# FIG WORKING WEEK 2019

## 22–26 April, Hanoi, Vietnam



"Geospatial Information for a Smarter Life and Environmental Resilience"




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# Application of Quasi-PSI method for landslide determination in Northern mountainous region of Vietnam by multi sensor Radar satellite images

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## Contents

- Reasons for research
- Methodology
- Data
- Results and discussion
- Conclusions

# Reasons for research

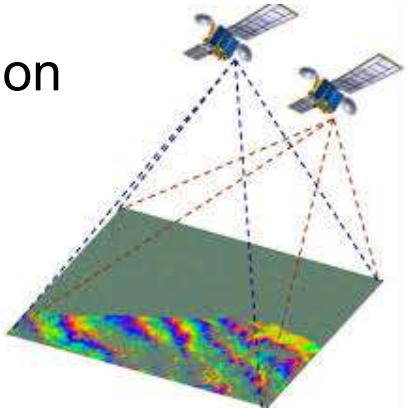
Laocai

Sonla

Hoabinh

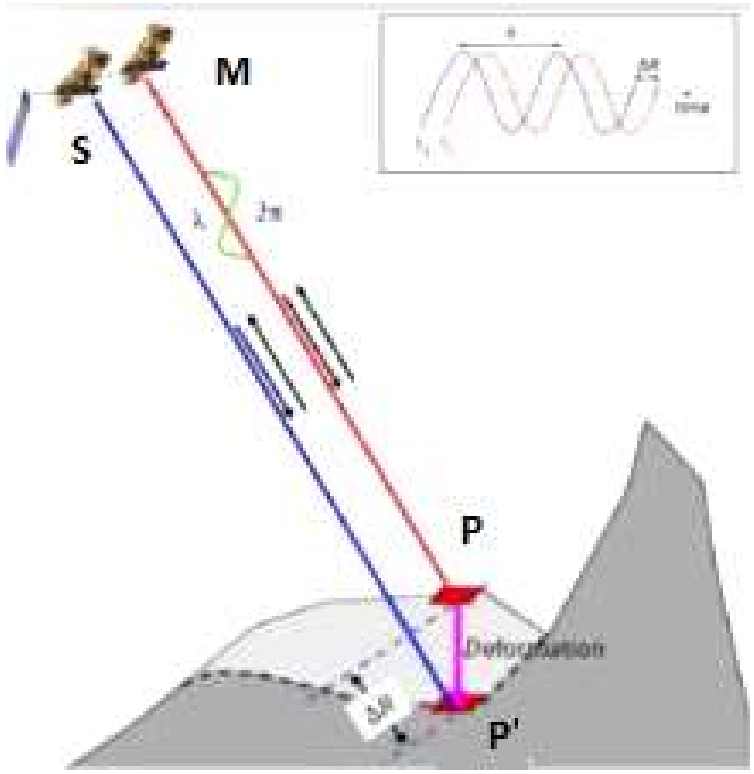
# Reasons for research

Methods for landslide detection



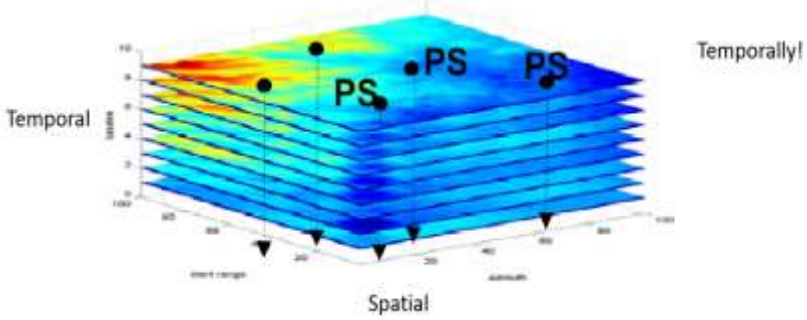
# Methodology

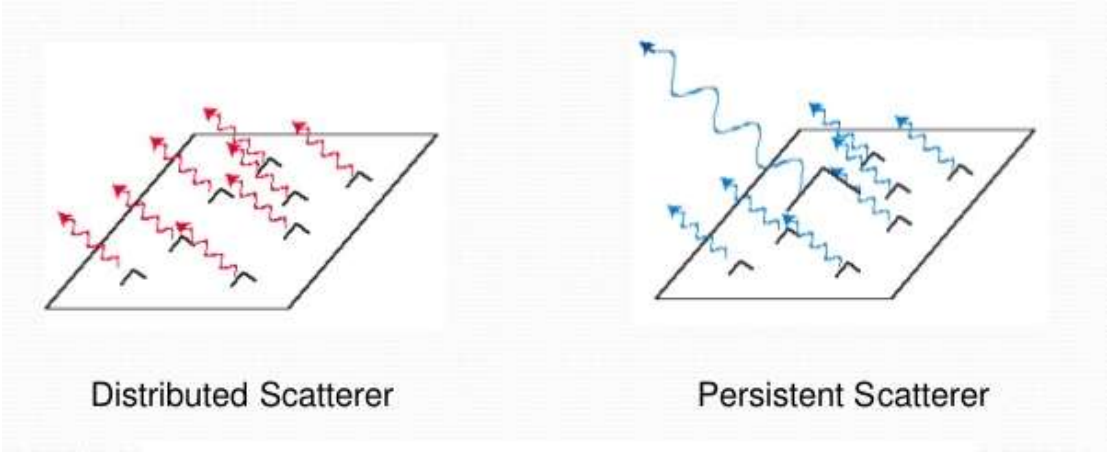
- Quasi-PSI method is a method developed from traditional method of determining ground deformation named DInSAR (Differential SAR Interferometry) and PSInSAR. DINSAR method determines the land deformation by the phase shift between two or three images acquired in different times over the same area on the surface




$$\Delta\varphi_{D-Int} = \Delta\varphi_{Int} - \varphi_{Topo\_stimu} = \varphi_{Displ} + \varphi_{Topo\_res} + \varphi_{Atm\_s} - \varphi_{Atm\_M} + \varphi_{Orb\_s} - \varphi_{Orb\_M} + \varphi_{Noise} + 2.k.\pi$$

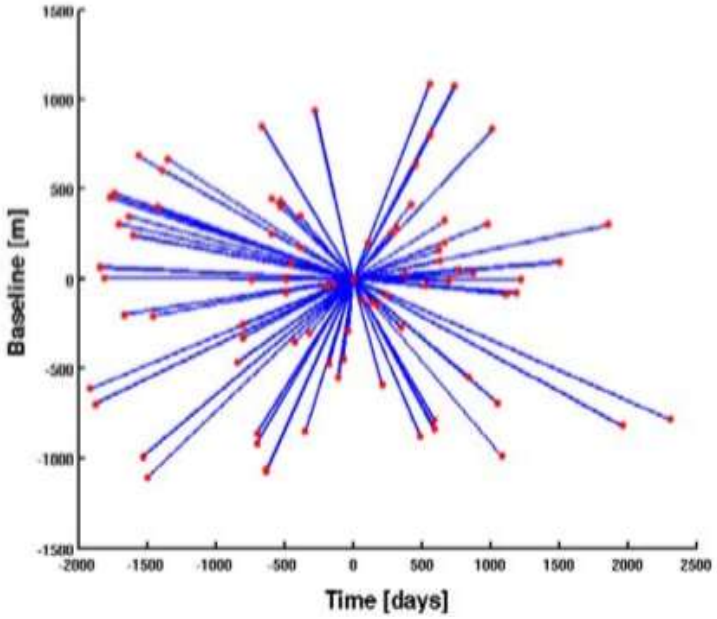
# PSInSAR

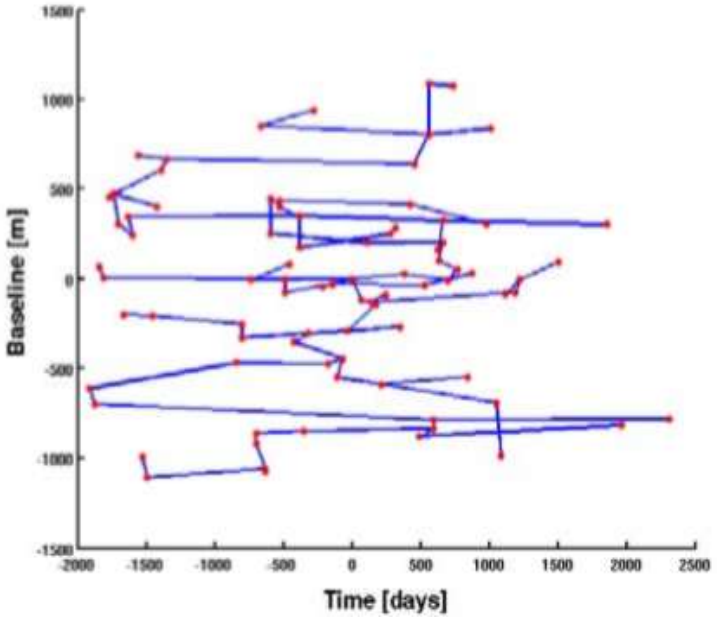


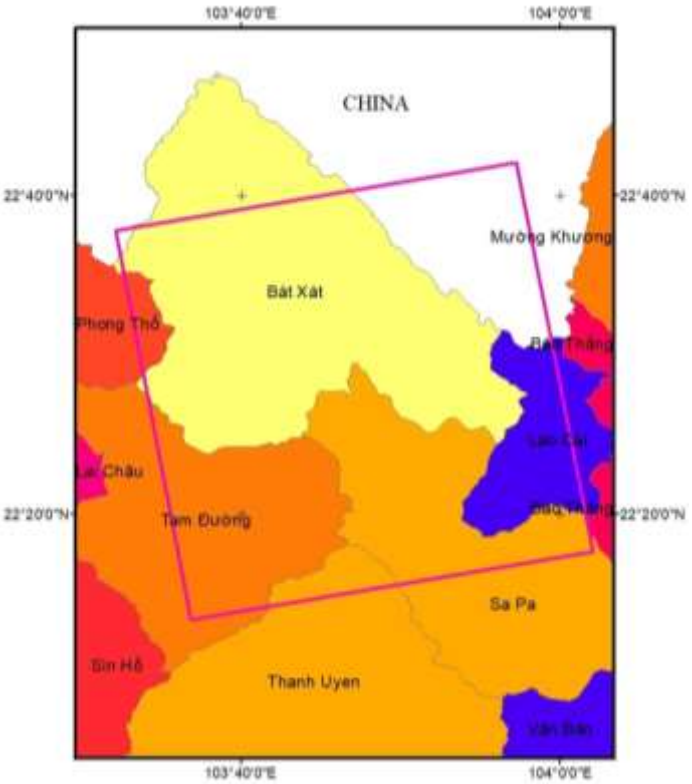

D. Perissin (2012)

# PSI vs Quasi-PSI



# Study Area and Data usage



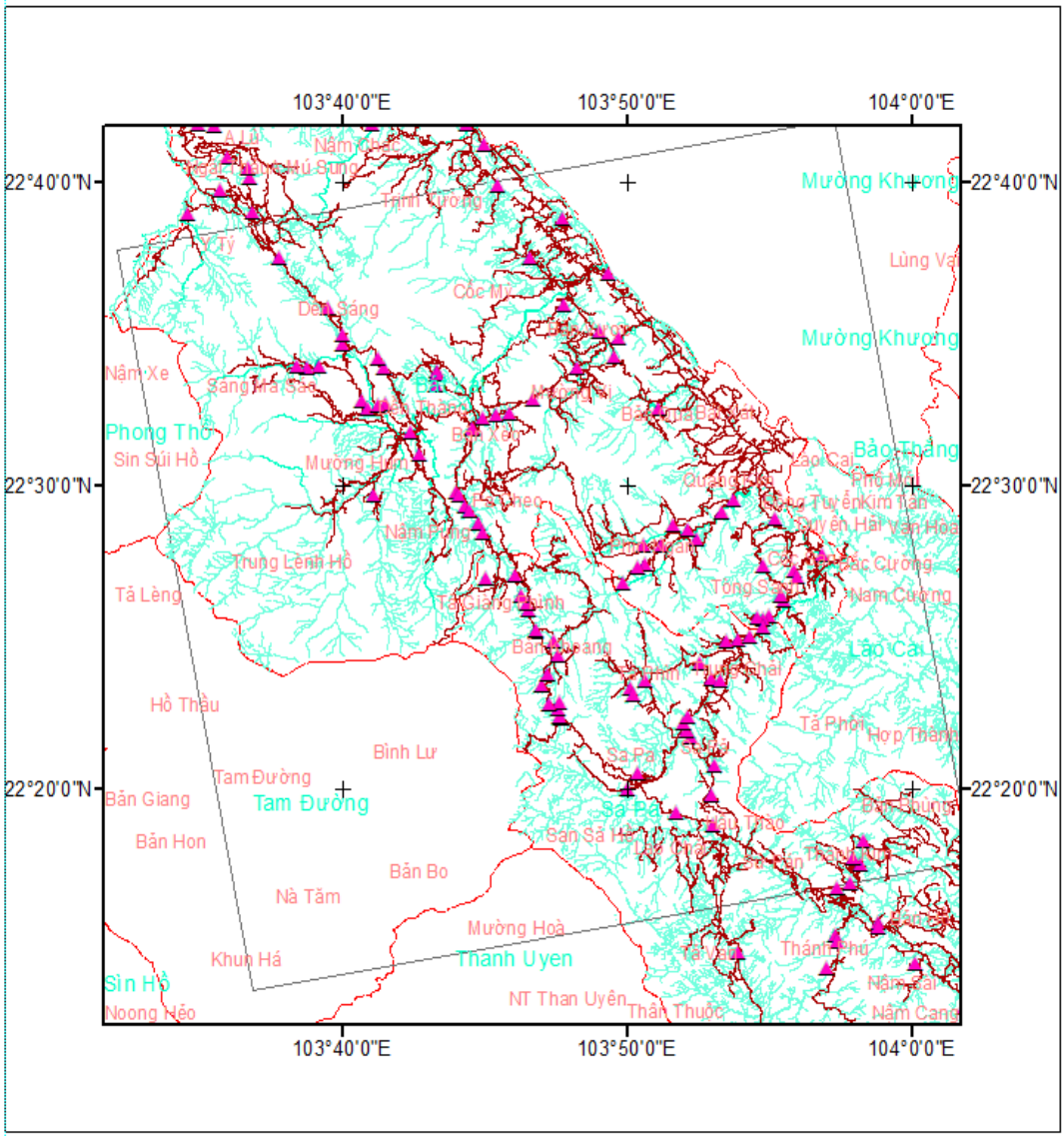

Our research area is partly in Bat Xat district and Sa Pa district in Lao Cai province. The entire terrain of this area is formed by many high mountain ranges, highlighting the two main mountain ranges forming the watersheds: Ngoi Phat, Lung Po stream, Quang Kim stream. Terrain changes gradually, the highest point with an elevation of 2945m, the lowest point with an elevation of 88m.

Every year from July to September is a period of high rainfall and frequent landslide and flash floods in mountainous areas of Vietnam, of which Bat Xat, Sa Pa districts are hot spots of landslide.

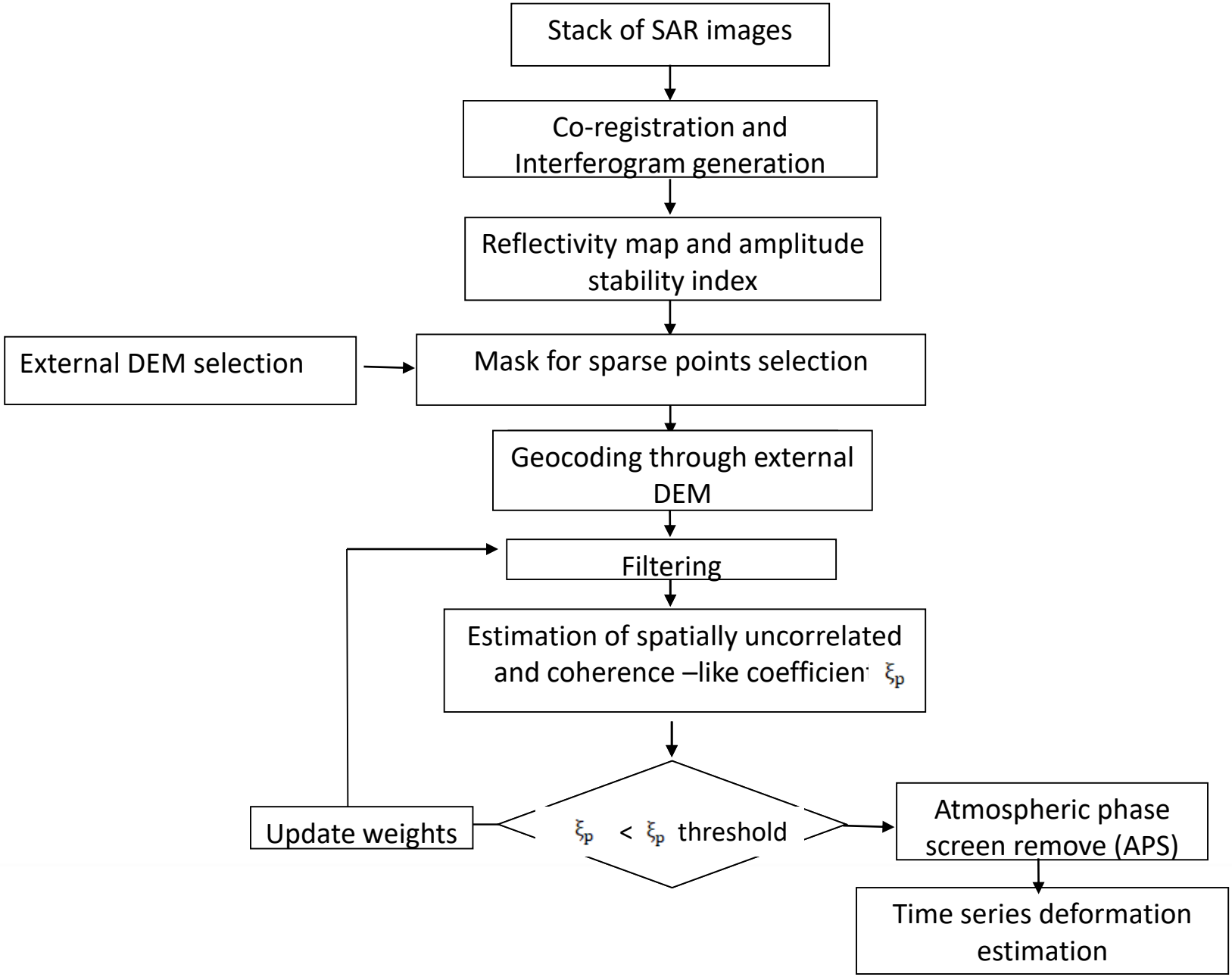
| ALOS PalSAR | | | | Sentinel -1A | | | |
|---|---|---|---|---|---|---|---|
| No | Date of Acquisition | Polarization | Orbit | No | Date of Acquisition | Polarization | Orbit |
| 1 | 2007/08/10 | HH | Ascending | 3 | 2017/04/30 | VV | Ascending |
| 2 | 2007/09/25 | HH | Ascending | 4 | 2017/05/24 | VV | Ascending |
| 3 | 2007/11/10 | HH | Ascending | 5 | 2017/08/04 | VV | Ascending |
| 4 | 2008/05/12 | HH | Ascending | 6 | 2017/08/16 | VV | Ascending |
| 5 | 2008/06/27 | HH | Ascending | 7 | 2017/09/21 | VV | Ascending |
| 6 | 2008/08/12 | HH | Ascending | 8 | 2017/10/15 | VV | Ascending |
| 7 | 2009/06/30 | HH | Ascending | 9 | 2017/10/27 | VV | Ascending |
| 8 | 2009/08/15 | HH | Ascending | 10 | 2017/11/20 | VV | Ascending |
| 9 | 2009/09/30 | HH | Ascending | 11 | 2017/12/26 | VV | Ascending |
| 10 | 2010/07/03 | HH | Ascending | 12 | 2018/01/19 | VV | Ascending |
| 11 | 2010/08/18 | HH | Ascending | 13 | 2018/02/24 | VV | Ascending |
| 12 | 2010/10/03 | HH | Ascending | 14 | 2018/03/20 | VV | Ascending |
| 13 | 2010/11/18 | HH | Ascending | 15 | 2018/04/13 | VV | Ascending |
| Sentinel -1A | | | | 16 | 2018/05/19 | VV | Ascending |
| 1 | 2017/03/13 | VV | Ascending | 17 | 2018/06/12 | VV | Ascending |
| 2 | 2017/04/06 | VV | Ascending | 18 | 2018/07/18 | VV | Ascending |

# Survey landslide positions

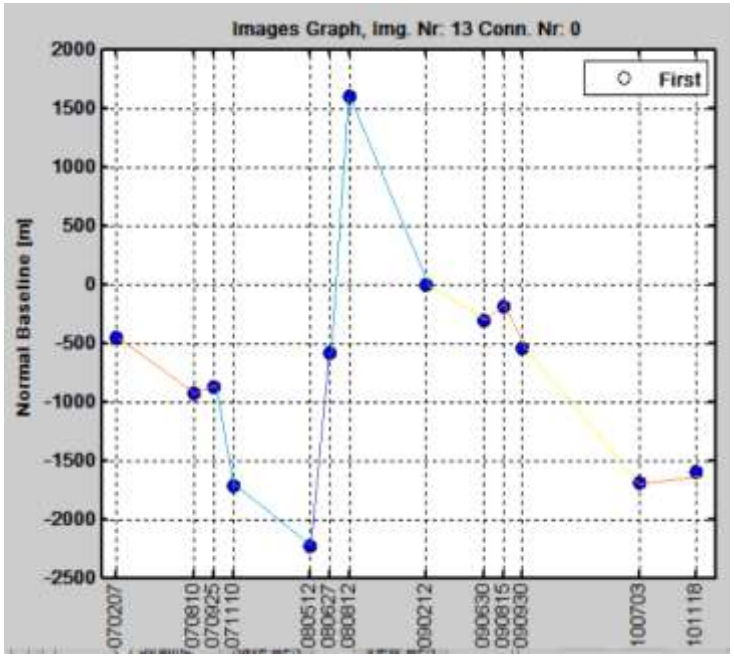
The map of landslide survey locations in the study area provided by Vietnam Institute of Geosciences and Mineral Resources



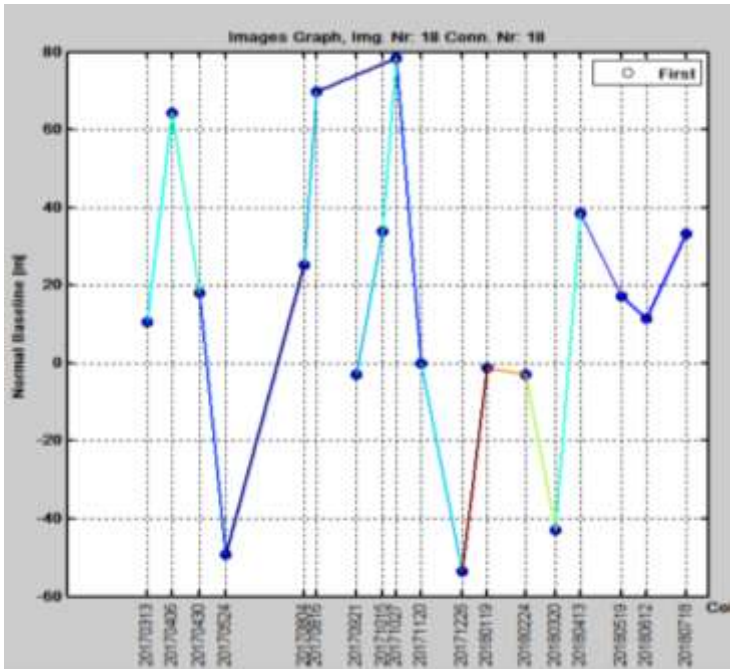
# Image processing flow chart



# Positions and the connections of ALOS PalSAR-1, Sentinel-1

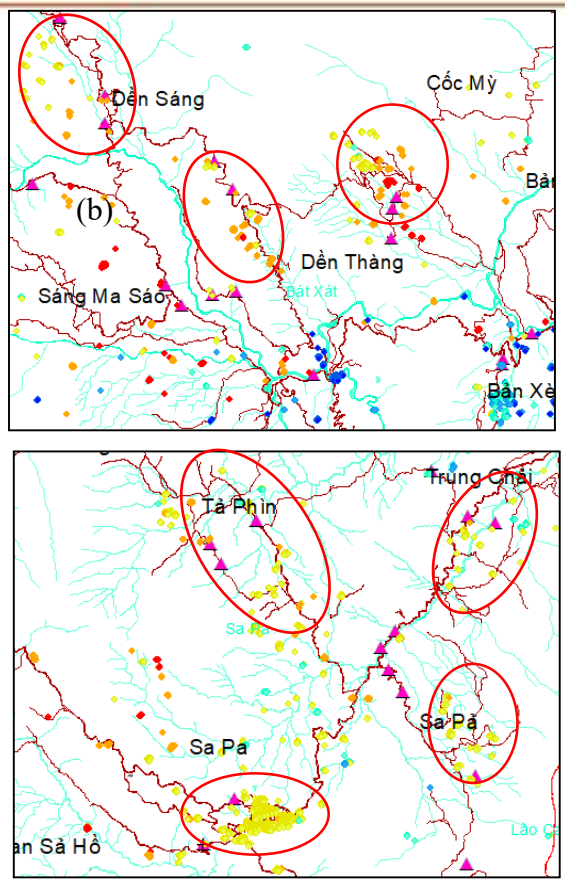


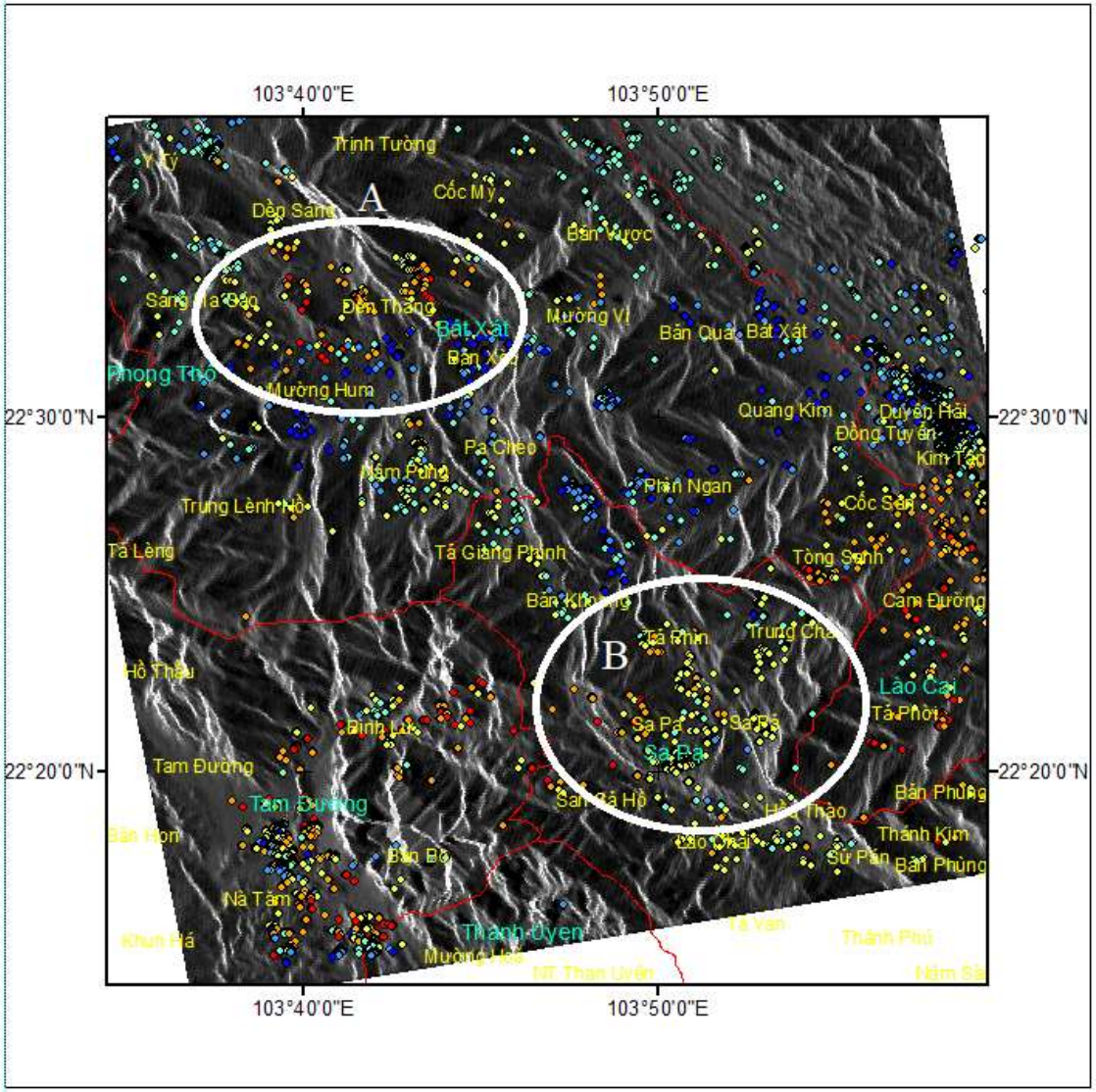

ALOS PalSAR-1

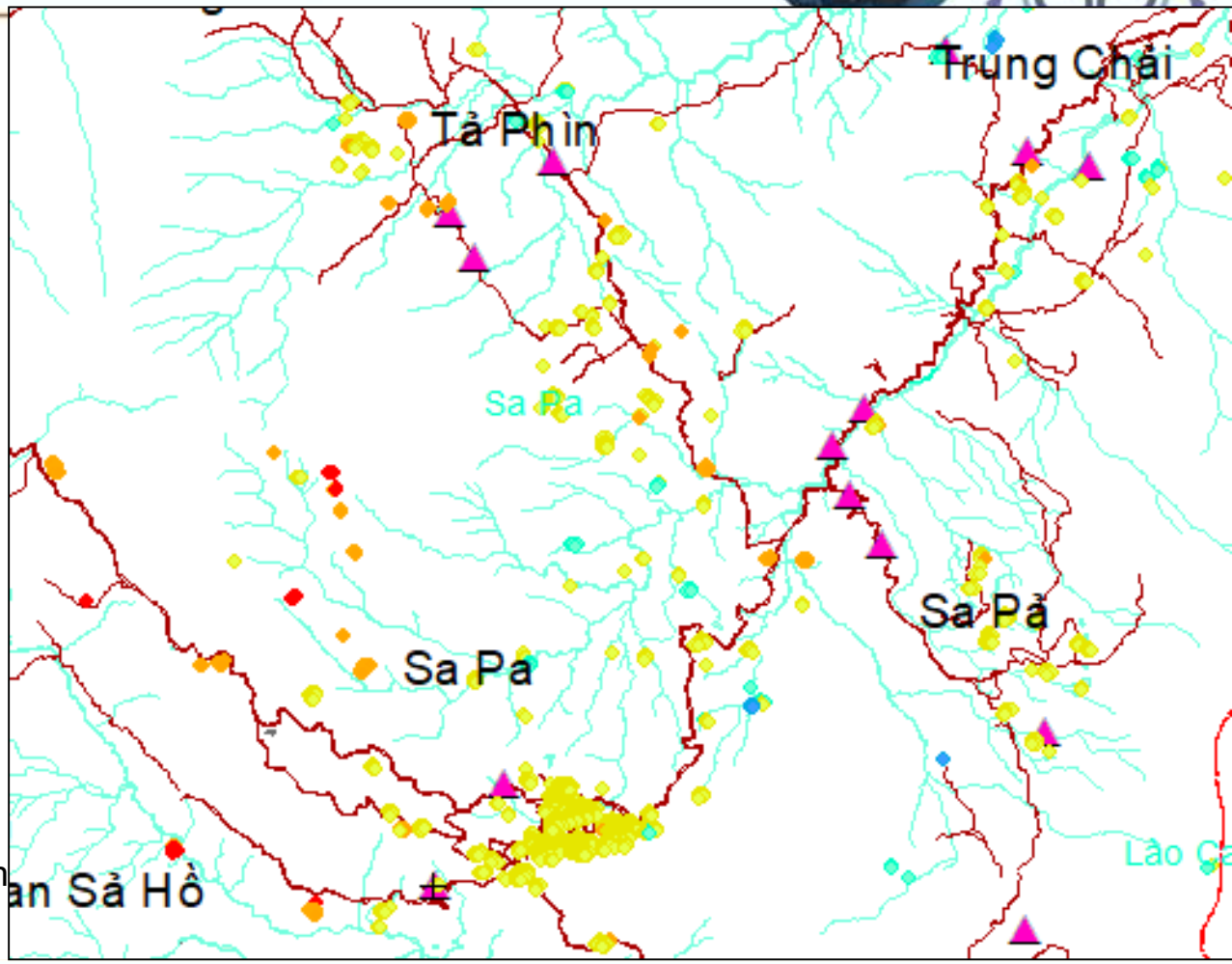



Sentinel-1A

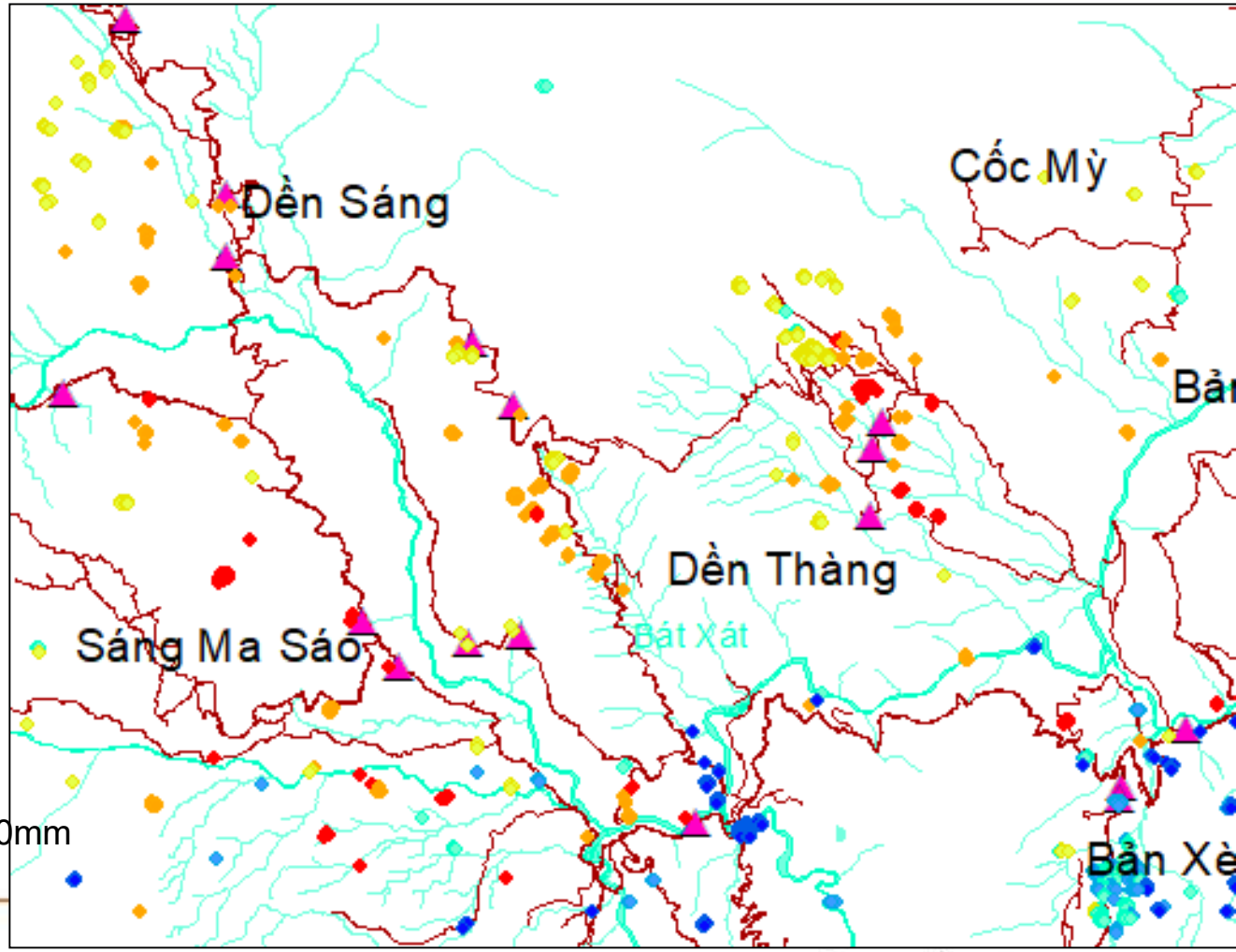
# The location of the landslides from the ALOS PalSAR-1 images.



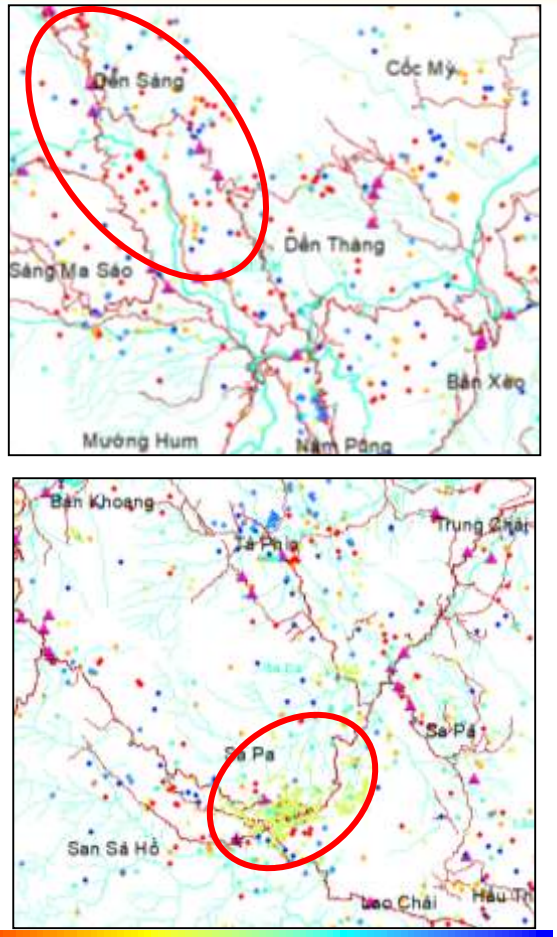



-350mm 500mm

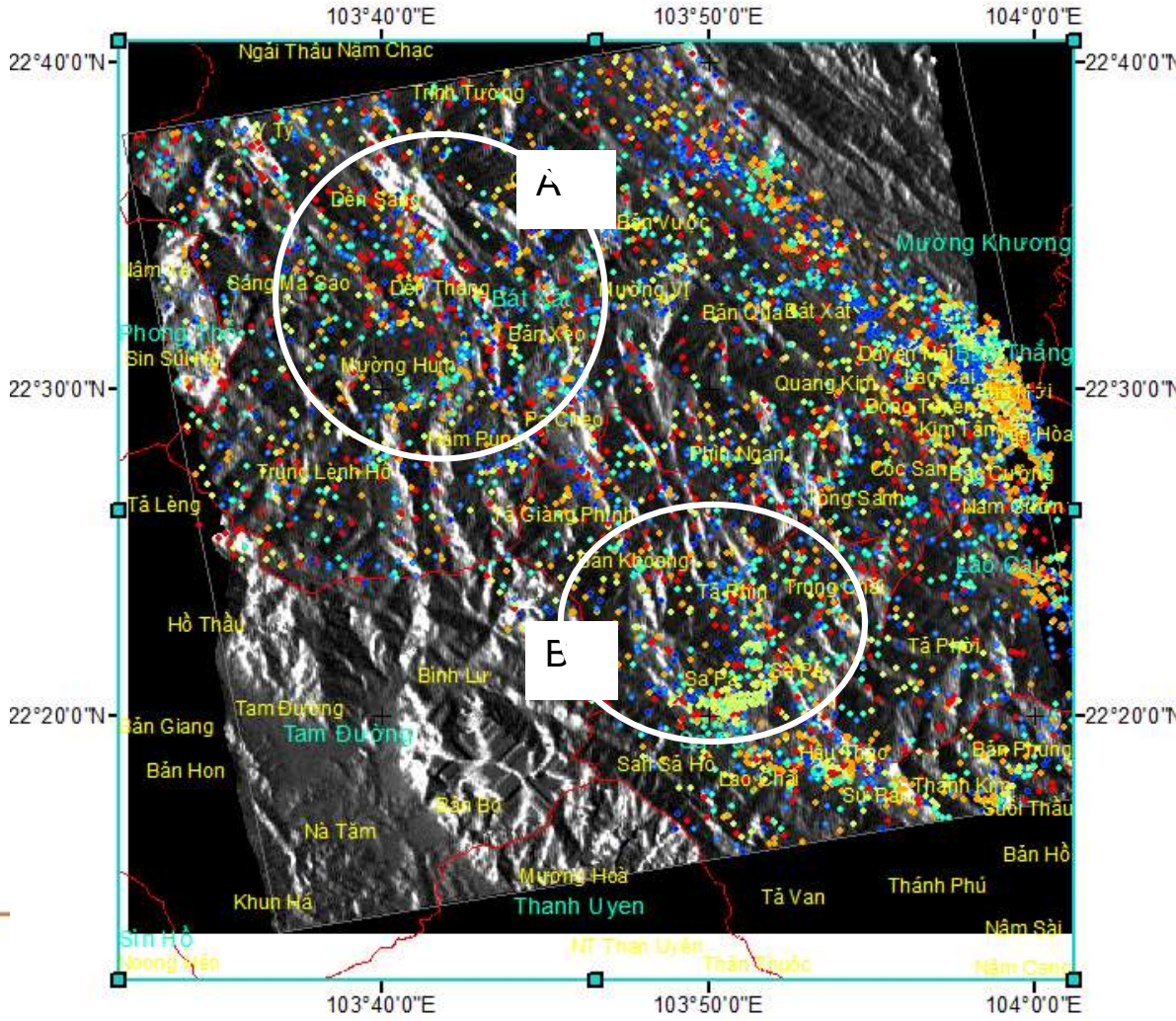


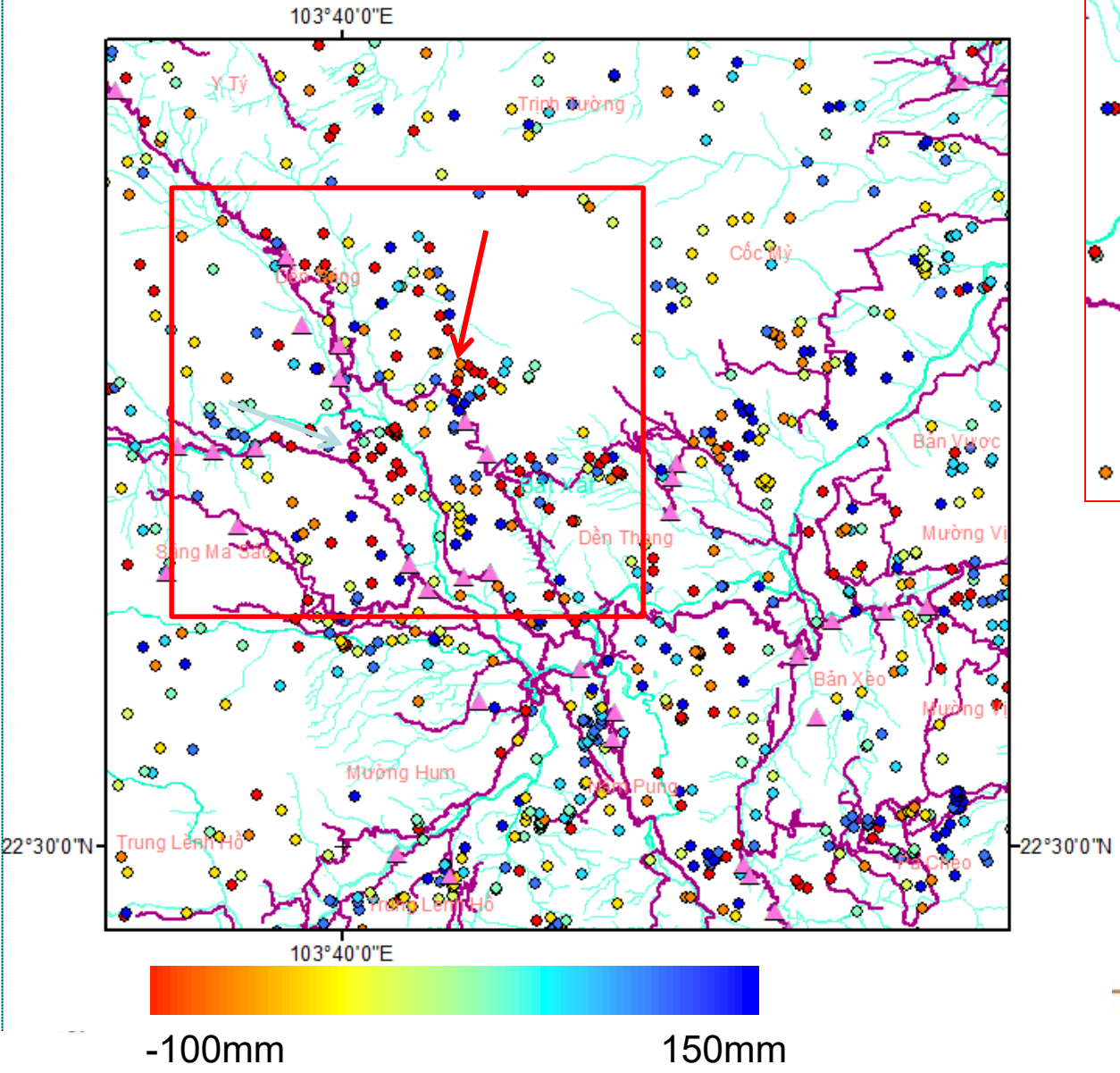

-350mm 500mm

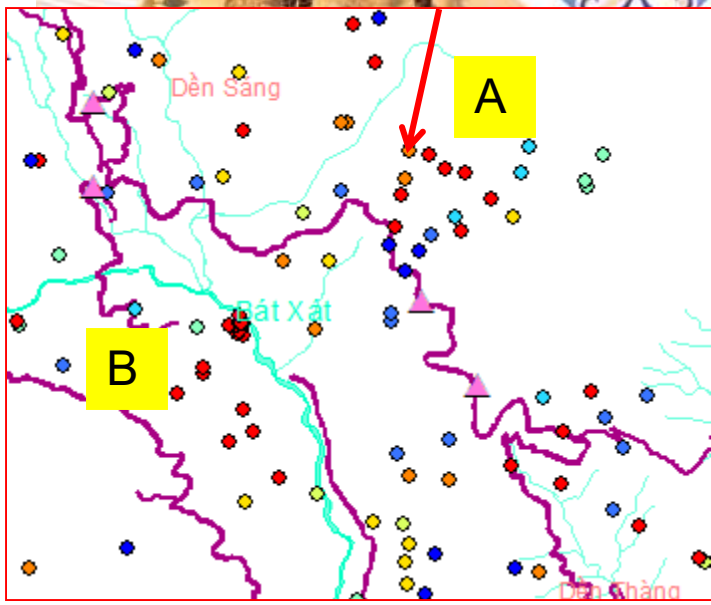
# Locations of landslides from the Sentinel -1A images

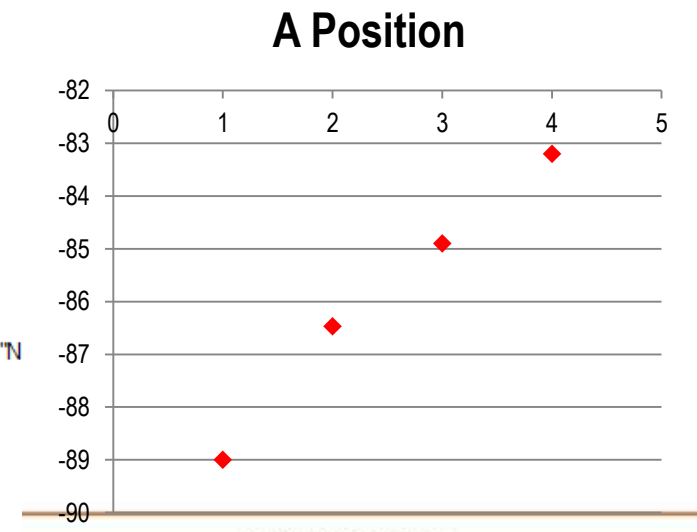



-100mm 150mm

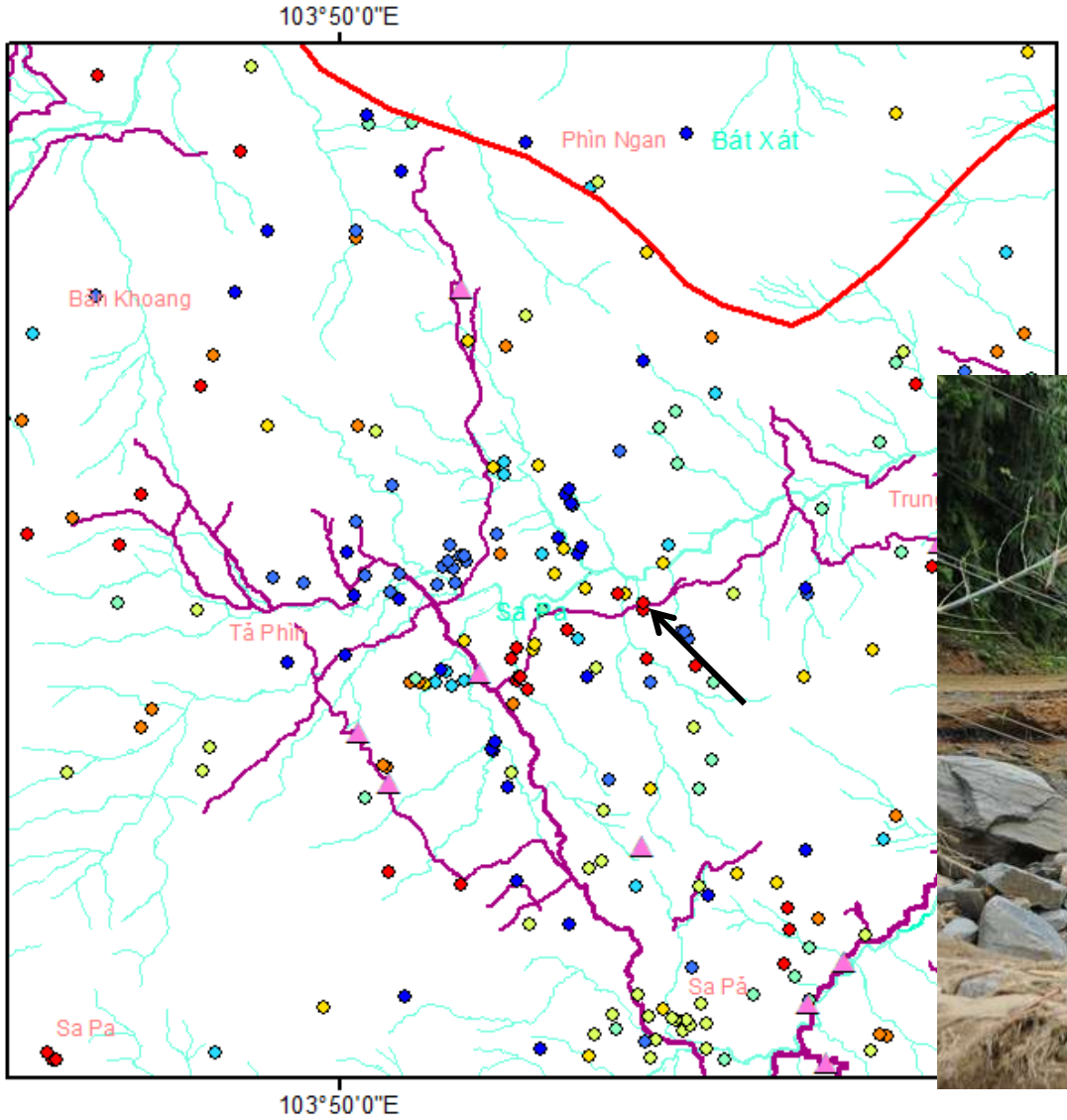



103°40'0"E
Y Tý
Trịnh Tường
Cốc Mỳ
Bản Vược
Dền Thàng
Mường Hum
Bản Xèo
Trung Lèng Hồ
22°30'0"N
103°40'0"E
-100mm
150mm

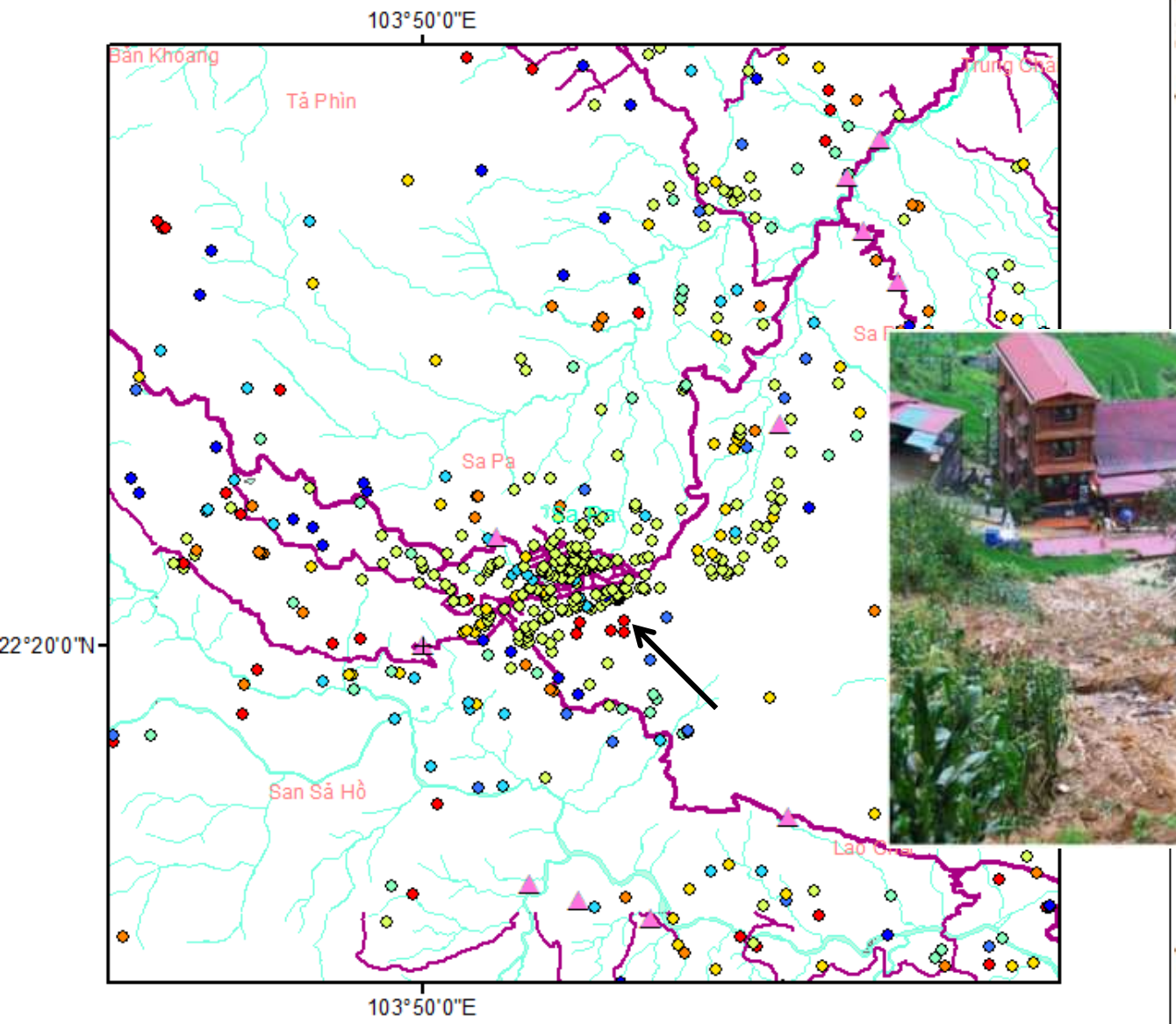

Dền Sáng
A
Bát Xát
B


A Position
-82
-83
-84
-85
-86
-87
-88
-89
-90
0
1
2
3
4
5

# Landslides in Taphin




# Landslides in Sapa




# Conclusions

- The Quasi-PSI method is suitable for mountainous areas with dense vegetation cover due to the selection of optimal coherence values and used them as weight to eliminate unsatisfactory PS points.
- The ALOS PalSAR-1 images was used for over 3 years from 2007 to 2010, while the Sentinel-1 images was used for one and half years from the beginning of 2017 to the middle of 2018. With ALOS palSAR dataset, the baselines were a bit long, besides, coherence of the image pairs were not high, thus the number of PS and DS points were not much, only 15063 points. With the higher number of images and the shorter baselines, the correlation of the image pairs was also higher so the number of PS and DS points was 20100 points. These points were the points used to determine landslides.
- Landslide survey sites provided by the Vietnam Institute of Geosciences and Mineral Resources were collected in 2013, which was different from the two time series of images. However, this time was close to ALOS palsAR image so there were a lot of sliding positions coinciding with the sliding position determined from the ALOS PalSAR images. For Sentinel-1 images, the time of acquiring images were quite far from the time of survey so the sliding positions were different. There was the locations in Densang and Sapa town where near the QL4D road were always at risk of sliding because it existed from 2007 to 2018. Since then, determining of the landslides from Radar satellite images can be used to detect at large, frequent and long-term landslides.
- Due to the landslide identification from the radar image is possible to get the sliding rate whereas the survey landslide is not available, therefore it is only possible to determine the location of landslide that occurred for comparing. In the near future we are planning to attach sensors to measure the sliding speed in some susceptible landslide locations to compare with the method of using radar interferometry method.

# Thank you for your attention