EXTRACTION OF BUILDING INFORMATION USING PLEIADES HIGH RESOLUTION DATA TO MONITOR PHYSICAL DEVELOPMENT OF URBAN AREAS

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Abstract- Megapolitan is a metropolitan area that has a diverse landscape and growing dynamically. Urban forms an increasingly large and diverse with the complexity of the buildings in it makes the process of extracting features of spatial information becomes more challenging. This study will test a model semi-automatic extraction of buildings and the building of the image of the Pleiades to be used in monitoring the physical development of the city. The difference in the value of spectral bands found on Pleiades is used to characterize the physical changes of building objects in the study area. The study results show this model can identify the physical changes due to the addition or alteration of buildings in urban areas are fast and accurate enough. This shows that monitoring physical development of urban areas can be done quickly using satellite remote sensing data.

Keywords: Pleiades, Information of Extraction Building, Urban Area

1. Introduction

Urban Area is a man-made product that has a high heterogeneity and continues to grow dynamically. A common problem encountered in the development of cities in Indonesia is the increasing need for urban space as the implications of an increase in the number of urban population, mainly caused by the high urbanization. Provision of land in the city center are increasingly expensive and limited to make urban developments tend to uncontrollable urban areas to suburban areas (sub-urban and urban fringe areas). Urban development to the suburban or urban sprawl known as these tend to follow the existing regional road network and spread sporadically and irregularly. Urban sprawl followed by large-scale conversion, good agricultural land, conservation land and vacant land. Often the land conversion violates the appropriations specified in the policy existing Spatial Plan.

Not only in the periphery, physical development also occurs in urban areas, such as land intensification and revitalization of the area. The high price of land in the city to make each party do everything possible to take advantage of existing land. Some parties seek to increase space by increasing the number of floors of the building, while others increase the space by utilizing the remaining land, both legally and illegally owned. Not surprisingly, the areas located in the center of town, difficult to find a vacant lot that is unemployed. Physical development that occurred in the city in addition to adding high intensity levels also resulted converted building land, mainly open land that can function as an open space, nice green open spaces as well as non-green open space. In the end many cities in Indonesia are not able to meet the allocation of minimum area of green open space, which is at least 30% of the total area of the city.

Physical development of urban happens inside and outside the city must be in accordance with the spatial use directives outlined in the Spatial Plan. For every physical development occurs should be monitored and evaluated so that development can be purposeful and consistent with the planned utilization of space. Monitoring is done continuously in the same period of time, not just during the review of the product of spatial planning only. The greater functionality and size of the city, the more narrow physical development monitoring period. Not easy and inexpensive to carry out monitoring of the physical development of the city, especially in large cities and metropolitan development is very fast.

Satellite remote sensing data is a source of spatial data that is used to view, monitor and analyze developments and physical changes that occur in a region. High resolution satellite data (spatial resolution: 10-30 meters), such as Landsat and SPOT, have long been used to monitor physical development of regions and cities. Using two pieces of data recorded in a different time, the direction of physical development and land conversion form as the effects of urban sprawl can be easily detected. For the scope of the vast territory and planning general scale (RUTR District / City), activity monitoring physical development of the city can count on medium resolution satellite data for the needed information is not detailed. On a more detailed planning, such as the Detailed Spatial Plan (RDTR), required information on the results of monitoring physical development in more detail, where every addition or subtraction of a building in an area can be identified. Surely this can't be done using the medium resolution satellite data are only able to provide information of land use changes.

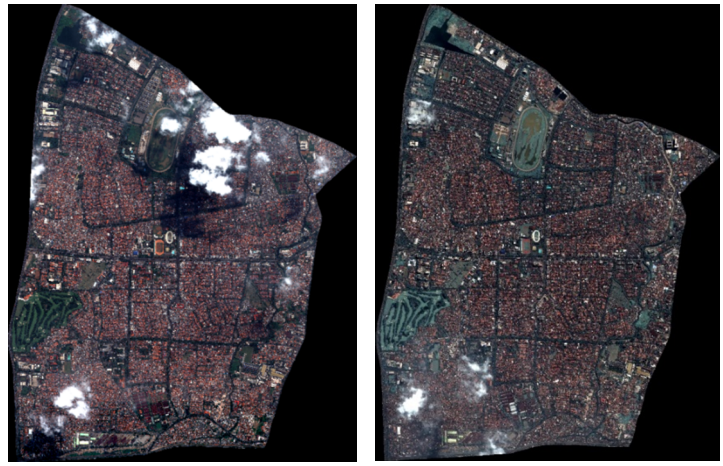
Currently the development of satellite remote sensing technologies that are in the era of extremely high resolution imagery (a spatial resolution of <1 meter), it is clear to see the building objects that exist in the Earth's surface. The use of very high resolution satellite data allows the holding activities of monitoring the development of the urban physical detail scale, where each addition, subtraction, or alteration of buildings can be identified. Many studies have examined the new method of information extraction of urban detail scale (1: 10000-1: 5000) using very high resolution satellite data, as performed by Briggs (2006), which examines the use of object-based segmentation method to separate any urban object information. This method is good enough for extracting features of urban objects, such as parcels and canopy shade trees, but not for monitoring the development of the physical city quickly. Rapid identification of the physical development of cities can facilitate efforts to prevent physical development that does not comply with the applicable policies space utilization.

The purpose of this study is to provide information extraction model building for monitoring urban rapid physical development. Model results of this study are expected to be used for: a). Conducting oversight of urban development that require speed and the fact that the actual time; and b). Provide early information will their physical changes in a region so that prevention against any violation of the RTRW can be prevented as early as possible.

2. Methods

2.1. Data and Location Study

The primary data used in this study is a Pleiades data level 1A, that has been corrected ortho systematic, date of recording; May 18, 2012 and August 8, 2015. Other data used is the Detail Spatial Plan East Jakarta 2010-2030 in shapefile format (shp). This data is used as reference material in the geometric and thematic processing of satellite imagery data.Location studies in Sub-district Pulo Gadung. Selection of study sites based on the request of the Dept. of City Spatial East Jakarta. Pulo Gadung region with consideration of the heterogeneity of the building has a fairly diverse and massive growth. Figure 1 displays the image used in the study.



Pleiades, May 18, 2012 Pleiades, August 8, 2015

Figure 1. Pleiades Satellite Imagery Used in the Study Area. *(Source: LAPAN, 2016)*

2.2 Image Processing and Data Analysis

In general, data processing carried out in two stages, namely the pre-processing and processing of data. All stages performed digitally using a software-ERDAS ER Mapper 2014 and 2.8 QGIS using digital segmentation approach and conversion of digital change number. Pre-processing stage in this research is intended to harmonize inter geometric image. The next stage is an image analysis to extract information digitally building and its amendments. Stages of processing more data is presented in Figure 2.

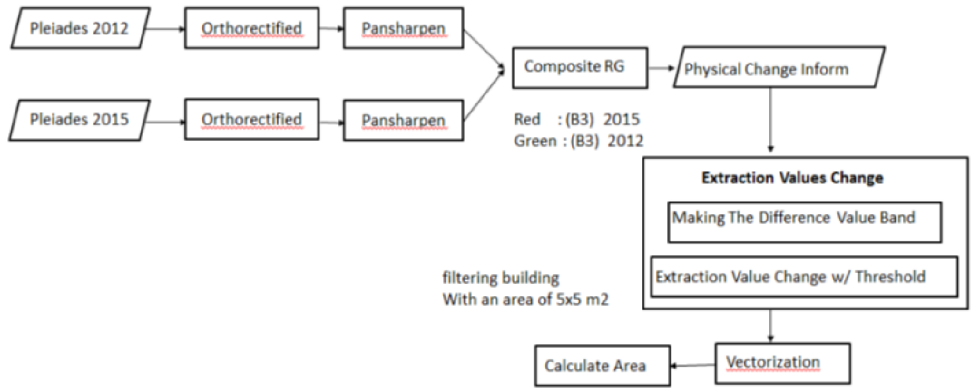


Figure 2. Stages of Data Processing

3. Data Pre-Processing

Before the further processing of data, each image data Pleiades first in geometric correction orthorectification using control points field / ground control points were taken using GPS Geodetic and parameters contained in the metadata. After each Data orthorectified, geometric correction using the second stage of registration to minimize geometric position shift between image pixels. Although both images has been corrected ortho-systematic, but still found a shift in position between the geometric image of 4-8 or 2-4 meter pixels. The registration process the image using the image of the Pleiades dated August 8, 2015 as a reference image because according to the results of field measurements, geometric image with the smallest deviation compared to the image of the Pleiades on May 18, 2012. The similarity of the position of each image pixel determines the level of confidence of the results of image analysis for changes in the value of the digital image at the same location showed the presence of land cover change on the pixel.

4. Data Processing

The next stage after the position of objects in each image of the Pleiades have been the same, is to identify changes to the building objects. Changes in building objects may include construction of new buildings on land that was originally an open space (non-building coverage) and additional buildings for their renovation or alteration of the building mass. The identification of the object changes the building is done by creating a composite image of the red channel and the green channel by entering the third band image of the Pleiades dated August 8, 2015 in the red channel and band 3 image of the Pleiades dated May 18, 2012 in the green channel. The image of the composite results shown in Figure 3.

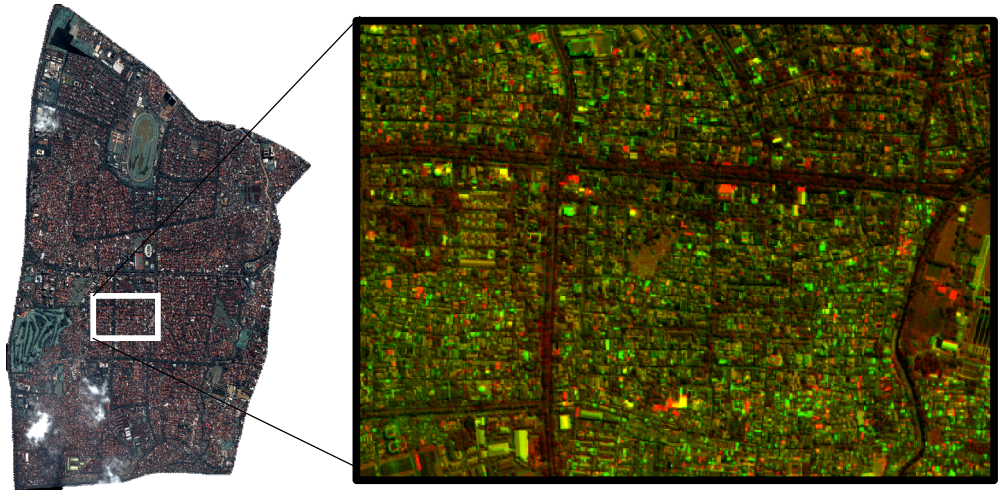


Figure 3. Image Composite R: Band 3 (2015), G: Band 3 (2012) Pleiades Data in Study Areas (Source: Results of Data Processing, 2016)

The result of the making of composite images with better color appearance is not true (false color composite) where there are two prominent colors that show the physical changes in the area. The red color indicates a change from the original area of vegetation into areas not vegetated, either in the form of buildings or other cover that eliminates vegetation. These changes could be due to the establishment of a new building or addition to a building for their renovation in the area of the original vegetation. While the color green to show physical changes in areas that are not vegetated. Changes due to the addition or renovation of a building in the area woke up. Figure 4 shows the colors are formed due to physical changes in an area.

The next step after any physical changes identified are separate objects that undergo physical changes with other objects that do not change by creating a channel (band) new. The new canal is made from the calculation of the value of the difference between channels in each year. It is based that any physical changes that occur on an object resulting in changes in spectral value on that object. Channel 3 data Pleiades is a red channel which has a high responsibility on the soil and vegetation, so as to identify any changes that are on the cover properly. Changes in land cover of the original vegetation or open land into smaller plots will make the red channel spectral value will increase. Difference in value of the red channel spectral data Pleiades in 2012 with the data in 2015 indicate a change in the object in question.

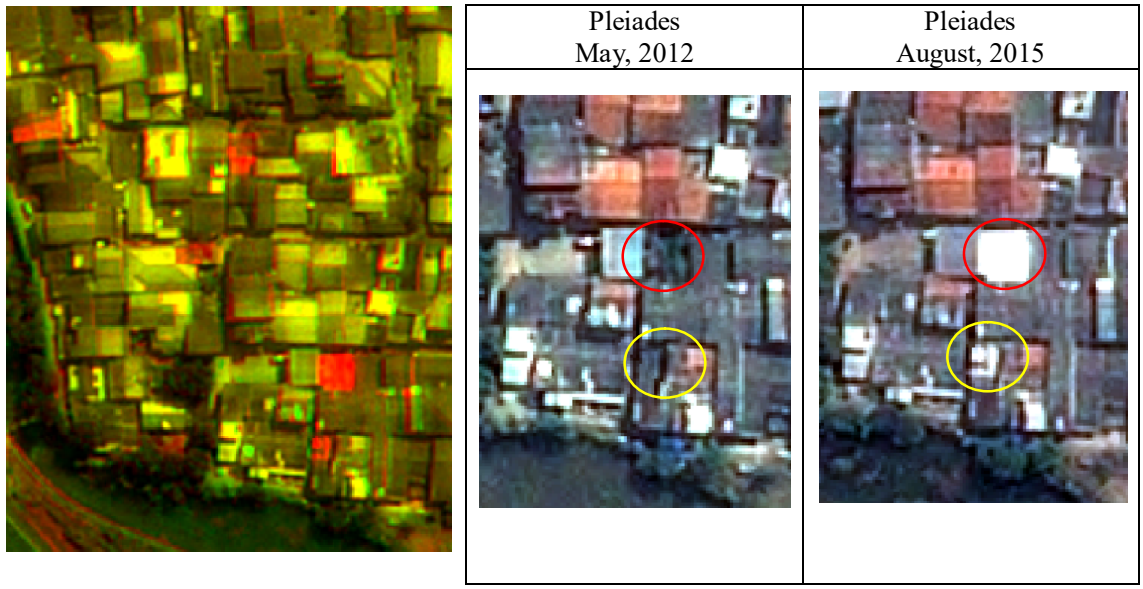


Figure 4. Results of the Composite Image and Form of Physical Changes that occurred (Results of Data Processing, 2016).

Once the objects are changed separated, then we have to get an overview of objects that undergo physical changes alone, no longer mixed with other objects, making it easier to delineate the objects are changed. Object delineation is done automatically using the classification function digital object based on the software QGIS. To facilitate and minimize errors, filtering (filters) to polygons classification results. Filtering is done using a broad measure of the object, which in this study objects with an area of <= 25 m2 will be eliminated. The parameters are based on the extent of the smallest area home building located in the study area. Results of classification of the objects change shown in Figure 5.

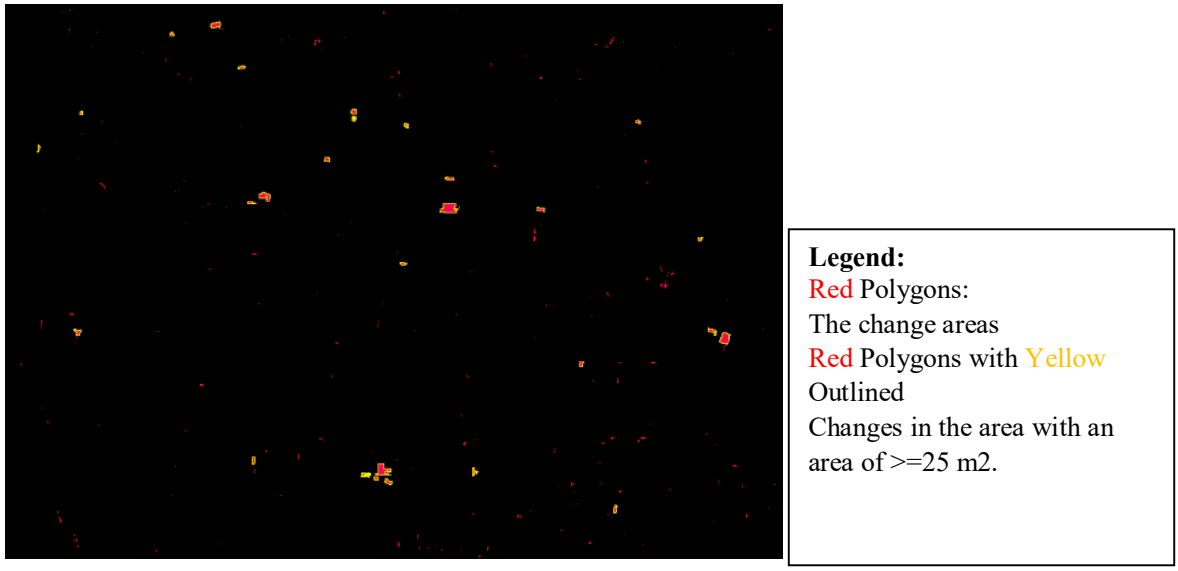


Figure 5. Polygon Classification Results In Changes Experiencing Objects (Results of Data Processing, 2016).

5. Analysis of Changes In Physical Objects on Green Areas (RTH) Region

This model can generate shape information changes quickly, but the accuracy of this model in describing the shape of the building footprint should be tested further in some locations with high levels of heterogeneity and higher density. The test results accuracy by verifying the depiction of objects directly on 10 sample points on the field in this study shows the level of trust the information produced reached 82%. This level of accuracy is determined by the position of the object, is hindered by a canopy of trees, clouds or shadows, and color of the roof of the building. The building with a green roof relative can't be identified automatically. In addition to getting polygon objects with depictions of good, necessary refining polygon shapes manually or automatically in order to eliminate the effects of non-pixels buildings that are all around the building. To determine the impact of changes in the physical form of additional buildings on green open space (RTH) of existing town, then the analysis is overlaying (overlay) using spatial analysis facilities in QGIS software. RTH existing information extracted from the EVI (Enhanced Vegetation Index) image of the Pleiades in 2015. From the analysis produced some additional information that is useful in urban spatial analysis, such as area, distribution, and other forms RTH shrinkage that occurs in one region and one area building whichever is-building in areas that should be addressed as the city green space. Overlay between existing RTH (2015) with the objects that undergo physical changes during the period 2012-2015 can be seen in Figure 6.

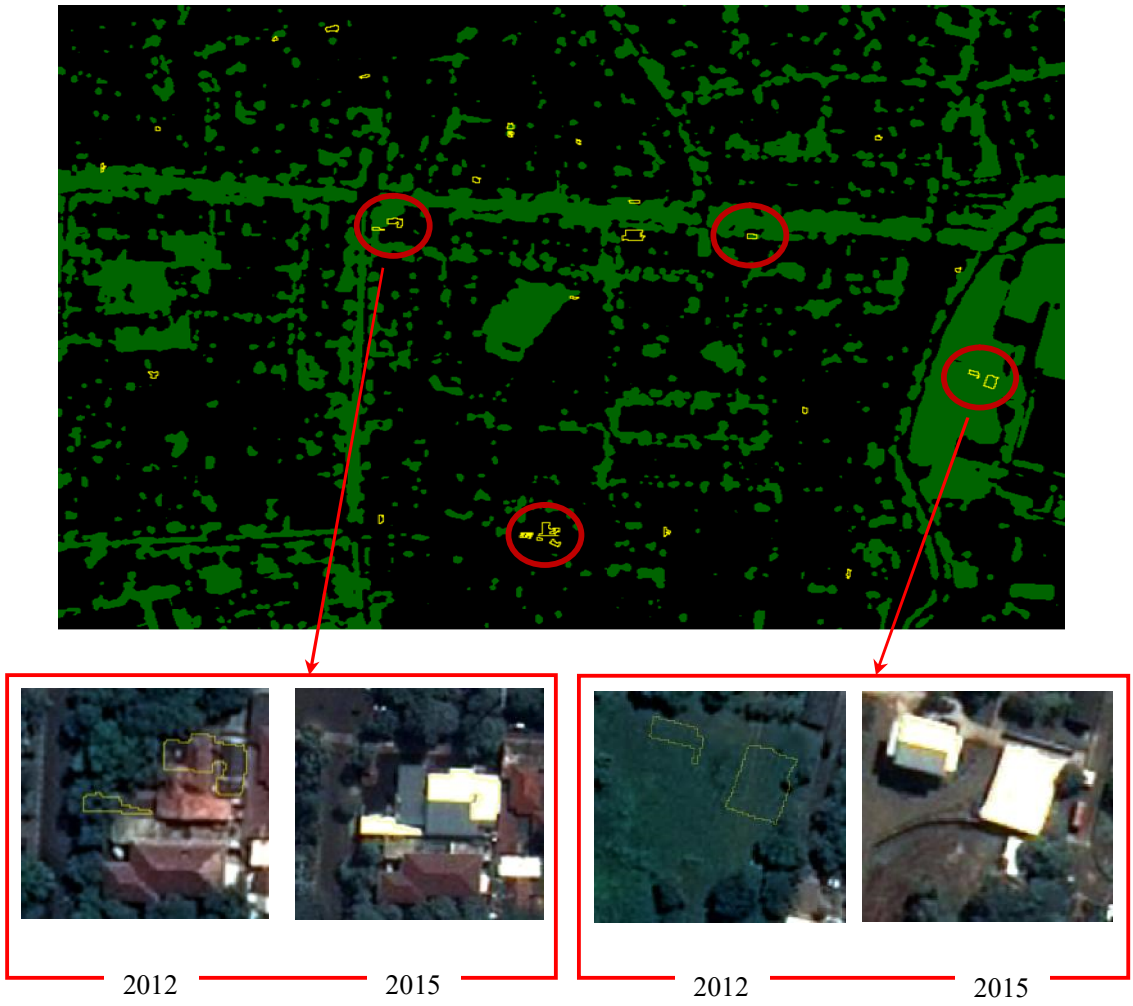


Figure 6. Overlay of Existing green space with Polygon Between Classification Results In Changes Experiencing Objects (Results of Data Processing, 2016)

6. Conclusion

This model can be used to monitor physical development, both additions to the building due to new construction and renovation, in urban areas up to the scale of districts or up to a scale of 1: 5,000. The advantage lies in the speed of the production of information and the level of confidence in the results of up to 82%, the information changes resulting from this model can be used as initial information and early warning system against any irregularities in the physical development of urban areas. In a more narrow region, especially in dense areas of settlement, this model should be tested further.

Acknowledgements

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