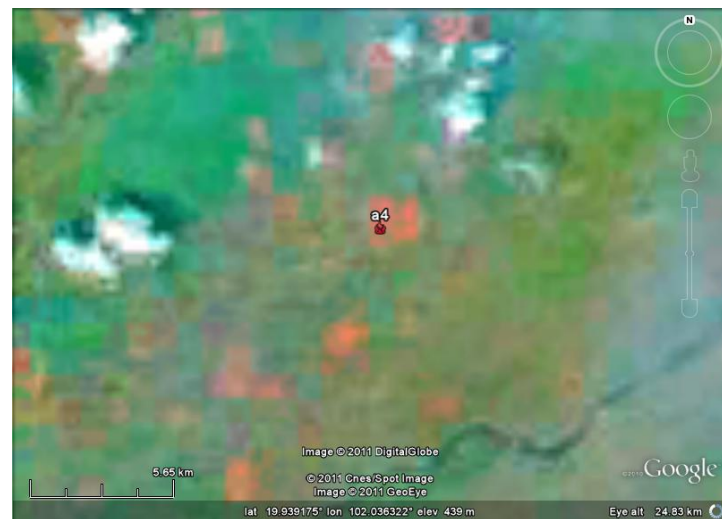


Figure 7 Burning site (marked by red icon a4) viewed with false color MODIS image of 250m resolution that show the burning area



Figure 8 Burning site (marked by red icon a4) viewed with false color MODIS image of 250m resolution that show the burning area

5. CONCLUSIONS

The fire information generated from daily MODIS data by both systems can be accessed through the Internet by the address <http://www.geoinfo.ait.ac.th/modis/modpro.php>. In this website, all of the MODIS Fire Information System modules are shown. User can download the data, visualize the fire occurrences with Google Earth, retrieve the old fire data from the database, etc. Users can use the MODIS Fire Product generated by the systems freely with the acknowledgement to the Geoinformatics Center of Asian Institute of Technology. The fire information can be applied for further research and applications on the forest fire research and study in regional and in national level. Further development of fire information systems for other countries is planned to conduct.

In this study, the capability of the MODIS Fire Information System for regional and national scale is described. The systems run automatically in near real-time processing. The fire information can be allocated by different administrative layers to have better understanding of the spatial distribution of the fire occurrences.

6. REFERENCES

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