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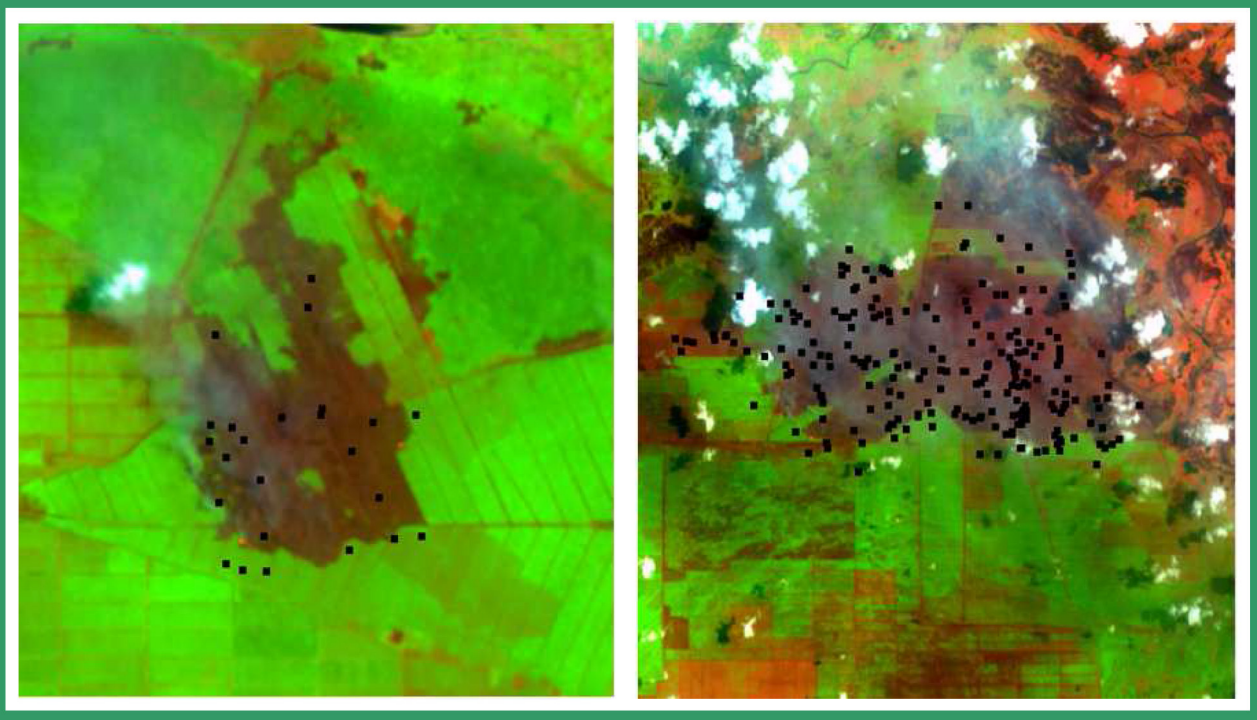

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Editorial Committee Preface

Dear Readers,

Welcome to the International Journal of Remote Sensing and Earth Sciences Vol. 13 No 2, December 2016. This journal is expected to enrich the serial publications on earth sciences, in general, and remote sensing in particular, not only in Indonesia and Asian countries, but also worldwide.

The contents of this journal are particular interest to remote sensing as the main data for geosciences, oceanography, marine biology, fisheries, meteorology, etc. In this thirteenth edition, various topics are discussed, including studies of bathymetry data extraction, utilization of near real-time NOAA/AVHRR satellite output, comparative test of several rainfall estimation methods, comparing atmospheric correction methods, technique for identifying burned vegetation area, technique to reconstruct MODIS band 6 reflection information, identification of forest type classification, and haze removal of visible Landsat 8 bands.

This journal is intended, among others, to complement information on Remote Sensing and Earth Sciences, and also encourage young scientists in Indonesia and Asian countries to contribute their research results. Therefore, we would like to invite scientists to manifest their ideas through scientific research papers. We are looking forward to receiving your manuscripts for the next edition of this journal.

Editor-in-Chief,

Dr. M. Rokhis Khomarudin

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ABSTRACT

DETECTION OF GREEN OPEN SPACE USING COMBINATION INDEX OF LANDSAT 8 DATA (CASE STUDY: DKI JAKARTA)/Sayidah Sulma, Jalu Tejo Nugroho, Any Zubaidah, Hana Listi Fitriana, and Nanik Suryo Haryani
IJReSES, 13 (1) : 1-8

Spatial information about the availability and presence of green open space in urban areas to be up to date and transparent was a necessity. This study explained the technique to get the green open spaces of spatial information quickly using an index approach of Landsat 8. The purpose of this study was to evaluate the ability of the method to detect the green open spaces, especially using Landsat 8 with a combination of several indices, namely Normalized Difference Build-up Index (NDVI), Normalized Difference Water Index (NDWI), Normalized Difference Build-up Index (NDBI) and Normalized Difference Bareness Index (NDBaI) with a study area of Jakarta. This study found that the detection and identification of green open space classes used a combination of index and band gave good results with an accuracy of 81%.

Keywords: *green open space, NDVI, NDWI, NDBI, NDBaI, Landsat 8*

ANALYSIS ON SCENE COMPATIBILITIES FOR MOSAIC OF LANDSAT 8 MULTI-TEMPORAL IMAGES BASED ON RADIOMETRIC PARAMETER/Haris Suka Dyatmika and Liana Fibriawati
IJReSES, 13 (1) : 9-18

Cloud free mosaic simplified the remote sensing imagery. Multi-temporal image mosaic needed to make a cloud free mosaic i.e. in the area covered by cloud throughout year like Indonesia. One of the satellite imagery that was widely used for various purposes was Landsat 8 image due to the temporal, spatial and spectral resolution which was suitable for many utilization themes. Landsat 8 could be used for multi-temporal image mosaic of the entire region in Indonesia. Landsat 8 had 16 days temporal resolution which allowed a region (scene image) acquired in a several times one year. However, not all the acquired Landsat 8 scene was proper when used for multi-temporal mosaic. The purpose of this work was observing radiometric parameters for scene selection method so a good multi-temporal mosaic image could be generated and more efficient processing. This study analyzed the relationship between radiometric parameters from image i.e. histogram and *Scattergram* with scene selection for multi-temporal mosaic purposes. Histogram and *Scattergram* representing radiometric imagery context such as mean, standard deviation, median and mode which was displayed visually. The data used were Landsat 8 imagery with the Area of Interest (AOI) in Kalimantan and Lombok. Then the histogram and *Scattergram* of the image AOI was analyzed. From the histogram and *Scattergram* analysis could be obtained that less shift between the data's histogram and the more *Scattergram* forming 45 degree angle for distribution of the data then indicated more similar to radiometric of the image.

Keywords*: Landsat 8, mosaic, histogram, Scattergram*

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ABSTRACT

DETERMINATION OF FOREST AND NON-FOREST IN SERAM ISLAND MALUKU PROVINCE USING MULTI-YEARS LANDSAT DATA/Tatik Kartika, Ita Carolita, and Johannes Manalu

IJReSES, 13 (1) : 19-26

Seram Island is one of the islands in Maluku Province. Forest in Seram Island are still exists because there is Manusela National Park, but they should be monitored. The forest and non-forest information are usually obtained through the classification process from a single data, but as generally with the other place in Indonesia is difficult enough to get a data which clear of the clouds. Dengan demikian digunakan data mosaic tahunan. The aim of this research was to reanalyze the stratification zone, their index and thresholds to get spatial information of the annual forest area in Seram Island using multi-years Landsat Data. The method consists of four stages: 1) analyzing the base probability result for determining stratification zone 2) determining the annual forest probability by applying indices from stage-I, 3) determining the spatial information of forest and non-forest annual phase-I by searching the lowest boundary of forest probability, and 4) determine the spatial information of forest and non-forest annual phase-II using the method of permutation of three data and multi-years forest rules. The results of this study indicated that Seram Island could be made into one stratification zone with three indices. The index equations were B2+B3-2B for index-1, B3+B4 for index-2, and -B3+B4 for index-3. The threshold ranged of index 1, 2, and 3 were between -60 and 0, 61 and 104, and 45 and 105, respectively. The lowest boundary of forest probability in Seram Island since 2006 to 2012 have a range between 46% and 60%. The last results were the annual forest spatial information phase II where the missing data on the forest spatial information phase I decreased. Those information is very important to analyze the change in forest areas, especially in Seram Island.

Keywords: *Landsat data, missing data, index equation, forest probability*

DEVELOPMENT OF PUSHBROOM AIRBORNE CAMERA SYSTEM USING MULTISPECTRUM LINE SCAN INDUSTRIAL CAMERA/Ahmad Maryanto, Nugroho Widijatmiko, Wismu Sunarmodo, Muhammad Soleh, and Rahmat Arief

IJReSES, 13 (1) : 27-38

One of the steps on mastery the remote sensing technology (inderaja) for satellite was the development of aerial camera prototype that could be an alternative for LAPAN light cargo aircraft mission (LAPAN Surveillance Aircraft, LSA-01). This system was expected could be operated to fulfill the emptiness or change the remote sensing data of optical satellite as the observer of vegetation covered by cloud. On this research, it was developed a prototype of pushbroom airborne camera 4-channels spectrum with very high resolution that worked on wavelength range seem near infra-red/ NIR used simple components that were available in the commercial market (commercial off-the-shelf/ COTS components). This research also developed georeference imagery software module used method of direct georeference rigorous model that had been applied on SPOT satellite. For this one, it was installed supported sensory for GPS and IMU as the writer of location coordinate and camera behavior while doing the imagery exposure or acquisition. The testing result gave confirmation that COTS components, such as industry camera LQ-200CL, and lower class GPS and IMU could be integrated became a cheaper remote sensing system, which its imagery product could be corrected systematically. The corrected data product showed images with GSD 0.4m still had positioning mistakes on average 157m (400 pixel) from the original position on GoogleEarth. On spectro-radiomatic aspect, the used camera had much higher sensitivity of NIR channel than the looked-channel so it caused bored faster. On the future, this system needed to be fixed by increasing the rate of GPS/ IMU data updates, and increased enough time resolution system so that the synchronization process and the availability supported data for completing more accurate georeference process. Besides, the sensitivity of NIR channel needed to be lower down to make it balance to the looked-channel.

Keywords: *airborne camera, industry camera, multi-spectrum, pushbroom*

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ABSTRACT

SPATIAL PATTERN OF HYDROLOGIC RESPONSE UNIT (HRU) EFFECT ON FLOW DISCHARGE OF CI RASEA WATERSHED USING LANDSAT TM IN 1997 TO 2009/Emiyati, Eko Kusratmoko and Sobirin
IJReSES, 13 (1) : 39-50

Hydrologic Response Unit (HRU) is a unit formed of hydrological analysis based on geology and soil type, slope, and land cover. This paper discussed the spatial pattern of Hydrologic Response Unit (HRU) in 1997-2009 and its impact on flow Ci Rasea watershed temporally. In this study, SWAT (Soil and Water Assessment Tool) model, based on land cover changed, was used to get HRU and flow in spatially and temporally. This method used Landsat TM 1997, 2003 and 2009 data for land cover and daily rainfall 1997-2009 for flow modeling. The results showed the spatial pattern of HRU in temporally was affected by landcover based on the changing of HRU. The majority of HRU spatial pattern at Ci Rasea watershed were clustered. During 1997-2009, accumulated surface runoff and the changing of flow discharge were affected by changes of HRU spatial pattern. The biggest accumulated surface runoff in Ci Rasea watershed influenced by HRU of agricultural cropland in area of clay soil type with slope slightly obliquely. While the smallest accumulated surface runoff in Ci Rasea watershed influenced by HRU of paddy field in the area of sandy loam soil type with a gentle slope. The changes of HRU agriculture cropland become HRU mixed cropland in area clay soil type with slope at a slight angle and HRU agriculture cropland become HRU paddy field in area, sandy loam soil type with a gentle slope could be decreasing the accumulation of surface runoff in Ci Rasea watershed.

Keywords: *Ci Rasea watershed, HRU, surface runoff, SWAT model, landcover*

DEVELOPMENT OF ANNUAL LANDSAT 8 COMPOSITE OVER CENTRAL KALIMANTAN, INDONESIA USING AUTOMATIC ALGORITHM TO MINIMIZE CLOUD/Kustiyo
IJReSES, 13 (1) : 51-58

Since January 2013, Landsat 8 data can be freely accessed from LAPAN, making it possible to use the all available Landsat 8 data to produce the cloud-free Landsat 8 composite images. This study used Landsat 8 archive images in 2015, Operational Land Imager (OLI) sensor in 30 meter resolution, geometric correction level of L1T. The eight data in L1T of 118-062, southern part of Central Kalimantanwere used to produce a cloud-free composite image. Radiometric correction using Top of Atmosphere (TOA) and Bidirectional Reflectance Distribution Function (BRDF) algorithm to produce reflectance images have been applied, and then the most cloud-free pixels were selected in composite result. Six composite methods base on greens, open area and haze indices were compared, and the best one was selected using visual analysis. The analysis shows that the composite algorithm using Max (Max (NIR, SWIR1) / Green) produces the best image composite.

Keyword: *Landsat 8, composite, cloud-free*

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ABSTRACT

VARIATION AND TREND OF SEA LEVEL DERIVED FROM ALTIMETRY SATELLITE AND TIDE GAUGE IN CILACAP AND BENOA COASTAL AREAS/Amelius Andi Mansawan, Jonson Lumban Gaol, and James P. Panjaitan
IJReSES, 13 (1) : 59-66

Observations of sea levels continuously is very important in order to adapt the disasters in the coastal areas. Conventionally observations of sea level using tide gauge, but the number of tide gauge installed along the coast of Indonesia is still limited. Altimetry satellite data is one solution; therefore it is necessary to assess the potential and accuracy of altimetry satellite data to complement the sea level data from tide gauges. The study was conducted in the coastal waters of Cilacap and Bali by analysis data Envisat satellite altimetry for period 2003 to 2010 and data compiled from a variety of satellite altimetry from 2006 to 2014. Data tidal was used as a comparison of altimetry satellite data. The altimetry satellite data in Cilacap and Benoa waters more than 90% could be used to assess the variation and the sea level rise during the period 2003-2010. The rate of sea level rise both the data of tidal and satellite altimetry data indicates the same rate was 3.5 mm/year in Cilacap in Benoa are 4.7 mm/year and 5.60 mm/year respectively.

Keywords*: altimetry, sea level rise tide, satellite*

LINEAMENT DENSITY INFORMATION EXTRACTION USING DEM SRTM DATA TO PREDICT THE MINERAL POTENTIAL ZONES /Udhi C. Nugroho and Arum Tjahjaningsih
IJReSES, 13 (1) : 67-74

Utilization of remote sensing in geology based on some identification of key parameters, they were the relief or morphology, flow patterns, and lineament, so it was necessary to study the parameter extraction method. This study aimed to obtain zoning lineament density in the Geumpang area, Aceh, associated with mineral resource potential.Information of lineament density using remote sensing data was expected to help solve the problems that arised in the activities of early exploration, the difficulty of finding the prospect area or areas that had special anomalous, so that the activities of pre-exploration always required a very wide area and required a very long time to determine the location anomaly, it would have a direct impact on the financial exploration activities.The used data was Landsat 8 and DEM SRTM 30m. The used method was processing of shaded relief on DEM data with the azimuth angle 0^o, 45^o, 90^o, and 135^o, then the result of hill shade process was done overlay, so DEM seen from all different azimuth angles. The results of the overlay was processed using the algorithm LINE with parameters such as the radius of the filter in pixels (RADI) 60, the threshold for edge gradient (GTHR) 120, the threshold for the curve length (LTHR) 100, the threshold for line fitting error (FTHR) 3, threshold for angular (ATHR) 30, and the threshold for linking distance (DTHR) 100. Vector lineament data from LINE algorithm process then performed density analysis to obtain lineament density zoning. Results from the study showed that the area has a high densitylineament associated with hydrothermal mineral potential, so it was useful at the time of exploration activities to minimize the survey area.

Keywords: geology, remote sensing, lineament, density, mineral, DEM, SRTM

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ABSTRACT

BATHYMETRY DATA EXTRACTION ANALYSIS USING LANDSAT 8 DATA/Kuncoro Teguh Setiawan, Syifa Wismayati Adawiah, Yennie Marini, and Gathot Winarso
IJReSES, 13 (2) : 79-86

The remote sensing technique can be used to produce bathymetric map. Bathymetric mapping is important for the coastal zone and watershed management. In a previous study conducted in Pulau Menjangan Bali, bathymetric extracting information from the top of the atmosphere (TOA) reflectance image of Landsat ETM+ data has R^2 = 0.620. Not optimal correlation value produced is highly influenced by the reflectance image of Landsat ETM+ data were used, hence the lack of the research which became the basis of the present study. The study was on the Karang Lebar water of Thousand Islands, Jakarta and the aim was to determine whether there was an increased correlation coefficient value of bathymetry extraction information generated from Surface reflectance and TOA reflectance image of Landsat 8 data acquired on August 12, 2014. Extraction absolute depth information obtained from the model logarithm of Landsat 8 surface reflectance images and pictures TOA produce a correlation value of R^2 = 0.663 and R^2 = 0.712. The method of extraction was done using algorithms Van Hengel and Spitzer (1991).

Keywords: *bathymetry, Landsat 8, reflectance, Van Hengel and Spitzer algorithm*

UTILIZATION OF NEAR REAL-TIME NOAA-AVHRR SATELLITE OUTPUT FOR EL NIÑO INDUCED DROUGHT ANALYSIS IN INDONESIA (CASE STUDY: EL NIÑO 2015 INDUCED DROUGHT IN SOUTH SULAWESI)/Amsari Mudzakir Setiawan, Yonny Koesmaryono, Akhmad Faqih, and Dodo Gunawan
IJReSES, 13 (2) : 87-94

Drought is becoming one of the most important issues for government and policy makers. National food security highly concerned, especially when drought occurred in food production center areas. Climate variability, especially in South Sulawesi as one of the primary national rice production centers is influenced by global climate phenomena such as El Niño Southern Oscillation or ENSO. This phenomenon can lead to drought occurrences. Monitoring of drought potential occurrences in near real-time manner becomes a primary key element to anticipate the drought impact. This study was conducted to determine potential occurrences and the evolution of drought that occurred as a result of the 2015 El Niño event using the Vegetation Health Index (VHI) from the National Oceanic and Atmospheric Administration (NOAA) Advanced Very High Resolution Radiometer (AVHRR) satellite products. Composites analysis was performed using weekly Smoothed and Normalized Difference Vegetation Index (or smoothed NDVI) (SMN), Smoothed Brightness Temperature Index (SMT), Vegetation Condition Index (VCI), Temperature Condition Index (TCI), and Vegetation Health Index (VHI). This data were obtained from The Center for Satellite Applications and Research (STAR) - Global Vegetation Health Products (NOAA) website during 35-year period (1981-2015). Lowest potential drought occurrences (highest VHI and VCI value) caused by 2015 El Niño is showed by composite analysis result. Strong El Niño induced drought over the study area indicated by decreasing VHI value started at week 21st. Spatial characteristic differences in drought occurrences observed, especially on the west coast and east coast of South Sulawesi during strong El Niño. Weekly evolution of potential drought due to the El Niño impact in 2015 indicated by lower VHI values (VHI < 40) concentrated on the east coast of South Sulawesi, and then spread to another region along with the El Nino stage.

Keywords*: drought, near real-time monitoring, NOAA-AVHRR, VHI, VCI, TCI, El Niño*

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ABSTRACT

COMPARATIVE TEST OF SEVERAL RAINFALL ESTIMATION METHODS USING HIMAWARI-8 DATA/Nanda Alfuadi and Agie Wandala
IJReSES, 13 (2) : 95-104

Indonesian society needs information on potential hydrometeorological disasters is increasing, because of that the development of rainfall estimation methods becomes an important because it relates to the impact of disaster risk reduction. Central Kalimantan has the area of cloud cover fairly intensive throughout the year can be as location for research of comparative test of rainfall estimation methods based on Himawari-8 IR1 (11μm) data. Some rainfall estimation methods tested in this research are AE, CST, CSTM, IMSRA, Non Linear Relation and Non Linear Inversion. Each of these methods tends to have a weakness in the value of accuracy, so this research aims to determine the most accurate method to be applied in Palangkaraya (27 meters above sea level) and Muratewe (60 meters above sea level) which is the districts / cities in Central Kalimantan. An experiment conducted during the period of highest rainfall in January and February 2016 by converting the temperature data cloud tops (IR1) into a precipitation with AE, CST, CSTM, IMSRA, Non Linear Relation and Non Linear Inversion method. Based on the results of quantitative analysis is known that the best method of six estimation methods in this research which can be applied in rainfall estimation in Muarateweh's and Palangka Raya's winter is IMSRA. Accuracy of entire estimation methods decreases when be applied in Palangka Raya at afternoon and in Muarateweh at night until early morning. The estimation method with the lowest score is the AE with an average MSE> 90 and the best estimation method is IMSRA with MSE value <12.

Keywords: *estimation, rainfall, satellite, Palangka Raya, Muaratewe*

COMPARING ATMOSPHERIC CORRECTION METHODS FOR LANDSAT OLI DATA/Esthi Kurnia Dewi and Bambang Trisakti
IJReSES, 13 (2) : 105-120

Landsat data used for monitoring activities to land cover because it has spatial resolution and high temporal. To monitor land cover changes in an area, atmospheric correction needed to be performed in order to obtain data with precise digital value picturing current condition. This study compared atmospheric correction methods namely Quick Atmospheric Correction (QUAC), Dark Object Subtraction (DOS) and Fast Line-of-sight Atmospheric Analysis of Spectral Hypercubes (FLAASH). The correction results then were compared to Surface Reflectance (SR) imagery data obtained from the United States Geological Survey (USGS) satelite. The three atmospheric correction methods were applied to Landsat OLI data path/row126/62 for 3 particular dates. Then, sample on vegetation, open land and bodies of water (waterbody) were retrieved from the image. Atmospheric correction results were visually observed and compared with SR sample on the absolute value, object spectral patterns, as well as location and time consistency. Visual observation indicates that there was a contrast change on images that had been corrected by using FLAASH method compared to SR, which mean that the atmospheric correction method was quite effective. Analysis on the object spectral pattern, open land, vegetation and waterbody of images corrected by using FLAASH method showed that it was not good enough eventhough the reflectant value differed greatly to SR image. This might be caused by certain variables of aerosol and atmospheric models used in Indonesia. QUAC and DOS made more appropriate spectral pattern of vegetation and water body than spectral library. In terms of average value and deviation difference, spectral patterns of open land corrected by using DOS was more compatible than QUAC.

Keywords: *Landsat, atmospheric correction, QUAC, FLAASH, DOS, surface reflectance*

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ABSTRACT

TECHNIQUE FOR INDENTIFYING BURNED VEGETATION AREA USING LANDSAT 8 DATA/ Bambang Trisakti, Udhi Catur Nugroho, and Any Zubaidah
IJReSES, 13 (2) : 121-130

During the last two decades, forest and land fire is a catastrophic event that happens almost every year in Indonesia. Therefore, it is necessary, develop technic to monitor forest fires using satellite data to obtain the latest information of burned area in a large scale area. This objective of this research is to develop a method for burned area mapping that happened between two Landsat 8 data recording on August 13rd and September 14th 2015. Burned area was defined as a burned area of vegetation. The hotspot distribution during the period August - September 2015 was used to help visual identification of burned area on the Landsat image and to verify the burned area resulted using the method. Samples were taken at several land covers to determine the spectral pattern differences among burned area, bare area and other land covers, and then perform the analysis to determine the suitable spectral bands or indexes and threshold values that will be used in the model. Landsat recorded before the fire was extracted from a soil, while Landsat recorded on September 14th was extracted for burned area. Multi-temporal analysis was done to get the burned area occurring during the certain period. The results showed that the clouds could be separated using a combination of ocean blue and cirrus band, the burned area by using a combination of NIR and SWIR band, while soil using ratio SWIR / NIR. Burned area Obtained in this study has a high correlation with the hotspot density of MODIS with the accuracy was 82,4 % relative to the hotspot.

Keywords: *burned area, Landsat 8, bare area, hotspot distribution*

TECHNIQUE TO RECONSTRUCT BAND 6 REFLECTANCE INFORMATION OF AQUA MODIS/Andy Indradjad, Noriandini Dewi Salyasari, and Rahmat Arief
IJReSES, 13 (2) : 131-138

Remote sensing data could experience damage due to sensor failure or atmospheric condition. Reconstruction technique to retrieve the missing information had been widely developed in the past few years. This writing aimed to provide technique to recover reflectance information of Aqua Moderate Resolution Imaging Spectroradiometer (MODIS) Band 6. Since Band 6 Aqua MODIS experienced sensor failure, lots of information would be missing. There were three kinds of methods used in repairing such damage. Two of which were categorized as spatial-based methods, i.e. NaN interpolation method and tensor completion method. Whereas, another method was a spectral-based one. NaN was an interpolation method to reconstruct missing value; while tensor completion method utilized low rank approximation, and spectral method used correlation between Band 6 and Band 7 which had near wavelength. Implementation of these methods was resulted in reconstruction of Aqua MODIS Band 6 data which was damaged due to detector dysfunction on Aqua satellite.

Keywords: *data reconstruction, MODIS band 6, aqua*

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ABSTRACT

IDENTIFICATION AND CLASSIFICATION OF FOREST TYPES USING DATA LANDSAT 8 IN KARO, DAIRI, AND SAMOSIR DISTRICTS, NORTH SUMATERA/Heru Noviar and Tatik Kartika
IJReSES, 13 (2) : 139-150

Forests have an important role in terms of carbon storage and other values. Various studies have been conducted to identify and distinguish the forest from non-forest classes. Some classes important forests such as secondary forests and plantations should be distinguished related to the restoration and rehabilitation program for dealing with climate change. Ministry of Environment and Forests (KLHK) perform interpretation of Landsat data and classifying forests into 7 classes of forest, the dry forest primary dry forest secondary swamp forest of primary, secondary swamp forest, mangrove forests primary, mangrove forests secondary and plantation forests, With the availability of Landsat data generation (Landsat 8), the study was carried out to distinguish several classes of important forest as dry forest primary dry forest of secondary and plantation forests using Landsat 8 to develop identification techniques classes specific forest. Case studies from a forest area in the province of North Sumatra, especially in the third district, namely Karo, Dairi and Samosir.

Key words*: identification techniques, important forest class, Landsat 8*

HAZE REMOVAL IN THE VISIBLE BANDS OF LANDSAT 8 OLI OVER SHALLOW WATER AREA/Kustiyo and Anis Kamilah Hayati
IJReSES, 13 (2) : 151-157

Haze is one of radiometric quality parameters in remote sensing imagery. With certain atmospheric correction, haze is possible to be removed. Nevertheless, an efficient method for haze removal is still a challenge. Many methods have been developed to remove or to minimize the haze disruption. While most of the developed methods deal with removing haze over land areas, this paper tried to focus to remove haze from shallow water areas. The method presented in this paper is a simple subtraction algorithm between a band that reflected by water and a band that absorbed by water. This paper used data from Landsat 8 with visible bands as a band that reflected by water while the band that absorbed by water represented by NIR, SWIR-1, and SWIR-2 bands. To validate the method, a reference data which relatively clear from cloud and haze contamination is selected. The pixel numbers from certain points are selected and collected from data scene, results scene and reference scene. Those pixel numbers, then being compared each other to get a correlation number between data scene to reference scene and between result scene and reference scene. The comparison shows that the method using NIR, SWIR-1, and SWIR-2 all significantly improved correlation numbers between result scene with reference scene to higher than 0.9. The comparison also indicates that haze removal result using NIR band had the highest correlation with reference data.

Keywords: *haze removal, shallow water, Landsat 8*