A REVIEW OF FOREST FIRE INFORMATION TECHNOLOGIES IN VIETNAM

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Abstract

Forest fires burn several thousand hectares of vegetation every year in Vietnam. Many of these fires have had negative impacts on human safety, health, regional economies, global climate change, and ecosystems in non-fire–prone biomes. To mitigate the fire-related problems, information and communication technology systems are required to manage the fire information as well as identify fire danger in advance of their potential occurrence. In this work, summarizes the research and deployment of technologies related to forest fires and forest fire prevention in Vietnam as well as in Vietnam National University, Hanoi.

I. Introduction

Vietnam spans a land area of around 33 million ha, of which 13.9 million ha are classified as forest (10.4 million ha of natural forests, 3.5 million ha of forest plantations) [1]. The anthropogenic causes of vegetation fires in Vietnam include: (i) Burning of agriculture land and straw and grass residue burning in rice fields is 20%;(ii) Local people using fire for hunting, trapping, and catching wild animals in forests, especially the use of smoke to harvest bee's honey causes 55%; (iii) Forest product exploitation for timber, wood, cooking, and smoking account for 15%; (iv) The remaining 10% of forest fires are caused by trading conflicts from forest resource exploitation by stakeholders who burn forests to harm other competitors [2]. Table 1 lists the number of forest fire occurrences and the burned area in Vietnam from January 2013 to August 2013.

Month	Forest fire	
	Occurrences	Burnt area (ha)
January	6	39
February	44	338
March	56	249
April	39	125
May	14	27.6
June	18	86.6
July	17	18
August	6	26
Total	**200**	**909.2**

Table 1. Forest fires in Vietnam from January 2013 to August 2013 (from Forest Protection Department, 2013)

Forest fires often occur in large scale and complex regions. Therefore, traditional forest fire detection and monitoring is difficult and not timely. The demands of accurate early warning system for forest fire are become imperative for the prevention of forest fires and forest fire problems mitigation. This article summarizes the research and deployment of information technologies related to forest fires and forest fire prevention in Vietnam as well as in Vietnam National University, Hanoi (VNU).

II. Vietnamese forest fire forecasting system development

Early forest fire forecasting and detection are an important topic research for forest fire protection. Knowing fire danger, we can mobilize the right resources for forest fire prevention to ensure both the minimizing the risk of forest fires and saving effort. However, prediction of forest fire is a complex task. It requires updating and storing continuous data of changes in the weather conditions as well as calculating the characteristics relevant to the fire ability of different type of forest. Along with the development of science and technology, forest fire forecasting in Vietnam has also been modified and improved.

Forest fire prediction by human: Forecasting forest fires in Vietnam began in 1981. However, it was mainly applied prediction method manually. Local forest rangers conduct ongoing monitoring meteorological data or use observation of the nearest weather stations to calculate the risk level for their local forest fires. Forest fire forecasting is done based on data recorded by the forest rangers. Since the complex computation requires the cooperation of the various social forces to predict forest fire, the results of this method often had low precision, poor communication ability and, therefore, had less effect to the behavior of community in preventing and fighting forest fires [3].

Forest fire forecasting software for individual region: Since 2001, as required by some local regions, staffs at the University of Forestry has developed forest fire forecasting software. This software allows automatic updating information, forecasts, and post advice on fire prevention solutions. The software has been evaluated as an initiative in Vietnam forest fire forecasting.

Besides, this software also includes features of revise, store and protect meteorological data to use for forecasting pests and diseases harmful to forests, forest productivity estimates, production planning and other practical activities. However, this is a forest fire forecasting software for individual region. It is not associated with GIS and remote sensing techniques [3].

Forest fire forecast by "Forest fire warning software version 1 and 2": Since early 2003, the FPD has collaborated with a research group team from the University of Forestry to build "Forest fire warning Software Version 1". It links many forces and modern facilities for forecasting and communication about the risk of forest fires. A brief description of this technology are as follows. At about 14 o'clock, FPD and Vietnam Television receive from the General Department for Hydrometeorology an e-mail containing information about weather conditions measured at 95 meteorological ground stations representing different regions of the country. Using formulas to predict forest fire, this system calculates the risk level for the local fire and shows them in a territorial map. To avoid confusion, the results predicted by Vietnam Television were compared with the those predicted by the FPD. If there is at least a certain area's forest fire danger level reached dangerous levels (level 4), the Vietnam Television will edit a hot news about "warning fire" at the end of the evening news. Meanwhile, FPD uses forecast information to direct the activities of forest fire protection on a national scale [3]. "Forest fire forecasting software version 2" has been overcome previous forecast of forest fire sofware. It provides information about the risk of forest fires in both images and text data. It has advanced geographical accuracy of forecast information to $1km^2$ and no longer depends on the boundaries of administrative units. This software met the information requirements of the fire risk of forest area community, those involved in the organization of production in forest areas, forest owners, government and organizations involved in forest protection management.

Online forest fire monitoring system: Since 2007, the Forest Protection Department (FPD), Ministry of Agriculture and Rural Development of Vietnam has deployed a Moderate Resolution Imaging Spectroradiometer (MODIS) Direct Broadcast receiving station in Hanoi with the primary purpose of early forest fire detection over Vietnam. The system named FireWatchVN, which includes near real-time active fire hotspot detection, interactive web-mapping fire visualization, fire database and statistical analysis functions, has been online [4] since December 2008, as stated in [5]. Built on the Web technology, FireWatchVN consists of components and functions as follows: Update fire detection information from MODIS, NOAA data; Provide and update low resolution image for fire; Allow to search fires in history data according to date and by location; Provide information fire warning; Statistical fire data years and under fire local.

III. Research activities of forest fire information systems in VNU

Fire Information for Resource Management System (FIRMS): Under the collaboration with University of Maryland, College Park and the Global Observation of Forest Cover (GOFC) Fire Implementation Team, scientists from VNU-UET localize the version of the Fire Information for Resource Management System (FIRMS) [6] and install at University of Engineering and Technology, Vietnam National University, Hanoi. This system provides an interactive

visualization of global active fires and global MODIS burnt areas. It also includes an email fire alert function [7].

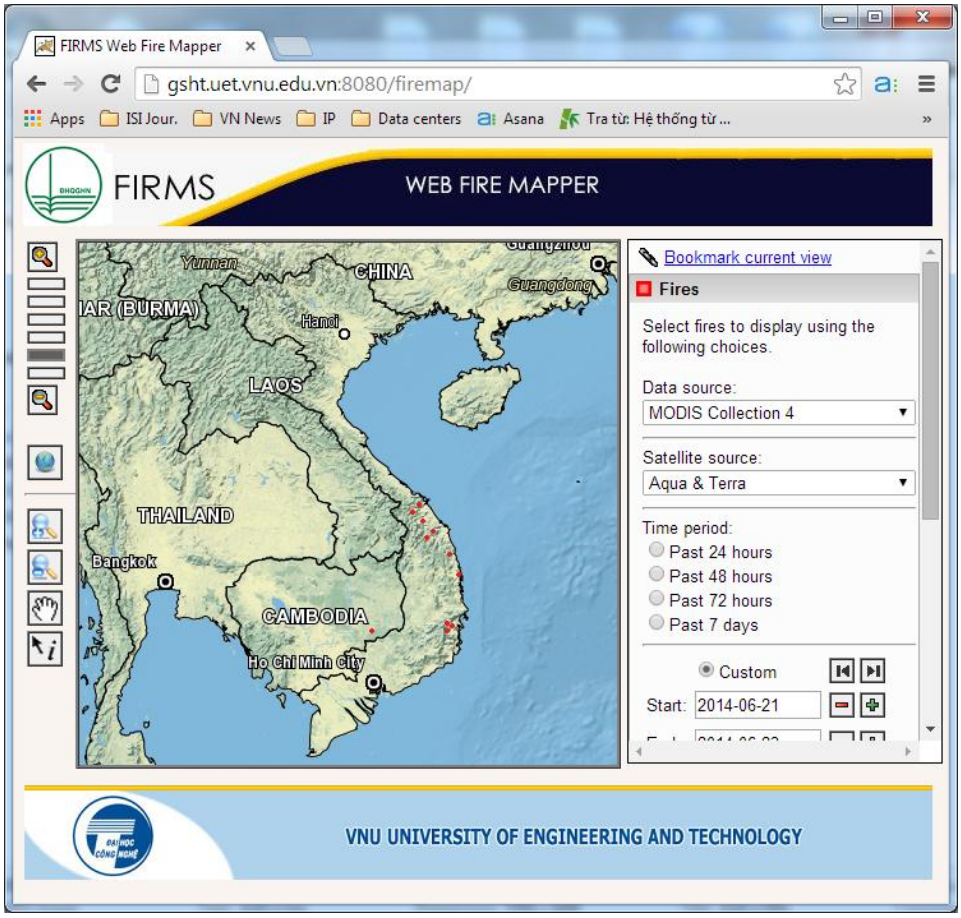

Figure 1. User interface of FIRMS installed at University of Engineering and Technology, Vietnam National University, Hanoi.

Forest fire information system (FORIS): This is ongoing project funded by Vietnam National University, Hanoi to achieve the goal of data integration for observing, monitoring and visualization of problems related to forest fires. The system provides information of forest fire detection and forecasting to perform the tasks including: integration, analysis, data processing, and display fire and fire danger information. Figure 2 shows the overall architecture of the system consisting of three main layers: Raw data layer; data processing and integration; and user interface layer.

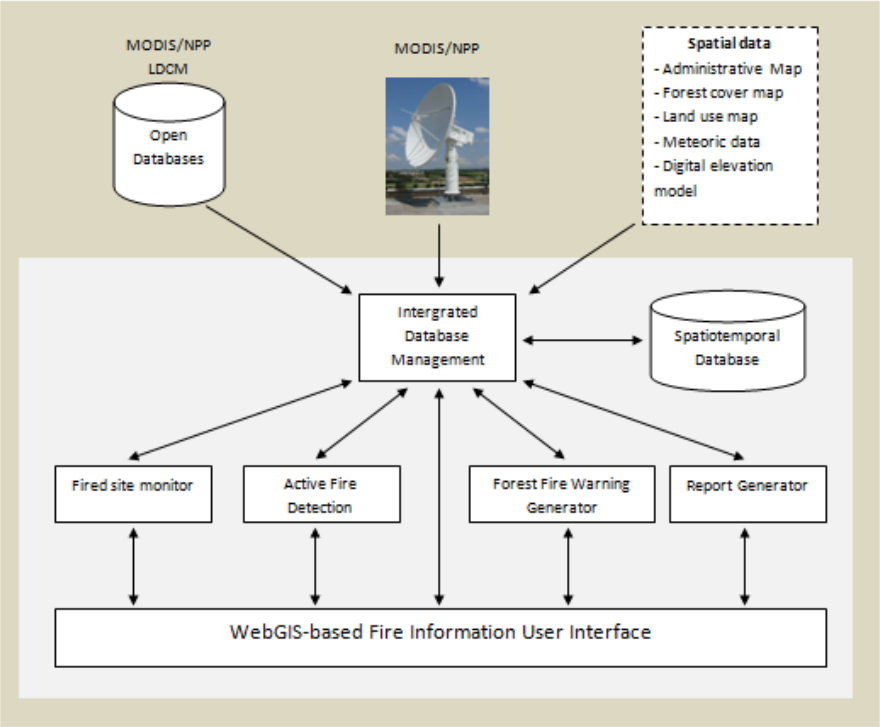

Figure 2. Architecture of the forest fire information system

Burned Area Detection Using Landsat 7 images: A group of scientists in Vietnam National University, Hanoi presented an approach to detect and extract the burned areas that use the high-resolution images acquired by the sensor on board Landsat satellite. This approach exploits the active fire maps from Fire Information for Resource Management System (FIRMS) [6] to locate the active fire positions. The approach, which is a simplified version of the earlier method of the MODIS Burned Area Detection [10], calculated the changes in the burned areas verified by the FIRMS active fire maps. The changes were calculated in both the spatial and temporal domain to generate a change density function suitable for discriminating the burned-related and unburned-related areas. This algorithm identifies the date of burning, to the nearest days within the individual Landsat 7 images at a 30-m spatial resolution. Figure 3 shows an example of detected burnt area from this work.

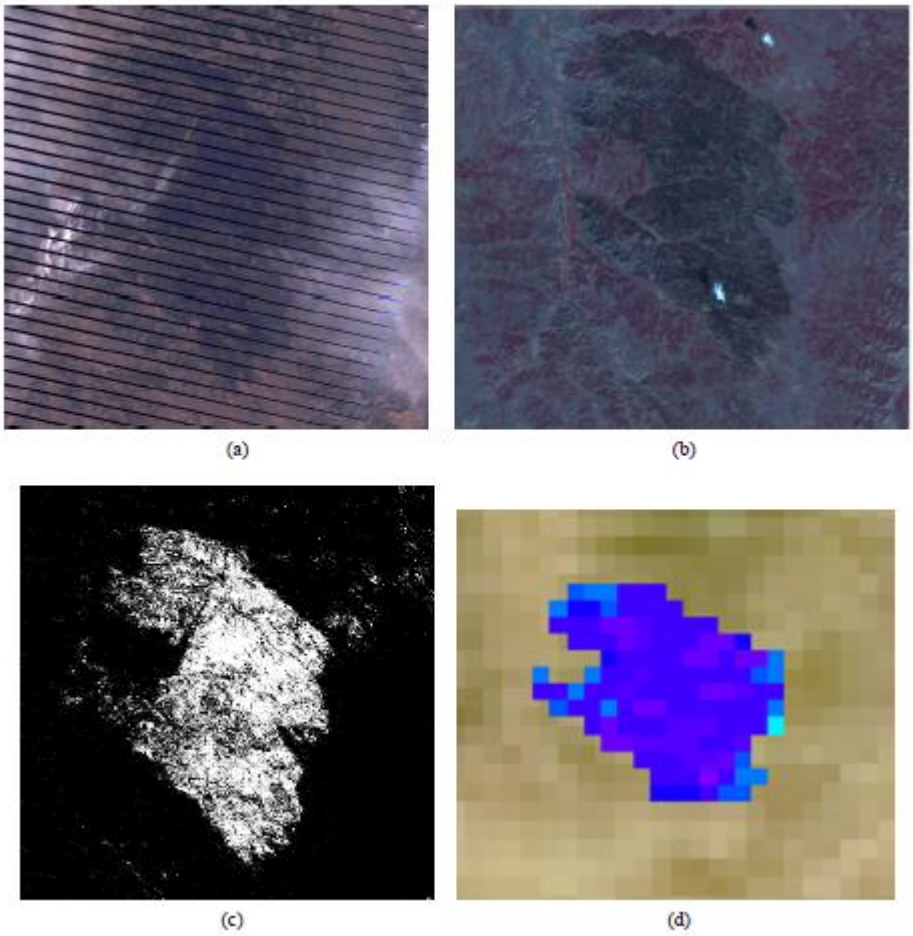

Figure 3. Study of the Ashland fire (a) Color image observations of Landsat 7 ETM+ SLC-off at 30-m spatial resolution, (b) Color image observations of ASTER at a 30-m spatial resolution, (c) Burned area (in white) extracted by the proposed method, (d) Burned area (in blue) from MODIS product.

Vegetation fires and air pollution in Vietnam: An international group of scientist from Vietnam National University, Hanoi and University of Maryland, College Park integrated satellite remote sensing data and ground-based measurements to infer fire air pollution relationships in selected regions of Vietnam [10]. The active fires and burnt areas at a regional scale from MODIS satellite data were first characterized. Then satellite-derived active fire data was used to correlate the resulting atmospheric pollution. Finally, the relationship between satellite atmospheric variables and ground based air pollutant parameters were analyzed. Experimental results show peak fire activity during March in Vietnam, with hotspots in the Northwest and Central Highlands. As can be seen from Figure 4, active fires were significantly correlated with UV Aerosol Index (UVAI), aerosol extinction absorption optical depth (AAOD), and Carbon Monoxide. The use of satellite aerosol optical thickness improved the prediction of Particulate Matter (PM) concentration significantly.

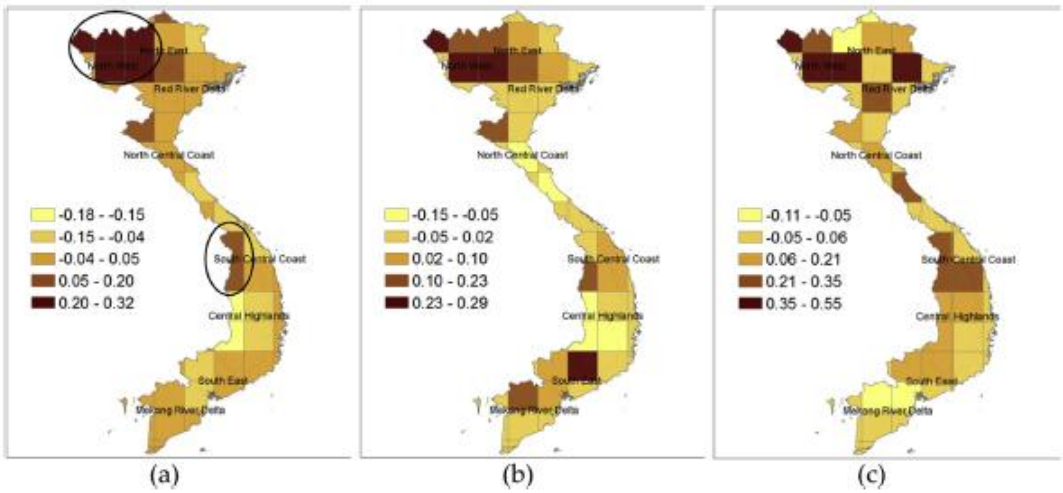

Figure 4. Correlation coefficient between Fire Count and AAOD (a), UVAI (b), MOPITT CO (c) from 2004 to 2012.

IV Conclusion

The information and communication systems to mitigate the forest fire-related problems can be included in green technology. In this article, we summarized the development progress for the forest forecasting systems in Vietnam. In which, three softwares were introduced. We also reported two deployments of technologies and two research activities related to forest fires in Vietnam National University, Hanoi.

V. Acknowledgment

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