Analysis of Accuracy Orthorectification Pleiades and QuickBird Imagery to Creation of Based Map of Detail Spatial Plan for Open Green Space (Case Study: Part of Tuban Urban Area)

Bangun Muljo Sukojo¹ and Salwa Nabilah¹

¹Department of Geomatics Engineering, Faculty of Civil, Environment, and Earth Engineering Institutit Technology of Sepuluh Nopember

bangunms@gmail.com

Abstract. Appropriate Government Regulation No. 15/2010 concerning the Organization of Spatial, Spatial Plan area (RTRW) Regency/City must assign part of its territory and put together a plan of Spatial Detail (RDTR). Map of RDTR that exist today can be said to be less qualified and their use should be insufficient. One of RDTR is about Open Green Space (RTH). In Act No. 26/2007 of spatial mentions open green space should consist of 30% of the city area that is 20% and 10% of the public and the private. In making the RDTR map can be done by using very high-resolution satellite imagery previously orthorectification needed to be made in advance. Therefore, it needs to be done research on the accuracy of very high-resolution satellite imagery, satellite imagery can be known so that it can be used for making the based map of RDTR with scale 1:5000. This research was conducted in the Urban area of Tuban, East Java. To create a base map of the Spatial Detail of this Plan needs to be done orthorectification using data that are the Pleiades Imagery, QuickBird Imagery, DEM data of Astrium Terra SAR X with a resolution 9 m, the measurement point of GCP and ICP with Geodetic GPS, and limits Urban administration. GCP and ICP are used as much as 5 and 12 points. After a specified GCP point, can do calculations of SoF with results indicators of SoF ≤ 1, and obtained of 0.1883. Then do the process of orthorectification with the GCP has been tied to BIG's SRGI with RMSError ≤ 1.5 pixels. As for the value of the RMS Error of 0.548 pixels for Pleiades Image and 0.366 pixels for QuickBird Image. To test the results of orthorectification, performed the accuracy test using ICP with a horizontal accuracy of 1.5175xRMSE. Test the accuracy of obtained results of 0.463 m for the image of the Pleiades and 0.414 m for QuickBird Imagery. So it can be specified in the 1:5000 scale for the image of the Pleiades enters class 1 and for class 1 entry QuickBird Imagery. Keywords: Geographic Information System, Landsat 8 Satellite, Quickbird Satellite, Remote Sensing, SPOT Satellite, Tuban Regency.

Keywords: Accuracy Test, Open Green Space, Orthorectification, Pleiades Imagery, QuickBird Imagery.
1. Introduction
Appropriate Government Regulation No. 15/2010 concerning the Organization of Spatial, Spatial Plan area (RTRW) Regency/City must assign part of its territory and put together a plan of Spatial Detail (RDTR). RDTR should have been set at the latest 36 months as the Regional Spatial Regulation. One of RDTR is about Open Green Space (RTH).

In Law No. 26/2007 on spatial planning mentioned Open Green Space (RTH) is an elongated/line area and/or in groups, which use more open, where the plants grow, both of which grow naturally or are deliberately planted, which Consisting of 30% of urban areas should be Open Green Space consisting of 20% public and 10% private.

Tuban is one of the urban areas that do not have Detailed Spatial Plan map, especially in Open Green Space. In order for the Tuban Urban Detailed Spatial Plan map to be made soon, there is a need for a basic map as a reference for making Detailed Spatial Plan maps, especially Green Open Space which is very needed in urban areas.

Basic Detailed Spatial Plan map creation must come from very high-resolution satellite images such as Pleiades, QuickBird, WorldView, GeoEye, and IKONOS. The process of recording satellite imagery is covered from rides (satellites) moving over the Earth's surface at hundreds of kilometers, thus causing satellite imagery to have geometric distortions. To reduce the effect of geometric distortion on the image is done geometric correction that can make the object on the image more in accordance with the actual object.

Orthorectification is the process of geometric correction of satellite imagery or aerial photographs to correct geometric errors of an image originating from topographic, sensor geometry and other errors. In previous research, orthorectification of high-resolution satellite images using RPC method and using DEM ALOS PALSAR with 12.5m spatial resolution in Surabaya [3]. Orthorectification in this research using Rational Polynomial Coefficients (RPC) method by using Digital Elevation Model (DEM) Astrium Terra SAR X which has 9m spatial resolution.

Therefore, in this final project examined the accuracy of very high resolution images of Pleiades and QuickBird with Ground Control Point (GCP) and Independent Check Point (ICP) measured using geodetic GPS with static differential method through orthorectification process for recommendation of making Open Green Space of Detailed Spatial Plan based map with scale 1: 5000 in Part of Tuban Urban area.

2. Research Methodology
2.1 Research Location
The location of this research is in Part of Tuban Urban Area, Tuban Regency, East Java, which is centered on geographic coordinates 6° 53’ 41” S and 112° 02’ 30” E covering five districts of Tuban District, Jenu District, Palang District, Merakurak District, and Semanding District. Not all villages of the district are included in the Tuban Urban, but only a few. For Tuban District all villages, Jenu District 1 village, Palang District 6 villages, Merakurak District 1 village, and Semanding District 10 villages.
2.2. Data and Equipment

2.2.1 Data
The data used in this research are:
1. Tuban Pleiades imagery August 2015
2. Tuban QuickBird imagery October 2013
3. DEM Astrium Terra SAR X with a 9m spatial resolution
4. Data of Tuban Urban Administration boundary from RBI scale 1: 25000
5. GCP and ICP data from Geodetic GPS survey 2017

2.2.2 Equipment
Equipment used in this research are:

a. Hardware
1. Geodetic GPS
2. Survey Form

b. Software
1. Geospatial processing software
2. Satellite Imagery processing software
3. GPS data processing software
4. Data calculation software

2.3 Stages of Data Processing
Stages of data processing in this study are shown in Figure 2. The explanation of the flowchart as follows:
1. Data Collection
At this stage of data collection were used that Pleiades Imagery, QuickBird Imagery, DEM Astrium Terra SAR X, Tuban Urban administrative boundary data, and the data point GCP and ICP were measured using geodetic GPS.

2. Pansharpening
Do the process of merging panchromatic and multispectral imagery to produce very high-resolution images that have color for easier identification in the laying point GCP and ICP.

3. Making Network Design
Make GCP and ICP of image interpretation that will be used for making networks and calculated strength are usually referred SoF value ≤ 1.

4. Field Survey
In a field survey carried out measurement points of GCP and ICP using geodetic GPS, then obtained coordinates of GCP and ICP that were later used to orthorectification process.

5. Orthorectification
After the obtained coordinates points of GCP and ICP and gained a good SoF value, it will be done using the orthorectification process with DEM Astrium Terra SAR-X which is useful for correcting satellite image of a geometric errors tolerance values can be seen from his error RMSE ≤ 1.5 pixels.

6. Accuracy Test
The accuracy test using ICP point coordinates that have been made and which will determine the scale and grade on the resulting map. With tolerance CE90 ≤ 1 meter in class 1 with the scale 1:5000.

7. Cropping Area
Satellite imagery has orthorectified then crop by the size of the corresponding region using the administrative boundaries of the RBI map with scale 1: 25000.
8. Classification of Open Green Space and Non
After that do the classification by doing digitization. The resulting classification is the classification which is the area of green open space and non, the classification is carried out in accordance with the Regulation of the Minister of Public Works No. 05/2008

9. Based Map of RDTR for Open Green Space Creation with Scale 1: 5000
After all, is done, the based map of RDTR for Open Green Space with scale 1: 5000, which will then be used for RTDR production, especially in the area of open green space in Part of Tuban Urban Area.

Figure 2. Flowchart of Research

3. Result and Analysis
3.1 Making Network from GCP and SoF Calculations
Good orthorectification depends on the strength of the networks that have been made. The closer to zero the better the SoF and the stronger the network. In this research, the design of networks with GCP is 5 points. From 5 GCP we get 7 baselines on the design of networks that have been made with a length of 3-4 km for a relatively flat area.
In this research using 5 point GCP and 12 point ICP, so Strength of Figure (SoF) got result equal to 0.1883 with calculation as follows:

- Number of baseline  : 7
- Number of Points  : 5
- N size  : Number of baseline x 3 = 13 x 3 = 39
- Nparameters  : Number of points x 3 = 5 x 3 = 15
- $u$ : Nsize - Nparameters = 39 - 15 = 24

$$SoF = \frac{\text{Trace}([A]^T \cdot [A]^{-1})}{u} \quad (1)$$

With SoF value, it can be said to enter in tolerance, where tolerance SoF ≤ 1.

### 3.2 Coordinates of GCP and ICP

The control point coordinate (X, Y) is obtained from satellite image interpretation and field measurements using GPS using a static method with duration of 30-45 minutes which is then processed through GPS data processing software including post processing (baseline process) and network adjustment.

The coordinates of GCP and ICP are tied to CORS ITS with ITSS code on the campus of ITS Surabaya and CTBN reference point in Tuban. Do the measurement point of CTBN then obtained coordinates then differencing with CTBN coordinates already fixed from BIG., Here is the difference obtained:

| Name of Points | East (m)       | North (m)      |
|----------------|----------------|----------------|
| GCP 01         | 611199.0355    | 9239278.634    |
| GCP 02         | 612435.5095    | 9239625.138    |
| GCP 03         | 612863.0395    | 9238136.419    |
Table 3. List of ICP Coordinates

| Name of Points | East (m)  | North (m)  |
|----------------|-----------|------------|
| ICP 01         | 611790.178| 9239035.116|
| ICP 02         | 612775.385| 9239699.464|
| ICP 03         | 612341.793| 9238991.136|
| ICP 04         | 612482.56  | 9239267.626|
| ICP 05         | 613082.787| 9239145.672|
| ICP 06         | 612764.403| 9238295.941|
| ICP 07         | 613260.634| 9238479.201|
| ICP 08         | 614717.44  | 9238872.364|
| ICP 09         | 614333.647| 9239344.962|
| ICP 10         | 614437.088| 9237593.941|
| ICP 11         | 614963.046| 9238119.501|
| ICP 12         | 614932.938| 9237005.816|

3.3 Orthorectification

Once the GCP coordinates are known, then the image orthorectification process can be done. The orthorectification process uses RPC methods that require DEM data. The DEM used is DEM Astrium Terra SAR X with 9m spatial resolution.

From orthorectification process then got RMSE value which have fault tolerance RMSE ≤ 1.5 pixels.

\[
RMSE_{horizontal} = \sqrt{\frac{\sum \left( (x_{data} - x_{cek})^2 + (y_{data} - y_{cek})^2 \right)}{n}}
\]  

(2)
Where:
\[ n = \text{Total number of checks on the map} \]
\[ D = \text{The difference between the coordinates measured in the field with the coordinates on the map} \]
\[ x = \text{Coordinate value on the} \ - \ X \text{axis} \]
\[ y = \text{Coordinate values on the} \ - \ Y \text{axis} \]

By using the above calculation, obtained the following results:

**Table 4. RMSE of Pleiades Image Orthorectification**

| Name of Points | East (m)       | North (m)      | Residual (m) |
|----------------|----------------|----------------|--------------|
| GCP 01         | 611199.0355    | 9239278.634    | 0.57         |
| GCP 02         | 612435.5095    | 9239625.138    | 0.24         |
| GCP 03         | 612863.0395    | 9238136.419    | 1            |
| GCP 04         | 615038.3985    | 9239216.128    | 0.61         |
| GCP 05         | 615117.9465    | 9237055.242    | 0.32         |

**Table 5. RMSE of QuickBird Image Orthorectification**

| Name of Points | East (m)       | North (m)      | Residual (m) |
|----------------|----------------|----------------|--------------|
| GCP 01         | 611199.0355    | 9239278.634    | 0.49         |
| GCP 02         | 612345.5095    | 9239625.138    | 0.015        |
| GCP 03         | 612863.0395    | 9238136.419    | 0.43         |
| GCP 04         | 615038.3985    | 9239216.128    | 0.1          |
| GCP 05         | 615117.9465    | 9237055.242    | 0.66         |

**Table 6. RMSE of Pleiades Image Accuracy Test**

| Name of Points | East (m)       | North (m)      | Residual (m) |
|----------------|----------------|----------------|--------------|
| GCP01          | 611199.04      | 9239278.63     | 0.285        |
| GCP02          | 612435.51      | 9239625.14     | 0.12         |
| GCP03          | 612863.04      | 9238136.42     | 0.5          |
| GCP04          | 615038.39      | 9239216.13     | 0.305        |
| GCP05          | 615117.95      | 9237055.24     | 0.16         |
| ICP01          | 611790.18      | 9239035.11     | 0.45         |
| ICP02          | 612775.39      | 9239699.46     | 0.345        |
| ICP03          | 612341.79      | 9238991.13     | 0.405        |
| ICP04          | 612482.56      | 9239267.62     | 0.43         |
| ICP05          | 613082.78      | 9239145.67     | 0.275        |
| ICP06          | 612764.40      | 9238295.94     | 0.355        |
| ICP07          | 613260.64      | 9238479.20     | 0.205        |
| ICP08          | 614717.44      | 9238872.36     | 0.36         |
| ICP09          | 614333.64      | 9239344.96     | 0.38         |
| ICP10          | 614437.08      | 9237593.94     | 0.42         |
| ICP11          | 614963.04      | 9238119.50     | 0.26         |
| ICP12          | 614932.93      | 9237005.81     | 0.36         |

RMSE (meter) 0.305

RMSE value obtained on Pleiades image of 0.548 and QuickBird image of 0.366 so it can be said to enter tolerance.

**3.4 Accuracy Test**

The accuracy test in this research is conducted by using 12 points of Independent Check Point (ICP) measurement coordinates according to the requirements given by BIG on spatial map validation module in 2016.
Table 7. RMSE of QuickBird Image Accuracy Test

| Name of Points | East (m)     | North (m)    | Residual (m)   |
|----------------|--------------|--------------|----------------|
| GCP01          | 611199.04    | 9239278.63   | 0.221527778    |
| GCP02          | 612435.51    | 9239625.14   | 0.098          |
| GCP03          | 612863.04    | 9238136.42   | 0.19375        |
| GCP04          | 615038.39    | 9239216.13   | 0.065          |
| GCP05          | 615117.95    | 9237055.24   | 0.297916667    |
| ICP01          | 611790178    | 92390351.16  | 0.234722222    |
| ICP02          | 612775385    | 9239699464   | 0.078472222    |
| ICP04          | 612482.56    | 9239267626   | 0.197222222    |
| ICP05          | 613082787    | 9239145672   | 0.184027778    |
| ICP06          | 612764403    | 9238295941   | 0.224305556    |
| ICP07          | 613260634    | 9238479201   | 0.17708333     |
| ICP09          | 614333647    | 9239344962   | 0.119444444    |
| ICP10          | 614437088    | 9237593941   | 0.15625        |
| ICP11          | 614963046    | 9238119501   | 0.170138889    |
| ICP12          | 614932938    | 9237005816   | 0.102083333    |

RMSE (meter) 0.273

The horizontal accuracy test can be calculated using the calculations determined by BIG for the creation of a base map:
Horizontal accuracy test = 1.5175 x RMSE Using the above calculations, obtained 0.463 m for Pleiades and 0.414 m for QuickBird.

Table 8. Geometry RBI Map accuracy

| Scale | RBI Map Accuracy on Horizontal Position |
|-------|----------------------------------------|
|       | Class 1 | Class 2 | Class 3 |
| 1: 5000 | 1       | 1.5     | 2.5     |
| 1: 2500 | 0.5     | 0.75    | 1.25    |
| 1: 1000 | 0.2     | 0.3     | 0.5     |

From those value it can be said that Pleiades can be used as base map of scale 1: 5000 class 2, while QuickBird scale 1: 5000 class 1.

3.5 Base Map of RDTR for Open Green Space in Part of Tuban Urban Area
Below is a based map of RDTR for open green spaces in Part of Tuban Urban Area according to Minister of Public Works Regulation No. 05/2008.
4. Conclusion and Suggestion

4.1 Conclusion

From data processing to analysis, researchers can conclude as follows:
1. With this final project, research has got the base map of RDTR for open green space in the Urban area of Tuban.
2. From orthorectification using Ratio Polynomial Coefficient (RPC) method with 5 point GCP, we get a RMSE value of 0.548 pixels for Pleiades Imagery and 0.366 pixels for QuickBird Imagery. With a tolerance of RMSE ≤ 1.5, it means that RMSE gained tolerance. The accuracy test using 12 ICP points, using the provisions of BIG obtained a result of 0.463 m for 1: 5000 scale Pleiades imagery entering class 1 and 0.414 m for 1: 5000 scale QuickBird imagery entering class 1.
3. In making the based map of RDTR for the open green space in the Part of Tuban urban area is required Very High-Resolution Satellite Imagery such as Pleiades and QuickBird Imagery which have 0.5 m and 0.65 m spatial resolution and DEM with high resolution also like DEM Astrium Terra SAR X with 9 m spatial resolution.

4.2 Suggestion

Suggestions from researchers for further research should:
1. When do the measurement point of SRGI (CTBN) on the ground that it was not possible to quantify then it can be done by doing the measurement around the point with a point of help, then the distance between the point SRGI (CTBN) and point help can be differenced.
2. If the satellite image data used in the study there were 2 that one of its data is lacking, then the determination of GCP on both the satellite images are distinguished in accordance with widely available satellite image data so that the image can be orthorectified with entirely.
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