remote sensing

Supplement

Operational Design of Indonesia's Early Warning System for Vegetation Cover Change Detection

This change detection system was developed by minimizing system interaction with the operator, in other words it is executed automatically so that information can be conveyed to users quickly. Figure xx shows a general diagram of the early warning system for vegetation cover change detection. The general design of the system is divided into several parts, namely: input data design, data processing design, and output data design.

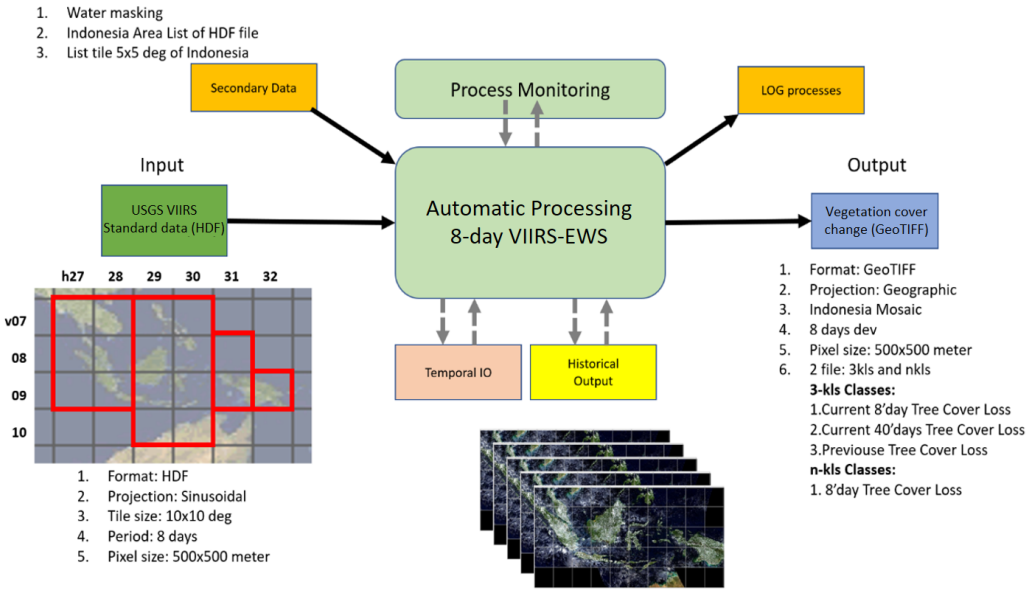

Figure 1. Diagram of the process of developing the early warning system for changes in vegetation cover based on VIIRS image data.

1. Input Data Design

The main data used are high temporal resolution optical satellite imagery data, VIIRS composite 8 days; obtained from NASA's Land Processes Distributed Active Archive Center (LP DAAC), USGS Earth Resources Observation and Science (EROS) Center through https://e4ftl01.cr.usgs.gov/VIIRS/VNP09H1.001/.

2. Data Processing Design

The processing design in detail is presented in Figure xx, which explains the form of processing module designs and input/output processing results from each module. The output of processing results can be in the form of temporal, historical and final results. Temporal results are immediately deleted after processing, Historical results are stored and will be used in subsequent processing, while final results are the final results that will be delivered to the user. Data processing is designed to process data automatically, so that data input/output (I/O), modules and interactions between modules have been built to run continuously. The main I/O data directory is set up in the processing server, while the sub directories are used to store I/O processing results for each module, as follows: to store water masking (00_mask), to store HDF file downloaded from USGS (01_HDF), results of data conversion, 5 bands (02_RAW_ERS), mosaic VIIRS image of the 5 bands images (03_GEO_ERS), tiling 5x5 degree of reflectance 5 bands images (04_TILE_5deg), creating the 160 series of vegetation index that are used for devegetation detection

(05_GBF_L1_TIMESERIES) and creating the 3 types of devegetation results (8-DAYS_DEV).

3. Output Data Design

The output data is divided into 2 parts, first: the main output will be utilized for the user's advantage, second: side output is used for validation, accuracy checks and other developments. There are two main outputs, namely:

Devegetation mosaics in Indonesia have 3 classes, namely:

a) Current 8'day Vegetation Cover Loss,
b) Current 40'days Vegetation Cover Loss and
c) Previous Vegetation Cover Loss

Mosaik Devegetation Indonesia region n-class, n=total 8-days data. The digital number of the n class output is the sequence of 8 daily devegetation data.

The rapid detection system for vegetation cover changes set up based on optical image data and construct into the following six modules

1) Data download module: to download VIIRS reflectance data from USGS,
2) Format data conversion module: to convert the VIIRS image data from the sinusoidal projection to geographic projection,
3) Mosaic and tiling module: to generate 5x5 deg image tiles and to create the quicklook 8-days data for all of Indonesia,
4) Time series processing module: to create a cloud free image using multi-time filtering method,
5) Devegetation identification module: to detect the vegetation cover changes and
6) Mosaic devegetation module: to mosaic 3-classes and n-classes of vegetation cover changes for all of Indonesia areas.

The modules and data flow design developing the early warning system for vegetation cover changes is illustrated in Figure xx.

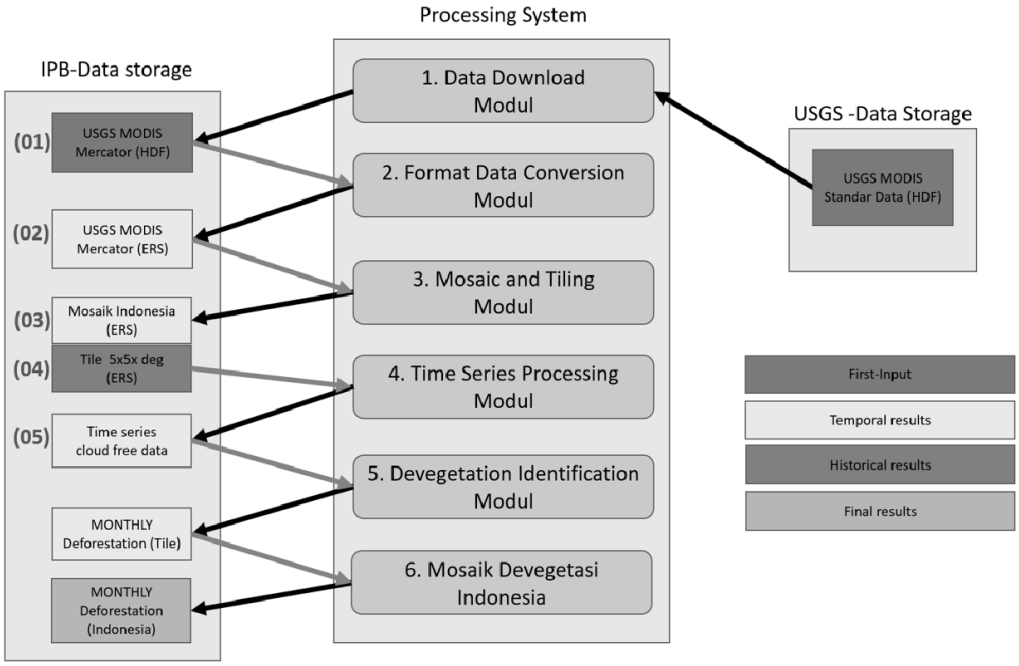

Figure 2. Modul and data flow design developing the early warning system for changes in vegetation cover based on VIIRS image data

Operational data processing in this system is carried out automatically, so it is necessary to run each processing nodes for producing additional output that is used to assess the results of the overall process of data processing on changes in vegetation cover (devegetation).

Each processing nodes that used for assessing overall result process consist of: 1). mosaic image as a result of the geometric transformations throughout Indonesia (for checking this stage, a quicklook image is made for the 3 RGB bands and some errors that might appear are some tiles with different composite bands and empty tiles with no data, and 2). the results of the final processing (for checking whether the results of the final processing process, if the result is available, it means the processing was successful).

For the implementation of a rapid change detection system, 1 data processing server (processing server) at the IPB's main campus is used, which it is connected to the BRIN-LAPAN server, the server with a large capacity storage. Data processing server specifications, namely: Dual processor Intel E5 family with 6 cores with a clock speed of 2.5 GHz; total memory DDR 3 12800, 24 GB; Hard disk with a volume of 24TB 6G SAS 10K rpm 2.5"; RAID controller with Flash Backed Write Cache feature; Ethernet card supports 10GB Ethernet.

Simulation of the Rapid Change Detection System

System simulations have been conducted starting from January 1, 2022 and several 8-day datasets have been processed. The results of the system simulation that has been carried out are as follows: (1) The data processing system has been operating automatically, (2) Information production is obtained with a 3-day delay from the last data, and (3) Email notifications have been successful for the last 3 data.

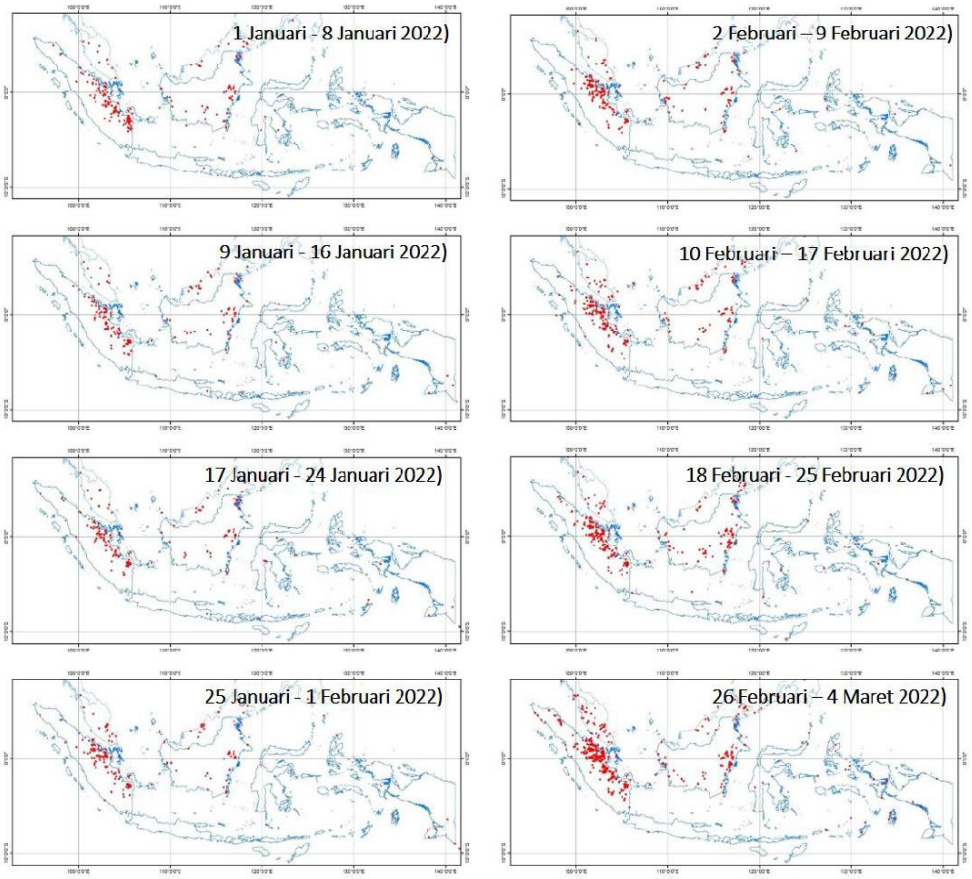

Figure 3. Results of identification of changes in vegetation cover data per 8 days using VIIRS data

The simulation has been tried to run on the server for producing the 8-days early warning system for national scale of Indonesia and the time required to process one 8-day devegetation data is data download 14 minutes, format data conversion 2 minutes, mosaic and tilling 1 minute, time series data processing 81 minutes, processing the devegetation algorithm 85 minutes and mosaic devegetation for all Indonesia 1 minute; so the total required time 3 hours and 3 minutes.