

# MAPPING AND MAP UPDATING WITH ALOS DATA THE INDONESIA EXPERIENCE

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**KEY WORDS:** Topographic Map Production, Map Updating, ALOS

### ABSTRACT:

This paper reports the results of a pilot project in mapping and map updating with ALOS data performed at the Indonesian National Coordinating Agency for Surveys and Mapping. The project consists of three parts, all aimed to explore the technological and economical aspect of ALOS-data utilization. The first is experiment on topomap production in area of Jakarta-Bogor using PRISM and AVNIR. The second is topomap updating of the Jakarta metropolitan area and Bali-island using PRISM and partially AVNIR. The third experiment is accuracy test in both planimetric and vertical component of (DEM produced by) PRISM.

### 1. INTRODUCTION

The mapping satellite ALOS of Japan was launched on January 24, 2006. ALOS has three sensors in single platform: Panchromatic Remote-sensing Instruments for Stereo Mapping (PRISM), to measure precise land elevation; Advanced Visible and Near Infrared Radiometer type 2 (AVNIR-2), which observes what covers land surfaces; and Phased Array type L-band Synthetic Aperture Radar (PALSAR), which enables day-and-night all-weather land observation (JAXA, 2006).

JAXA has invited Indonesia to participate in a research project on possible use of the upcoming ALOS data. The National Institute of Aeronautics and Space of The Republic of Indonesia (LAPAN) is the liaison for JAXA and coordinator for all Indonesian participating partners. At the end of 2006 the calibration and commissioning phase of ALOS was finished and early 2007 the data was delivered to the pilot project participants (Amhar, 2006).

The research topic carried out by BAKOSURTANAL is the most challenging one because it will be the comprehensive test for the main purpose of ALOS, i.e. mapping! Mapping and map updating, especially in rapid physical developed metropolitan with a lot of buildings or in ever-cloudy forest area, is always complicated and expensive while the suitable technology is not always available. ALOS with combination of several sensors shall answer the challenges. In the other side, the capacity of integrated platform for several sensors in ALOS should be tested comprehensively, especially in topographic map production in which the geometric aspect is the main concern.

At the first sight, ALOS seems to be the most cost-effective data source for mapping at the scale 1:25.000. Table-1 shows the

ALOS raw data price estimation, which will be only about 10% of average map-cost (~ US\$ 30 / sq.Km) in comparison to other data source. The mapping price itself will be less than 30% mapping price with some other data source (i.e. ~ US\$ 100 /sq.Km)

Data Price – Level 1A-1B2		End-user Price /scene		Total Price	
Sensor	Coverage	Yen	USD	For TLM-data	
		2500	207.1	min	max
		0	8		
km x km		Yen/ km2	USD/ km2	USD/ km2	4x
PRISM	35	35	20.41	0.17	0.38
AVNIR	70	70	5.10	0.04	
PALSAR-FBS	70	70	5.10	0.04	0.31
PALSAR-Polarimetry	30	30	27.78	0.23	1.24

Table 1. Price estimation for Topographic Line Map (Topomap) production

### 2. OBJECTIVES, METHODOLOGY AND RESULTS

Originally, three experiments (topomap generation in urban & sub-urban area of Bogor using PRISM + AVNIR, 3D-city model of Jakarta using PRISM + PALSAR, and topomap generation over cloudy forest in Kalimantan using PALSAR FBS + Polarimetry) would be taken to benchmark the ALOS data, so that evaluation on some technological and financial aspect of ALOS data-utilization can be performed. After delivery the data, some changes in the research design must be done, due to the availability and quality of the ALOS data.

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## 2.1 Topomap Production

This part of research is the most challenging part. The topomap production line must be tested with ALOS data. PRISM and AVNIR data should give an up-to-date topographic map at the scale 1:25.000, with accuracy comparable to the one made in 2000 based on 1:30.000 aerial photograph added with some field survey. The study area represents a typical Indonesian area mixture (mountainous area – flat area, midsize city and rural area).

The first step of work is building the image to make it ready for the mapping process. In the first data we received, PRISM scene were delivered as 4 strips which must be mosaicked. Eight GCPs are used to get geocorrected PRISM data. AVNIR scene were delivered as 4 images in each band (Red, Green, Blue and Near InfraRed). The RGB-composite image was then build. Then PRISM and AVNIR were then combined to build pan-sharpened image.

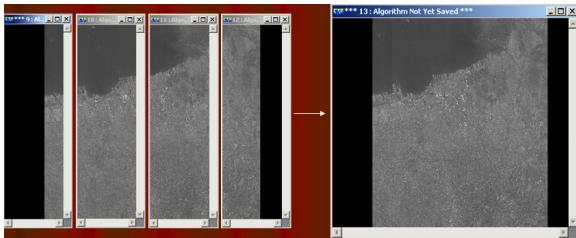


Figure 1. PRISM strip-mosaicking

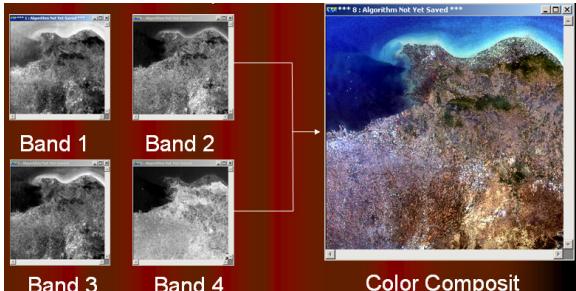


Figure 2. AVNIR compositing



Figure 3. pan-sharpened image

To build the Digital Elevation Model, two PRISM scenes (forward and backward or forward and nadir) are used. A softcopy photogrammetry system will be used to generate the Digital Elevation Model (DEM). Some softcopy photogrammetry software with stereoscopic capability like PCI-

Geomatics 10.1.2, KLT-Atlas 12.16.6.7, BAE-Soccetset 5.4.1, Summit Evolution 4.2 / 4.3 and Leica Photogrammetry Suite (LPS) - Erdas Imagine are tested.

To generate DEM from PRISM, a software made by RESTEC (Dr. Makoto Ono), a second software made by JAXA (which run under Linux environment) are also tested.

For rigorous map production, a workstation PC with stereo-screen (or Z-screen) and stereo-glass is obligatory. For this kind of PC, 2 GB memory, 2 x 200 GB harddisk and strong graphic accelerator is a must.

Before building the DEM automatically using image correlation, a stereoscopy from both images must be built successfully. In some vegetated area, automatic DEM-generation (image-correlation) from PRISM didn't give good accuracy. Interactive DEM-editing gives a better result, but this needs stereoscopic hardware and more manual work. This stereoscopy is useful both for correcting the elevation and also for extracting 3D-features for topomap.

After correction to the elevation of terrain, DEM will be Digital Terrain Model (DTM). The DTM will be used further to generate the contour line.

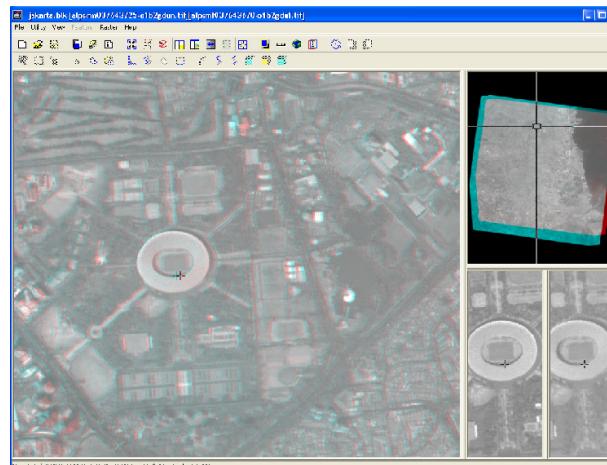


Figure 4. Anaglyph stereo display of ALOS-PRISM for Senayan area using Leica Photogrammetry Software (LPS) - Erdas Imagine

The other part of topomap (rivers, coastlines, roads, settlement and vegetation) could be digitized from pan-sharpened data.

The combination of this planimetric detail and contour line form the so called manuscript map. For the final map, additional information such as administrative boundaries, building identifications, street classes and geographical names must be collected from field survey or authoritative institution. This step is considered unnecessary for this research.

The general approach is described in the following flowchart:

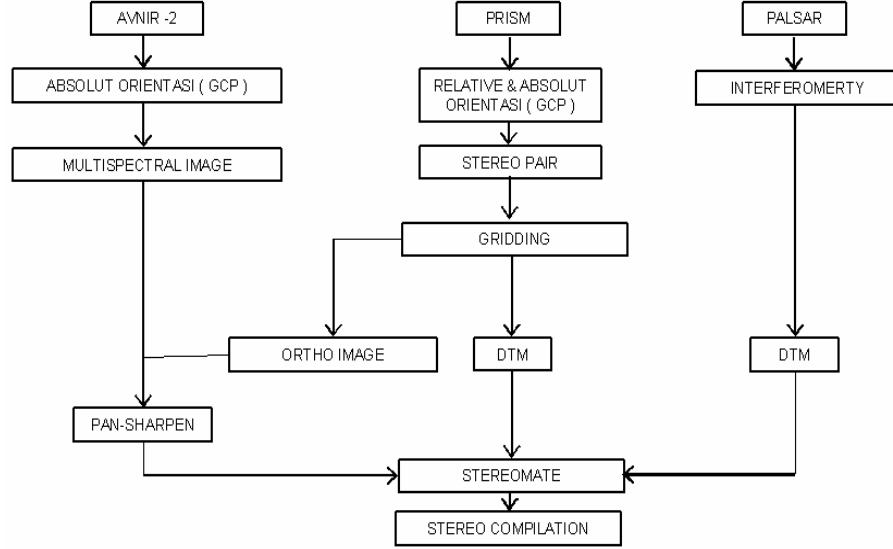


Figure. 5. Flowchart of the research method

No	Scene ID	Date	Area	Level
1	ALAV2A037643720	20061009	Jakarta	1B2
2	ALAV2A037643730	20061009	Bogor	1B2
3	ALPSMB037643780	20061009	Jakarta	1B1
4	ALPSMN037643725	20061009	Jakarta	1B1
5	ALPSMB037643790	20061009	Bogor	1B1
6	ALPSMN037643735	20061009	Bogor	1B1
7	ALPSRP031590020	20060828	Berau	1.1 (FBS)
8	ALPSRP038300020	20061013	Berau	1.1 (FBS)
9	ALPSRP021527040	20060620	Bogor	1.5 (FBS)
10	ALPSRP021527050	20060620	Jakarta	1.5 (FBS)

Table 2. ALOS data received by Bakosurtanal

AVNIR level 1B2 means geometrically corrected data with rough DEM correction. PRISM level 1B1 means radiometrically calibrated data, but not yet geometrically corrected. PALSAR level 1.1. data is complex data on slant range, while level 1.5 means the data has been geo-referenced. For creating DEM with interferometry, level 1.1 data is needed.

For PALSAR, the situation is more complicated. PALSAR processing will require a deep knowledge on interferometry and polarimetry. For interferometry, the existing software in Bakosurtanal is not suitable either to read PALSAR SLC data and to process it into DEM. So DEM generation from PALSAR using Interferometric method has not yet succeeded. For polarimetry, no quadpol polarimetry data is available until now. The resolution of PALSAR is also surprisingly less than expected. On PALSAR image, the complex of Bakosurtanal's office (Bakoplex) is hardly recognized. Thus, more knowledge and skill are necessary for object recognition from PALSAR imagery.

## 2.2 Topomap Updating

Updating of topomap is easier since it just needs simpler hardware and software. But on the other hand, it needs an existing (older) topomap. The hardware used for simple map updating are common IT-hardware, i.e. simple Pentium-4 PC. The software is similar. For simple map updating, simple CAD or GIS editing software such as AutoCAD-Map, ArcView or ArcGIS or Er-Mapper is enough. Object recognition using pan-sharpened PRISM+AVNIR can be done adequately. So, map updating is in reality easier than complete map generating that needs DEM generation.

For map updating, the panchromatic image would be enough to use, but pan-sharpened image might give a better result. Fig-6 shows the pan-sharpened image draped by road-layer of topographic base map in Jakarta-Bogor area. It is clear that new highway is not yet there in the vector-topographic base map. One can then update this map with the new objects.



Figure 6. Map Updating in Jakarta

The second test was done in Bali-island. In this case, only PRISM scene is used, and it is sufficient! The violet line is coastal line and rivers after a reclamation process and the

yellow line is the new road network which did not yet exist in the topographic-map but detectable in the ALOS-PRISM image.

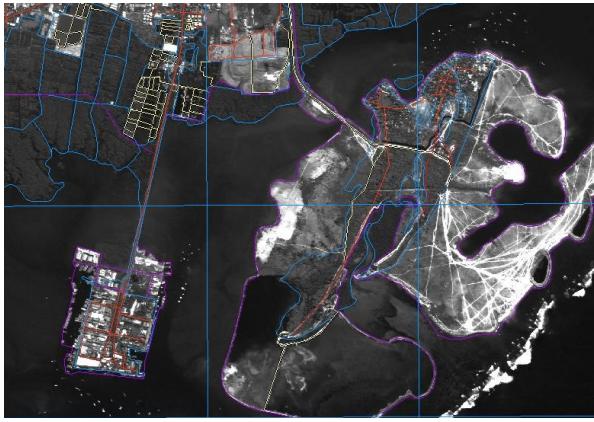


Figure 7. Updating 2D of topographic map in area of Bali.

### 2.3 Accuracy Test

In this chapter, the geometric accuracy of ALOS (both planimetric and vertical) will be proven. The hypotheses of the research were: (1) ALOS data can be used to the mapping objective with certain requirements; (2) The accuracy is nearly close to the benchmark data.

**2.3.1 Planimetric Accuracy.** The planimetric accuracy will be tested in field using GPS on objects that are well recognized both on the image and in the field. There are 26 measured GPS points (Fig. 8) that are then compared to the coordinates in ALOS-PRISM. The result in table-3 shows that the average deviation is about 2.38 m in Easting and 2.65 m in Northing. The standard deviation is better than 4 m for both direction. This mean that ALOS PRISM is almost suitable for mapping up to the scale 1:25.000.

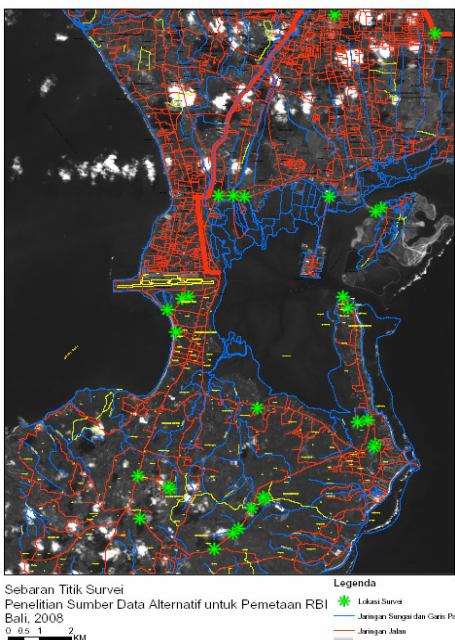


Figure 8. Location of checked points to test planimetric accuracy (in Bali)

Object ID	Differences GPS-ALOS (m)			
	$\Delta X$	$\Delta Y$	Abs ( $\Delta X$ )	Abs ( $\Delta Y$ )
5	5.56	2.55	5.56	2.55
6	3.73	-2.08	3.73	2.08
7	1.83	5.69	1.83	5.69
8	1.97	8.51	1.97	8.51
9	-1.67	2.05	1.67	2.05
10	0.28	-0.80	0.28	0.80
11	1.12	1.42	1.12	1.42
12	9.77	-0.02	9.77	0.02
13	-0.54	4.22	0.54	4.22
14	2.60	3.52	2.60	3.52
15	3.83	-2.86	3.83	2.86
16	7.50	6.94	7.50	6.94
17	1.88	4.27	1.88	4.27
19	-2.59	-6.11	2.59	6.11
20	3.48	3.30	3.48	3.30
21	12.93	0.86	12.93	0.86
22	0.56	6.68	0.56	6.68
23	-0.36	4.97	0.36	4.97
24	3.13	4.27	3.13	4.27
25	-1.52	-0.75	1.52	0.75
26	1.03	-0.45	1.03	0.45
27	-2.41	1.93	2.41	1.93
28	2.18	12.96	2.18	12.96
29	2.21	1.95	2.21	1.95
30	2.77	1.46	2.77	1.46
31	2.70	4.43	2.70	4.43
Average	2.38	2.65	3.08	3.66
St. Dev.	3.55	3.89	2.94	2.93

Table 3. Comparison of Coordinates measured by GPS in the field and on PRISM image

**2.3.2. Vertical Accuracy.** For the vertical accuracy, since it is difficult to have a well distributed leveling data, the DEM from ALOS-PRISM computed with three different softwares (PrismDEM from RESTEC; JaxaDEM and PCI-Geomatica) are compared to DEM from SRTM-X. The comparison are done in a complete area, not just in a transect.

The different of the three software is that PCI-Geomatica is a commercial GIS/Remote Sensing software not specific for ALOS, while PrismDEM and JaxaDEM are software specific developed for ALOS data processing. In the last two softwares, the user doesn't need to entry the orbit and sensor parameter information since it has been built in internally in the softwares. But a commercial software like PCI-Geomatica is used, the user must entry these parameters which are not always readily available. The user must look for another way to get these information by investigating the metadata and entry them manually.

The comparison to SRTM-X (vertical accuracy about 6-16 meter) could be done after resampling the produced DEMs to the resolution of SRTM-X (30 meter). This test could not measure the absolute vertical accuracy (which should be compared to levelling data), but could measure the relative vertical accuracy and its distribution. The following figures show the results in area of Jakarta-Bogor.

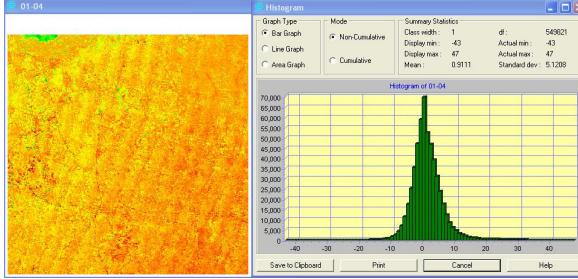


Figure 9. Difference between DEM from PrismDEM to SRTM-X

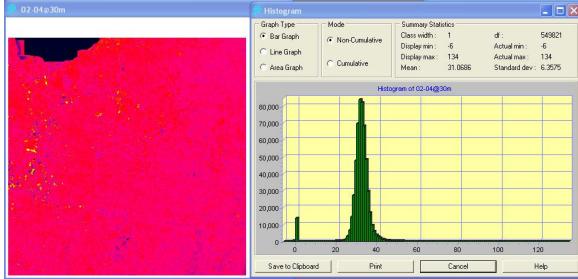


Figure 10. Difference between DEM from JaxaDEM to SRTM-X

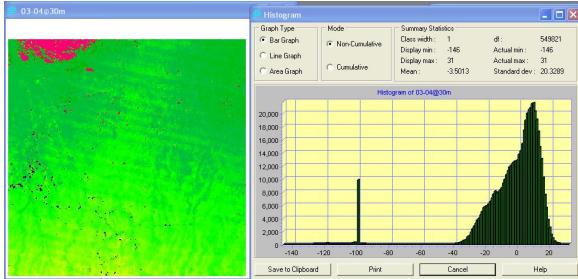


Figure 11. Difference between DEM from PCI to SRTM-X

From the figures above, it could be seen that the height difference from PrismDEM and PCI are about 0 as expected, although PCI produces some outliers. The difference to JaxaDEM is the bias or shifting about 30 meter, which caused by a systematic error in the used ground control.

Therefore the accuracy of DEM could be seen from the standard deviation. PrismDEM and JaxaDEM has standard deviation of 5-6 meter, while PCI about 20 m. This shows that the knowledge about the orbit and sensor parameter integrated in PrismDEM or JaxaDEM could produce better DEM compared to commercial software which the user should look for the needed information.

When the standard deviation of 5-6 meter could be used as reference (think that all those comparisons are to SRTM-X), then PRISM is usable for mapping at the scale 1:50.000 and partially for 1:25.000. Normally, the required vertical accuracy

should be less than half of contour interval and the contour interval is half of the map scale. It means that if the map scale is 1:25.000, the contour interval is 12.5 m, and the vertical accuracy should be less than 6.25 m.

### 3. CONCLUSION

As a relatively new remote sensing system, ALOS is a nice alternative for data sources in mapping activities in Indonesia. This study shows the potential of ALOS-PRISM with its geometric evaluation. The planimetric accuracy of ALOS-PRISM is better than 5 meter so that it will fulfill the specification of mapping at the scale 1:25.000. The vertical accuracy is in reference to DEM-SRTM-X approximately about 6 meter, which will fulfill the specification of mapping at the scale 1:50.000. The combination of these two accuracies shows that ALOS-PRISM will be an alternative data sources for map generating at the scale 1:50.000 or smaller and for map updating at the scale 1:25.000.

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