Images Time Series Analysis for Land Deformation and Mapping Shallow Landslides based on SENTINEL - 1 and Optical Satellite Images Data: Case Study on Batam Island, Indonesia

Tiggi Choanji, Chunwei Sun, Li Fei, Marc-Henri Derron, Michel Jaboyedoff

RISK Group, Institute of Earth Sciences, University of Lausanne

UNIL | University of Lausanne
Institute of Earth Sciences
Geopolis
CH-1015 Lausanne

INTRODUCTION

Batam is an island and a city in Riau Kepulauan Province of Indonesia. It is known for its free trade zone area as part of the SIJORI triangle (Singapore-Johor-Riau). Being strategically located close to Singapore and Malacca Strait gives Batam its status as a special economic region in Indonesia

The city is growing rapidly as a strategic benchmark between border of two countries. However, along with the rapid development, land deformation is also happen, and also followed by potential landslide hazards that occur in this region, considering that this area has some area that prone to shallow landslide.

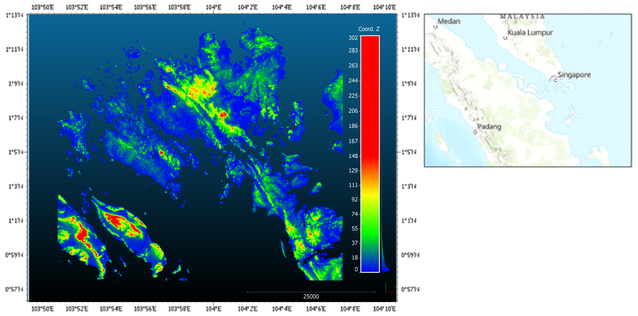


Fig. 1. Location of Batam island area, topography are hilly on the middle part of the island

GEOLOGICAL SETTING

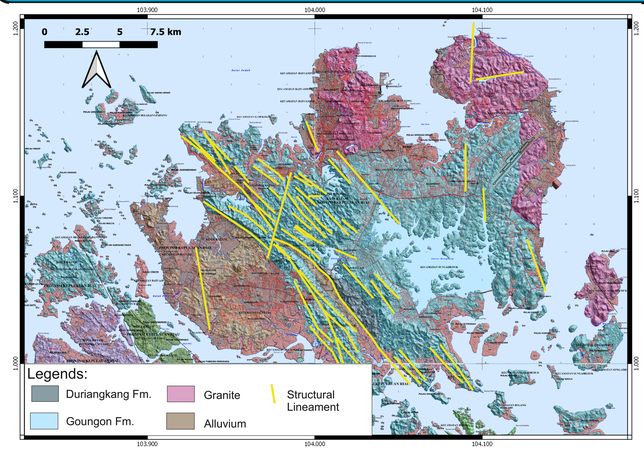


Fig. 2. Geological map of the batam island (modified from remotesensing geology and Geological map)

Geology of batam area consist of four formation, which are Goungon Fm. dominated by tuffaceous sandstone and silt stone. Duriangkang Fm. involved lithology dark-grey shale and quartz sandstone. Granite, and Alluvial. This area are having structural geology that highly intensed trending Northwest-Southeast.

METHOD

DINSAR ANALYSIS

- Apply orbit
- Coregistration
- Enhanced Spectral Diversity
- Interferogram
- Deburst
- Topographic Phase Removal

INTERFEROGRAM ANALYSIS

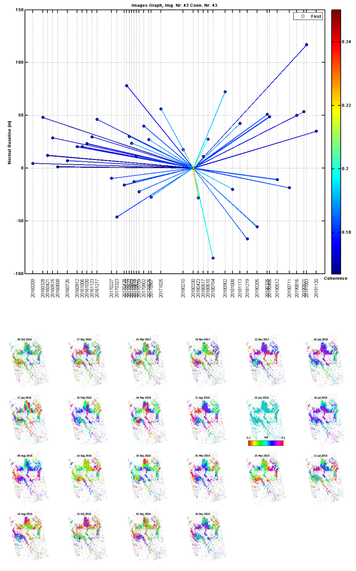
- PS Processing
- Estimate Phase Noise
- PS Selection
- PS Weeding
- PS Correction
- PS Unwrapping
- PS Estimate spatially- corrected look angle error

Optical Image Identification using Landsat – 8

Time Series Deformation And Mapping Shallow Landslide

Fig. 3. Flow charts of the standard processing chain PSI- INSAR (left) and Table acquistion date and total data processed images

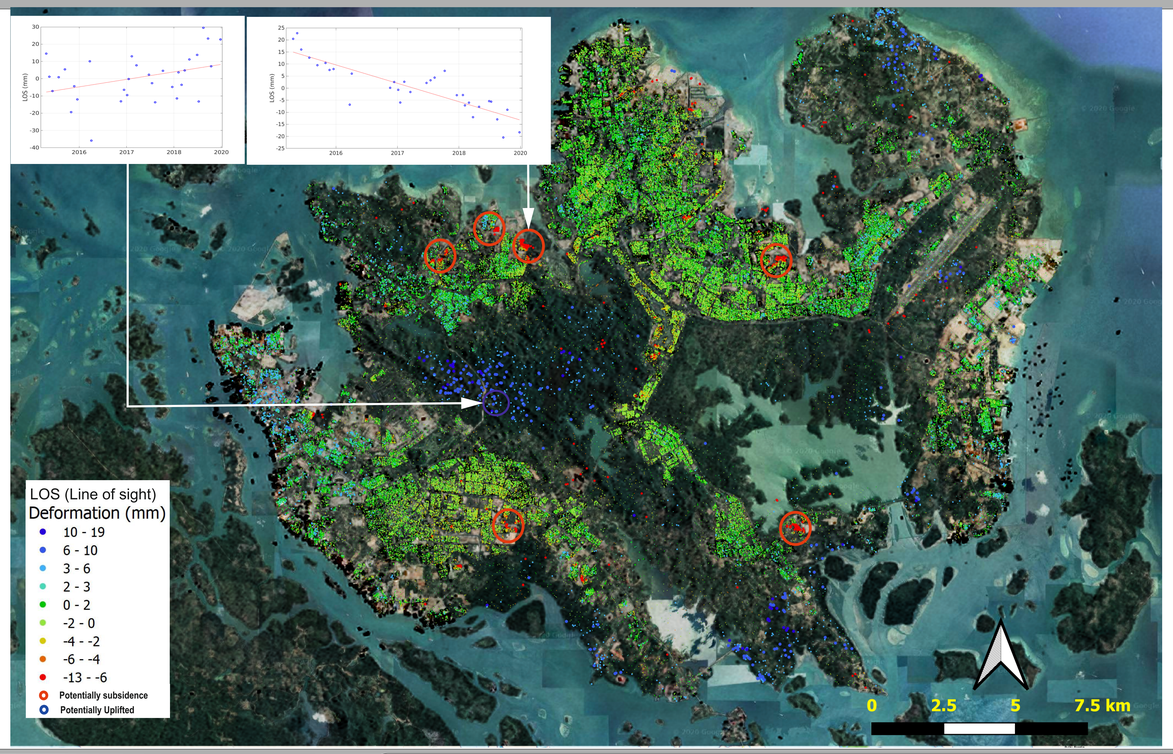
RESULT



The satellite image SENTINEL – 1A processed using 32 images from 9/02/2016 – 15/10/2019, ascending, and VV polarization. After generating interferograms and coherence, initial PS candidates are selected based on the amplitude stability, resulting 276465 PSC's according to the threshold, it shows a good coherency. Some points to be inferred based on the result, are:

1. Subsidence mostly occurs on near waterfront area, based on value of Line of Sight showed negative value with maximum 13 mm /year, this occurs mostly as inhabitant position located on alluvium as unstable lithology for housing.
2. Some LOS positive value showed on the hilly part, that interpreted uplifted due to active structural area, from the value 10 - 19 mm / year. It is based on result of some hilly area that resulting same trend of positive value that having same geological structural trend.
3. Tectonically, batam area are quite stable because located in back-arc area. So, it interpreted that the there are some long effect of subduction that uplifted the structure, however, this hypothesis need to be improved based on field check.
4. Mapping Landslide using PSI method in this area showed simply movement, which needs to be improve as it can be identified on optical images.

Fig. 4 Interferogramtic image from 32 Sentinel 1-A images (bottom left), and statistic data sets of processing images. (above)



CONCLUSION

Persistent Scaterred Interferometry using from SENTINEL 1A is effective for defining land deformation (subsidence and uplift) in structural area, however for mapping shallow landslide and identification, it still need further improvement with other method.

ACKNOWLEDGEMENT

Author would like to thanks to ESA and NASA who provide SENTINEL 1-A data access, so this research can be done. Also thanks to UNIL, Institute of Earth Sciences that provide supervision and facility for processing image as part of PhD. And also Indonesian Endowment Fund for Education (LPDP), Indonesia for grant support of scholarship and research.

REFERENCES

Hooper, A., A multi-temporal InSAR method incorporating both persistent scatterer and small baseline approaches, Geophys. Res. Lett., 35, L16,302, 2008. 1
Hooper, A., P. Segall, and H. Zebker, Persistent scatterer InSAR for crustal deformation analysis,with application to Volcan Alcedo, Gal´ apagos, ´ J. Geophys. Res., 112, 2007. 1, 3.4.1, 3.4.2, 4.2
J. M. Delgado Blasco, M. F., Automated snap sentinel-1 dinsar processing for stamps psi with open souce tools, 2018. 2.4.2, 3.2
Foumelis, M., J. M. Delgado, Y.-L. Desnos, M. Engdahl, D. Fernandez, J. L. L. Veci, and C. Wong, Esa snap - stamps integrated processing for sentinel-1 persistent scatterer interferometry, IEEE Int. Geosci and Remote Sensing Symposium. IGARSS 2018, 2018. 1, 3.2
Werner, C., U. Wegmuller, T. Strozzi, and A. Wiesmann, Gamma sar and interferometric processing ¨ software, in Proceedings of the ers-envisat symposium, gothenburg, sweden, vol. 1620, p. 1620,2000. 1

EGU General Assembly 2020
EGU2020-5018, 2020