

SATELLITE DATA ACQUISITION AND UTILIZATION FOR FOREST FIRE MANAGEMENT IN VIETNAM

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Abstract

Since early 2007, the Forest Protection Department (FPD, Ministry of Agriculture and Rural Development of Vietnam) has installed and started operating a MODIS Direct Broadcast receiving station in Hanoi with primary purpose for early forest fire (hotspots) detection over Vietnam's territory. The TeraScan system routinely acquires processes and archiving daily MODIS data on-board of TERRA and AQUA satellites, while its Vulcan module automatically creates hotspots' data using NASA ATBD-MOD14 algorithm. In order to support effective and timely forest fire management, the hotspots' information detected is communicated in near-realtime to all concerned locations over the country through email notification. The effectiveness of the system in supporting the forest fire management during the 2007 is also presented in the paper. In addition, the FPD is currently developing an on-line fire information system (www.kiemlam.gov.vn/firewatch.htm), which includes not only near-realtime active fire monitoring, but also interactive fire visualization, fire database and statistical analysis functions. To further improve frequency and accuracy of hotspots detection from satellite data, the FPD is planning to add L-band receiver for receiving more data from NOAA-x and METOP satellites in the third quarter of 2008. Preliminary results of the upgrading satellite receiving system and in expanding the utilization of satellite data for multi-disciplinary resources management will also be presented and discussed.

I. INTRODUCTION

Together with flood and drought, forest fire is one of the most frequently occurred natural disasters in Vietnam, causing severe damage to the country's economy as well as to the forest ecological system. The most damaging are large fires at the primary dense forest, national parks, and conservation areas such as the famous fire at the U Minh national park in April 2002 (Nguyen Hong Quang, 2004; Tran Hung, 2004). According to the statistical data for the period of 1992 – 2006 from the Forest Protection Department (FPD) of Vietnam, on average, about 1.254 forest fires a year causing the damages to about 6.646 hectares of forest, of which 2.854 hectares of natural forest and 3.791 hectares of planted forest (Figure 1). Considerable efforts have been taken by the FPD in strengthening our capacity to tackle the forest fire such as investment in its equipments, related infrastructure, improving the inter-agency coordination and awareness raising among the forest owners and the public. These efforts have directly contributed to significant reduction of burned areas and mitigation of forest fire damage. Further, the fire warning, early forest fire detection and timely communication are equally important in order to further strengthen its effectiveness in forest fire management.

Since forest fires cover large areas, usually in hilly complex terrain, it is difficult to monitor them using conventional systems, especially for developing countries with little infrastructure and few resources for continuous monitoring of environmental variables. It is obvious that use of Earth Observation Satellite (EOS) data is potentially of great interest in early detection of forest fire in Vietnam's land territory. The data from EOS series such as NOAA, MERIS, MODIS (Moderate Resolution Imaging Spectroradiometers) can provide information about the Earth's

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surface in a wide range of wavebands including visible and near-infrared spectra, SWIR and in thermal range. Especially MODIS data, which include 6 bands in the thermal spectra of 3.66 – 4.08 μm and 10.78 – 12.27 μm , are currently used by most countries over the World for early detecting fires or thermal anomalies – as a example is the Worldwide Forest Fire Information System at the Maryland University (<http://maps.geog.umd.edu/firms/>) or the similar system in the South-east region at the Asian Institute of Technology, Thailand (<http://www.geoinfo.ait.ac.th/mod14/>). Although those fire information available for download on Internet, the delay sometime up to 48 hours has restricted the FPD of Vietnam in our efforts to overseeing and coordinating effective and timely forest fire management over the country.

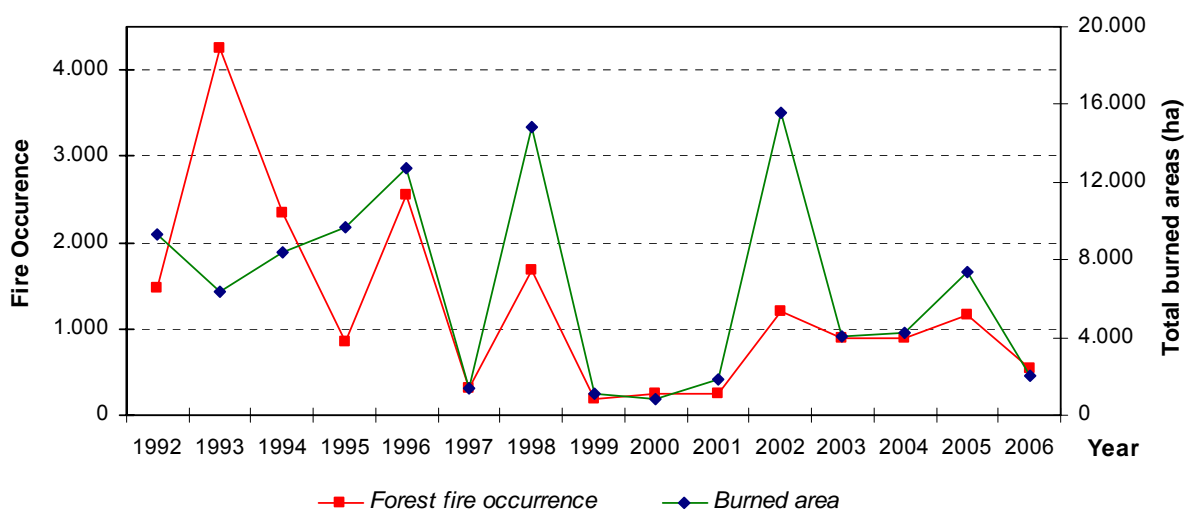


Figure 1. Statistical data on forest fire occurrence and total burned areas (1992 – 2006)

In order to be able to detect forest fire early for informing the concerned local authorities and for timely and effective forest protection and management in Vietnam, the FPD has been approved by the Ministry of Agriculture and Rural Development (MARD) to install a MODIS ground receiving station. And since 1st February 2007, the FPD MODIS station has started its MODIS data receiving and processing operations (Figure 2). At the present, FPD MODIS station can receive about 4 MODIS scenes from TERRA and AQUA satellites (2 day- and 2 night-scenes). These scenes are routinely processed, extracted the fire locations and put on the maps (with UTM WGS 1984 coordinates). All processed results are uploaded onto the FPD Website (<http://www.kiemlam.org.vn/dubaochay/dubaochay.htm>) just about an hour after the satellite passed. The regional FPD branch offices, forest owners are regularly check the detected forest fires on Web in order to organize appropriate ground checking and/or timely implement fire extinguishing actions.

II. THE MODIS DATA RECEIVING AND PROCESSING SYSTEM

2.1 MODIS Data

The Moderate Resolution Imaging Spectroradiometers (MODIS) are one of 5 sensors on board of TERRA satellite (launched in December 1999) and AQUA satellite (launched in May 2002) aiming at monitoring the change on the Earth's land and sea surfaces and its atmosphere worldwide. The typical applications include atmospheric profiling, clouds studies, climatic characteristics, vegetation cover and the change in agricultural and forest lands, forest fires, ocean color and ocean temperatures, etc. The MODIS data includes 36 bands in visible, infrared, short-wave and thermal spectra with spatial resolutions of 250 m, 500 m and 1000 m. MODIS data can be acquired regularly 2 day scenes and 2 night scenes for most of locations on the Earth's surface. The frequent and synoptic characteristics (large swath of 2230 km)

together with specially designed atmospheric bands of MODIS offer the alternative to lessen the cloudiness problem in monitoring environmental changes, which is especially helpful in case of tropical climate zone of the Indochina. In Vietnam, the combination of multispectral and multitemporal characteristics of MODIS data have allowed the long-term monitoring of the vegetation cover changes, the surface moistures (i.e., vegetation-temperature dryness index) and urban heat islands phenomena, etc. as presented in a number of recent studies (Nguyen Dinh Duong, 2003; Tran Hung and Yasuoka, 2005; Tran Hung, 2007). With the MODIS data receiving routinely at the FPD since 2007, the use of Direct Broadcast MODIS will be very useful for natural disaster early warning and mitigation, which requires operational and near realtime information.

2.2 The MODIS Receiving Station and Data Processing

The FPD TeraScan MODIS ground receiving station supplied by the SeaSpace Corp. (US) is installed on the roof-top of the A6-B building at the MARD Headquarter (No. 2 Ngoc Ha, Hanoi). This is a complete X-Band (TeraScan 2.4m LEO) for MODIS data receiving and processing with following components:

- The 2.4m X-Band Antenna with radome (3.2m in diameter) and Antenna control and tracking software (Figure 2);
- TeraScan® Data Acquisition Module) with MODIS Receiver / Bit Synchronizer;
- Server for data processing (TeraScan® Data Processing Server);
- TeraScan® Data Acquisition and Processing Software, including Vulcan module for computing the fire locations;
- GPS/NTP Server;
- Complete documentation.

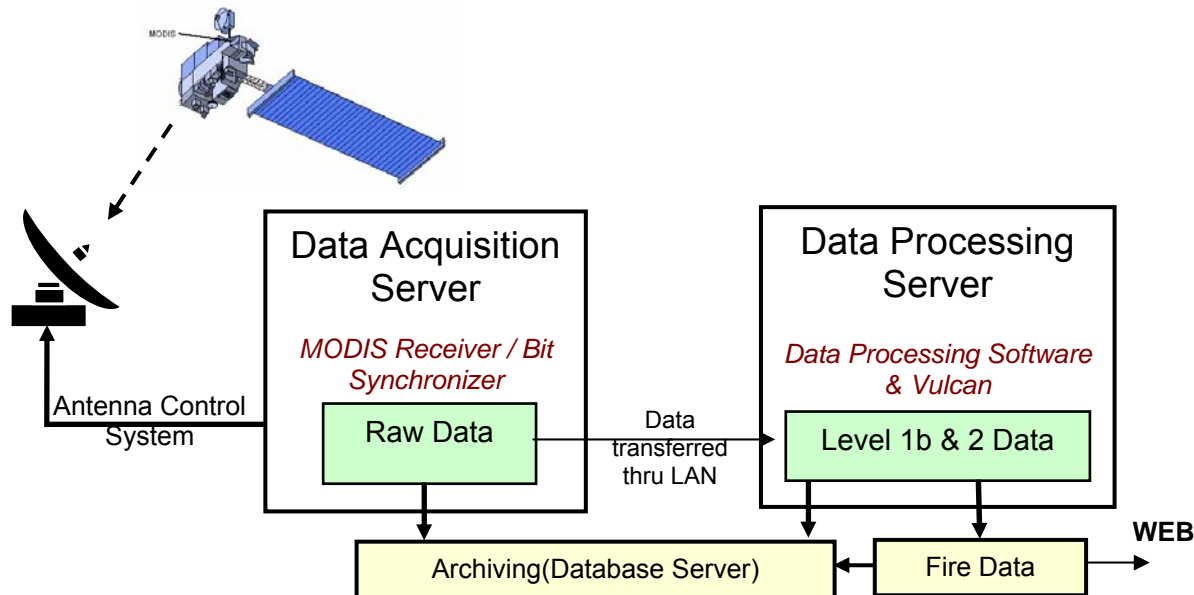


Figure 2. MODIS data acquisition and processing at the FPD MODIS Station scheme

With current configuration, the FPD MODIS station is receiving directly 4 MODIS scenes per day-night when TERRA and AQUA satellites pass overhead. The Antenna receiving coverage covers whole Vietnam's land and sea territory (Figure 4). In addition, the TerraScan system can receive data from IRS-P4 satellite (OCEANSAT) and if upgraded with additional L-band receiver can also receive and process data from other satellites such as NOAA-x, METOP...

The MODIS data acquisition and processing system at FPD composes of 2 main Servers as presented in Figure 2. Data Acquisition Server is configured to ingest data acquired from Antenna through data receiver and then frame-synchronize to produce time-ordered level 0 data before sending through LAN cable to the Data Processing Server for further processing or archiving. The Data Processing Server will then routinely process level 0 data using TeraScan Data Processing Software (equivalent to NASA or Wisconsin University IMAPP software) to generate calibrated and geolocated (to UTM WGS84 coordinate system) radiances - level 1b data. This pre-processing and processing routines include atmospheric correction and automatic geometric correction (for details please see Tran Hung et al. 2000; 2001). The standard level 1b products include: 250m-resolution image of band 1 & 2; 500m-resolution image of band 3-7 & aggregated bands 1&2; and 1000m-resolution image of band 8-36 & aggregated bands 1 – 7. The quicklooks are generated with true color combination of R/G/B – bands 1/2/1 with 1000m-resolution for day scenes and B-W image of Band 31 for night scenes, which are used for quick quality check and cloud coverage assessment.

At the present, MODIS level 1b products are sent directly to the FPD archive and only few thermal bands (e.g., 20, 22 and 31) as well as cloud masks are routinely used for computing the forest fires locations – as described below. The FPD is currently planning to exploit more, generating level 2 or higher MODIS products for environmental applications – such as interdisciplinary natural resources management in monitoring forest changes, drought, flood as well as oceanic applications (Nguyen Dinh Duong, 2003; Tran Hung, 2007).

III. APPLICATION IN FOREST FIRE EARLY DETECTION

3.1 Fire Detection Procedure

The forest fire warning system at the FPD is an automatic system for early detecting forest fires (hotspots) on Vietnam's land territory (Figure 3). After Data Processing Server has received and routinely generated level 1b products from TERRA and AQUA satellites (calibrated and geolocated radiances, the TeraScan Vulcan module automatically process bands 20, 22 and 31 with cloud masks in order to create fire products (using NASA ATBD-MOD14 algorithm – see Kaufmann & Justice, 1998). The fire products include fire image and a list of forest fire locations. The fire information is transferred to the FPD computer system in near-realtime for further processing and communicating to the regions of concern over the country. Figure 4 presents the fire image of the 02 April 2007 at 10:11am, including information on acquisition time, the amount of fires detected, burned areas and the cloud coverage. The fire intensity is also computed in W/m^2 and also presented on the image with different color ramp.

3.2 Near-realtime Communicating Fire Information through Web

In order to communicate the forest fires detected soonest possible to concerned local authorities over the country for timely fire extinguishing actions, the FPD with the technical support from the GeoViet Consulting Co. Ltd. (<http://www.geoviet.vn>) has developed the operational Automatic Hotspot Mapping system for routinely and near-realtime uploading the fire information onto the (<http://www.kiemlam.org.vn/dubaochay/dubaochay.htm>) FPD Forest Fire Warning Website. For each of MODIS scene the FPD receiving station acquired, the fire information is updated on the Website, including:

- Fire image for the whole country (Figure 4)
- Number of forest fires detected for each of province, cities over the country (Table 1)
- Maps of forest fires detected on top of forest map scaled 1:1,000,000 with administrative boundaries and main geographic features (Figure 5)
- List of forest fires locations containing information on date time of MODIS data acquired, geographical coordinates (Long/Lat), administrative locations (province /

district), fire intensity, affected areas for local FPD authorities to take appropriate and timely actions (Table 2).

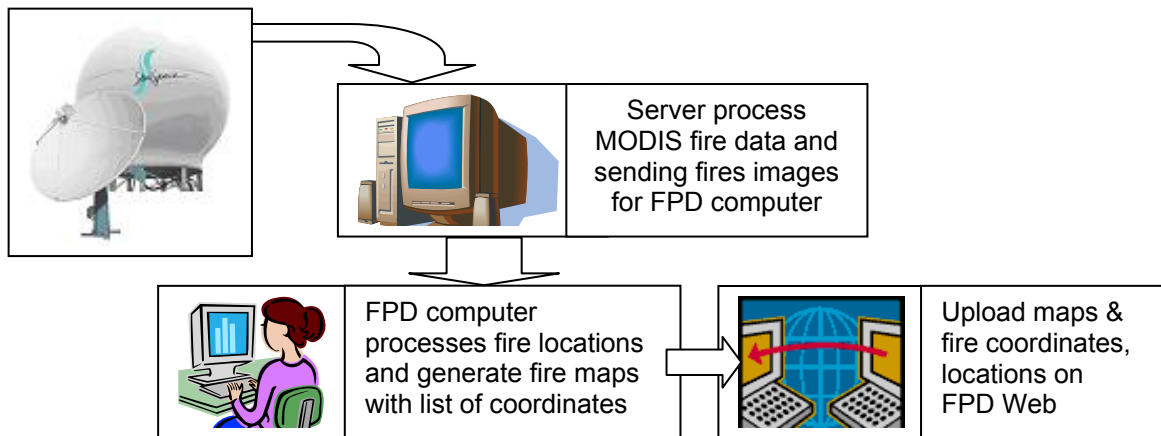


Figure 3. Scheme on processing and communicating the fire information from MODIS data



Figure 4 Image of forest fires detected on Vietnam's territory at 10:11am on 02 April 2007)

Table 1 The forest fires detected on Vietnam's territory at 10:11am on 02 April 2007

Provinces, Cities	Fires detected	Provinces, Cities	Fires detected	Provinces, Cities	Fires detected
Son La	13	Quang Ninh	2	Ninh Thuan	1
Dien Bien	8	Phu Tho	2	Lang Son	1
Lai Chau	7	Nghe An	2	Lam Dong	1
Dak Lak	5	Gia Lai	2	Binh Dinh	1
Thanh Hoa	3	An Giang	2	Binh Thuan	1
Dak Nong	2	Thua Thien Hue	1	Bac Lieu	1

Table 2 The coordinates of forest fires detected at 10:11am on 02 April 2007

Provinces, Cities	District	Long	Lat	Provinces, Cities	District	Long	Lat
An Giang	Tinh Bien	105.085	10.493	Son La	Quynh Nhai	103.822	21.587
An Giang	Chau Phu	105.216	10.473	Son La	Muong La	104.150	21.584
Bac Lieu	Hong Dan	105.320	9.593	Son La	Thuan Chau	103.835	21.513
Binh Thuan	Ham Tan	107.732	10.849	Son La	Thuan Chau	103.640	21.350
Binh Dinh	Van Canh	109.056	13.759	Son La	Song Ma	103.599	21.109
Gia Lai	Chu Se	108.082	13.498	Son La	Song Ma	103.712	21.088
Gia Lai	Ayun Pa	108.523	13.359	Son La	Moc Chau	104.742	20.978
Lai Chau	Muong Te	102.892	22.447	Son La	Song Ma	103.814	20.901
Lai Chau	Sin Ho	103.184	22.446	Thanh Hoa	Quan Hoa	104.845	20.593
Lai Chau	Sin Ho	103.077	22.428	Thanh Hoa	Muong Lat	104.60	20.427
Lai Chau	Sin Ho	103.384	22.378	Thanh Hoa	Nhu Xuan	105.403	19.548
Lai Chau	Phong Tho	103.754	22.363	T.Thien Hue	Phg. Dien	107.392	16.475
Lai Chau	Muong Te	102.287	22.318	Dien Bien	Tua Chua	103.363	22.103
Lai Chau	Sin Ho	103.254	22.128	Dien Bien	Tua Chua	103.398	21.945
Lam Dong	Duc Trong	108.345	11.644	Dien Bien	Muong Lay	103.124	21.913
Lang Son	Dinh Lap	106.984	21.513	Dien Bien	Muong Lay	102.791	21.763
Nghe An	Ky Son	104.031	19.327	Dien Bien	Tuaân Giao	103.325	21.719
Nghe An	Th.Chuong	105.122	18.848	Dien Bien	Tuan Giao	103.179	21.680
Ninh Thuan	Ninh Son	108.827	11.999	Dien Bien	Dien Bien	102.918	21.228
Phu Tho	Thanh Son	104.961	21.258	Dien Bien	Dien Bien	103.072	21.118
Phu Tho	Thanh Son	105.164	21.004	Dak Lak	CuM'Gar	108.09	12.986
Quang Ninh	TX. C.Pha	107.333	21.188	Dak Lak	Ma'Drak	108.648	12.837
Quang Ninh	TX. Uong Bi	106.781	21.063	Dak Lak	Ma'Drak	108.684	12.620
Son La	Quynh Nhai	103.504	21.930	Dak Lak	Ea Kar	108.509	12.613
Son La	Quynh Nhai	103.598	21.896	Dak Lak	Lak	108.202	12.368
Son La	Quynh Nhai	103.563	21.762	Dak Nong	Krong No	107.962	12.438
Son La	Muong La	103.846	21.692	Dak Nong	Dak Mil	107.621	12.334
Son La	Quynh Nhai	103.579	21.657				

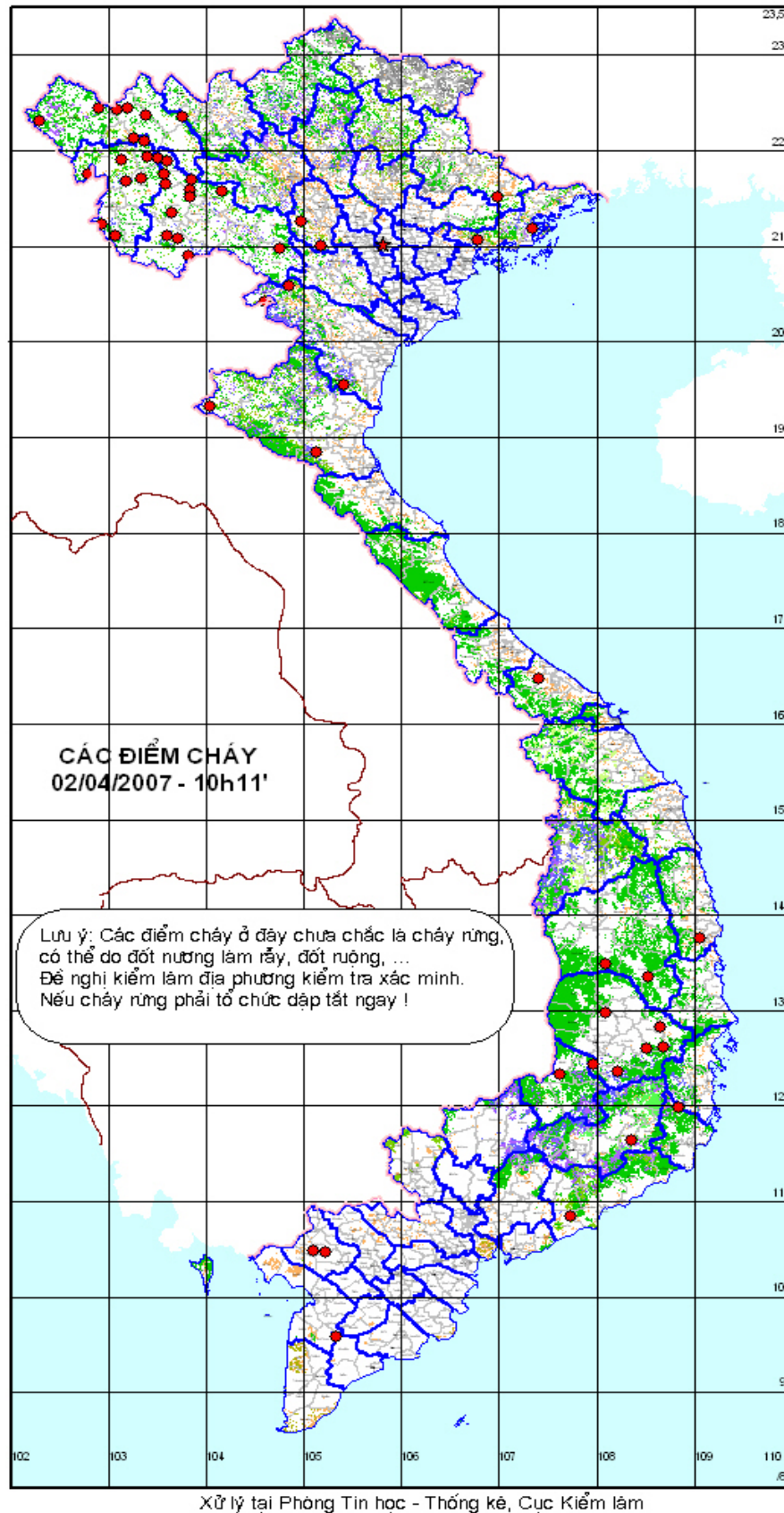


Figure 5 Map of forest fires detected on Vietnam's territory at 10:11am on 02 April 2007

The information on forest fire early detection is routinely uploaded onto the Web and updated 4 times a day-night. The regional FPD offices and local authorities with Internet connection can

be easily monitor the near real-time fire information through the FPD Website and make timely decision on ground checking and mobilize resources for fire fighting when necessary.

3.3 Archiving and Using Fire Statistical Data

In addition to the daily operational use of satellite-based fire information, the forest fire historical data are archived since February 2007 in the FPD Server as a fire database, which could be queried, retrieved by date and time and summarize by months, quarters and years for comprehensive forest fire management. After every month, the FPD has conducted the summary and upload onto the summary maps of all forest fires detected as well as generate the summary tables of forest fires by administrative units (Table 3 and Figure 6).

Further, for long-term forest fire management purpose, the FPD has created monthly fire risk assessment maps (Figure 7) based on the summarized amount of forest fires actually detected in that month. These maps will present the seasonal assessment of fire risks for different regions of the country, which could be used to generate forest fire warning (forecasting) maps in future.

Table 3 Summary of all forest fires detected in February and March 2007

No	Provinces, Cities	Total number of fires in 2007		No	Provinces, Cities	Total number of fires in 2007	
		February	March			February	March
0	Whole country	1.588	1.865	26	Thua Thien Hue	6	4
1	Son La	345	344	27	Ha Tinh	6	0
2	Lai Chau	282	425	28	Thanh Hoa	5	19
3	Dien Bien	264	323	29	Khanh Hoa	5	13
4	Gia Lai	127	92	30	Hoa Binh	5	2
5	Dak Lak	107	75	31	Biinh Duong	4	13
6	Dak Nong	60	72	32	Bac Giang	4	0
7	Lam Dong	49	45	33	Phu Tho	4	0
8	Kon Tum	38	70	34	Quang Binh	4	0
9	Quang Ninh	34	0	35	Quang Ngai	3	4
10	Binh Thuan	30	12	36	Quang Nam	2	37
11	Lao Cai	23	20	37	Long An	2	12
12	Binh Phuoc	22	17	38	Tien Giang	2	10
13	Yen Bai	21	42	39	Da Nang City	2	3
14	Nghe An	20	32	40	Bac Kan	2	0
15	Lang Son	14	1	41	An Giang	1	17
16	Dong Nai	13	19	42	Phu Yen	1	8
17	Ninh Thuan	12	13	43	Soc Trang	1	5
18	Dong Thap	11	37	44	Ca Mau	1	2
19	Tay Ninh	11	15	45	Thai Nguyen	1	0
20	Ha Giang	9	3	46	Binh Dinh	0	5
21	Cao Bang	9	1	47	Ho Chi Minh City	0	3
22	Kien Giang	7	21	48	Tra Vinh	0	3
23	Tuyen Quang	7	2	49	Bac Lieu	0	3
24	Ba Ria V.Tau	6	14	50	Hau Giang	0	1
25	Quang Tri	6	5	51	Vinh Phuc	0	1

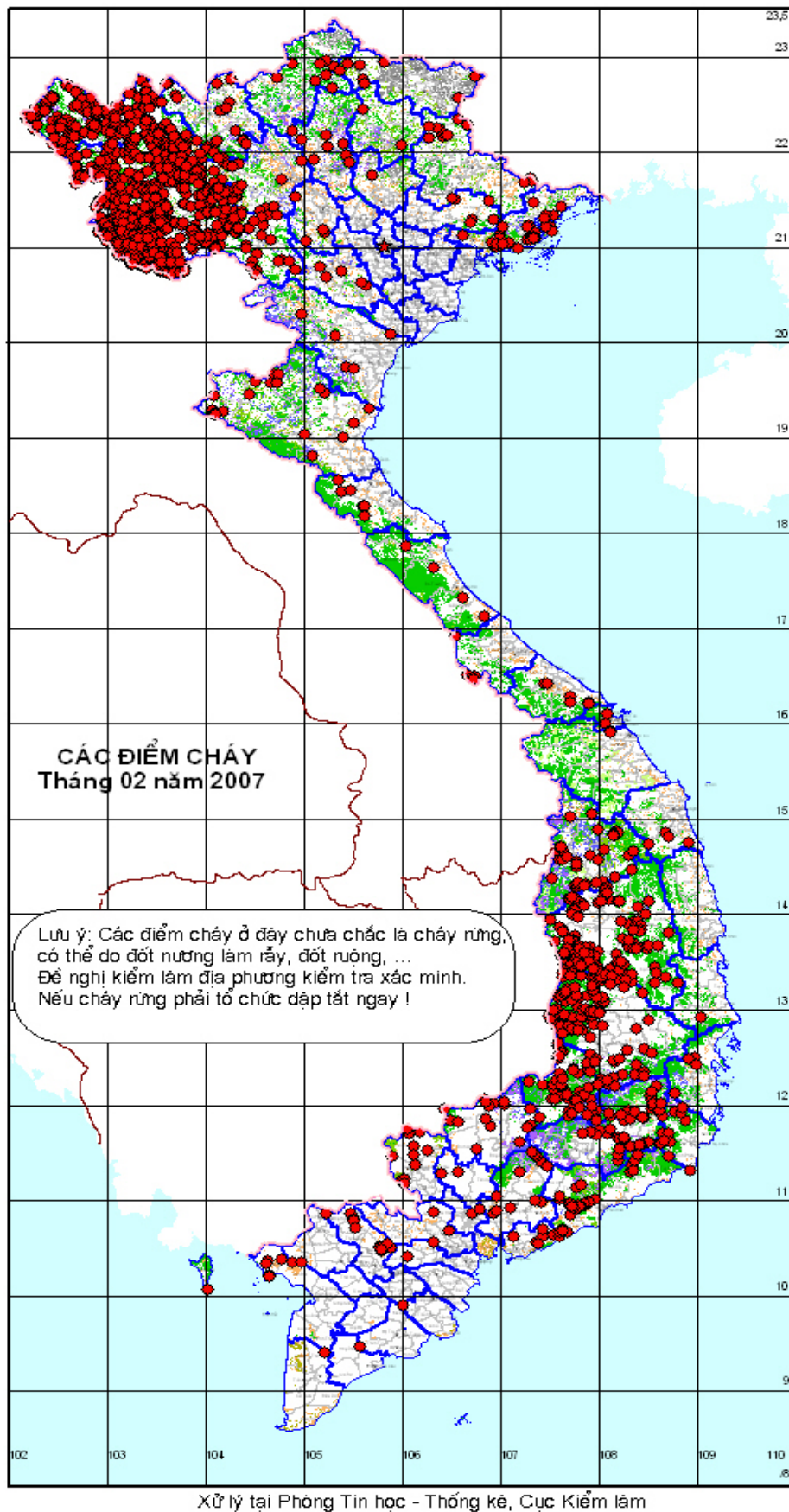


Figure 6 Summary map of all forest fires detected on Vietnam's territory in February 2007

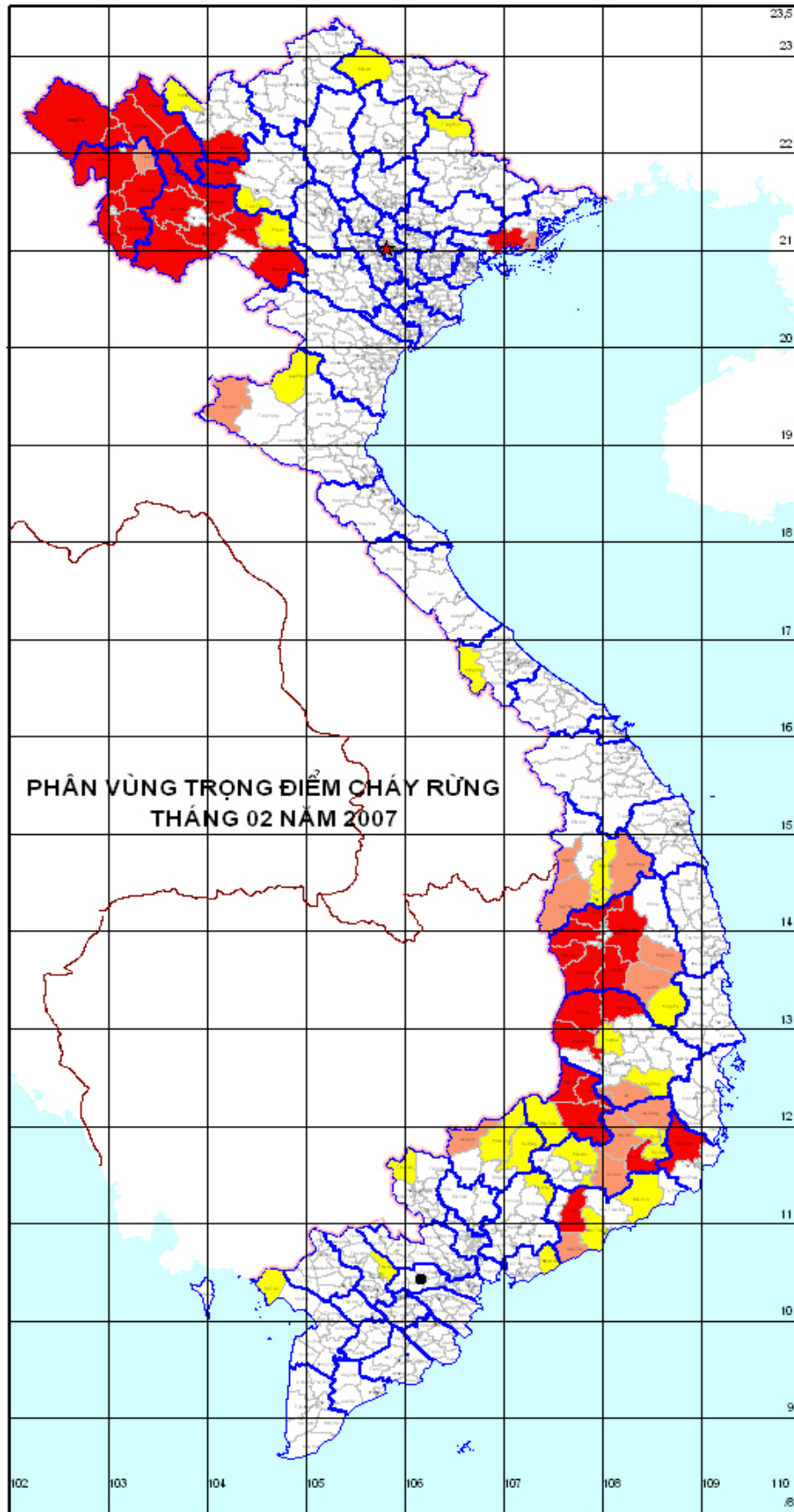


Figure 7 Monthly fire risk assessment map for February 2007 (**red** – regions with fire risk level 5, **pink** – level 4 and **yellow** – level 3)

3.4 Effectiveness of the FPD MODIS Station in Forest Fire Management

Since February 2007, the TeraScan MODIS receiving station at the FPD is operating with high stability, routinely receiving and producing MODIS data products and forest fires were detected in near realtime manner in support to the daily FPD forest fire fighting operations nationwide. As thus, it has gradually create the working habit for FPD forces in using the satellite-based information on the FPD Website for forest fire management. Table 4 shows the summarized amounts of forest fires detected by the MODIS data during the period of February – August 2007 as compared to the actual forest fires reported on the ground by local FPD forces. In February 2007, the FPD has detected 1.588 fire locations (hotspots) based on MODIS data, of which 113 actual forest fires were early detected and warned. In March 2007, 1.865 hotspots detected, of which 119 actual forest fires were early detected and warned. With archived database of forest fire historical data, the FPD is working to improve its effectiveness in managing the forest fire in medium- and long-term as well as creating basis for increasing the reliability of forest fire detection from MODIS data.

Table 4. Summarized number of forest fires (hotspots) detected by the FPD MODIS station as compared to the actual forest fires reported on ground during Feb – Aug 2007

Month	Number of forest fires detected by MODIS data	Number of actual forest fires reported
2	1.588	113
3	1.865	119
4	1.610	72
5	549	59
6	218	36
7	116	30
8	70	22

IV. EXPANDING THE FPD FOREST FIRE INFORMATION SYSTEM

Since February 2007, the FPD MODIS receiving station has produced convincing practical results in applying remote sensing technology in natural resources management, particularly in operational management of forest fire. This practical experience will be very useful for installing and operating other satellite receiving stations such as the “*Vietnam national ground receiving station*” recently installed and operated by the National Remote Sensing Center (Ministry of Natural Resources and Environment) (Nguyen Xuan Lam, 2006). Technical cooperation and experiences sharing will be a good approach in bringing together resources in practical and effective monitoring and management of natural resources and environment as well as contributing to further development and application of remote sensing technology in Vietnam.

In October 2008, the FPD is planning to upgrade the TeraScan satellite receiving station adding L-band receiver in order to receive and process NOAA-x, METOP data. By the end of 2008, the forest fires will be monitored more frequently, up to 8 - 10 scenes per day-night, and so improve the reliability of satellite-based fire detection. With this upgrading in hardware, the FPD satellite receiving system is also being expanded in terms of further development in data processing, presenting and interdisciplinary applications. Currently, GeoViet Consulting is supporting the FPD in developing the Vietnam’s FireWatch system for online monitoring and managing forest fire with main features as follows:

- Routine processing of satellite data (MODIS, NOAA/AVHRR), generating forest fire hotspots using NASA ATBD-MOD14 Algorithm;

- Online interactive system for analyzing the hotspots, uploading onto online maps (DEM, Landsat images, base maps, forest maps), which are interactively presented online to assist concerned local authorities in finding and locating the fire locations on the ground;
- Analyzing and classifying hotspots into probable forest fire and non-fire hotspots;
- Module for hotspots archiving and statistical analysis of historical fire data, risk mapping;
- Online interactive system for communicating forest fire information to the concerned local authorities;
- Generating and archiving level 1b data (with quicklooks for interactive online reference) as online database for resources and environment applications.

Preliminary results of the Vietnam's FireWatch will be presented in the Conference.

In parallel, with increased satellite data acquired, and accumulated overtime, the FPD is working on using the short-term (daily) and long-term (yearly) time series to reduce the cloud effects and increase the reliability of the forest fire detection. Also, the integration with fire warning computed from regularly meteorological observations and updated forest information (maps) as well as utilizing the statistical analysis to comprehensively improve the forest fire management. Further, the FPD is working on high-level data processing to produce level 2 and higher cloud-free products such as filtered/combined reflectance images, NDVI, surface temperature, sea surface temperature, ocean color, etc. for multi-disciplinary applications. With database built, the FPD aims at long-term monitoring the forest cover and forest status over the country. The FPD is looking to build cooperative framework with government offices, researchers and experts in order to promote the effective use of satellite data not only for forest fire management, but also for resources and environmental monitoring such as climatic studies, drought/flood monitoring, disaster mitigation, agricultural and ocean environment applications, etc.

References

1. Forest Protection Department, Ministry of Agriculture and Rural Development. The Forest Fire Early Detection Website <http://www.kieklam.org.vn/dubaochay/dubaochay.htm> and Forest Fire Early Warning Website <http://www.kieklam.org.vn/dubaochay/canhbao.asp> (in Vietnamese)
2. Kaufmann Y. and Justice C., 1998. Algorithm Technical Background Document, MODIS Fire Products, version 2.2. pp. 30-35
3. Nguyen Dinh Duong, 2003. Application of moderate resolution satellite data for monitoring natural resources and environment. Scientific Report of the Vietnam Environmental Protection Agency, 12/2003 (in Vietnamese)
4. Nguyen Xuan Lam, 2006. Vietnam national ground receiving station. *Vietnam's Journal of Remote Sensing and Geoinformatics*, Vol. 1 – 10/2006, pp. 11-19 (in Vietnamese)
5. Nguyen Hong Quang, 2004. Project Document on "Strengthening the FPD capacity in applying Remote Sensing and IT for early warning and detection of forest fires in Vietnam (for the period 2005 – 2010). Presented at the First MARD Forest Fire Seminar (organized by the Forest Protection Department of Vietnam), Hanoi, July 6-7, 2004 (in Vietnamese)
6. Tran Hung, 2007. MODIS data to monitor surface soil / vegetation moisture status: A study with temperature – vegetation dryness index (TVDI). *Vietnam's Journal of Remote Sensing and Geoinformatics*, Vol. 2 – 4/2007, pp. 38-45 (in Vietnamese)
7. Tran Hung, Yasuoka Y., 2005. MODIS Applications in Environmental Change Researches in the Southeast-Asian Region. *International Journal of Geoinformatics*, Vol. 1(1), March 2005, pp. 117-123
8. Tran Hung, 2004. Forest Fire in Vietnam – a MODIS Perspective. Presented at the First MARD Forest Fire Seminar (organized by the Forest Protection Department of Vietnam), Hanoi, July 6-7, 2004

9. Tran Hung, Ochi, S., Nemoto, T., Kitsuregawa, M. and Yasuoka, Y., 2001. MODIS data acquisition, processing and scientific utilization framework at the Institute of Industrial Science, University of Tokyo. *Proceedings of the 22nd Asian Conference on Remote Sensing*, Singapore, 1, 488-492
10. Tran Hung, Ochi S., Nemoto T., Kitsuregawa M. and Yasuoka Y., 2000. Data Acquisition and Processing System at the Institute of Industrial Science, University of Tokyo. Presented at the *4th International Conference on Direct Broadcast of Earth Observation Data*, Dundee, Scotland (UK), June 2000