DRAGON 2021 SYMPOSIUM

Dragon 4 Final Results Poster Session

19 July 2021

Europe: 10:00 to 12:00, China: 16:00 to 18:00

INTRODUCTION

Dragon 4 project id: 32278

Poster Title: On the applicability of satellite SAR interferometry to landslide hazards detection in hilly areas: a case study of Shuicheng, Guizhou in Southwest China

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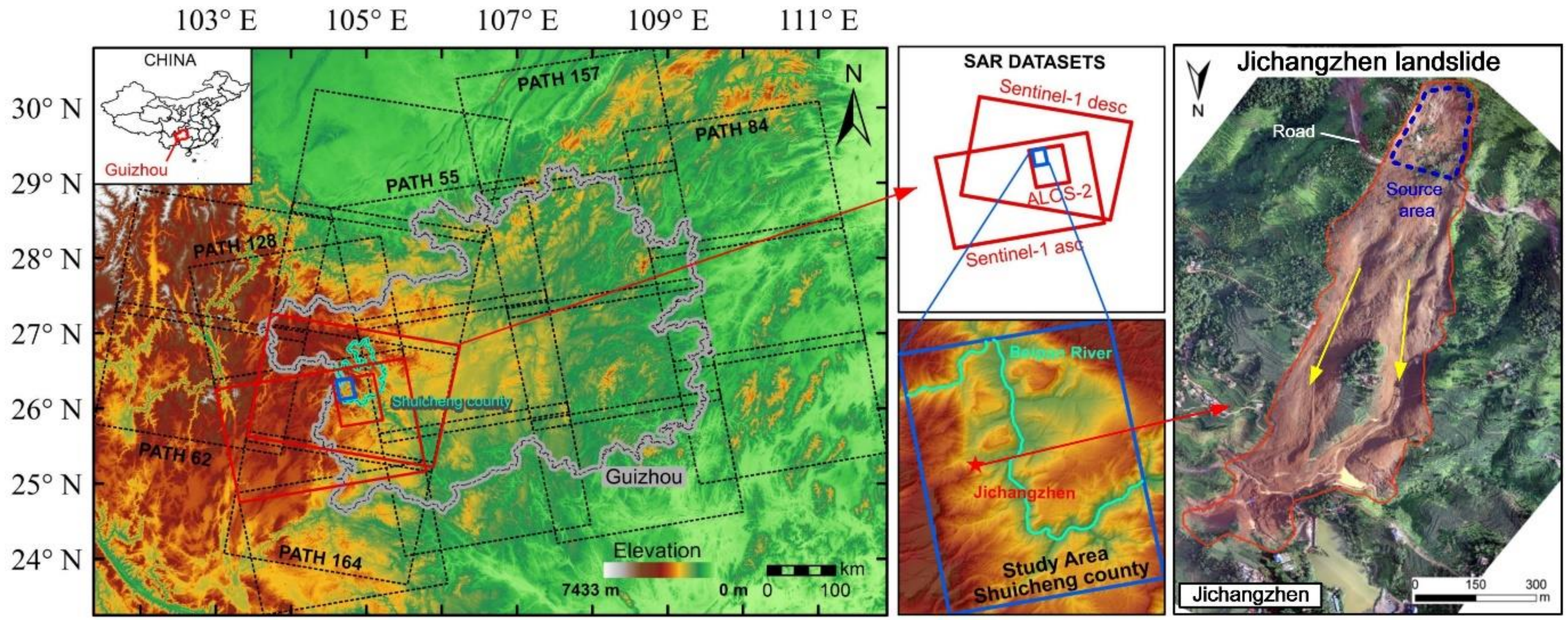
OBJECTIVES & RESEARCH APPROACH

Objectives

- Study Area : Shuichen county, Guizhou Province
- SAR Data: ALOS-2 PALSAR-2; Sentinel-1 (Path 128);Sentinel-1 (Path 164)
- Auxiliary Data: The land-cover map; STRM DEM

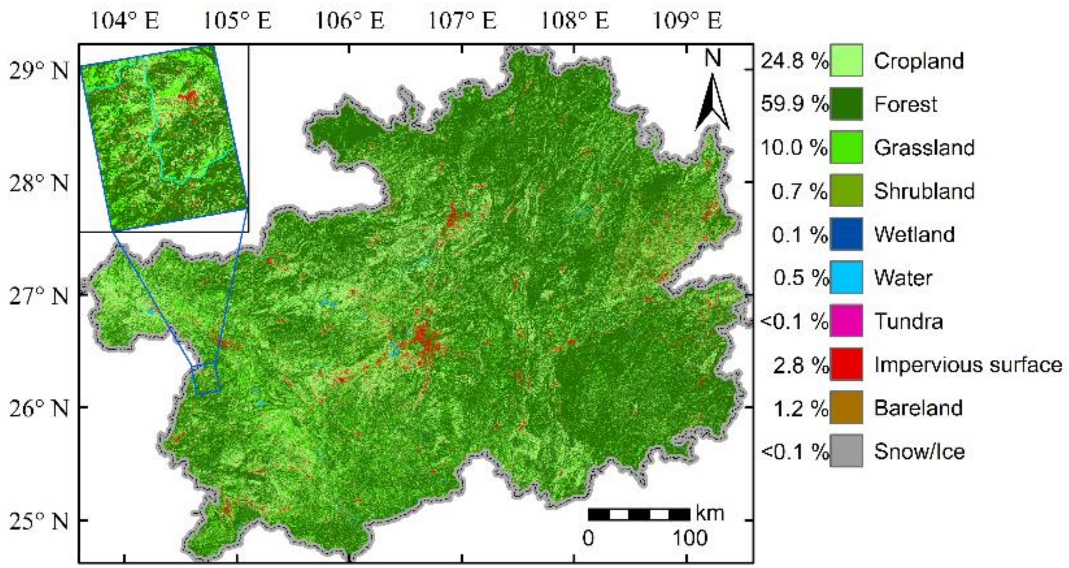
Research Approach (including EO and other data)

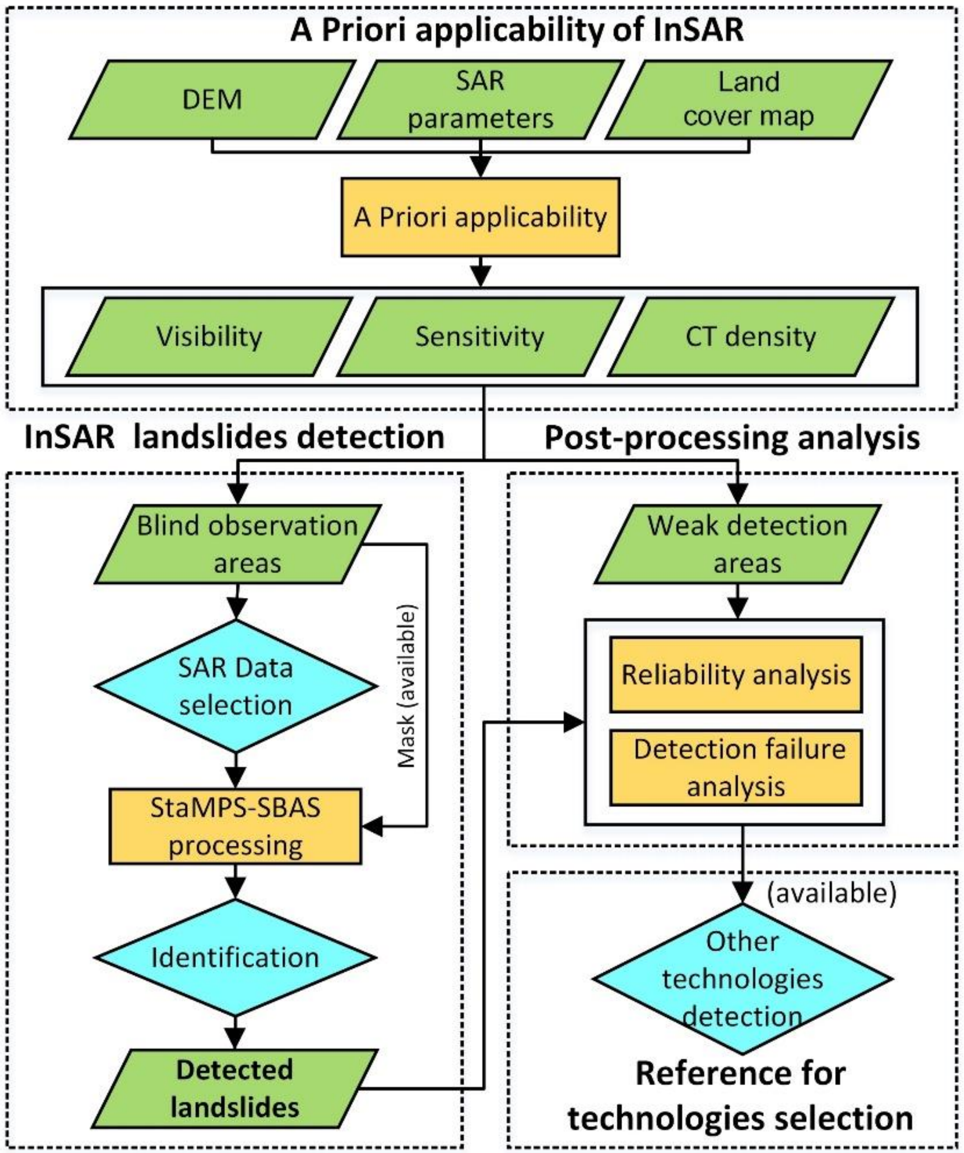
- A priori estimation of applicability
- Applicability analysis
- Post-processing analysis: Landslides mapping and reliability analysis
- Post-processing analysis: Detection failure analysis



- **Study Area :**
  Guizhou Province
  Shuichen county
- **SAR Data:**
  ALOS-2 PALSAR-2;
  Sentinel-1 (Path 128);
  Sentinel-1 (Path 164)
- **Auxiliary Data:**
  The land-cover map;
  STRM DEM

Parameters	ALOS-2 PALSAR-2	Sentinel-1 (Path 128)	Sentinel-1 (Path 164)
Orbital track	Ascending	Ascending	Descending
Heading angle(°)	-10.5	-12	+12
Incidence angle (°)	36.2	30 ~ 46	30 ~ 46
Resolution (m)	3	Rg × Az: 5×20	Rg × Az: 5×20
Number of scenes	16	67	69
Acquisition dates	From 16th April 2017 to 07th July 2019	From 01st April 2017 to 20th July 2019	From 03rd April 2017 to 22nd July 2019





A priori estimation of visibility, sensitivity, and CT density is first conducted using DEM, SAR acquisition parameters, and land cover map. The a priori results contain the blind observation area and weak detection area of InSAR, which can be further used for InSAR landslide detection and post-processing analysis.

- **Visibility :**

Ground visibility of SAR satellites is related to the geometric distortion that depends on the observation geometry between the radar LOS and local terrains.

- **Sensitivity :**

Sensitivity refers to the percentage of total slope movement that the SAR satellite can measure, i.e. the projection of ground three dimensional deformation onto the radar LOS direction.

- **Coherent targets (CT) density:**

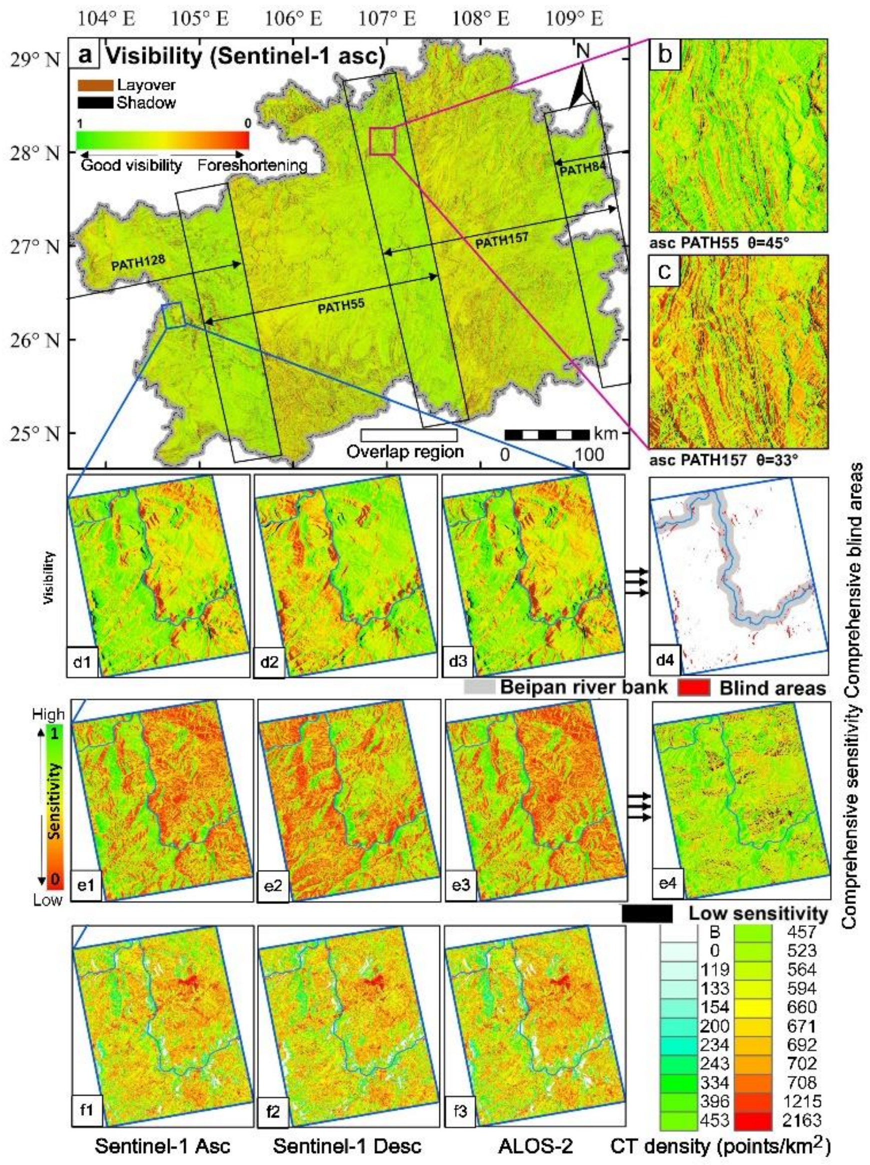
The density of coherent targets affects the performance of time series InSAR analysis and can be qualitatively evaluated by exploiting existing land cover/use maps and local incidence angle.

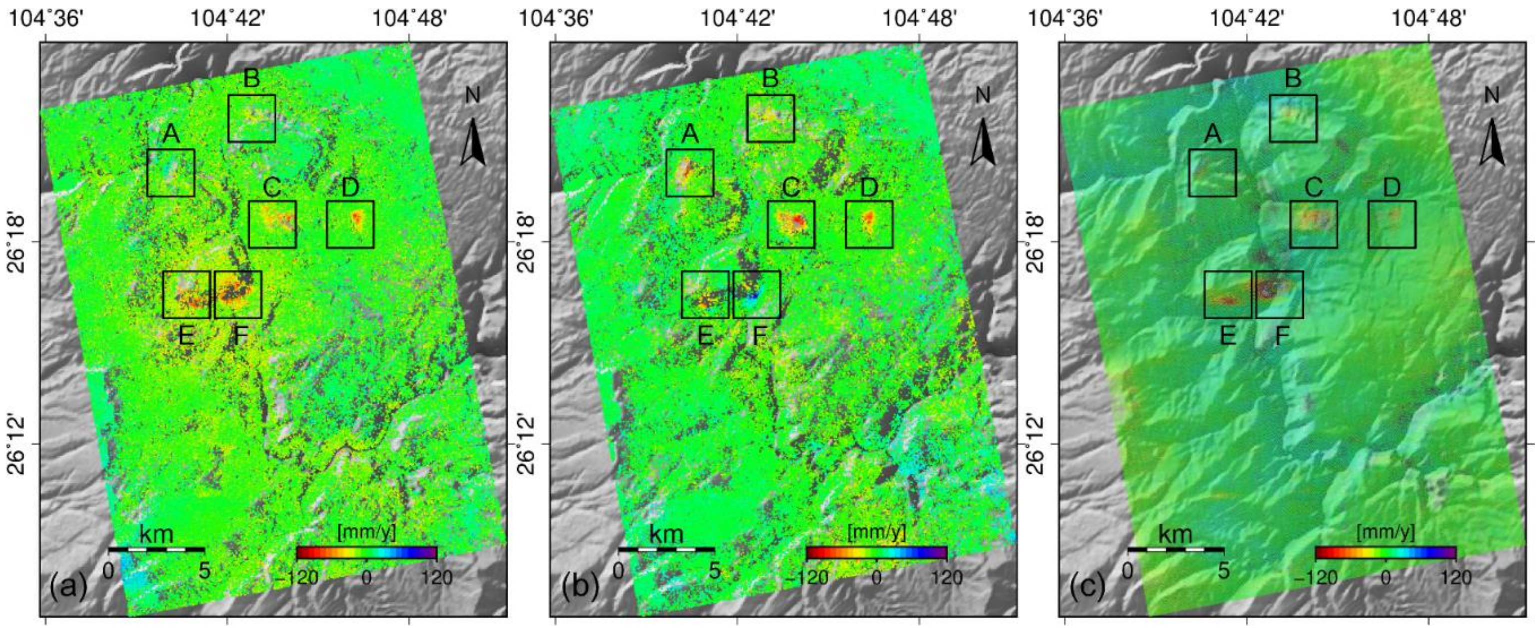
KEY RESULTS

The InSAR applicability depends on an applicability results, including visibility, sensitivity, and CT density.

A visibility maps over Guizhou Province for ascending Sentinel-1 and the visibility maps under radar incidence angles of b 45°and c 33°. d1~d3, e1~e3, and f1~f3 show the visibility, sensitivity, and CT density of ascending Sentinel-1, descending Sentinel-1 and ascending ALOS-2, respectively. The combined applicability of landslides can be derived from d1~d3) and e1~e3

- These blind areas and low sensitivity areas provide references for other technical methods to supplement the detection of landslides.
- The low CT density distribution area of C-band SAR image can provide a reference for whether to purchase L-band SAR data.





Index	SAR datasets	Detected landslides					
		A	B	C	D	E	F
Visibility	Sentinel-1 Asc	0.4, L	0.5, L	0.56	0.73	0.53, L	0.75, S
	Sentinel-1 Des	0.65	0.76	0.65	0.45	0.65	0.45, L
	ALOS-2 Asc	0.43, L	0.53, L	0.52	0.63	0.51, L	0.76, S
Sensitivity	Sentinel-1 Asc	0.35	0.37	0.15	0.25	0.36	0.49
	Sentinel-1 Des	0.54	0.73	0.55	0.37	0.45	0.19
	ALOS-2 Asc	0.33	0.32	0.16	0.24	0.35	0.51
CT density (points/km^2)	Sentinel-1 Asc	594	564	702	1215	594	671
	Sentinel-1 Des	457	523	702	1215	594	564
	ALOS-2 Asc	594	564	702	1215	594	671

Note: S and L are the abbreviation of shadow and layover, respectively

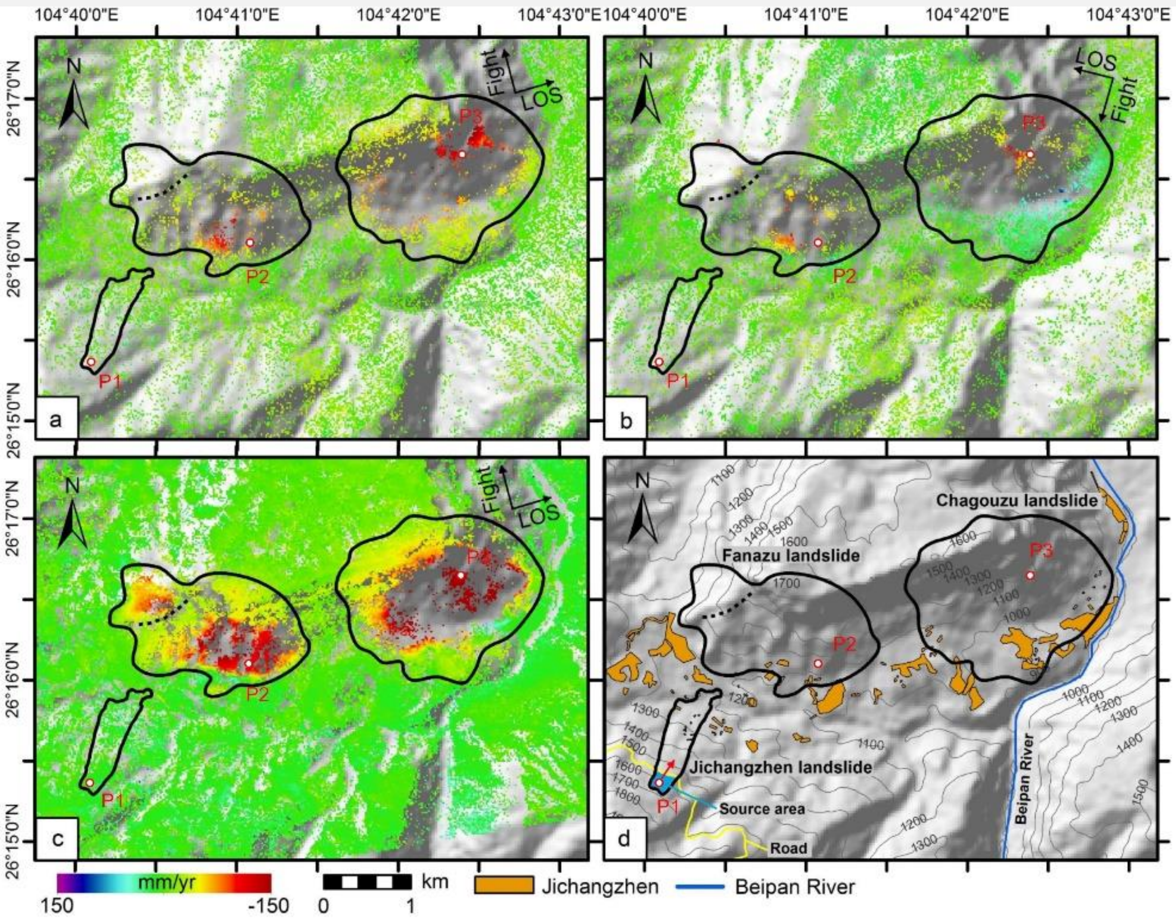
The reliability of landslides detection in Shuicheng County can be analyzed considering the priori estimation results.

The quantitative visibility index, sensitivity index, and qualitative CT density in the six identified landslide area are given in left table.

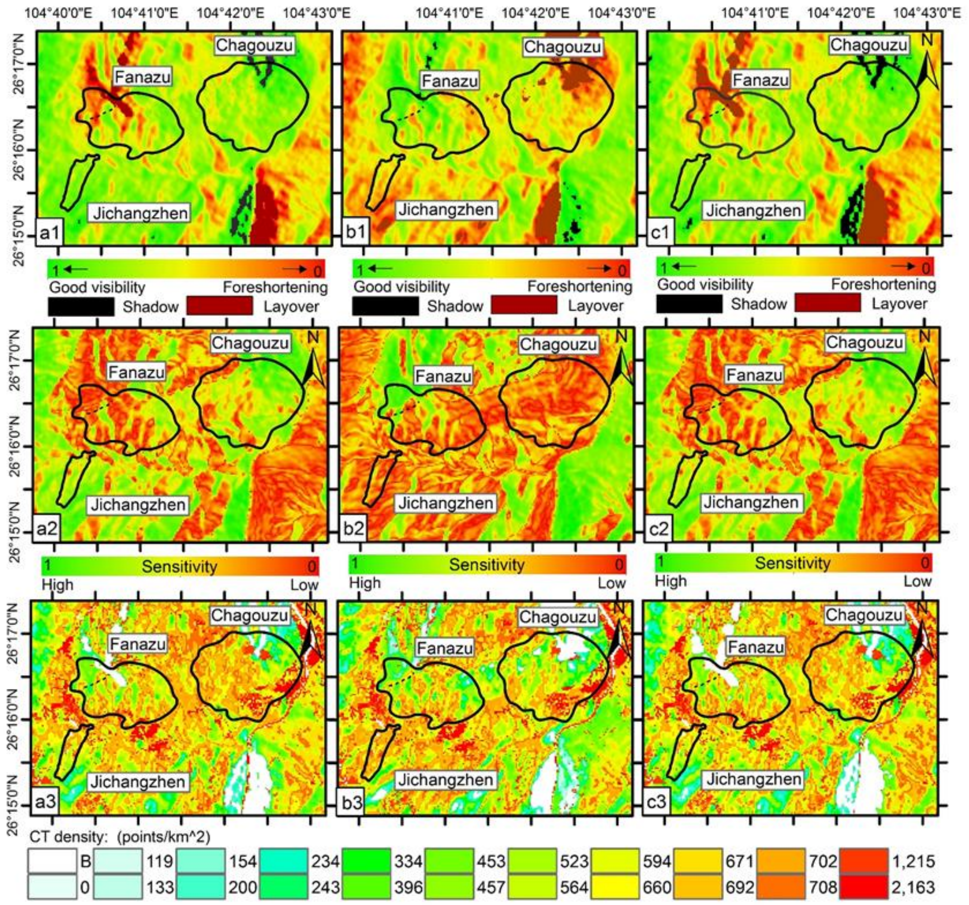
The larger index of visibility, sensitivity, and CT density, the better reliability of detected landslide. Low visibility and sensitivity indicate that the range or magnitude of landslide deformation may be underestimated.

There is no precursory deformation detected from the three kinds of SAR datasets before the Jichangzhen landslide failed.

The reason of InSAR detection failure of Jichangzhen landslide is analyzed using the a priori estimation.



The InSAR-derived LOS deformation rate maps around Jichangzhen landslide from (a) ascending Sentinel-1, (b) descending Sentinel-1, and (c) ascending ALOS-2, as well as d the topographic map (d)



The visibility maps, sensitivity maps and the qualitative estimation of CT density maps of (a1-3) asc Sentinel-1, (b1-3) desc Sentinel-1 and (c1-3)ALOS-2 around jichangzhen.

There is no precursory deformation detected from the three kinds of SAR datasets before the Jichangzhen landslide failed.

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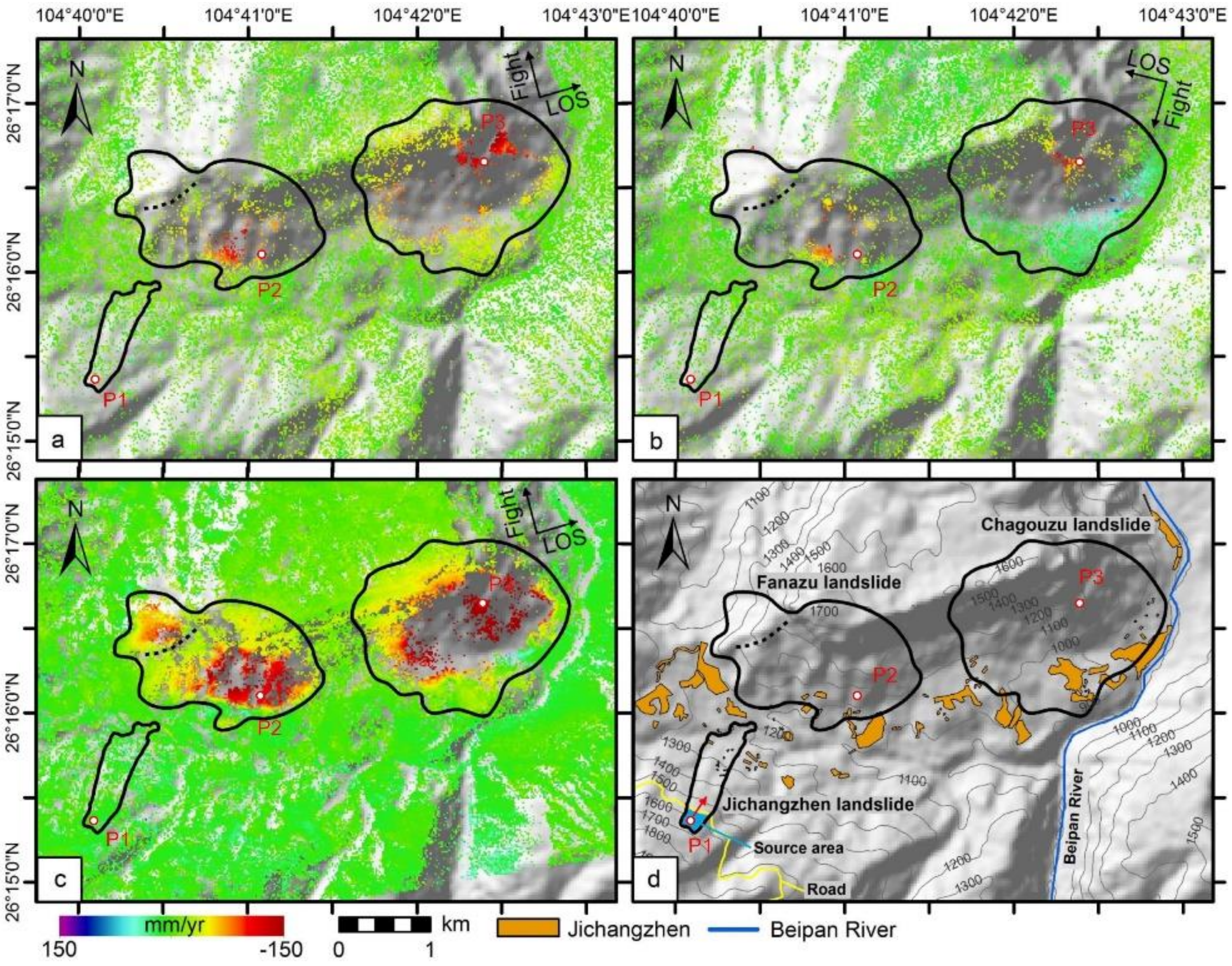
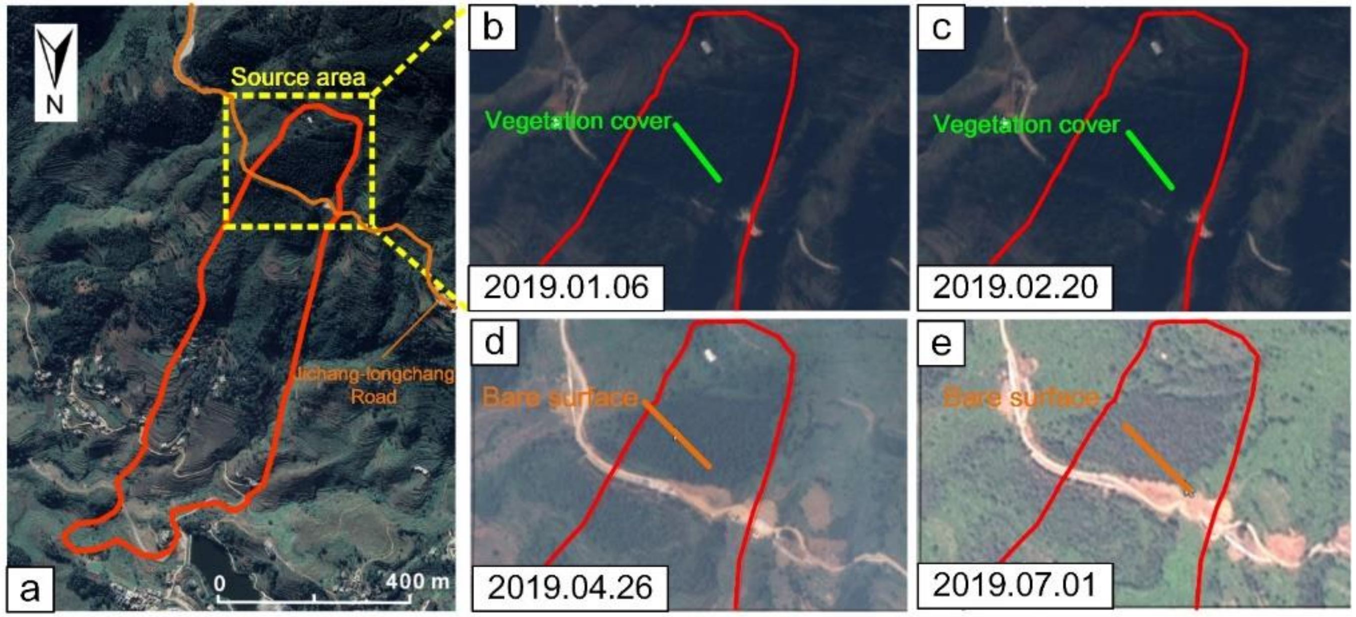


The InSAR-derived LOS deformation rate maps around Jichangzhen landslide from (a) ascending Sentinel-1, (b) descending Sentinel-1, and (c) ascending ALOS-2, as well as d the topographic map (d)

- Judging from the amplifying visibility estimation, the effect of geometric distortion of SAR image on the detection failure can be ignored.
- According to the sensitivity estimation, the sensitivity of observation has few effects on the detection failure.
- The high CT density of L band ALOS-2 SAR data demonstrated that CT density has less impact on the landslide detection.

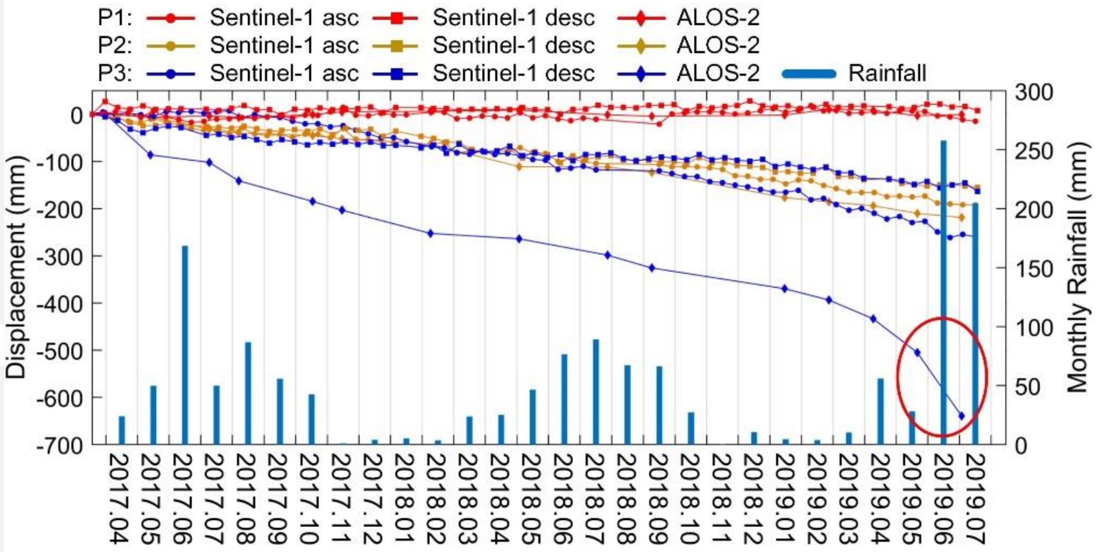
The landslide detection failure of Jichangzhen landslide is not affected by geometric distortion, low sensitivity, and decorrelation by vegetation.



- Optical satellite images showed that there were **engineering activities** in the landslide source area several months before the disaster, which caused the surface to be exposed.
- one month before the landslide failure, the average monthly **rainfall** reached 257 mm, which was nearly 1.5 times the maximum monthly rainfall in previous years

- There is **no obvious precursory deformation** at the source area of the Jichangzhen landslide, at where point P1 is located.
- The ALOS-2 displacement time series at point P3 shows an **accelerated deformation trend** of Chagouzu landslide under the action of heavy rainfall in June and July 2019, indicated by red circle in right figure.

The heavy rainfall seriously eroded the bare surface in the source area of Jichangzhen landslide, causing the slope instability. Although the ascending Senitnel-1 and ALOS-2 have high InSAR applicability for the Jichangzhen landslide, their revisiting intervals are too long to capture the relatively sudden movement.



SUMMARY & CONCLUSIONS

Brief discussion

- There are some limitations for the a priori applicability assessment, such as conditions of assumption, limitations of resolution of auxiliary data,etc.
- There are also some limitations for the post-processing analysis. the accuracy of reliability depends on the spatial resolution, timeliness, and accuracy of the a priori information.
- For high-resolution SAR images, the DEM and land cover classification products with matched resolutions are required to achieve optimal results.

Conclusions

- We proposed a landslides detection procedure containing InSAR applicability estimation.
- The InSAR applicability depends on an applicability results, including visibility, sensitivity, and CT density, are analyzed.
- The reliability of landslides detection result in Shuicheng County are analyzed considering the priori estimation results.
- The reason of InSAR detection failure of Jichangzhen landslide is analyzed using the a priori estimation.

REFERENCES & ACKNOWLEDGEMENTS

Key references

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Acknowledgements

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