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Quality Assessment of an Extended Interferometric Radar Data Processing Approach

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Introduction

- Legislation act about Geospatial Information in Indonesia initiated the massive production of Large Scale Topographical Maps since 2011 (Table 1).
- Conventional lengthy method by using Airborne data acquisition e.g. Digital Metric Camera, LiDAR, IFSAR.
- Satellite-based data as an alternative to perform Large Scale Topographical Mapping.
- Rapid Mapping needs Ground Control Point (GCP) and Digital Surface Model (DSM) to support “Village Mapping” in a scale of 1:5,000.

	Map scale (1:M)	Map Coverage (Length×Width) in Km	Map Sheets (Numbers)	Availability (%)
1	1,000,000	668 × 442	37	100
2	500,000	334 × 221	103	100
3	250,000	167 × 111	309	100
4	100,000	55.6 × 55.6	1,245	100
5	50,000	27.8 × 27.8	3,899	100
6	25,000	13.8 × 13.8	13,020	40
7	10,000	4.6 × 4.6	91,547	1.5
8	5,000	2.3 × 2.3	379,014	0.2
9	2,500	1.15 × 1.15	880,206	0
10	1,000	0.58 × 0.58	2,729,319	0

Table 1. : Indonesian Topographical Maps Volume (2017)

Research Objectives and Motivation

- Evaluate and identify potential drawbacks in the DSM generation workflow of the Sentinel Application Platform (SNAP) Desktop.
- Present a more robust approach for the TanDEM-X Coregistered Singlelook Slant-range Complex (CoSSC) DSM generation in order to comply with High Resolution Terrain Information (HRTI) Level 4 Specification.
- Investigate the height accuracy of the DSM calculated with our extended solution.

Area of Interest

- The Geospatial Information Agency of Indonesia in Cibinong, supported by the available reference data and services including Continuous Operating Reference System (CORS).
- Urban area of approximately 15 Km^2 with an approximate elevation of 140 meters above mean sea level (msl).
- The terrain condition is classified as medium undulated urban region with a lot of hilly and vegetated areas.

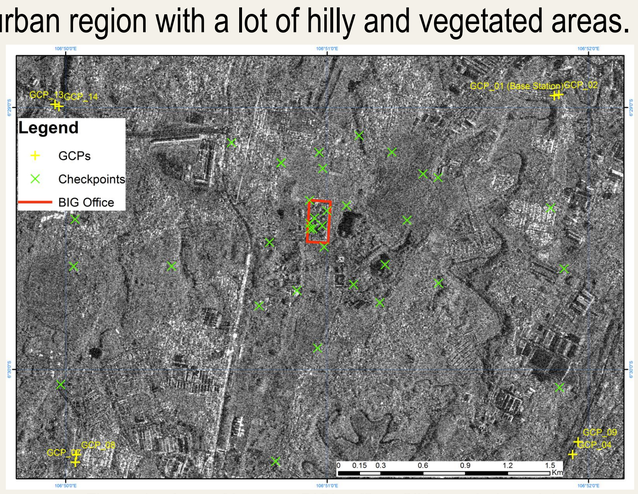


Figure 1. : Area of Interest (BIG’s office, Cibinong,Indonesia)

Data Used

1. TanDEM-X Stripmap product (Table 2) i.e. CoSSC format [1].

Scenes	HOA* / Baseline (m)	Looking Direction	Acquisition Date
S01	135.280 / 040.394	Descending	30-01-2012
S02	034.090 / 146.064	Descending	31-10-2012
S03	061.715 / 095.550	Ascending	09-01-2013
S04	120.747 / 052.689	Ascending	11-10-2013

Table 2. : TanDEM-X CoSSC Data (*Height of Ambiguity)

2. Reference data:
   - GCPs
   - Intermediate DEM – TanDEM-X Scientific [3]
   - Aerial Photo using Digital Camera:
     1. Leica RCD30 (Metric Camera)
     2. Trimble Phase One (P65+)

Interferometric SAR Data Processing

IFSAR DSM generation in SNAP Desktop [5]:

1. Phase Unwrapping in Statistical-Cost Network-Flow Algorithm for Phase Unwrapping (SNAPHU).
2. Extended IFSAR in Phase to Elevation step (Figure 2).

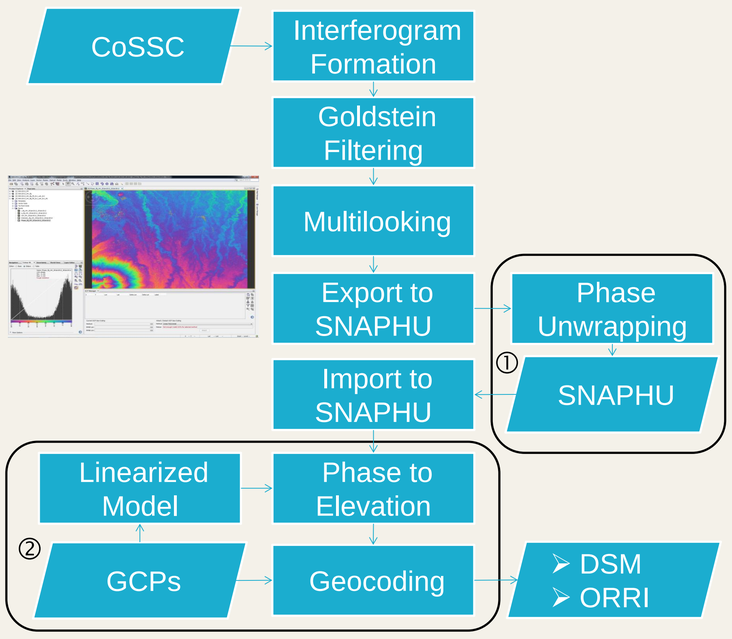


Figure 2. : IFSAR Data Processing Workflow

Extended Tool

Pre-condition and workflow:

1. Input parameters : (Unwrapped Phase, Effective Baseline, Initial Phase Offset)
2. Constants : Wavelength (λ), Speed of light (C_0)
3. Phase Offset Functions introduced by [4].
4. GCP data to provide Initial height reference based on Indonesian Geospatial Reference System (SRGI)
5. Linear adjustment of 3 parameters : Height Reference (h_{ref}), Absolute Phase Offset ($\Delta\Phi$), and Baseline (ΔB_P)
6. Output : Unwrapped Phase, Final Height Reference, Adjusted Baseline
7. Unwrapped Phase to Elevation: Calculated height based on adjusted parameters

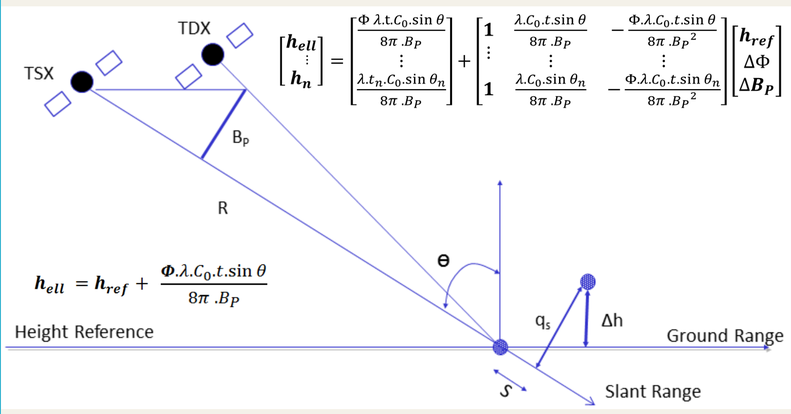


Figure 3. : TanDEM-X Bi-static Geometric Consideration

Absolute Height Accuracy Assessment

Measure the deviation of each grid point on Leica RCD30 DSM (10x10cm) and GNSS Checkpoints (cm absolute height accuracy) to the corresponding points on our generated DSM [2].

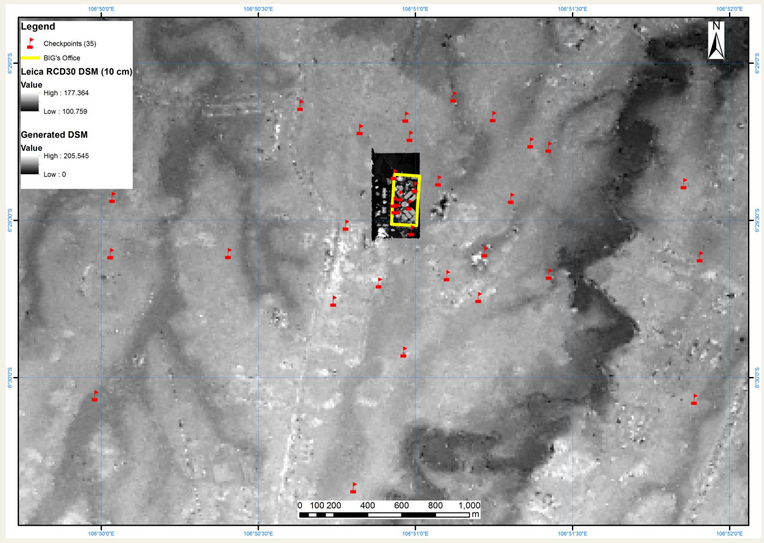


Figure 4. : Data used for Absolute Height Accuracy Assessments

Results and Discussion

- Absolute height accuracy assessment using 4,333,640 gridded points (Leica RCD30 DSM) and 35 Checkpoints (GNSS)
- The Terrain profile from the DSM calculated with the extended tool shows better similarity with Leica RCD30 DSM rather than IDEM (Figure 5).

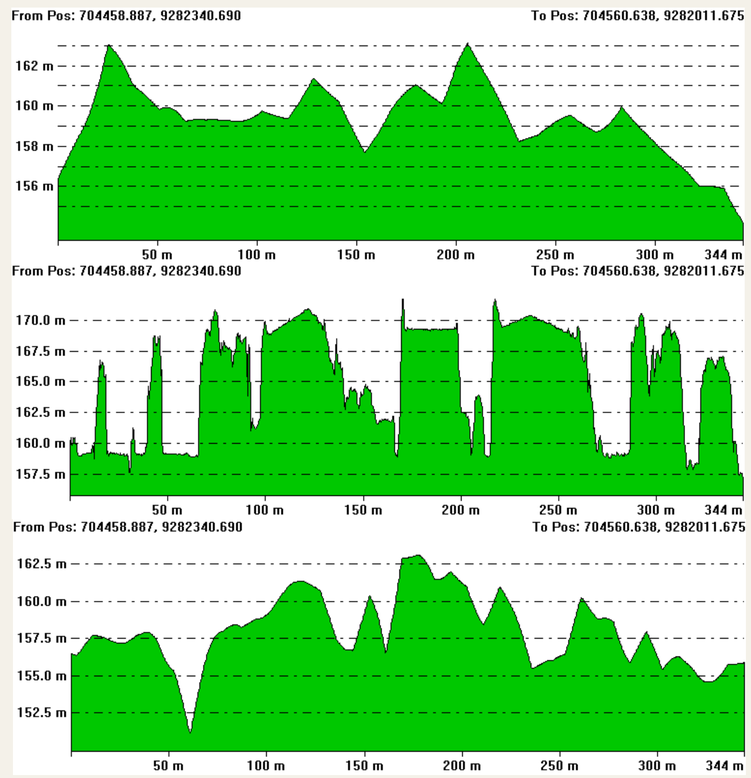
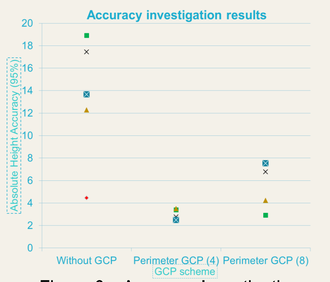


Figure 5. : Building profile in BIG Office : IDEM (upper part), Leica RCD-30 DSM (middle), Generated DSM from Linearized approach (lower)

- Without GCP, leads to an inaccurate DSM i.e. 12-19 m Absolute Height Acc.
- With GCPs our generated DSM comply with HRTI Level 4 Specification i.e. 2 - 3.5 m Absolute Height Accuracy (Figure 6)



	IDEM (m)	IFSAR DSM (m)			
		S01	S02	S03	S04
Without GCP	4.45	18.91	12.28	17.45	13.67
Perimeter GCP (4)	-	3.38	3.48	2.75	2.49
Perimeter GCP (8)	-	2.91	4.23	6.76	7.53

Figure 6. : Accuracy Investigation results refer to the Leica RCD30 DSM and 35 Checkpoints

Conclusions and Further Work

- ✓ An extended tool to determine height reference, the phase offset estimation, and baseline for a more accurate IFSAR DSM generation has been presented.
- ✓ Our approach for TanDEM-X CoSSC data processing is appropriate for 1:10,0000 Large Scale Topographical Mapping in Indonesia
- ✓ Simultaneous implementation on multi TanDEM-X CoSCC datasets

Acknowledgements

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