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Figure 3.1. Typical appearance of mangrove vegetation in the composite 564 (RGB) Landsat 8 Data.

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Editorial Committee Preface

Dear Readers,

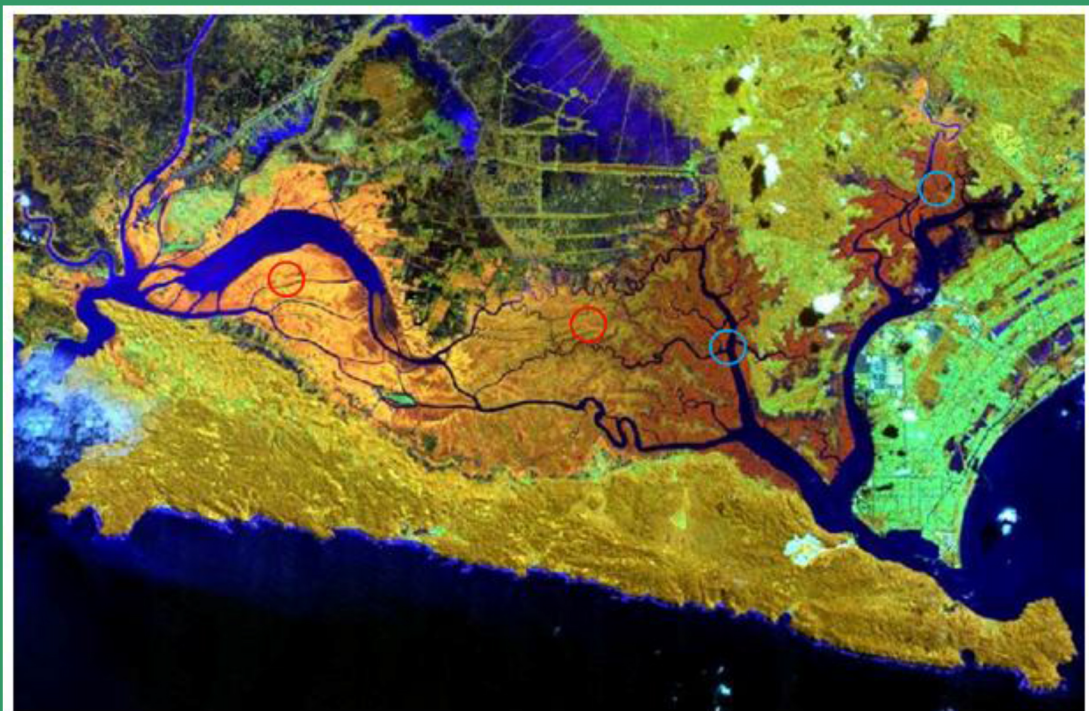Welcome to the International Journal of Remote Sensing and Earth Sciences Vol. 11 No 2, December 2014. This journal is expected to enrich the serial publications on earth sciences, in general, and remote sensing in particular, not only in Indonesia and Asian countries, but also worldwide.

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 eleventh edition, various topics are discussed, including studies of analysis of SAR main parameters for SAR sensor design, A two-steps radiometric correction multispectral and multitemporal for seamless mosaic, evaluation of mangrove damage level, evaluation of Spot-5 image fusion, the use of high resolution images, analysis of sea surface height anomaly characteristics, sub bituminous coal detection, and information system of drought impact on rice production.

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

Contents

ABSTRACT

DIGITAL IMAGE PROCESSING OF SPOT-4 FOR SHORELINE EXTRACTION IN LAMPUNG BAY/ Emiyati, Syarif Budhiman, and Ety Parwati
IJReSES, 11 (1) : 1-10

Shoreline is an imaginary line separating land and seawater. The intensification of land used/land cover at Lampung bay causes shoreline change either abrasions or accretions. The objectives of this study were to compare the shoreline extraction based on the digital image processing of SPOT-4 using ratio band of infrared and green band, Normalized Difference Vegetation Index (NDVI), and (band infrared) methods and to analyze shoreline change at Lampung Bay. Those methods applied on both cloudy free and cloudy SPOT-4 images and the result compared with RBI map as reference. The result showed that the best metod for shoreline axtraction was ratio band due to accuracy high and stable eventhough it applied on cloudy image. The shoreline changes at Lampung Bay along 2008 to 2012 caused by accretions. The total area of accretion at Lampung Bay for fours years were 662 Ha with the rates 165 Ha/year. The high of accretion rate caused by reclamation for urban built up, fishponds and mangrove.

Keywords : *shoreline, SPOT-4 image, ratio method, NDVI, single band infrared, Lampung Bay*

MODIS STANDARD (OC3) CHLOROPHYLL-A ALGORITHM EVALUATION IN INDONESIAN SEAS/Gathot Winarso and Yennie Marini
IJReSES, 11 (1) : 11-20

The MODIS-estimated chlorophyll-a information was widely used in some operational application in Indonesia. However, there is no information about the performance of MODIS chlorophyll-a in Indonesian seas and there is no data used in development of algorithm was taken in Indonesian seas. Even the algorithm was validated in other area, it is important to know the performance of the algorithm work in Indonesian seas. Performance of MODIS Standard (OC3) algorithm at Indonesian seas was analyzed in this paper. The in-situ chlorophyll-a concentration data was collected during MOMSEI (*Monsoon Offset Monitoring and Its Social and Ecosystem Impact*) 2012 Cruise 25th April – 12th May 2012 and also from archived data of the Research and Development Center for Marine Coastal Resources, Agency of Marine and Fisheries Research and Development, Indonesian Ministry of Marine Affairs and Fisheries. The in-situ data used in this research is located in Indian Ocean the west of Sumatera part and Pacific Ocean the north of Papua Province part. Satellite data which is used is Ocean Color MODIS Level-2 Product that downloaded from NASA and MODIS L-0 from LAPAN Ground Station. MODIS Level 0 from LAPAN then processed to Level-2 using latest SeaDAS Software. The match-up resulted the MNB(%) is -4.8% that means satellite-estimated was underestimate in 4.8 % and RMSE is 0.058. When the data was separated following to the data source, the correlation and trend line equation became better. From MOMSEI Cruise data, the MNB(%) was -18.8% and RMSE 0.05. From Pacific Ocean Data, MNB (%) was -27 % and RMSE 0.049. From SONNE Cruise 2005, MNB (%) was -27 % and RMSE 0.049. MODIS standard algorithm is work well in Indonesia case-1 seawaters, which contain chlorophyll-a only, and derived that influence to the electromagnetic wave.

Keywords : *MODIS, Chlorophyll-a, OC3 Algorithm, Indonesian seas*

ABSTRACT

DETECTION OF ACID SLUDGE CONTAMINATED AREA BASED ON NORMALIZED DIFFERENCE VEGETATION INDEX (NDVI) VALUE / Nanik Suryo Haryani, Sayidah Sulma, and Junita Monika Pasaribu
IJReSES, 11 (1) : 21-32

The solid form of oil heavy metal waste is known as acid sludge. The aim of this research is to exercise the correlation between acid sludge concentration in soil and NDVI value, and further studying the Normalized Difference Vegetation Index (NDVI) anomaly by multi-temporal Landsat satellite images. The implemented method is NDVI. In this research, NDVI is analyzed using the remote sensing data on dry season and wet season. Between 1997 to 2012, NDVI value in dry season is around – 0.007 (July 2001) to 0.386 (May 1997), meanwhile in wet season NDVI value is around – 0.005 (November 2006) to 0.381 (December 1995). The high NDVI value shows the leaf health or thickness, where the low NDVI indicates the vegetation stress and rareness which can be concluded as the evidence of contamination. The rehabilitation has been executed in the acid sludge contaminated location, where the high value of NDVI indicates the successfull land rehabilitation effort.

Key words: *acid sludge, contamination, Normalized Difference Vegetation Index (NDVI)*

INTERPOLATION METHODS FOR SEA SURFACE HEIGHT MAPPING FROM ALTIMETRY SATELLITES IN INDONESIAN SEAS/Rossi Hamzah and Teguh Prayogo
IJReSES, 11 (1) : 33-40

Altimetry satellite data, has a very low spatial resolution for using in determine fishing ground area. With very low spatial resolution is required interpolation method that can mapped Sea Surface Height (SSH) with a good result. SSH data from Global Near Real Time from AVISO, mapped in geographic projection and interpolated with Inverse Distance Weighting (IDW) and Ordinary Krigging method. This interpolation method are expected to know which the good method for mapped SSH data in resulting better information. The results of statistical calculation shows that RMSE value and standar deviations from kriging method is smaller than IDW method.

Keywords: *spatial interpolation, kriging, inverse distance weighting, sea surface height, altimetry*

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ABSTRACT

APPLICATION OF CMORPH DATA FOR FOREST/ LAND FIRE RISK PREDICTION MODEL IN CENTRAL KALIMANTAN/Indah Prasasti, Rizaldi Boer, and Lailan Syaufina

IJReSES, 11 (1) : 41-54

Central Kalimantan Province is a region with high level of forest/land fire, especially during dry season. Forest/land fire is a dangerous ecosystem destroyer factor, so it needs to be anticipated and prevented as early as possible. CMORPH rainfall data have good potential to overcome the limitations of rainfall data observation. This research is aimed to obtain relationship model between burned acreage and several variables of rainfall condition, as well as to develop risk prediction model of fire occurrence and burned acreage by using rainfall data. This research utilizes information on burned acreage (Ha) and CMORPH rainfall data. The method applied in this research is statistical analysis (finding correlation and regression of two phases), while risk prediction model is generated from the resulting empirical model from relationship of rainfall variables using Monte Carlo simulation based on stochastic spreadsheet. The result of this study shows that precipitation accumulation for two months prior to fire occurrence (CH2Bl) has correlation with burned acreage, and can be estimated by using following formula (if rainfall ≤ 93 mm): Burnt Acreage (Ha) = 5.13 – 21.7 (CH2bl – 93) (R^2 = 67.2%). Forest fire forecasts can be determined by using a precipitation accumulation for two months prior to fire occurrence and Monte Carlo simulation. Efforts to anticipate and address fire risk should be carried out as early as possible, i.e. two months in advance if the probability of fire risk had exceeded the value of 40%.

Keywords: *Forest/Land Fire Risk, CMORPH, Monte Carlo Simulation, Central Kalimantan*

SYNERGY APPROACH FOR IMPLEMENTING THE POLICY ON HIGH RESOLUTION IMAGERY TO ACCELERATE BASIC AND THEMATIC GEOSPATIAL INFORMATION/Sukendra Martha, Aris Poniman, and Hartono

IJReSES, 11 (1) : 55-62

Presidential Order no. 6/2012 mentioned explicitly to use ortho-rectifed image for the purposes of national program done by all Indonesian governmental agencies. Policy of uses, control quality, processing and distribution of high resolution of satellite data are regulated by this Order. There are some advantages of implementing this Order particularly in accelerating the national geospatial data and information, however, without synergy use of high resolution imagery (including integration, coordination and harmonization), in the present condition so far some obstacles have been discovered. Without synergic actions or approaches, the Order will not provide optimal impact as the main objectives to make more efficient in using the national budget. This article describes the needs of synergy approach to implement the Presidential Order no. 6/2012 concerning the uses, distribution of high remotely sensed imageries.

Keywords: *remote sensing policy, basic and thematic geospatial information, synergy approaches.*

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ABSTRACT

DETECTING THE SPATIAL DISTRIBUTION OF SETTLEMENTS ON VOLCANIC REGION USING IMAGE LANDSAT-8 OLI IMAGERY/Suwarsono and M. Rokhis Khomarudin
IJReSES, 11 (1) : 63-72

Geologically, Indonesia region is on track ring of fire, brings the consequence that the danger of volcanic eruption could occur at any time. Information sites where the settlement is located in the affected areas on emergency response process is needed in quick time. The availability of up to date data is important because it illustrates the actual condition of the region. Active volcanic landforms ranging from the crater to footslope in general is prone area to volcanic eruption, either by the threat of lava flows, pyroclastic falls, or lahars. This study aims to detect the spatial distribution of the settlement on volcanic region using Landsat-8 OLI. Parameters used for the detection of settlements is Normalized Difference Build-up Index (NDBI). Research methods include radiometric correction, delineation of the boundaries of volcanic landforms, NDBI value extraction, extraction of settlement areas, as well as the accuracy assesment. Study area is Sinabung Volcano region located in the province of North Sumatera. Recently, the volcano experienced a devastating and catastrophic eruption. The results showed that the spatial distribution of settlements on volcanic landforms can be detected quickly from Landsat-8 OLI based on NDBI parameters with a sufficient degree of accuracy.

Keywords : *Settlement, Volcanic Landforms, Sinabung Volcano, NDBI*

APPLICATION OF VAN HENGEL AND SPITZER ALGORITHM FOR INFORMATION ON BATHYMETRY EXTRACTION USING LANDSAT DATA/Kuncoro Teguh Setiawan, Syifa Wismayati Adawiah, Takahiro OSAWA, and I. Wayan Nuarsa
IJReSES, 11 (1) : 73-80

Remote sensing technology provides an opportunity for effective and efficient bathymetry mapping, especially in areas which level of depth changes quickly. Bathymetry information is very useful for hydrographic and shipping safety. Landsat medium resolution satellite imagery can be used for the extraction of bathymetry information. This study aims to extract information from the Landsat bathymetry by using Van Hengel and Spitzer rotation algorithm transformation (1991) in the water of Menjangan Island, Bali. This study shows that Van Hengel and Spitzer rotation algorithm transformation (1991) can be used to extract information on the bathymetry of Menjangan Island. Extraction of bathymetric information generated from Landsat TM imagery data in March 19, 1997 had shown the depth interval of (-0.6) m to (-12.3) m and R^2 value of 0.671. While Data LANDSAT ETM + dated June 23, 2000 resulted in depth interval of 0 m to (-19.1) m and R^2 value of 0.796. Furthermore, data LANDSAT ETM + dated March 12, 2003 resulted in depth interval of 0 m to (-22.5) m and R^2 value of 0.931.

Keywords: *Bathymetry, LANDSAT ETM+, Van Hengel and SpitzerAlgorithm*

ABSTRACT

ANALYSIS OF SAR MAIN PARAMETERS FOR SAR SENSOR DESIGN ON LSA/Muchammad Soleh and Rahmat Arief
IJReSES, 11 (2) : 85-96

LAPAN plans to conduct a flight test of LSA (LAPAN Surveillance Aircraft). LSA STEMME-S15 is capable of carrying sensor payloads up to 160 kg that are mounted on both sides of the wings with altitude between 400-2000 m. LSA can be designed to perform imaging by using optical sensors and SAR (Synthetic Aperture Radar). Compared to imaging using optical sensors, SAR sensor has advantages such as it can operate all day and night, able to penetrate clouds, and able to see objects from side looking, while optical sensors generally see the object perpendicular to the ground. Therefore the use of SAR imaging technology can complement optical imaging technology. To design SAR system imagers on LSA, it is necessary to simulate the primary parameters SAR i.e. altitude and look angle of sensor, speed of LSA, SAR frequency and signals power shot to object to calculate the resolution of azimuth and ground range values that can be obtained. This SAR parameters simulation used MATLAB which have been designed with two approaches; the first approach where the SAR sensor is ideal and in which all the fundamental parameters (such as polarization, frequency, etc.) are used to generate the desired sensitivity and resolution of azimuth and ground range, and the second approach is where SAR sensor is designed in a limited antenna size (constraint case), with the assumption that the dimensions of the antenna and the average available power are fixed. The data used in this simulation is a pseudo-data obtained from LSA technical spesification and SAR sensor. The simulation results with the first approach shows that if LSA is flying at an altitude of 1000 m, with speedof 36.11 m/s, and SAR frequency of 5.3 GHz,then to get resolution of azimuth, slant range and ground range of 1 m, 1.2 m and 3 m, it is necessary to design the length and width ofSAR antenna at 2 m and 13.5 cm, with look angle of 23.5 degrees. While the result of second approach simulation is that if LSA is flying on the same altitude and speed, on the same look angle and SAR frequency, with a particular design of antenna length and width of 2 m and 13.5 cm, thenazimuth, slant range and ground range resolution of 1 m, 1.87 and 4.79 m will be obtained. Form both simulations, it can be concluded that limited SAR system on LSA, especially on the technical aspects of mounting and space as in the simulation with the second approach, will produce slightly lower slant range and ground range resolution when compared with SAR system in the first simulation. This shows that space limitation on LSA will affect decrease the value of spatial ground range resolution. The simulation results are expected to be inputson designing SAR imaging system on LSA.

Keywords : *Synthetic Aperture Radar (SAR), LAPAN Surveillance Aircraft (LSA), SAR parameters*

A TWO-STEPS RADIOMETRIC CORRECTION OF SPOT-4 MULTISPECTRAL AND MULTITEMPORAL FOR SEAMLESS MOSAIC IN CENTRAL KALIMANTAN/Kustiyo, Ratih Dewanti, and Inggit Lolita Sari
IJReSES, 11 (2) : 97-104

This research analyzed the radiometric correction method using SPOT-4 imageries to produce the same reflectance for the same land cover. Top of Atmosphere (TOA) method was applied in previous radiometric correction approach, this TOA approach was upgraded with the reflectance effect from difference satellite viewing angle. The 250 scene of Central Kalimantan SPOT-4 imageries from 2006 until 2012 with varies viewing angle was used. This research applied two-step approaches, the first step is TOA correction, and the second step is normalization using a linear function of reflectance and satellite viewing angle. Gain and offset coefficient of this linear function was calculated using an iterative approach to producing the same reflectance in the forest area. The target of iterative processed is to minimize the standard deviation of a digital number from a forest area in the selected region. The result shows that the standard deviation of a digital number from a forest area in the two steps approach are 8.6, 16.5, and 16.8 for band 1, band 3 and band 4. These values are smaller compared with the standard deviation of digital number result from TOA approach are 15.0, 28,3 and 34.7 for band 1, band 3 and band 4. Decreasing the standard deviation shows the homogeneity of forest reflectance that could be seen in the seamless result. This algorithm can be applied for making seamless SPOT-4 mosaic whole of Indonesia.

Keywords: *Radiometric correction, Reflectance, Viewing angle*

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ABSTRACT

EVALUATION OF MANGROVE DAMAGE LEVEL BASED ON LANDSAT 8 IMAGE/Gathot Winarso and Anang D. Purwanto
IJReSES, 11 (2) : 105-116

Monitoring of mangrove damage in Java requires special attention because the mangrove vegetation has been under pressure from various other land uses which are considered more productive. This paper applied quick-mangrove-damage-detection technique using Landsat 8. The purpose of this study is to develop mangrove damage identification algorithm using Landsat 8. The findings from field survey in Segara Anakan-Cilacap show that major mangrove logging generates the growth of minor mangrove, specifically *Derris* and *Acanthus* type; the minor mangrove cover area is categorized as high density based on NDVI value. The index use does not meet the actual condition in the field. This study proposes a new index as mangrove quality indicator. The new proposed mangrove index is derived from 2 bands that could differentiate mangrove vegetation where different digital number of two bands is higher from mangrove forest than non-mangrove forest. That phenomenon is caused the low of SWIR spectral on mangrove forest due to absorption by wet soil below the mangrove forest where flooded in high tide. The new mangrove index is formulated as (NIR – SWIR / NIR x SWIR) x 10000. The new mangrove index has good correlation with density of major mangrove in the field, and also good correlation with mangrove degradation map. Mangrove index has been functioning properly and can be applied in Segara Anakan, Cilacap and potentially can be applied in other locations.

Keywords: *Mangrove, new index, mangrove degradation, remote sensing*

EVALUATION OF SPOT-5 IMAGE FUSION USING MODIFIED PAN-SHARPENING METHODS/ Sukentyas Estuti Siwi
IJReSES, 11 (2) : 117-126

Image fusion, commonly known as pan-sharpening, is a method that combines two data: a panchromatic image that has geometric detail information with the highest spatial resolution and multi-spectral image that has the highest color information but with the lowest resolution. *Pan-sharpening* is very important for various remote sensing applications, such as to improve the image classification, to change the detection using temporal data, to increase the geometric, image segmentation, and to improve the visibility of certain object that does not appear on certain data. This study aims to compare the existing pan-sharpening methods such as Brovey, Brovey modification using green and red band, Gram-Schmidt, HPF, Multiplicative, and SFIM. The quality of the pan-sharpening result should be evaluated, this study used Universal Image Quality Index (UIQI/Q index); this evaluation method gives the opportunity to choose which method is best to provide the most similar spectral information with the original multispectral image. A pan-sharpening qualitative analysis shows that there has been a sharpening process on all pan-sharpening images. Based on spectral visualization (color display), several pan-sharpening methods such as HPF multiplicative method provides brighter colors and Brovey transformation method displays dark colors. Gram-Schmidt method also provides a different color from the original multispectral image. A pan-sharpening quantitative analysis shows that the best pan-sharpening method with UIQI value> 0.9 is Brovey modification using green and red band. This is due to the green band (500-590 nm) and the red band (610-680 nm) wavelength are in the panchromatic band (480-710 nm) of the SPOT-5 Data.

Keywords: *Image Fusion. Pan-sharpening method, SPOT-5, UIQI*

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ABSTRACT

THE USE OF HIGH RESOLUTION IMAGES TO EVALUATE THE EVENT OF FLOODS AND TO ANALYSE THE RISK REDUCTION (CASE STUDY: KAMPUNG PULO, JAKARTA)/M. Rokhis Khomarudin, Suwarsono, Dini Oktavia Ambarwati, and Gunawan Prabowo
IJReSES, 11 (2) : 127-136

The flood hit Kampung Pulo region in almost every year. This disaster has caused the evacuation of some residents in weeks. Given the frequency of occurrence is quite high in the region it is necessary to do a study to support disaster risk reduction. This study aimed to evaluate the incidence of flooding that occurred in Kampung Pulo in terms of topography, river conditions, characteristics of the building, and socioeconomic conditions. Methods of study include geomorphology analysis, identification of areas of stagnant, the estimated number of people exposed, the estimation of socio-economic conditions of the population, as well as determining the location of an evacuation. The data used is high-resolution remote sensing imagery is QuickBird and SPOT-6. It also used the results of aerial photography using Unmanned Aerial Vehicle (UAV). Aerial photography was conducted on January 18, 2013, which is when the serious flooding that inundated almost the entire region of Kampung Pulo. Information risk level of buildings and population resulting from this study were obtained by using GIS. The results obtained from this study can be used to develop recommendations and strategies for flood mitigation in Kampung Pulo, Jakarta. One of them is the determination of the location for vertical evacuation plan in the affected areas.

Keywords: *Flood risk, Kampung Pulo, high-resolution remote sensing, UAV*

ANALYSIS OF SEA SURFACE HEIGHT ANOMALY CHARACTERISTICS BASED ON SATELLITE ALTIMETRY DATA (CASE STUDY: SEAS SURROUNDING JAVA ISLAND)/Sartono Marpaung and Wawan K. Harsanugraha
IJReSES, 11 (2) : 137-142

Sea surface height anomaly is a oceanographic parameter that has spatial and temporal variability. This paper aims to determine the characters of sea surface height anomaly in the south and north seas of Java Island. To find these characters, a descriptive analysis of monthly anomaly data is performed spatially, zonally and temporally. Based on satellite altimetry data from 1993 to 2010, the analysis shows that the average of sea surface height anomaly varies, ranging from -15 cm to 15 cm. Spatially and zonally, there are three patterns that can be concidered as sea surface height anomaly characteristics: anomaly is higher in coastal areas than in open seas, anomaly is lower in coastal areas than in open seas and anomaly in coastal area is almost the same as in open seas. The first and second patterns occur in the south and north seas of Java Island. The third pattern occurs simultaneously in south and north seas of Java Island. Characteristics of temporal anomaly have a sinusoidal pattern in south and north seas of Java Island.

Keywords: *Altimetry, Zonal, Anomaly, Characteristics and Sea Surface Height*

ABSTRACT

UTILIZATION OF SAR AND EARTH GRAVITY DATA FOR SUB BITUMINOUS COAL DETECTION / Atriyon Julzarika and Kuncoro Teguh Setiawan
IJReSES, 11 (2) : 143-152

Remote sensing data can be used for geological and mining applications, such as coal detection. Coal consists of five classes of Anthracite, Bituminous, Sub-Bituminous, Lignite coal and Peat coal. In this study, the type of coal that is discussed is Sub bituminous, Lignite coal, and peat coal. This study aims to detect potential sub bituminous using Synthetic Aperture Radar (SAR) data, and earth gravity. One type of remote sensing data to detect potential sub bituminous, lignite coal and peat coal are SAR data and satellite data Geodesy. SAR data used in this study is ALOS PALSAR. SAR data is used to predict the boundary between Lignite coal with Peat coal. The method used is backscattering. In addition to the SAR data is also used to make height model. The method used is interferometry. Geodetic satellite data is used to extract the value of the earth gravity and geodynamics. The method used is physical geodesy. Potential sub-bituminous coal can be known after the correlation between the predicted limits lignite coal-peat coal by the earth gravity, geodynamics, and height model. Volume predictions of potential sub bituminous can be known by calculating the volume using height model and transverse profile test. The results of this study useful for preliminary survey of geological in mining exploration activities.

Keywords: *SAR and Earth Gravity Data, sub bituminous, lignite coal and peat coal, height model*

AN EFFECTIVE INFORMATION SYSTEM OF DROUGHT IMPACT ON RICE PRODUCTION BASED ON REMOTE SENSING/Rizatus Shofiyati, Wataru Takeuchi, Soni Darmawan, and Parwati Sofan
IJReSES, 11 (2) : 153-162

Long droughts experienced in the past are identified as one of the main factors in the failure of rice production. In this regard, special attention to monitor the condition is encouraged to reduce the damage. Currently, various satellite data and approaches can withdraw valuable information for monitoring and anticipating drought hazards. MODIS, MTSAT, AMSR-E, TRMM and GSMaP have been used in this activity. Meteorological drought index (SPI) of the daily and monthly rainfall data from TRMM and GSMaP have analyzed for last 10-year period. While, agronomic drought index has been studied by observing the character of some indices (EVI, VCI, VHI, LST, and NDVI) of sixteen-day and monthly MODIS, MTSAT, and AMSR-E data at a period of 4 years. Network for satellite data transfer has been built between LAPAN (data provider), ICALRD (implementer), IAARD Cloud Computing, University of Tokyo (technical supporter), and NASA. Two information system have been developed: 1) agricultural drought using the model developed by LAPAN, and 2) meteorological drought developed by Takeuchi (University of Tokyo).The accuracy study using quantitative method for LAPAN model uses VHI is 60% (Kappa 0,44), while that of for University of Tokyo model uses qualitative model with KBDI value 500-600 shows an early indication of drought for paddy field. This will help the government or field officers in rapid management actions for the indicated drought area.This paper describes the implementation and dissemination of drought impact monitoring model on the area of rice production center using an integrated information system satellite based model. The two developed information systems are effective for spatially dissemination of drought information.

Keywords: *drought, rice production, satellite remote sensing, information system*