FIRE AND THERMAL ANOMALY MONITORING IN LAOS USING MODIS AUTOMATIC NEAR REAL-TIME SYSTEM

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Abstract: Shifting cultivation is the big problem in Laos which links with poverty eradication. Therefore, the application of remote sensing and GIS technology to the study forest fire and slash-burn will bring great benefit to the rural development in Laos, in particularly in the area where the fire occurrence locations can not be identified, which is difficult for decision making for development programs. The detection and allocation of the fire using satellite imagery will help to solve the problem of fire identification. In order to implement this, the authors have developed the automatic processing system using MODIS Fire product generation as the core of the system to detect and allocate the geographical location of the active fire. The detected location will be overlaid with the administration and land use information which will be easy to the local officers to use for decision making for controlling shifting cultivation and slash-and-burn activities in the country. The detected information will be stored in the database which users can access online. The system is the extended version of the main MODIS Fire Information System which was developed to monitor the fire occurrence in South and Southeast Asian region, including Laos. The extended system is developed specifically for Laos which will provide more detailed information.

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 AIT MODIS Fire Information System which covers all of the countries in South and Southeast Asian region. As Laos is included in the region, and one of the high-ranked biomass burning sources, it is necessary to apply MODIS imagery to understand the biomass burning in Laos.

This system is the extended version of the existing AIT MODIS Fire Information System that was developed in 2006 at Geoinformatics Center, which will focus specifically to the active fire occurrence and thermal anomalies in Laos, to understand the fire distribution in different administrative levels which will be helpful to understand the human activities in the area.

2. OVERVIEW OF THE MODIS FIRE ALGORITHM USED FOR THE STUDY

The MODIS fire algorithm that used in this study is the same algorithm that was is the ATBD-MOD14, which was developed by NASA. This algorithm were used to develop the free software "MODIS Active Fire Product (MOD14) Production Code, version 4.3.2" (Giglio and al, 2003). Our fire product is therefore, denoted as MOD14 following the NASA/MODLAND team product naming. The main idea of this algorithm is that, it uses brightness temperatures derived from MODIS Level1B bands, which are 4 and 11 μm, denoted by T_{22} and T_{31}, respectively. The MODIS sensor has two 4-μm bands, named 21 and 22, which are used by the fire detection algorithm. Band 21 saturates at nearly 500 K; Band 22 saturates at 331 K. As the low-saturation band 22 is less noisy and has a smaller quantization error, T_{22} is derived from this band whenever possible. However, when band 22 saturates or has missing data, it is replaced with the high saturation band to derive T_{22}. T_{31} is computed from the 11-μm band (band 31), which saturates at approximately 400K for the Terra MODIS and 340K for the Aqua MODIS. The 12-μm band (band 32) is used for cloud masking; brightness temperatures for this band are denoted by T_{12}.

The 250-m resolution red and near-infrared bands, aggregated to 1km, are used to reject false alarms and mask clouds. These reflectances are denoted as $\rho_{0.65}$ and $\rho_{0.86}$, respectively. The 500-m 2.1-μm band, also aggregated to 1km, is used to reject water-induced false alarms; the reflectance in this band is denoted by $\rho_{2.1}$. A summary of all MODIS bands used in the algorithm is shown in Table 1.

Band number	Central wavelength (μm)	Purpose
1	0.65	Sun glint and coastal false alarm detection; cloud masking
2	0.86	Bright surface, sun glint, and coastal false alarm rejection; clouds masking
7	2.1	Sun glint and coastal false alarm rejection
21	4.0	High-range band for active fire detection
22	4.0	Low-range channel for active fire detection
31	11.0	Active fire detection, cloud masking
32	12.0	Cloud masking

Table 1 MODIS bands used in detection algorithm

3. METHODOLOGY

The methodology of this research is to apply the fire product (MOD14) generated by the AIT MODIS Information System to generate the map of active fire occurrence, and also for the analysis of the distribution of the fire occurrence in Laos. The fire product in this study is a text file that is arranged into columns of physical parameters, which are granule lines and samples, geographic latitude and longitude of the file pixel, band 2 reflectance of pixel fire, band 21 or 22 brightness temperature of fire pixel, band 31 brightness temperature of fire pixel, total emitted power and the detection confidence of the fire pixels. The fire pixels are classified into three categories based on the fire detection confidence level. The fire pixels are sent to the database for the analysis of the active fire distribution at the provincial and district levels. The active fire information retrieving from the database can help the user to understand the characteristics of the fire phenomenon, which are related to the human activities in the forestry and agricultural

area and will be useful for decision-makers in the forest and agricultural resources management planning.

3.1 MODIS Fire Archiving Database of Laos

As explained in the section 3. regarding the fire pixels text file, generated by the MODIS Fire Product generation module, which 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 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 users interface of this database in shown in the Figure 1.

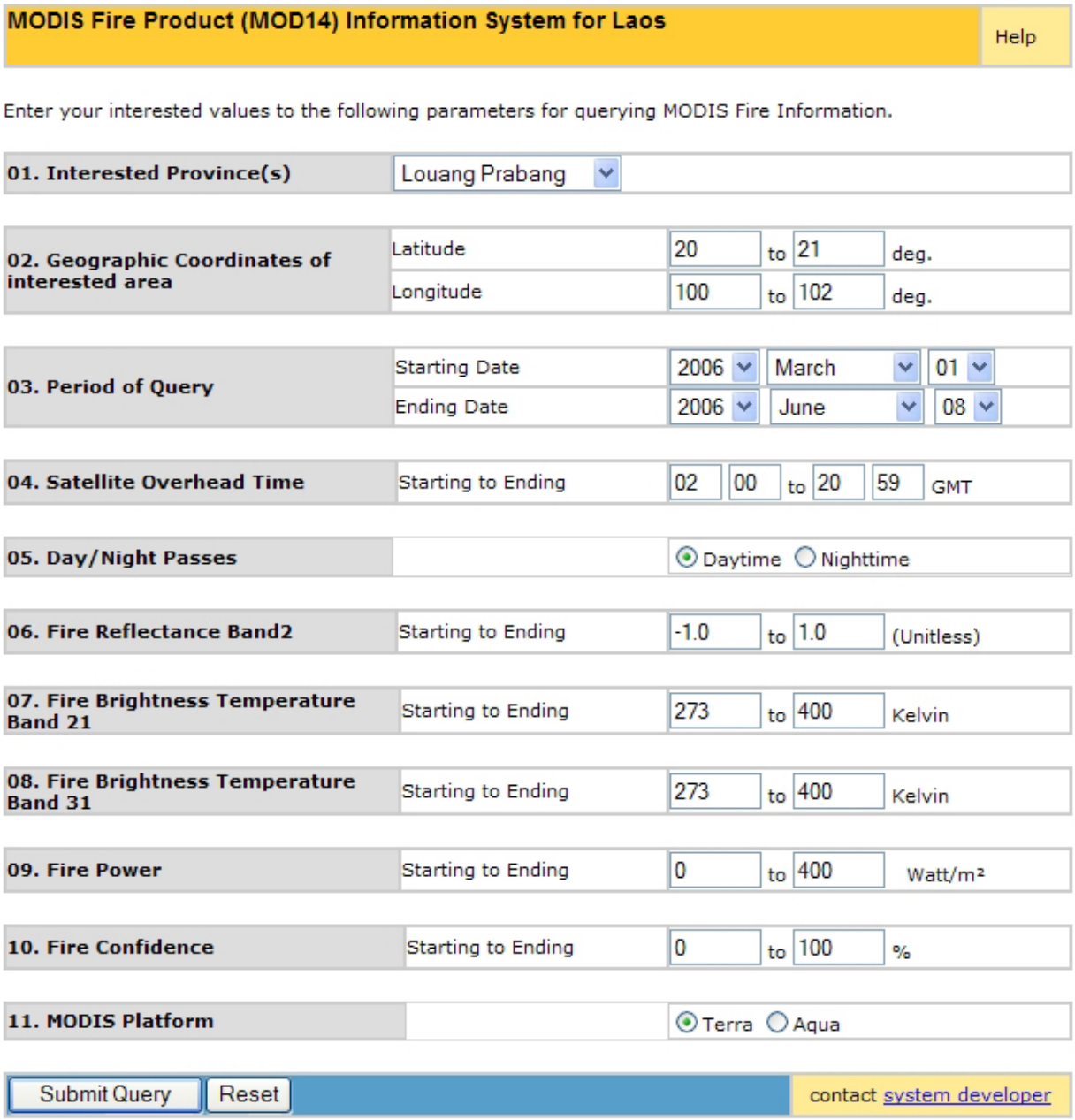

Figure 1 User interface of the MODIS Fire Archiving Database

3.2 MODIS Fire Visualization in Laos using Google Earth and MODIS True Color 250m Images

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 module is the combination of near-real time true color MODIS image of 250m, which the 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. 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.

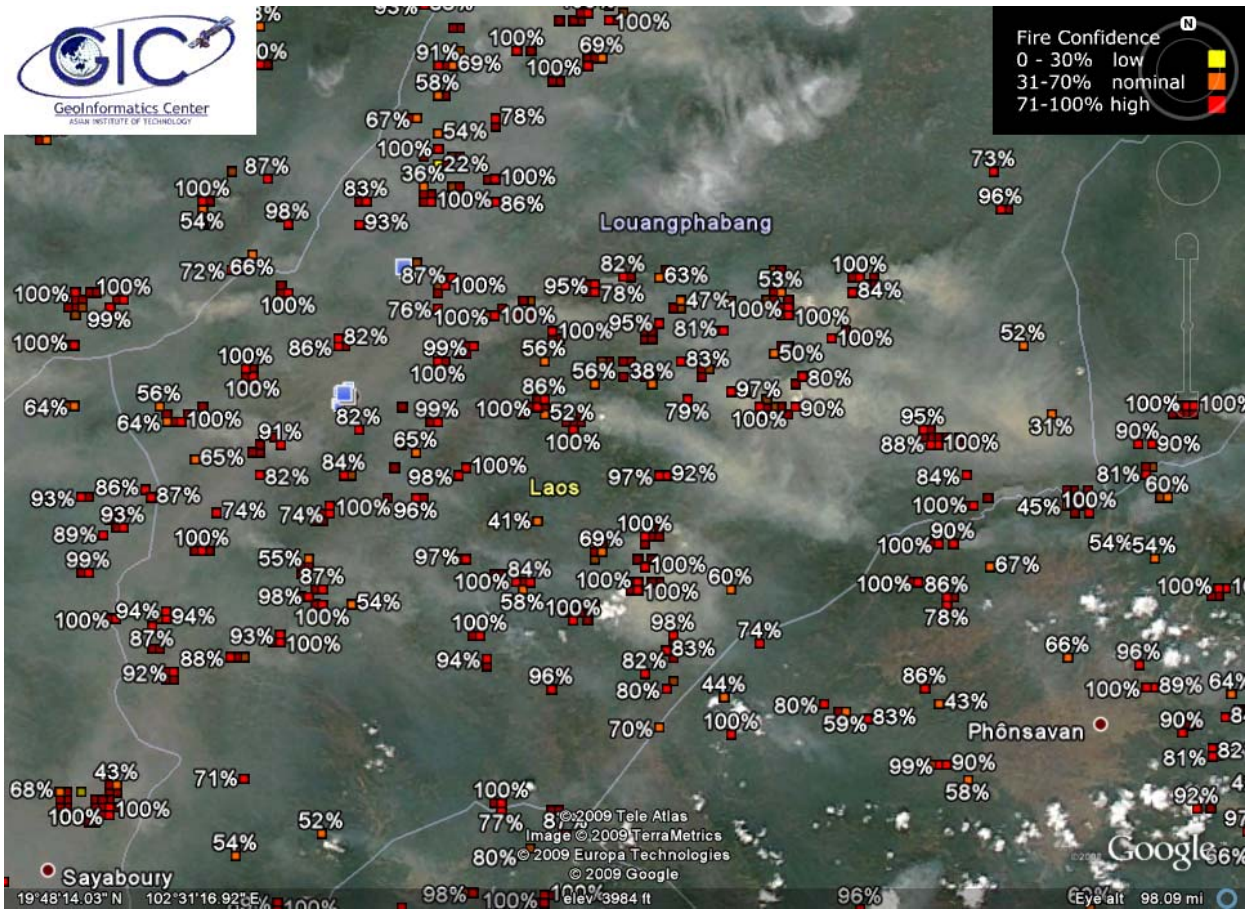

Figure 2 Spatial visualization of active fire pixels using MODIS True Color 250m images on Google Earth. The gray patch represents smokes which are mostly coming out from the group of active fire pixels with high fire confidence

4. CONCLUSIONS

In this study, the extended version of the MODIS Fire Information System for Laos is developed. The system runs 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. The information can be accessed on the internet at the website www.geoinfo.ait.ac.th/mod14/.

REFERENCES

Giglio. L., Descloitres. J., Justice C. and Kaufmann Y., 2003. An Enhanced Contextual Fire Detection Algorithm for MODIS. Remote Sensing of Environment 87, pp273-282.

Justice C., et al., 2002. The MODIS Fire Products, Remote Sensing of Environment 83 (2002), pp244-262.

Kaufmann Y. and Justice C., 1998. Algorithm Technical Background Document, MODIS Fire Products, version 2.2. pp30-35.