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## Development of National Forest/Land Fire Monitoring System Using Remote Sensing Satellite Data (Terra/Aqua Modis and SNPP) by Automation and Nearly Real-time.

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# Development of National Forest/Land Fire Monitoring System Using Remote Sensing Satellite Data (Terra/Aqua Modis and SNPP) by Automation and Nearly Real-time.

A Indradjad, W Sunarmodo, N Salyasari and B Pratiknyo

Remote Sensing Technology and Data Centre (Pustekdata), National Institute of Aeronautics and Space (LAPAN), Jl. LAPAN No. 70 Pekayon, Pasar Rebo, Jakarta Timur 13710, Indonesia

andy.indradjad@lapan.go.id

**Abstract.** Hotspot monitoring system using remote sensing satellite data such as Terra/Aqua Modis and SNPP VIIRS. In order to manage national natural disaster (such as forest/land fire disaster), accurate-real time-accessible data and information are required. In this case the use of remote sensing satellites data is use for the monitoring of natural disasters, especially forest/land fires that occur very massive need monitoring in real time and up to date. Information systems for monitoring of forest/land fires, can be built using remote sensing data of Terra/Aqua Modis and SNPP satellites that continuously monitor the condition of the land/forest by photographing the Indonesian territory respectively four times a day. The hotspot data requirement is 30 minute after the reception in ground station. The built system consists of the reception, processing, cataloguing and dissemination data, in order to fit the requirement the system need to be automation. The data receiving process is done at Parepare and Rumpin ground stations, followed by sending data to Pekayon in real time. Data processing is done in Pekayon using automated software open source module. Furthermore, data cataloguing is built using spatial and numerical based databases. The appearance system is built interactively with web-based online and mobile, user can do searching hotspot information based on location, degree of trust and time of incident. The monitoring system of forest / land fires that have been built have been published and utilized nationally, especially the BNPB in the context of the prevention and mitigation of forest / land fire disasters in Indonesia. Users can access through the website <http://modis-catalog.lapan.go.id> or can download android-based mobile app "Hotspot LAPAN". It is expected that with online and mobile web based online and mobile fire monitoring system, it can be used for the prevention and mitigation of forest/land fire disaster in Indonesia.

## 1. Introduction

Based on BNPB (National Agency for Disaster Countermeasure) report, Forest or land fire is happen in Indonesia annually and 10.8 % of the total disaster happen in Indonesia. Most of the forest or land fire caused by people for land clearing, and it dependent to the climate and it will make worse. Forest or land fire is strongly effect to life but it is difficult to detect the source or burning area because of huge amount of Indonesian forest. One of the method to detect forest fire is using remote sensing satellite data. Data can be form as fire hotspot or the image of source smoke. With the use of satellite



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data, an early warning and monitoring of the forest fire in Indonesia can be performed efficiently, another advantage is the monitoring can be more often, because satellite orbiting earth and can cover at least once a day.

MODIS (Moderate Resolution Imaging Spectroradiometer) can be used to detect fire hotspot, it is used the location coordinate of the fire. The algorithm is developed globally by NASA and the software implementation developed by Wisconsin University. (Liam E. Gumley, 2005). These MODIS data can be acquire from two satellite which are TERRA and AQUA satellite. It will provide 4 hotspot data every day for day and night. First algorithm to detect fire hotspot called collection 5 and then this algorithm get some improvement and it called collection 6. (Louis Giglio, 2016). ). The use of MODIS can be apply for analysis because of the long time series data. (E-M Fuchs, 2015). Improvement to detect fire hotspot can be perform with small satellite but better in resolution such as HJ for the result of MODIS data (S.D. Wang, 2012). Validation for this low resolution satellite data can be perform using Landsat 8 data with OLI data. (Wilfrid Schroeder, 2016).

Data VIIRS (Visible Infrared Imager Radiometer Suite) is a sensor which is embedded in satellite S-NPP (Suomi National Polar-orbiting Partnership). Data VIIRS can provide hotspot information and it can also show effected area of the forest fire using 375m resolution data. (Patricia Oliva, 2015). Data VIIRS also planned to operational in the future satellite JPSS (Joint Polar Satellite System). JPSS will make use of several satellite series, with these constellation it will provide more hotspot information data for monitoring. Data VIIRS in S-NPP satellite and JPSS satellite will have same only little different in radiometric characteristic. (Hassan Oudrari,2015).

In the efforts of monitoring forest or land fire using remote sensing satellite data, LAPAN (Indonesian National Institute of Aeronautics and Space) has operational to acquire satellite data for hotspot monitoring. LAPAN has been acquired satellite data such as MODIS from satellite TERRA and AQUA, and also satellite S-NPP for the sensor VIIRS. Data VIIRS from S-NPP satellite can be receive from the LAPAN ground station since 2012 and the data can be processed to hotspot information since 2013 (Budhi Gustiandi,2013). This hotspot information is standard information which is derived only from the parameter from the satellite and does not require additional information.

The requirement for the user to received the hotspot information is as soon as possible after the data receive from the ground station. This can be called as near real time and defined as 30 minutes after the data received at ground station. This means all the time that need for processing the data and transfer to the data centre in Jakarta. After the information ready it will deliver to the user that need through dissemination system.

This research is aim to create a system that can obtain hotspot information from the ground station with time concern as 30 minutes after the satellite data receive in the ground station. In order to achieve the requirement the system should be build fully automatic since the receiving ground station, processing the data and send the data to the user throughout the dissemination system.

## **2. Data and Methodology**

The Data which are used in this research are MODIS and VIIRS data from LAPAN ground station. LAPAN remote sensing ground station such as in Pare-pare, South Sulawesi and Rumpin Bogor. All hotspot information data derived from satellite data are store in database in Remote sensing data centre in Pekayon, Jakarta. The communications network between ground station and data centre are already install.

For this research, the method are using the open source processing software for each satellite sensor. Open source processing software for MODIS provided by IMAPP. Open source processing software for VIIRS is provided by CSPP. Installation for the software are also provided within installation package.

The user guide of the software is used to install the software in server computer. The server will use Centos 7 Linux operating system. In order to achieve automation, this research will make use of programming language such as bash programming and python. The automation script is build to create

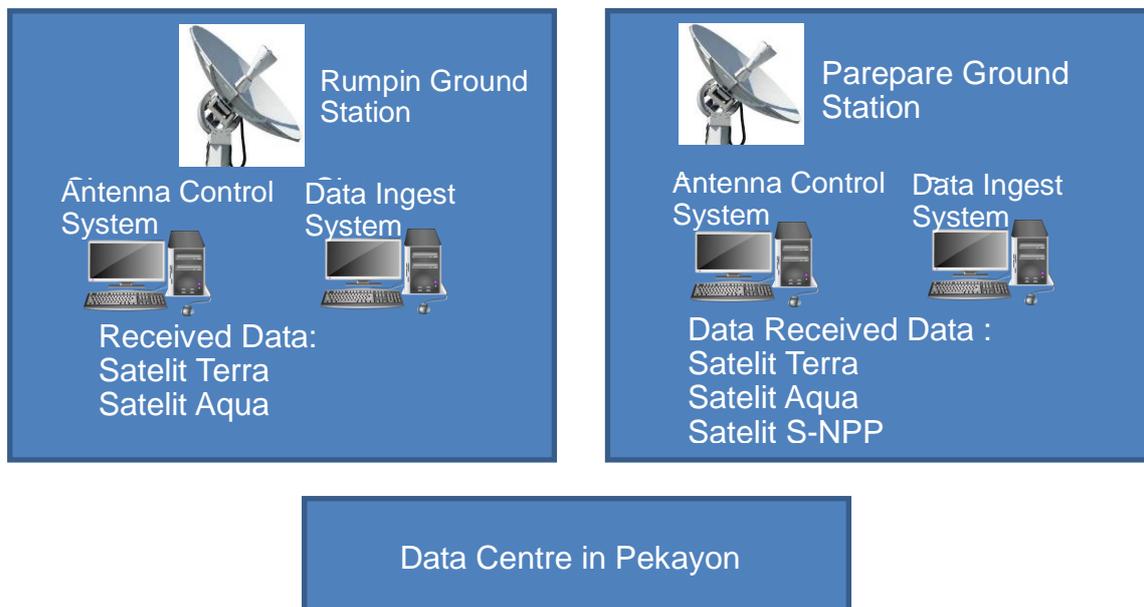
fully automatic since antenna controlling to receive the data from the satellite, processing data to hotspot information, send hotspot information to data base and email the user. All system is shown in figure 1.



**Figure 1.**

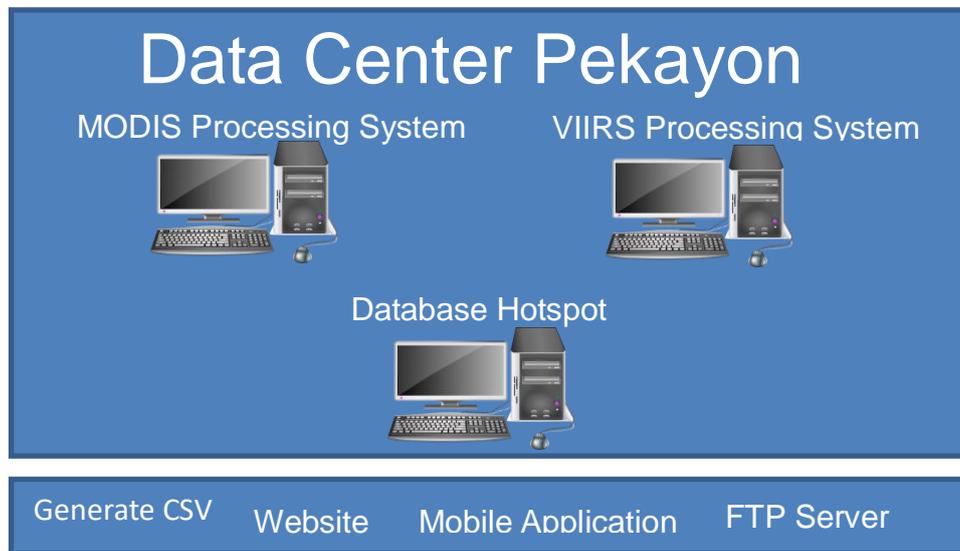
**3. Results and Discussion**

Data Acquisition part is build in order to receive data from the satellite. It consist of Antenna and its control, receiver and demodulator. All system in this part should be run smoothly and fully automatic it can control antenna movement to follow the satellite, and automatic switching frequency between different satellite. All system antenna system is controlled with scheduler, this scheduler will initiate system setup for the satellite configuration. After the data being receive it will be stored in acquisition storage, and it should be send to processing storage to continue data processing. Processing server can be placed at the ground station to maximize the speed for transferring but full raw data have to be transfer to the data centre after that, it will process all other product, and also for back up system. Figure 1, show the created system for Data acquisition part, this system is for receiving data from the satellite. This system include Parepare and Rumpin remote sensing ground station. All system has been done automatically, operators only need to monitor the system.



**Figure 2. Data Receiving System**

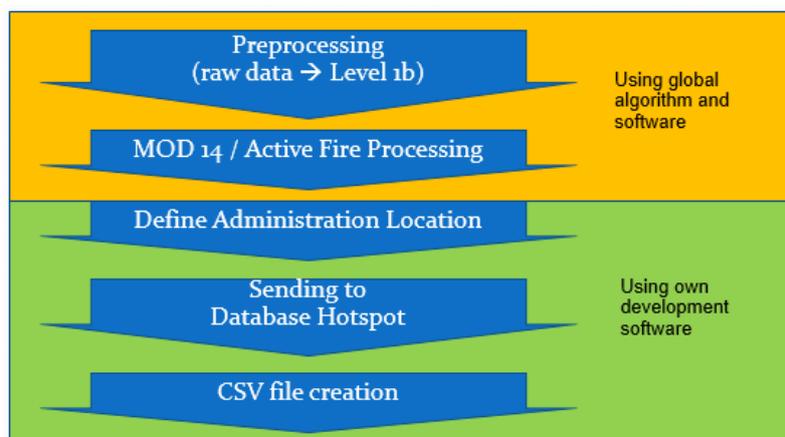
Data processing part is for processing data received from the ground station and send to processing server in Data Centre in Pekayon Jakarta. The system is shown in figure 3, The processing server consist of two system. The first one process data from sensor MODIS, these data should come from both ground station, data process sequentially. The first data come to the system will be serve first and when it is finish it will continue to next one. The second one process data from sensor VIIRS this system only serve data from Parepare ground station as shown in figure 2, only Parepare can receive S-NPP Satellite which VIIRS come from. After that the system will produce information about hotspot and it will send to hotspot database. When new data come to the database it will generate csv file, update the website, mobile application and also send csv file to the ftp server.



**Figure 3.** Data Processing System

The data processing system has a flowchart from pre processing to hotspot information generation. These step are shown in figure 4. In first part for pre-processing and hotspot information related product it use software provided globally. MODIS Data processing level 1b and mod 14 using IMAPP Virtual Appliance ver.2 (using C6) from Wisconsin Universitas VIIRS (S-NPP) data processing (S-NPP) using Active Fires software from Community Software Processing Package (CSPP).

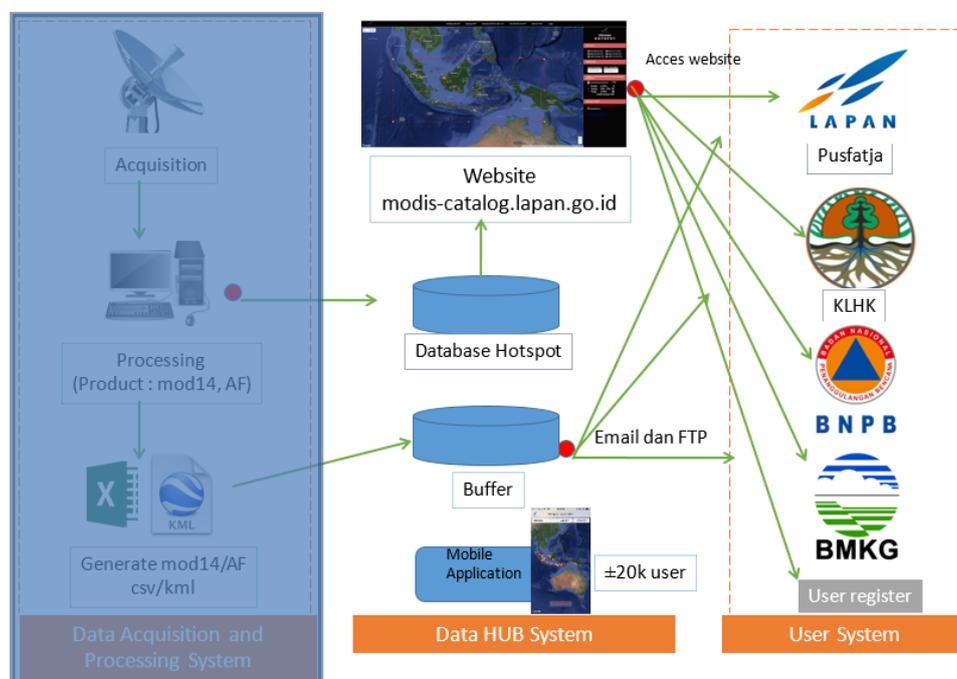
These two processing package can be configure automatically after data ready from the ground station. These steps produce data standard for MODIS it is called MOD14 in HDF format, VIIRS it is called Active Fire in HDF-5 format. All the product should give information about location (Latitude and Longitude) of hotspot and its confident level. The next step is define the location with administrative information such as province, district and sub district. After that sending the information to the database, and create csv file. All of these steps make use of own developed software in python language



**Figure 4.** Hotspot information Processing flowchart

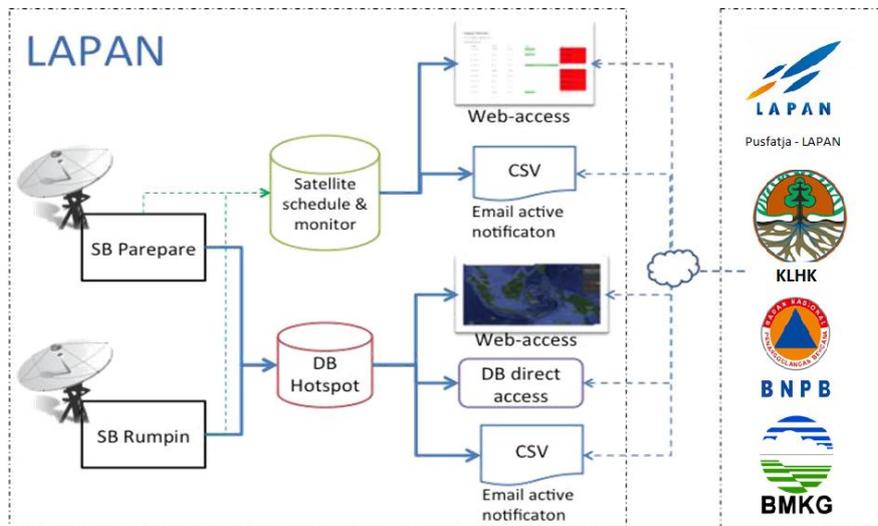
Data dissemination part, provide user with some choice to get hotspot information. The first one all user can have hotspot information from Website. The website is interactive to meet user need about the hotspot information. User can choose the province or all of Indonesia, satellite, time and confident

level. User can also download the viewed data in csv format. Website user interface can view number of hotspot viewed in the map. The second user can show the hotspot information in their mobile phone, it will make easier when they in the field on the way to one of the point. The mobile application is made in both iOS and android version. The interface for mobile application is much simpler then in the website, user can not download the data, it is only shown on the maps. Registered user can download hotspot information in csv file directly from ftp server. User can download new created csv file and use the data for ground checking. The system also can send email both notification and hotspot information data in csv format, but only registered user can receive the email. the email will be send automatically to the user after new csv file created. The data dissemination part is shown on figure 5, it also view the connection with previous part. User that already make use of this system such as ministry of environmental and forestry (KLHK), Meteorological, Climatological and Geophysical Agency (BMKG), National Agency for Disaster Countermeasure (BNPB) and also Remote Sensing Application Center (Pusfatja-LAPAN). These user can connect directly through out data buffer in FTP server so it make easier to have the data after it is created.



**Figure 5.** Dissemination System

The whole system integration is shown on figure 6. The complete system which all part can run automatically can meet the requirement of hotspot information which is 30 minutes information created after it is received in ground station. The user can have information about the satellite will be received for one day before, show they can expect number of hotspot information they will get, if the hotspot did not arrive on time they notify the system administrator if it can be recover for some errors it will be send but if not they will be notify as soon as possible. The all system run on different places such as ground station and data center it require good connection network between all part. These systems run on different machines, each machine or server running different operating system, and the automatic system can run on all part to make sure system can run smoothly.



**Figure 6.** Hotspot monitoring system integration

All system can run automatically and require no operator to operate, but for some reason it can fail to produce hotspot information. When it fail it will be shown on dashboard monitoring system, and operators can do some trouble shooting to fix it or the they can contacts system engineers to analyse the fail and try to fix it. Some errors can not be fix such as data did not received at ground station, it can be caused by antenna failure. The system dashboard monitoring shown on figure7. It show red colour on information that fail or green colour when no problem.

No	Tanggal	Satelit	AOI	Proses	CSV	Thumbnail
14	2017-08-10	AQUA	17:57:54	100% Complete Success	02:30:01	
15	2017-08-10	AQUA	19:37:31	100% Complete Success	02:30:01	
Station Bumi Pare-pare						
No	Tanggal	Satelit	AOI	Proses	CSV	Thumbnail
1	2017-08-09	TERRA	01:57:00	100% Complete Success	02:30:01	
2	2017-08-09	TERRA	03:36:10	100% Complete Success	03:58:02	
3	2017-08-09	AQUA	04:50:53	100% Complete Success	05:30:01	
4	2017-08-09	AQUA	06:28:51	100% Complete Success	06:58:01	
5	2017-08-09	TERRA	14:10:00	100% Complete Success	14:40:01	
6	2017-08-09	AQUA	17:13:40	100% Complete Success	17:40:01	
7	2017-08-09	AQUA	19:54:02	100% Complete Success	19:10:01	
8	2017-08-10	TERRA	01:04:31	100% Complete Success	01:30:02	
9	2017-08-10	TERRA	02:39:33	100% Complete Success	03:10:01	

**Figure 7.** Processing monitoring site

Screenshot of the product of hotspot information both website and mobile application is shown on figure 8 and 9. The both dissemination systems updated automatically, when user connected to the site it will show last updated data.



Figure 8. Hotspot information website

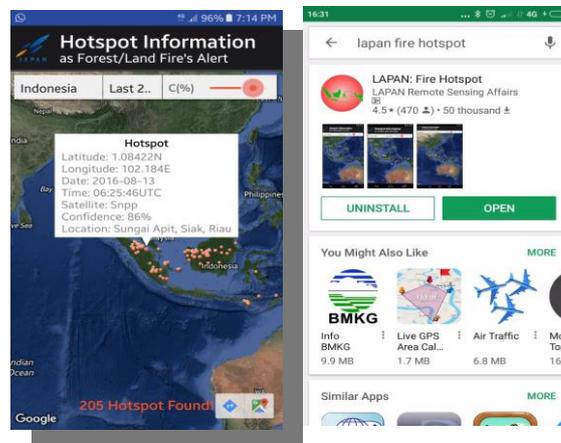


Figure 9. Hotspot information mobile application

All system speed depending on network connection speed between machines especially if they are on separate locations. Another time consume part is data processing, data processing for MODIS can meet the requirement but for VIIRS still have problem. VIIRS processing system use at least one hour for processing and it make data delivery more time than requirement. This problem can be solved with multi cores processing it will decrease the time consume, until half or more, depending number of cores. The software processing configuration can not use multi cores processing when it only have little memory or RAM. It require more memory every add more core, the hardware of the processing system have 24 cores but it only have 16 GB of RAM which only can use one core for processing. It means will require hardware memory upgrade. The upgraded server still on preparation but the system still can run only need more time to produce.

#### 4. Conclusions

Hotspot information system that is build by LAPAN can meet the requirement for 30 minutes data delivery after satellite data receive in the ground station. For the VIIRS data from S-NPP satellite it require more time to deliver regarding time consuming in processing and require more memory to apply multi core processing. The system is fully automatic until information delivery to the user and it is operator independent

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