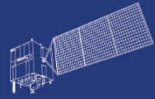


HY



HJ-1AB



CBERS



Gaofen



Beijing-2



Sentinel-1



Sentinel-2



Sentinel-3



Sentinel-5p



Aeolus

2023 DRAGON 5 SYMPOSIUM

3rd YEAR RESULTS REPORTING

11-15 SEPTEMBER 2023

PROJECT ID. 59339

APPLICATION OF SPACEBORNE SAR INTERFEROMETRY TO
GEOHAZARD MONITORING

ROBERTO TOMÁS (roberto.tomas@ua.es) & QIMING ZENG (qmzeng@pku.edu.cn)



Universitat d'Alacant
Universidad de Alicante



THURSDAY, 14/SEP/2023

ID. 59339

PROJECT TITLE: EARTH OBSERVATION FOR SEISMIC HAZARD ASSESSMENT AND LANDSLIDE EARLY WARNING SYSTEM

PRINCIPAL INVESTIGATORS: ROBERTO TOMÁS (roberto.tomas@ua.es) & QIMING ZENG (qmzeng@pku.edu.cn)

CO-AUTHORS: JUAN MANUEL LOPEZ-SANCHEZ, CHAOYING ZHAO, ZHENHONG LI, KEREN DAI, CRISTINA REYES-CARMONA, LIURU HU, MARÍA INÉS NAVARRO-HERNÁNDEZ, HENGYI CHEN, JIAYIN LUO, XIAOJIE LIU, DIANA ORLANDI, ESTEBAN DÍAZ, JOSÉ LUIS PASTOR, ADRIÁN RIQUELME, MIGUEL CANO

PRESENTED BY: ROBERTO TOMÁS

Main objective of the project

The primary goals of the project are to further develop advanced SAR and optical techniques to investigate seismic hazard and risk, detect potential landslides on wide regions, and demonstrate EO-based landslide early warning system over selected landslides.



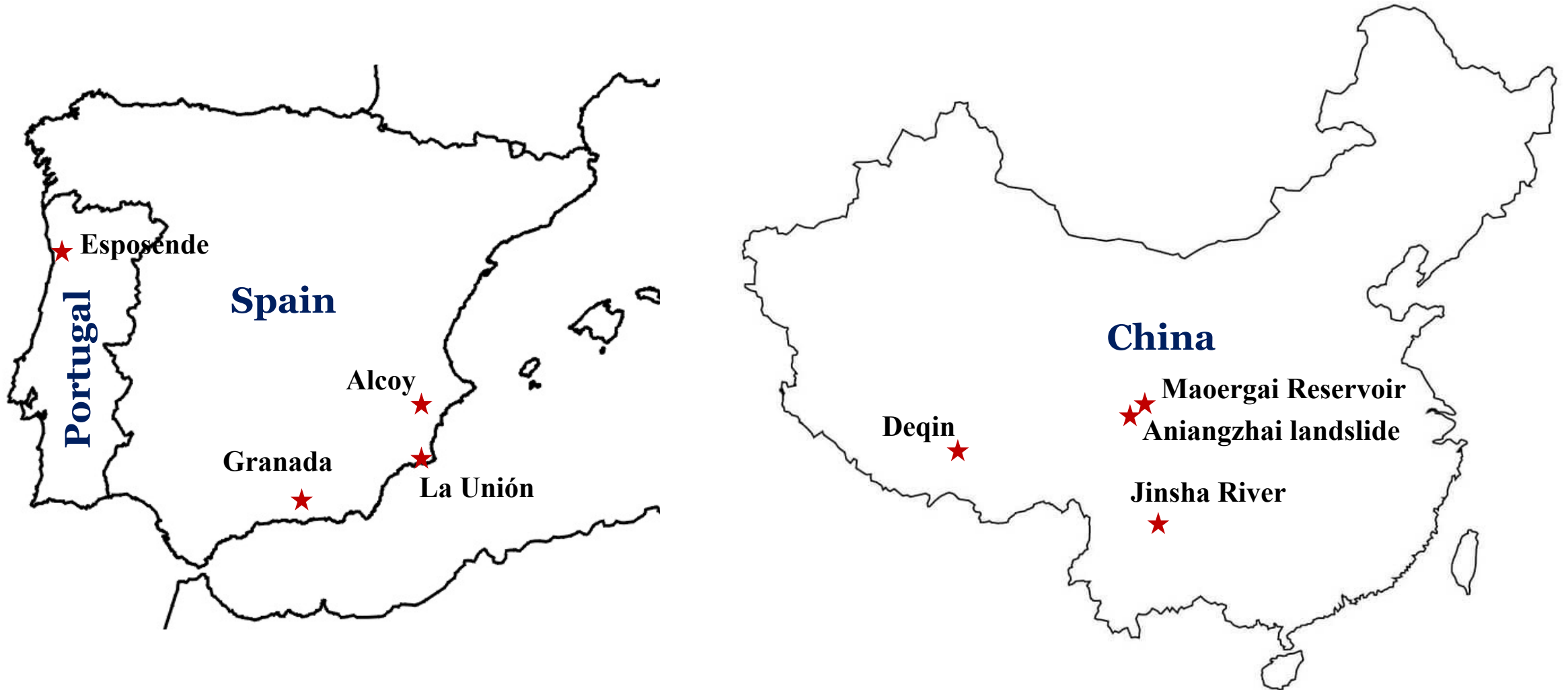
ESA Third Party Missions	No. Scenes
1. Sentinel 1-A/B	1708
2. ENVISAT	190
3.	
4.	
5.	
Total:	1898
Issues: nothing to report	

ESA Third Party Missions	No. Scenes
1. Cosmo-SkyMed	114
2. PAZ	21
3. ALOS PALSAR 1/2	570
4.	
5.	
6.	
Total:	705
Issues: nothing to report	

Chinese EO data	No. Scenes
1. Lutang-1	4
2.	
3.	
4.	
5.	
6.	
Total:	4
Issues: nothing to report	

Landslides

Main study areas



Field data collection campaigns

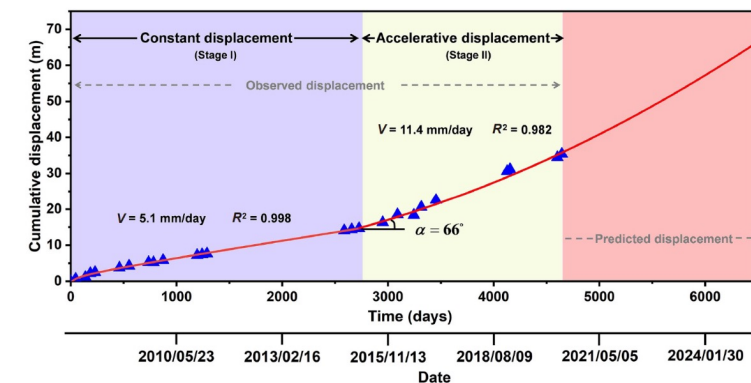
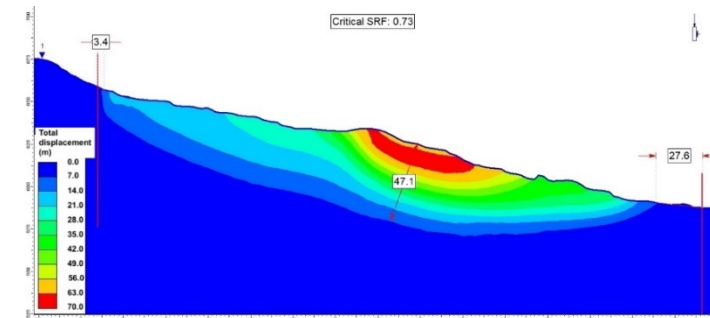
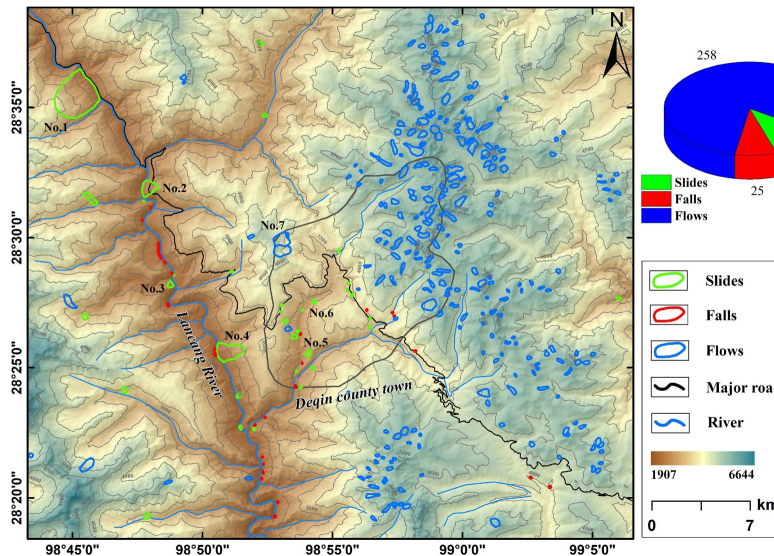
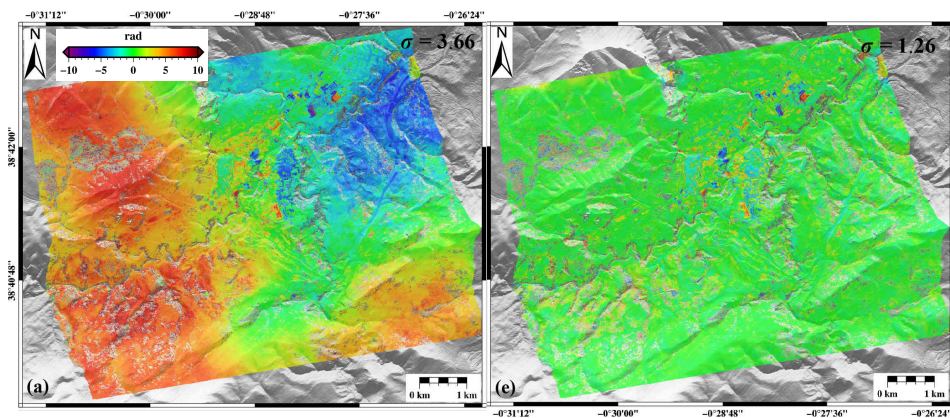
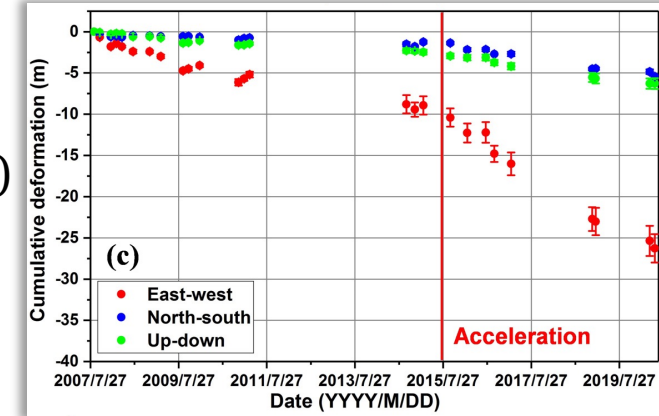
AREA	DATA COLLECTION/CAMPAIGN	SOURCE	USE
Alcoy, Spain	<ul style="list-style-type: none"> • Permanent GNSS station • Inclinometer • Surveying • Damage assessment • Geomorphological map • Landslide inventory map • Rainfall time series • Geological map • Geotechnical data • Seismic catalog 	Instituto Cartográfico Valenciano (ICV) Ministerio de Fomento Ministerio de Fomento Own field campaign Own field campaign Geological survey of Spain (IGME) Spanish Meteorological Agency (AEMET) Geological survey of Spain (IGME) Geological survey of Spain (IGME) National Geographic Institute (IGN)	Validation Validation Validation Validation Characterization Validation Triggering factors analysis Conditioning factor análisis Modelling Triggering factors analysis
Deqin, China	<ul style="list-style-type: none"> • Landslide inventory map • Optical satellite images • UAV optical images 	China Institute of Geo-environment Monitoring National Platform for Common Geospatial Information Services Own field campaign	Validation Photointerpretation Photointerpretation
La Unión, Spain	<ul style="list-style-type: none"> • Landslide inventory map • Rainfall timeseries • LiDAR point clouds • Geological map • Geotechnical data 	Geological survey of Spain (IGME) Spanish Meteorological Agency (AEMET) National Centre for Geographic Information (CNIG) Geological survey of Spain (IGME) Geological survey of Spain (IGME)	Validation Triggering factors analysis Change detection Conditioning factor analysis Modelling
Jinsha river, China	<ul style="list-style-type: none"> • Seismic catalog • Digital surface model • Rainfall time series • River wáter level time series 	China Earthquake Network Center (CENC) LOS AW3D30 DSM NASA's Global Precipitation Measurement Mission (GPM) Published data	Triggering factors analysis Calculation of direction derivatives Triggering factors análisis Triggering factors analysis

Field data collection campaigns

AREA	DATA COLLECTION/CAMPAIGN	SOURCE	USE
Granada, Spain	<ul style="list-style-type: none"> Digital elevation model Geological map Map of faults Landslide inventory map 	Andalusian Environmental Information Network Geological survey of Spain (IGME) Geological survey of Spain (IGME) Own field campaign	Geomorphological análisis Geomorphological análisis Geomorphological análisis Validation
Aniangzhai landslide, China	<ul style="list-style-type: none"> Optical satellite images HR UAV model HR UAV LiDAR 	Own field campaign, Chengdu University of Technology Own field campaign, Chengdu University of Technology Own field campaign, Chengdu University of Technology	Photointerpretation Photointerpretation Geomorphological analysis
Maoergai Reservoir, China	<ul style="list-style-type: none"> Rainfall timeseries Reservoir water level time series 	Unknown Unknown	Wavelet analysis Wavelet analysis
Esposende, Portugal	<ul style="list-style-type: none"> Rainfall timeseries Geological map UAV optical images Terrestrial LiDAR 	<ul style="list-style-type: none"> IPMA Own field campaign Own field campaign Own field campaign 	Triggering factors analysis Conditioning factor analysis Photointerpretation and 3D modelling 3D modelling & discontinuities id.

Results: 1st and 2nd years

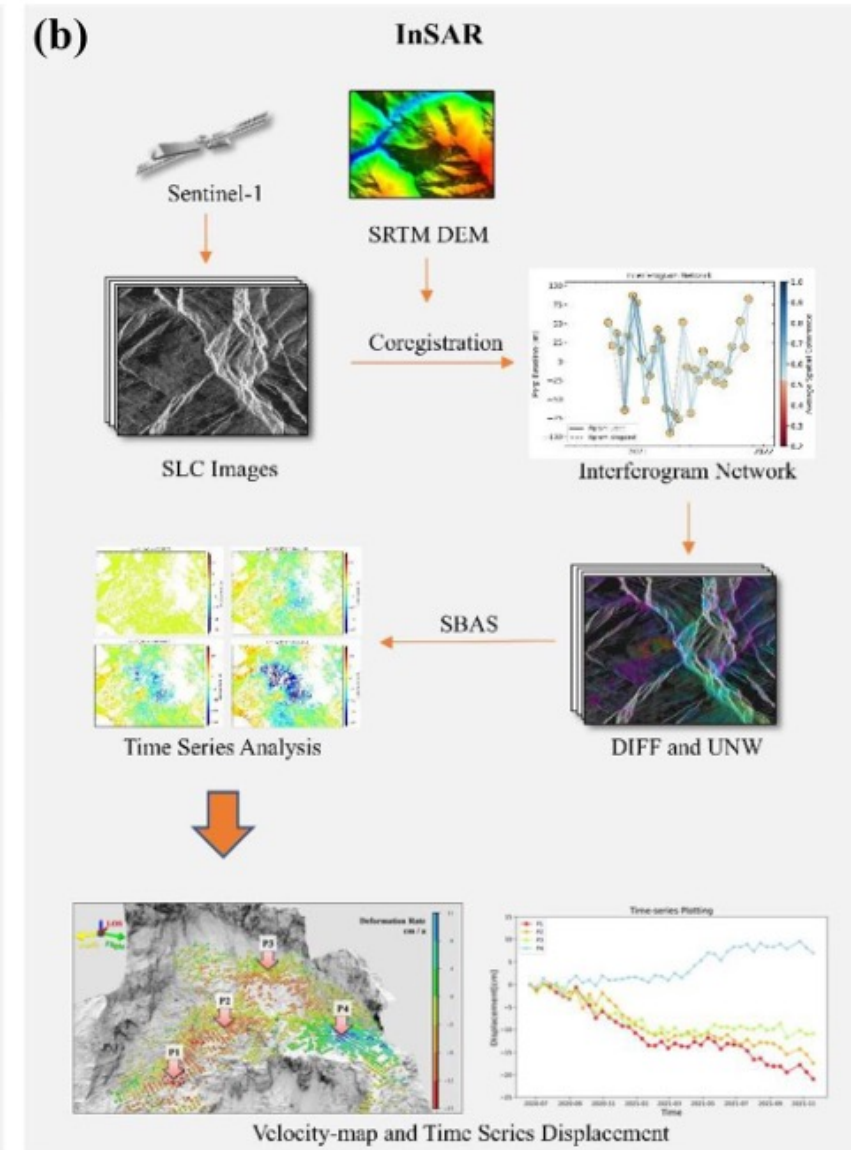
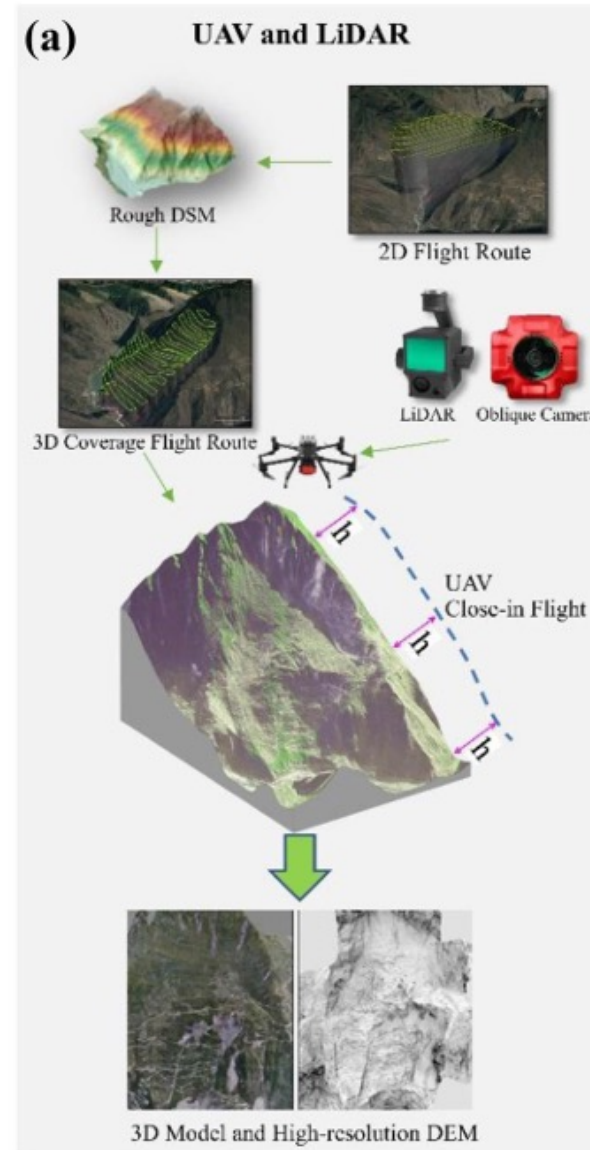
- Procedure for phase unwrapping errors and troposph. delay correction (WP1)
- Estimation of 3-D long-term landslide deformation (WP2)
- Mapping and deformation monitoring of landslides (WP2)
- Identification of triggering factors and modelling (WP3)
- Application of InSAR-based landslide early warning system (WP3)



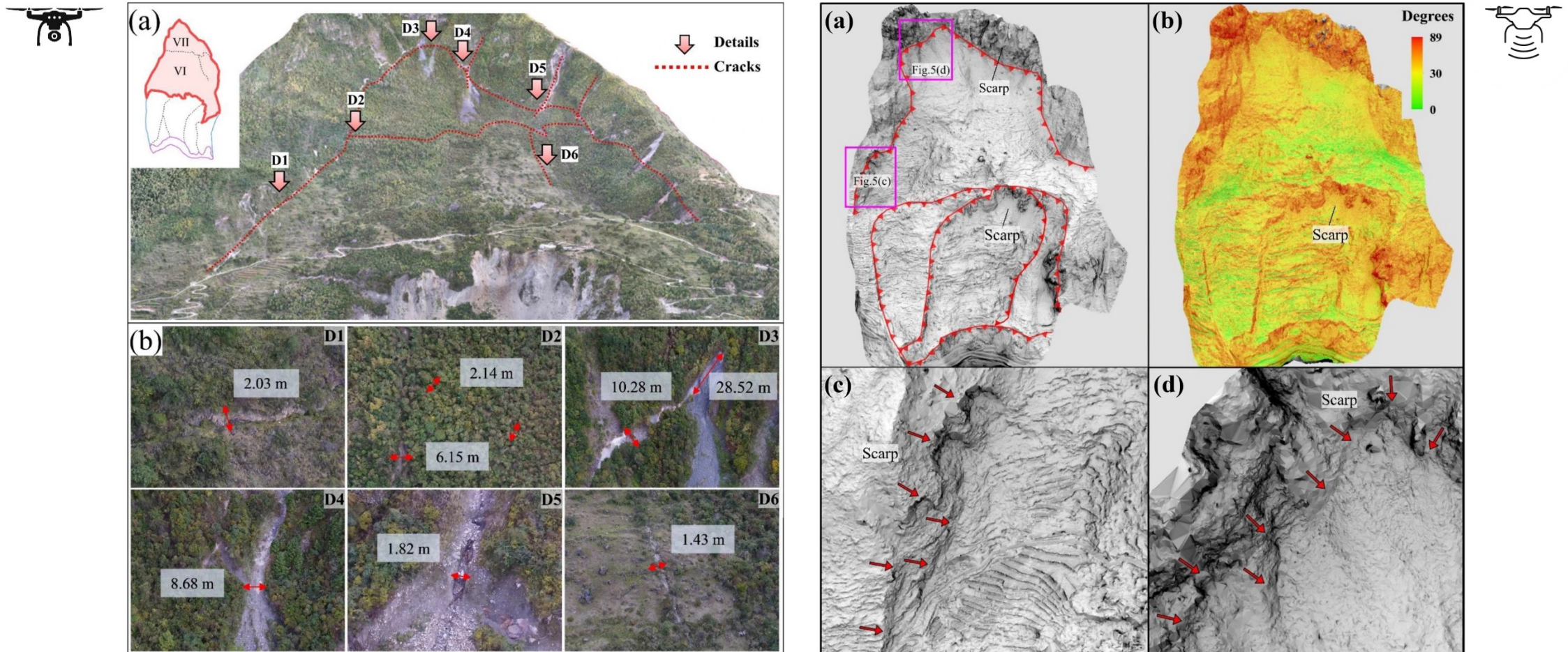
Multitechnique monitoring of a landslide induced by a cascade effect



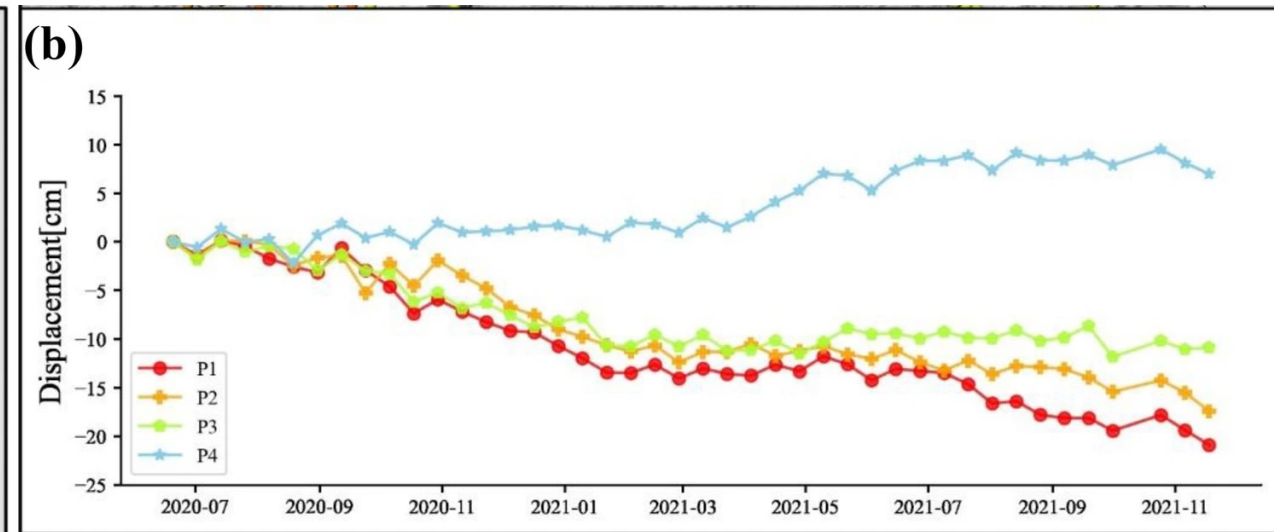
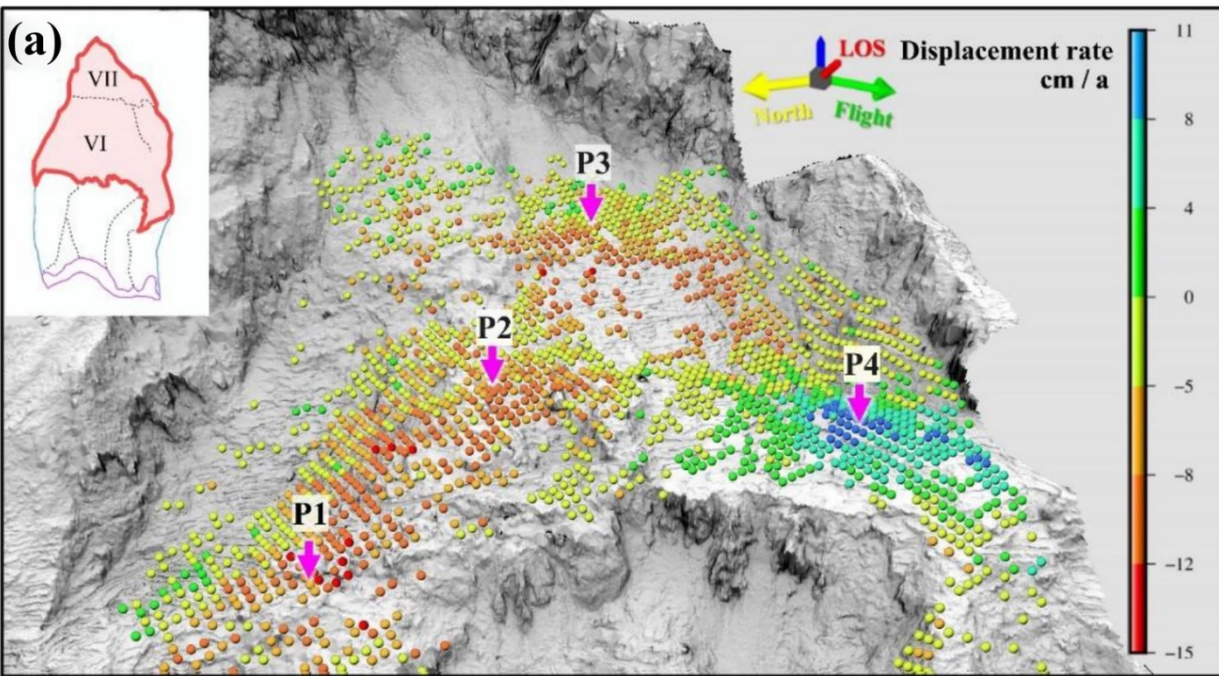
Results: Identification of triggering factors



Results: Identification of triggering factors

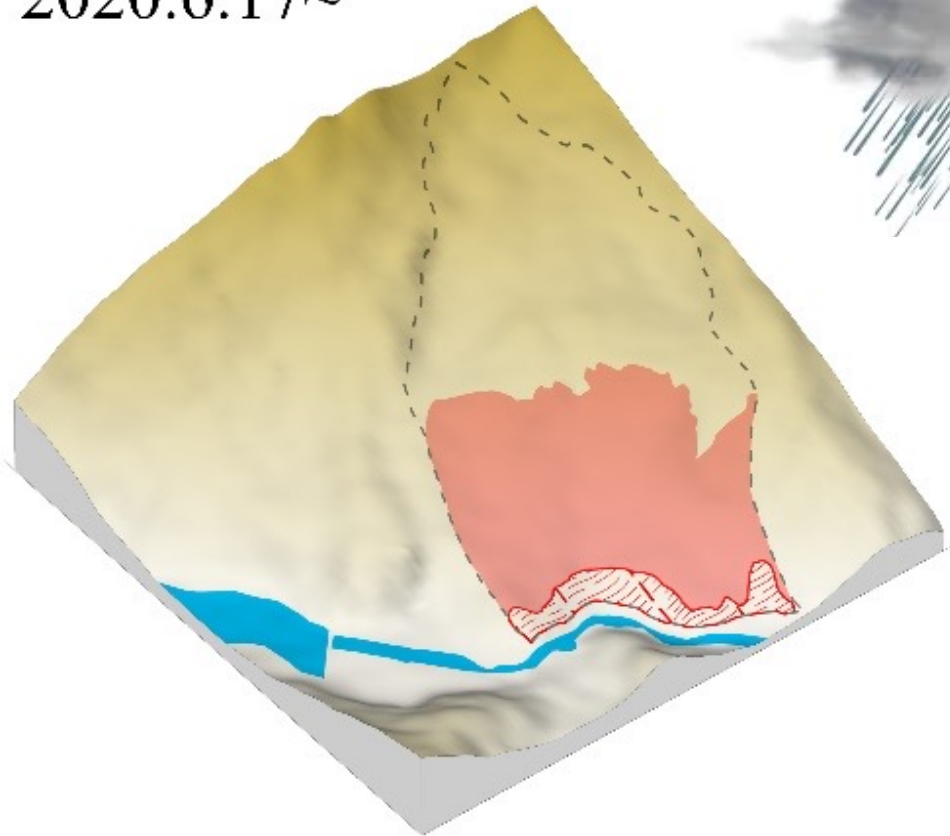


Results: Identification of triggering factors



Results: Identification of triggering factors

2020.6.17~

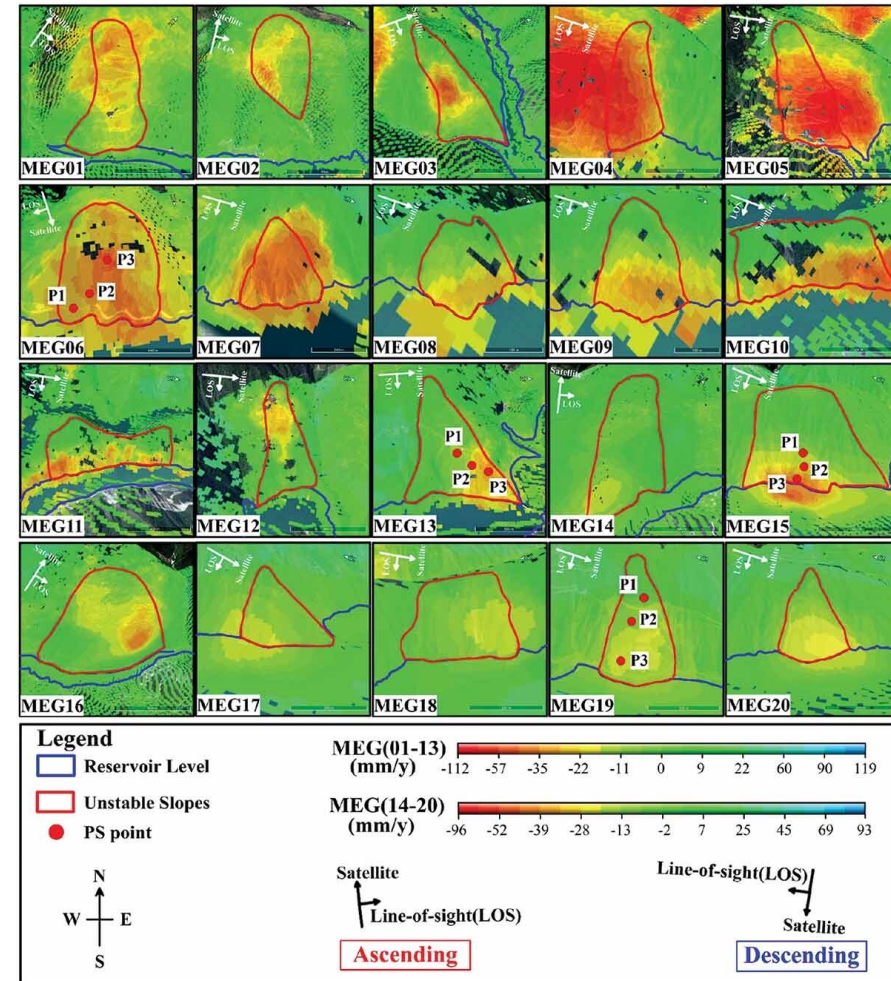
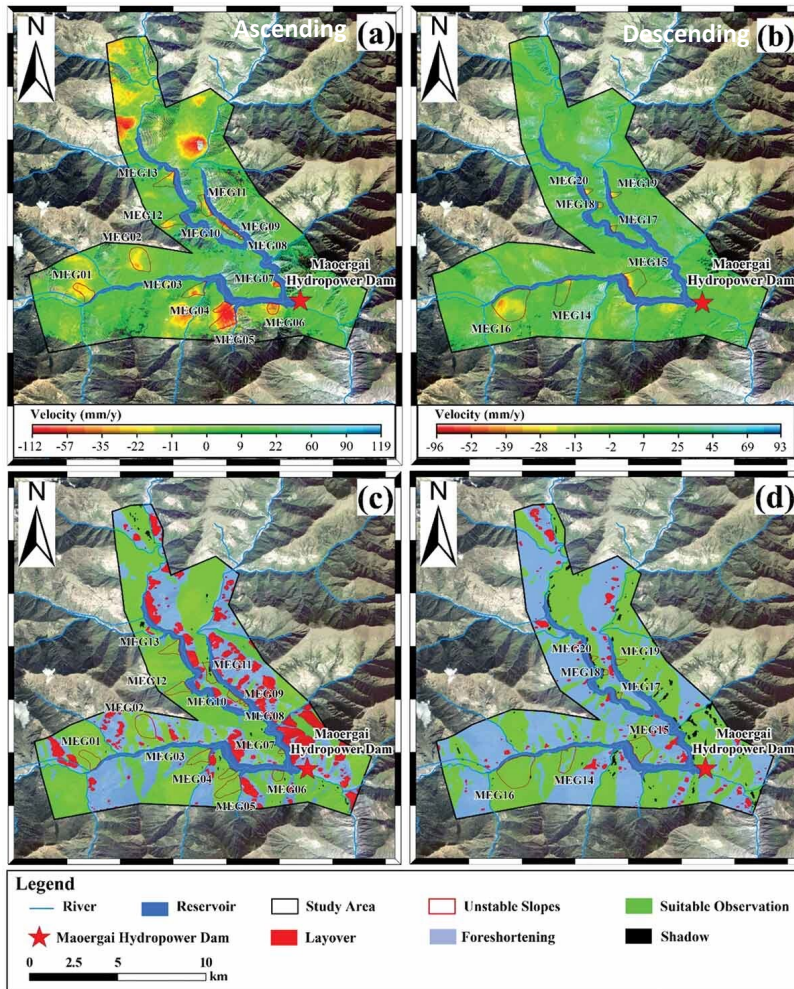


Evolution of Aniangzhai landslide after 2020 6.17 event

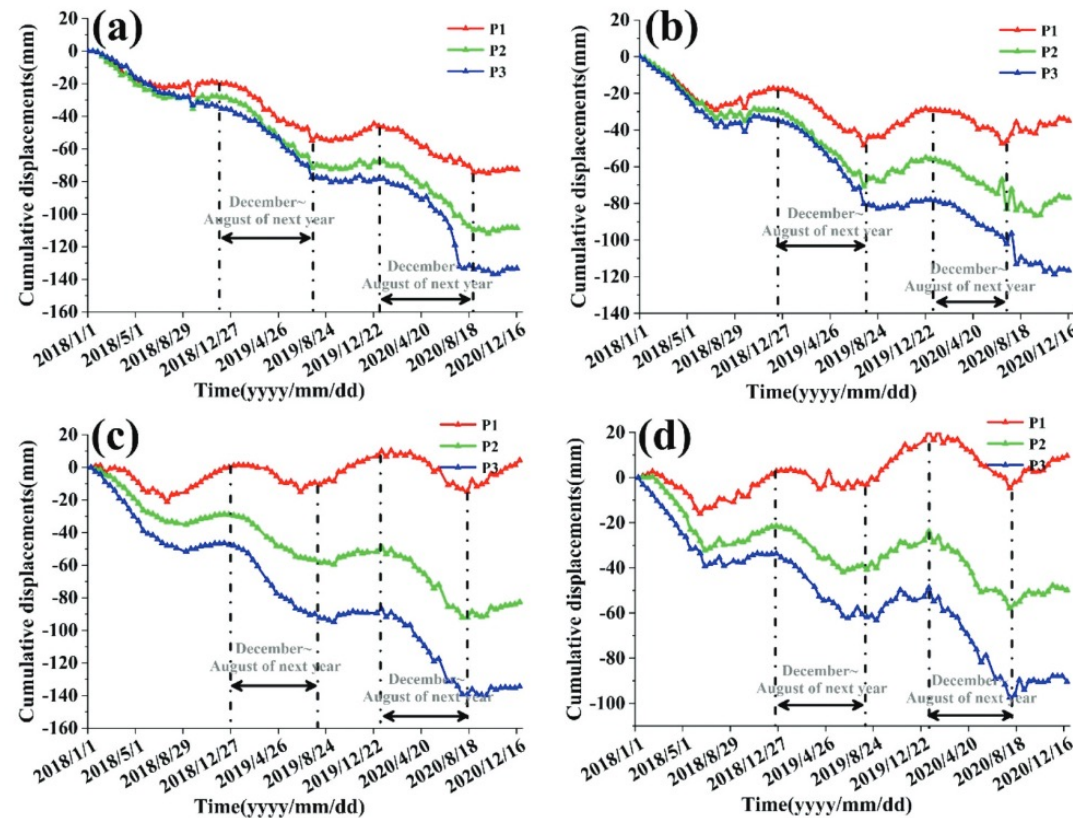
Relationship between reservoir water level and landslides displacements



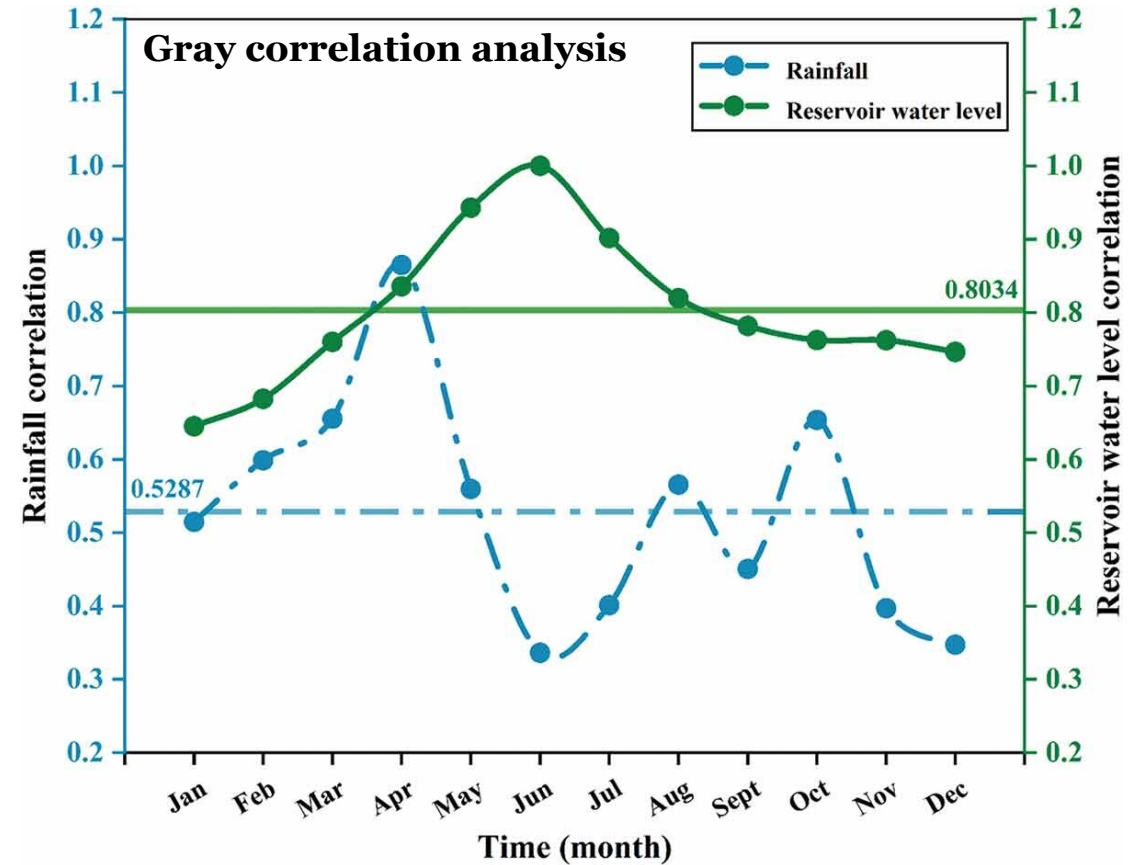
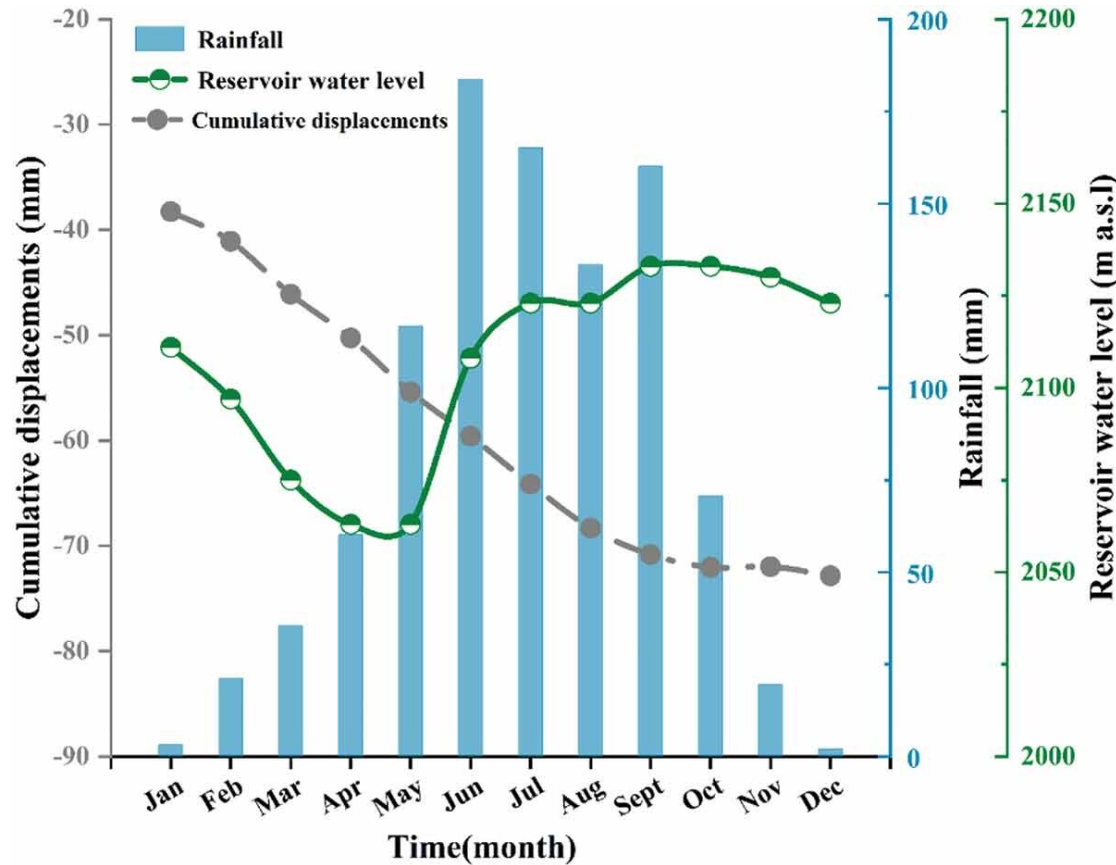
Results: Identification of triggering factors and conceptual modelling



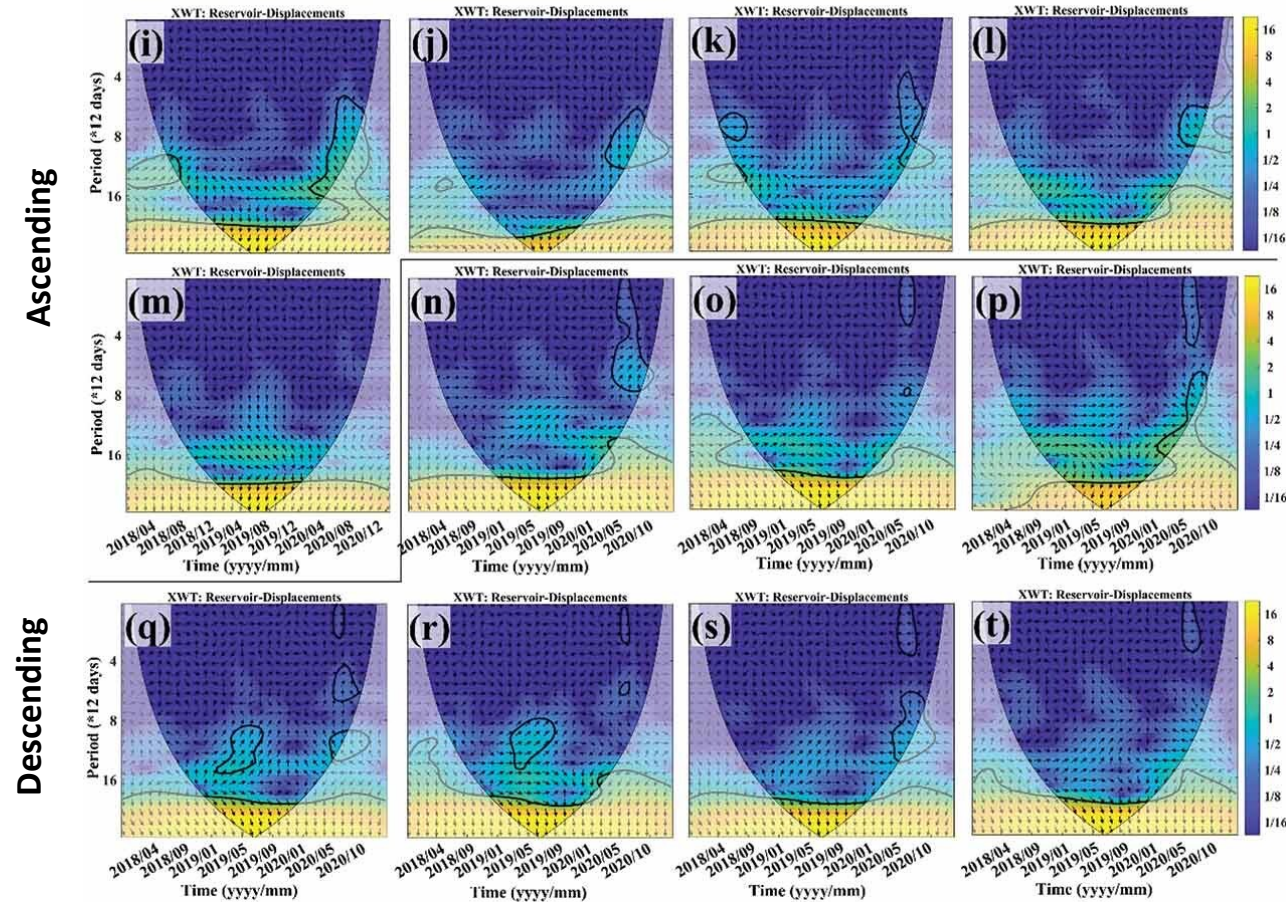
Results: Identification of triggering factors and conceptual modelling Maoergai Reservoir (China)



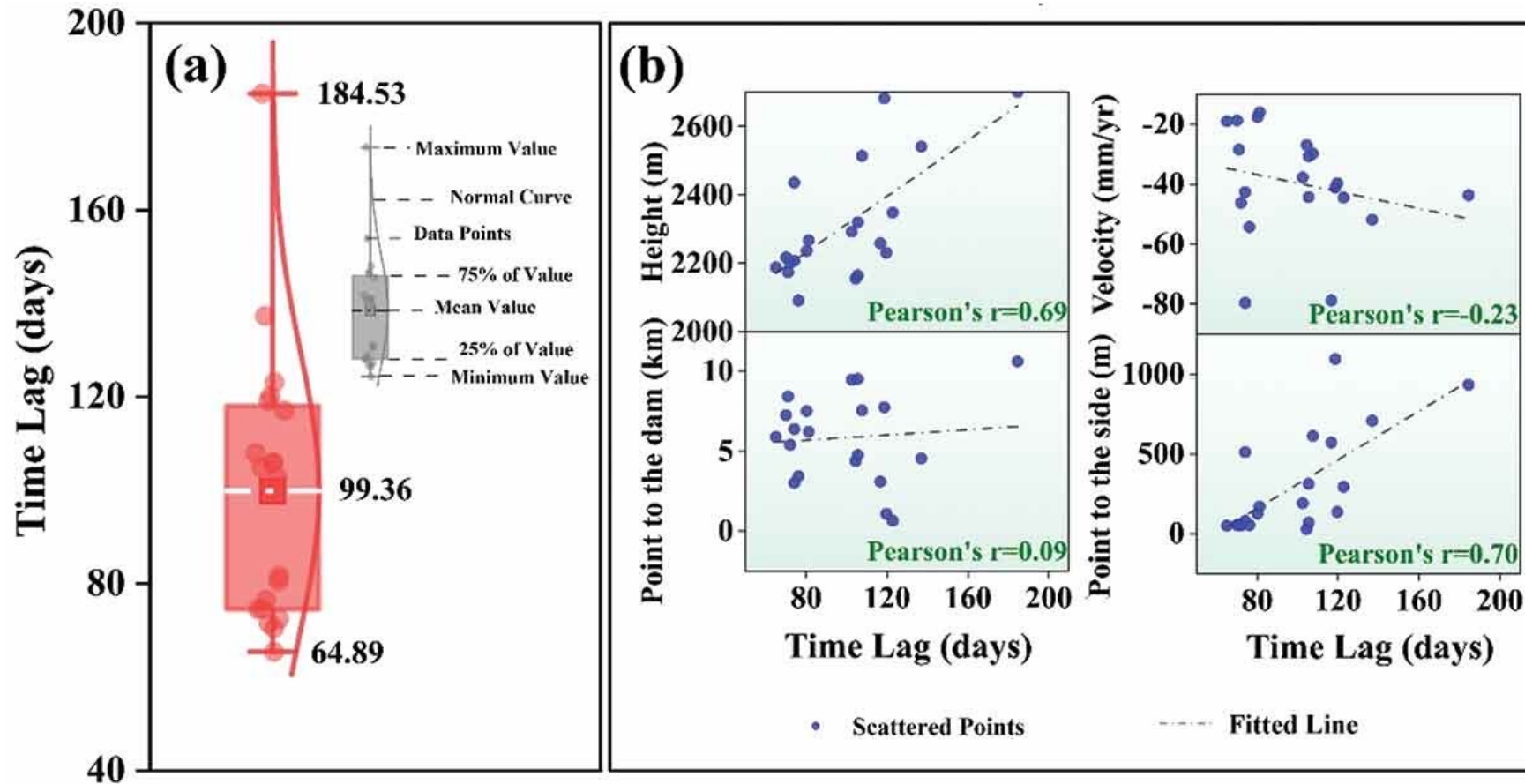
Results: Identification of triggering factors and conceptual modelling



Results: Identification of triggering factors and conceptual modelling



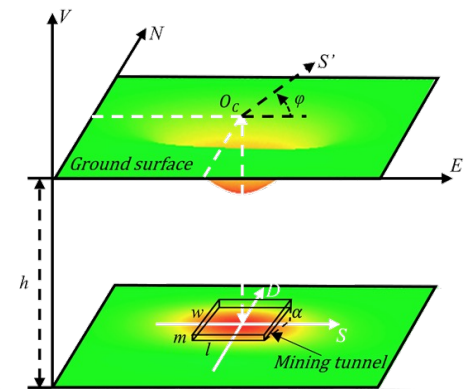
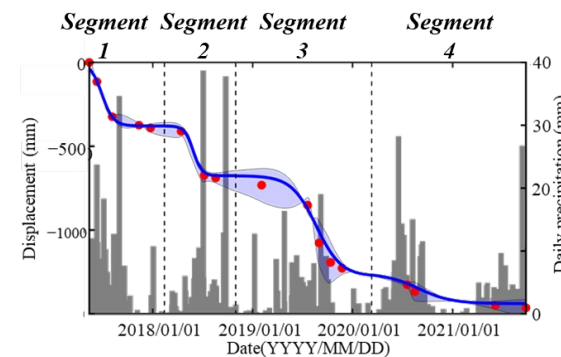
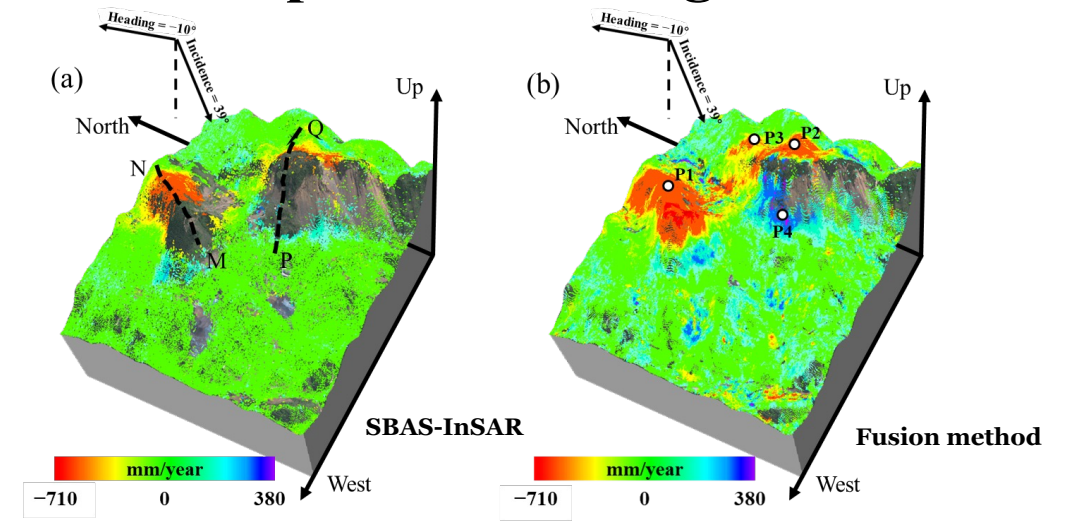
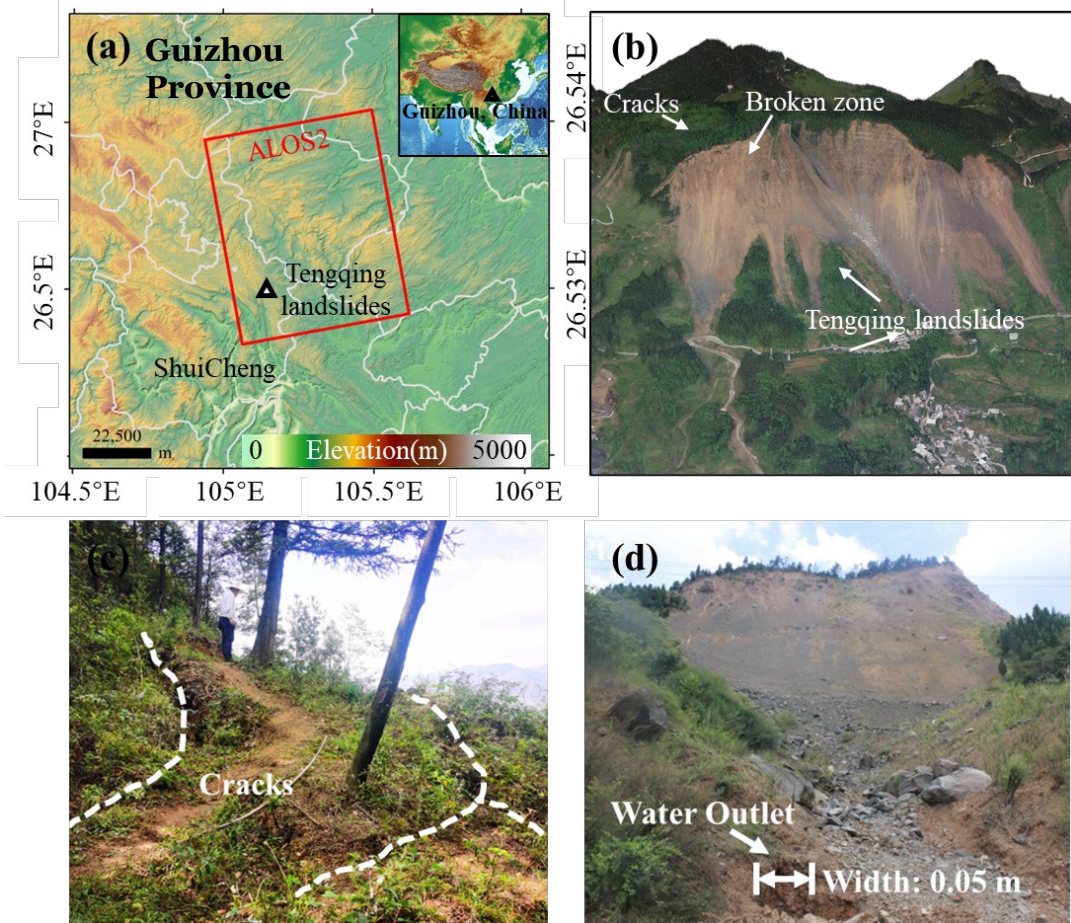
Results: Identification of triggering factors and conceptual modelling



Monitoring and modelling of a mining-induced landslide



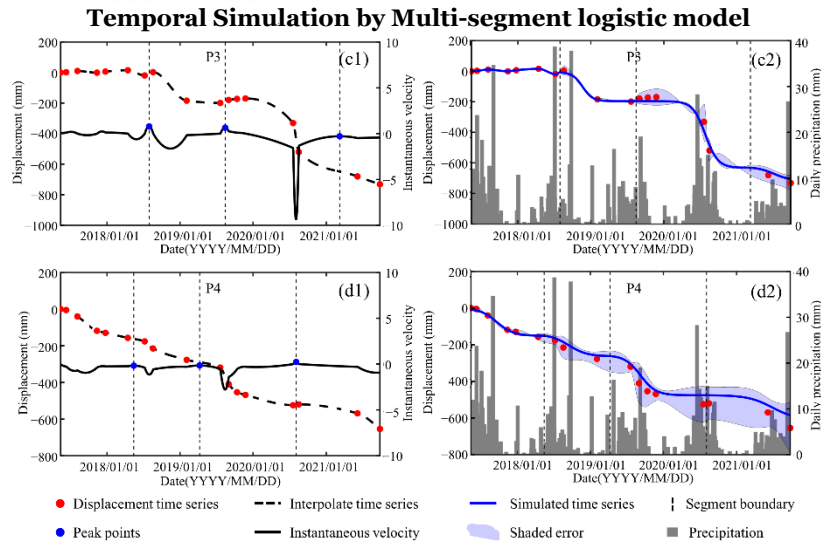
Results: Identification of triggering factors and conceptual modelling



Temporal Simulation by Multi-segment logistic model

Spatial Modeling by Probability Integral Method

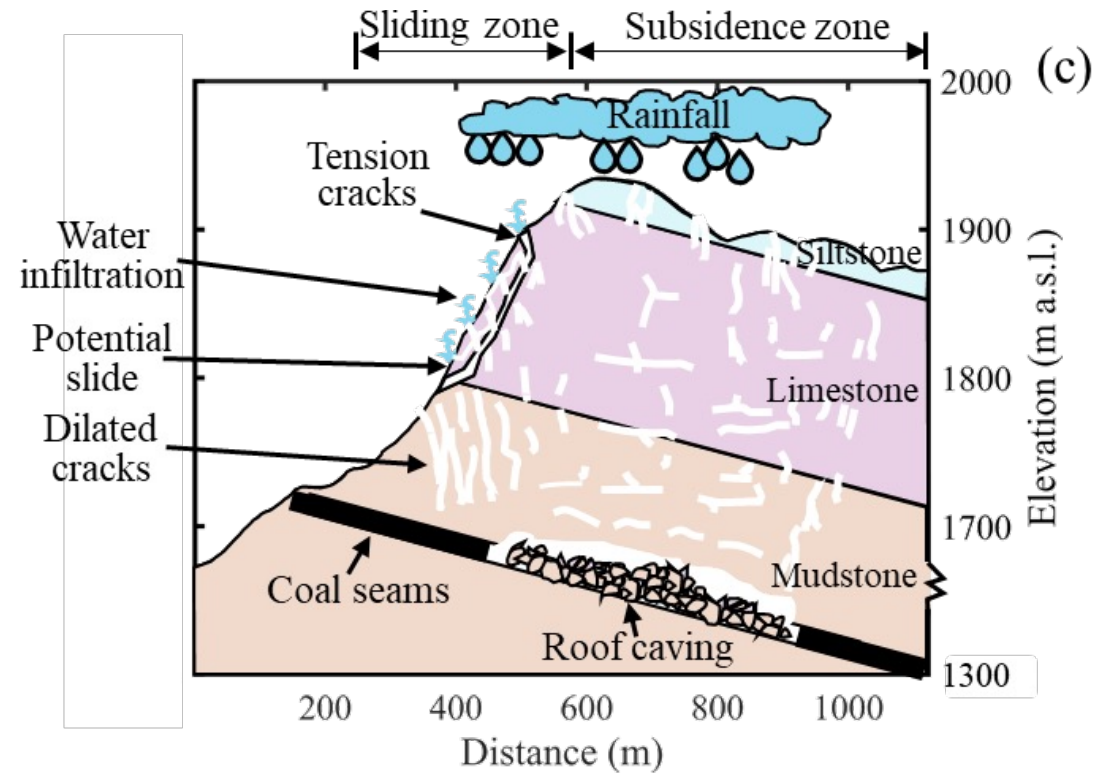
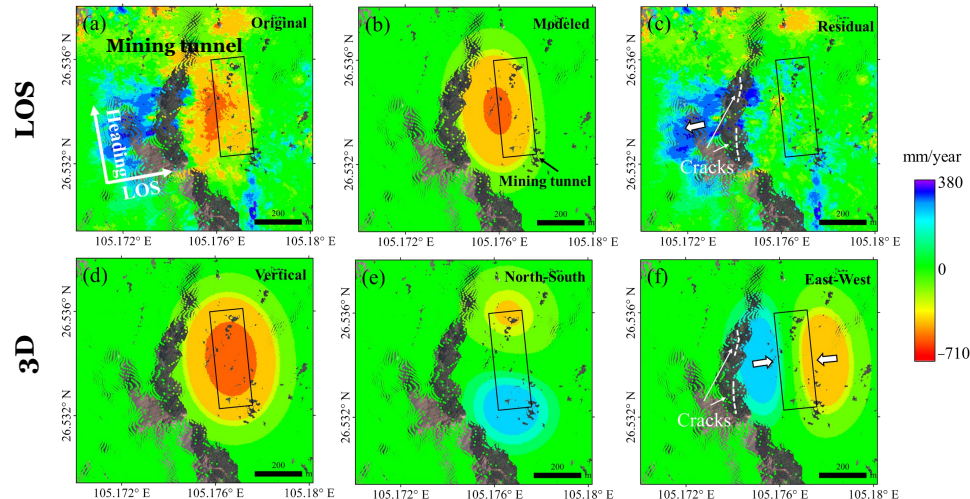
Temporal Domain



Mountain summit:
Mining effect >
Rainfall effect

Sliding Surface:
Mining effect <
Rainfall effect

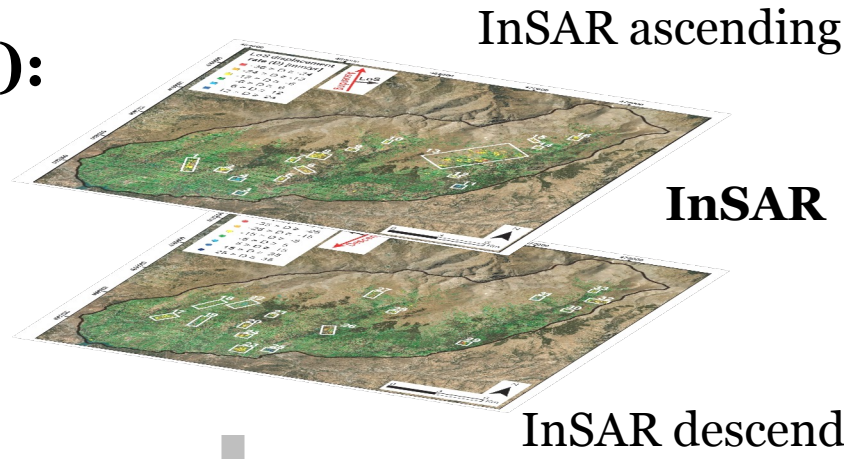
Spatial domain



Integration of Satellite Interferometry and Landscape Analysis to Detect Large Landslides in Mountainous Areas

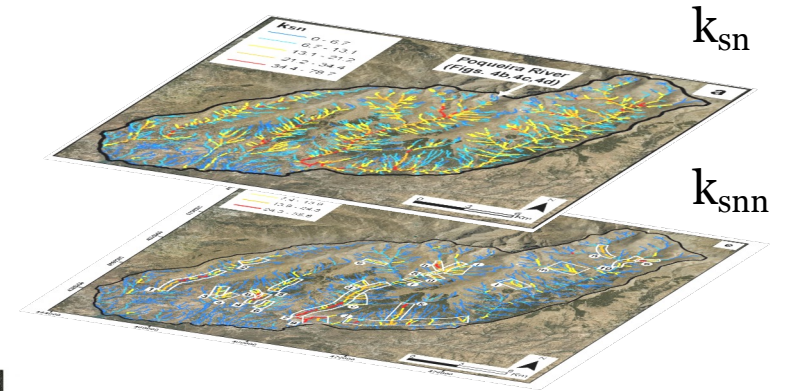


Granada (Spain):



InSAR

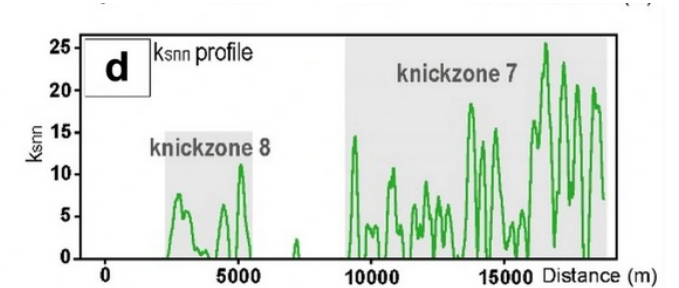
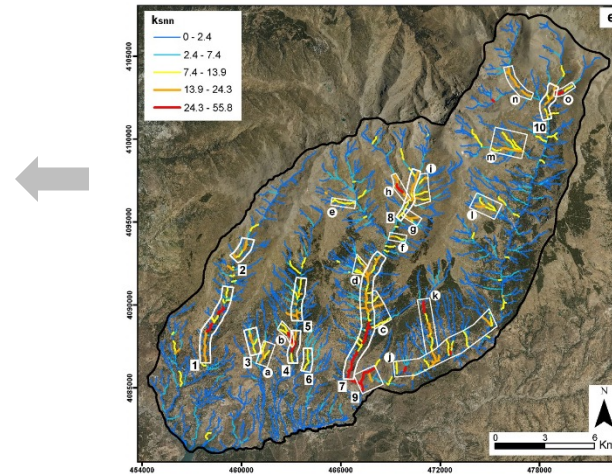
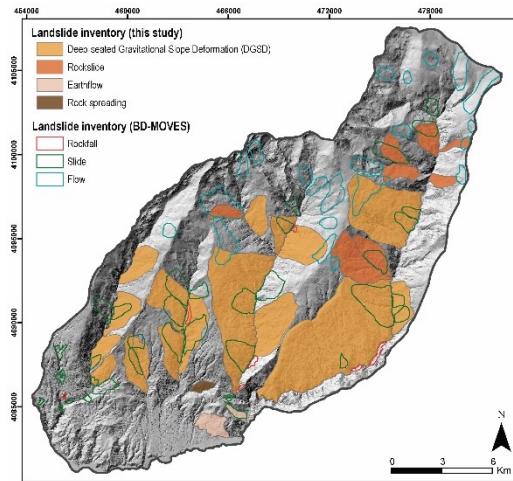
DEM
(morphometric analysis of rivers)



InSAR descending

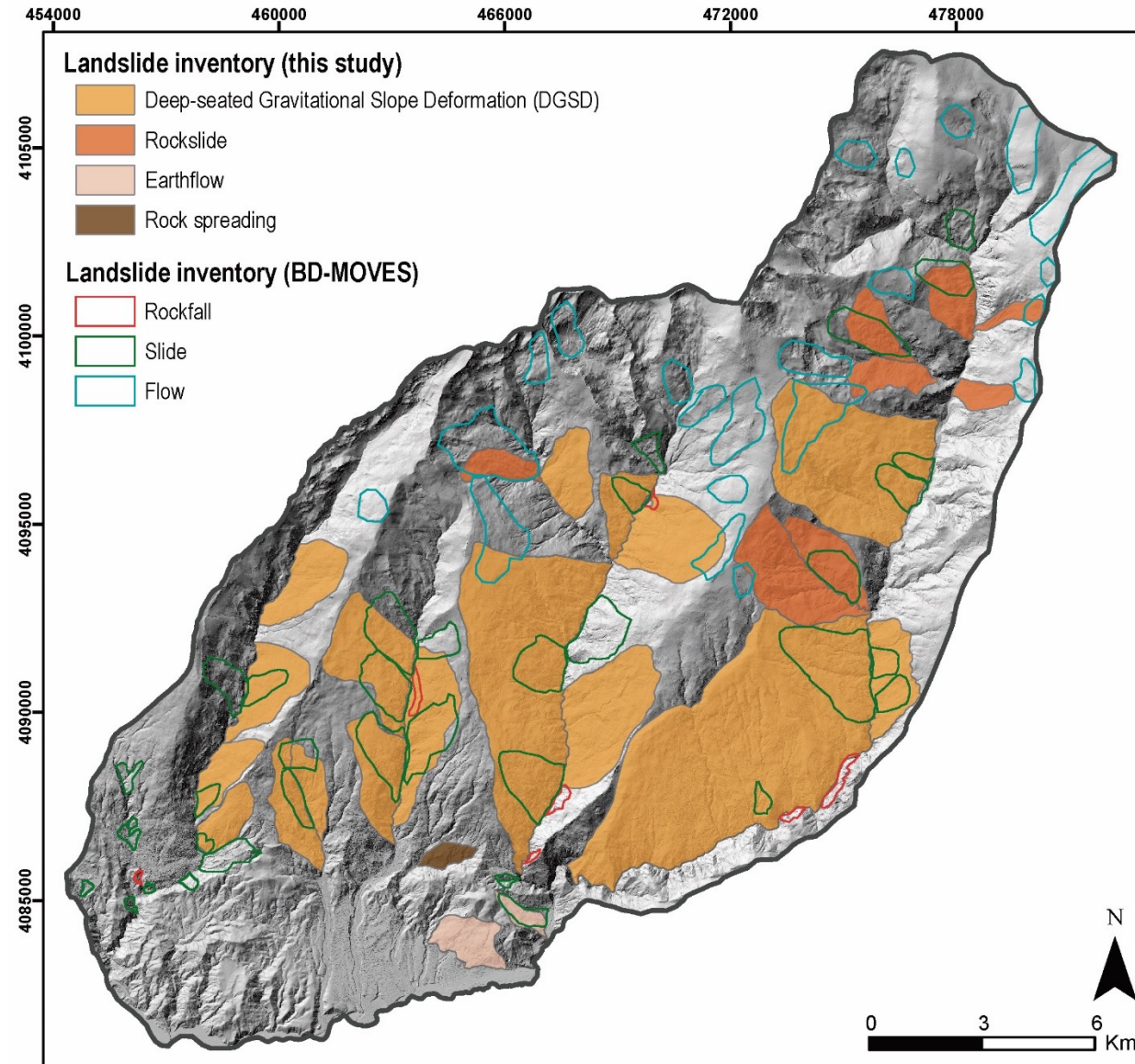
**River anomalies
(or knickzones)**

Landslide inventory map



Fieldwork →

Granada (Spain):



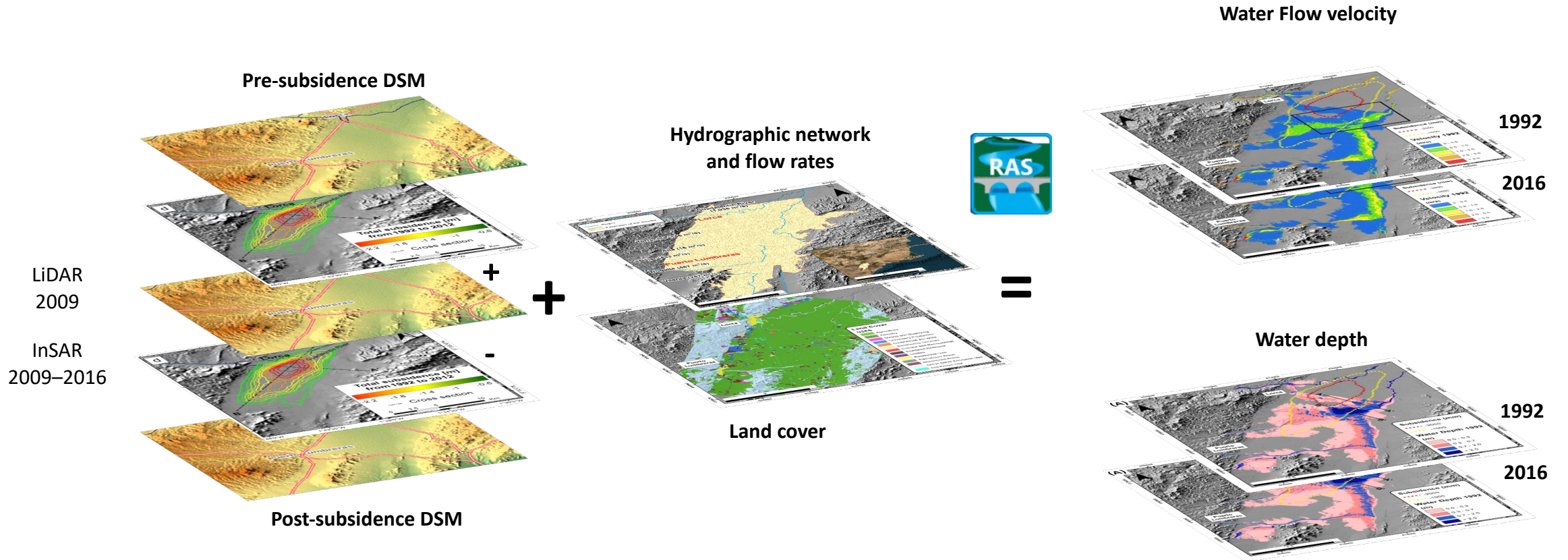
Reyes-Carmona, C., Galve, J.P., Pérez-Peña, J.V., Moreno-Sánchez, M., Alfonso-Jorde, D., Ballesteros, D., Torre, D., Azañón, J.M. & Mateos, R.M. 2023. Improving landslide inventories by combining satellite interferometry and landscape analysis: the case of Sierra Nevada (Southern Spain). *Landslides*, 20, 1815-1835.

Other geohazards

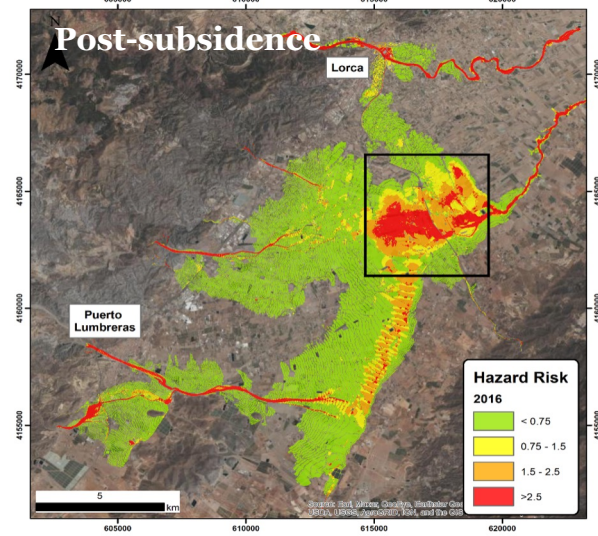
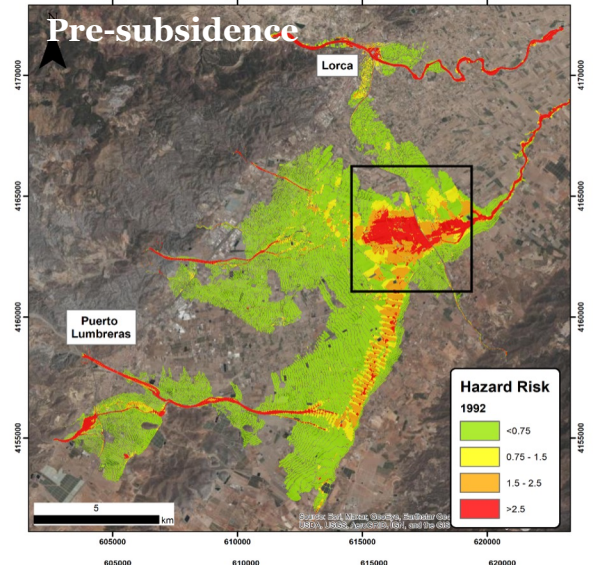
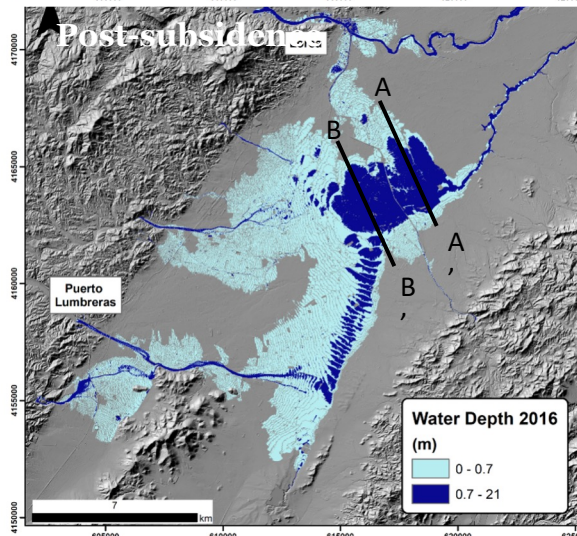
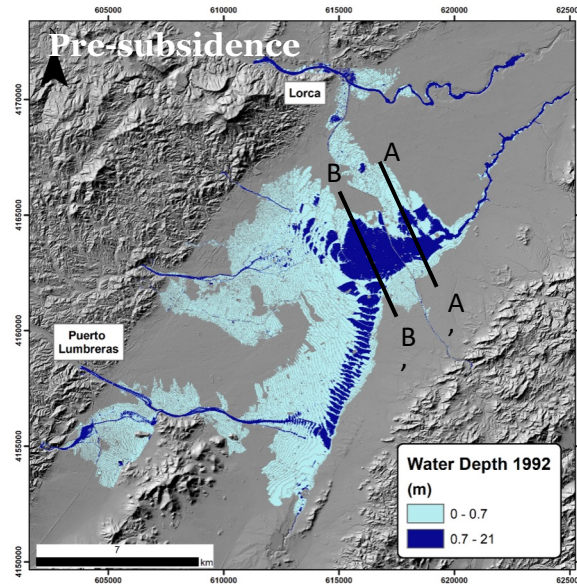
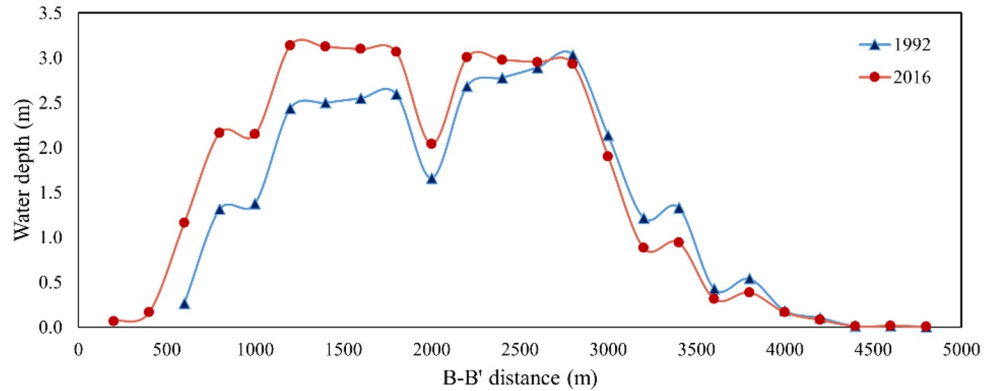
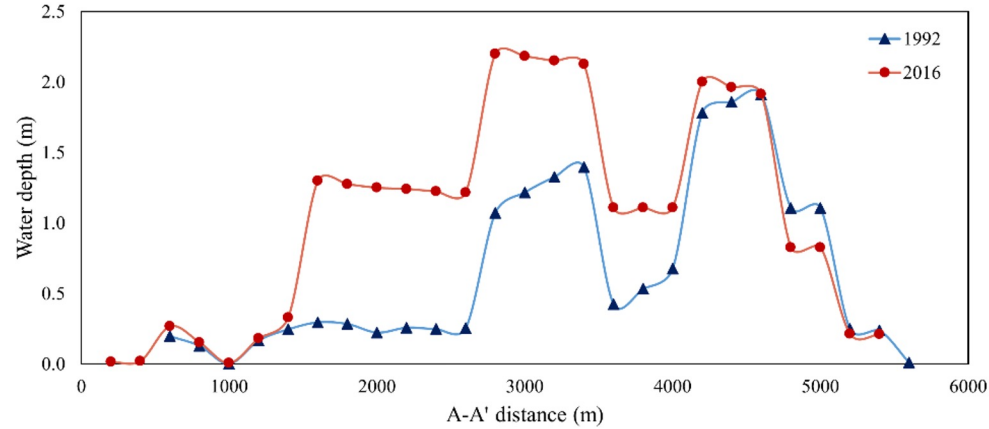
Flooding modelling using InSAR datasets



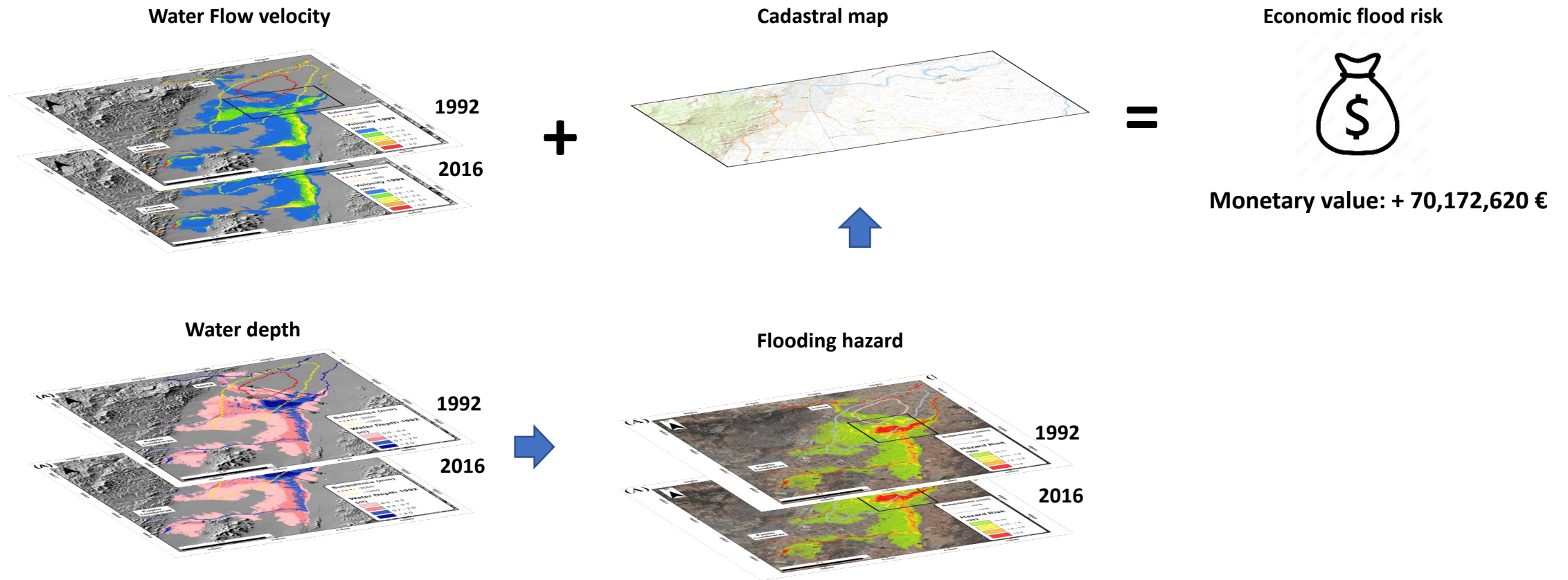
Other results:



Other results:



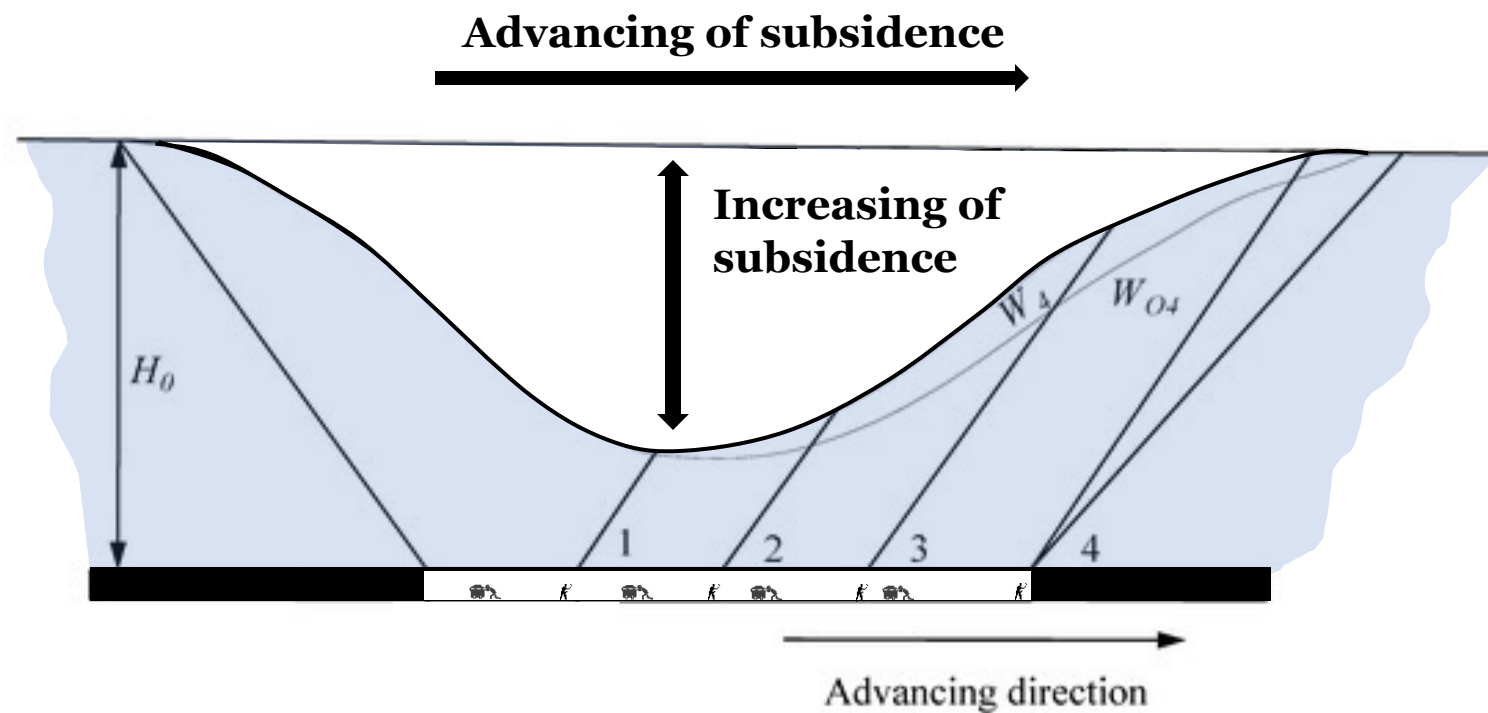
Increase of flooding potential in the Guadalentín valley



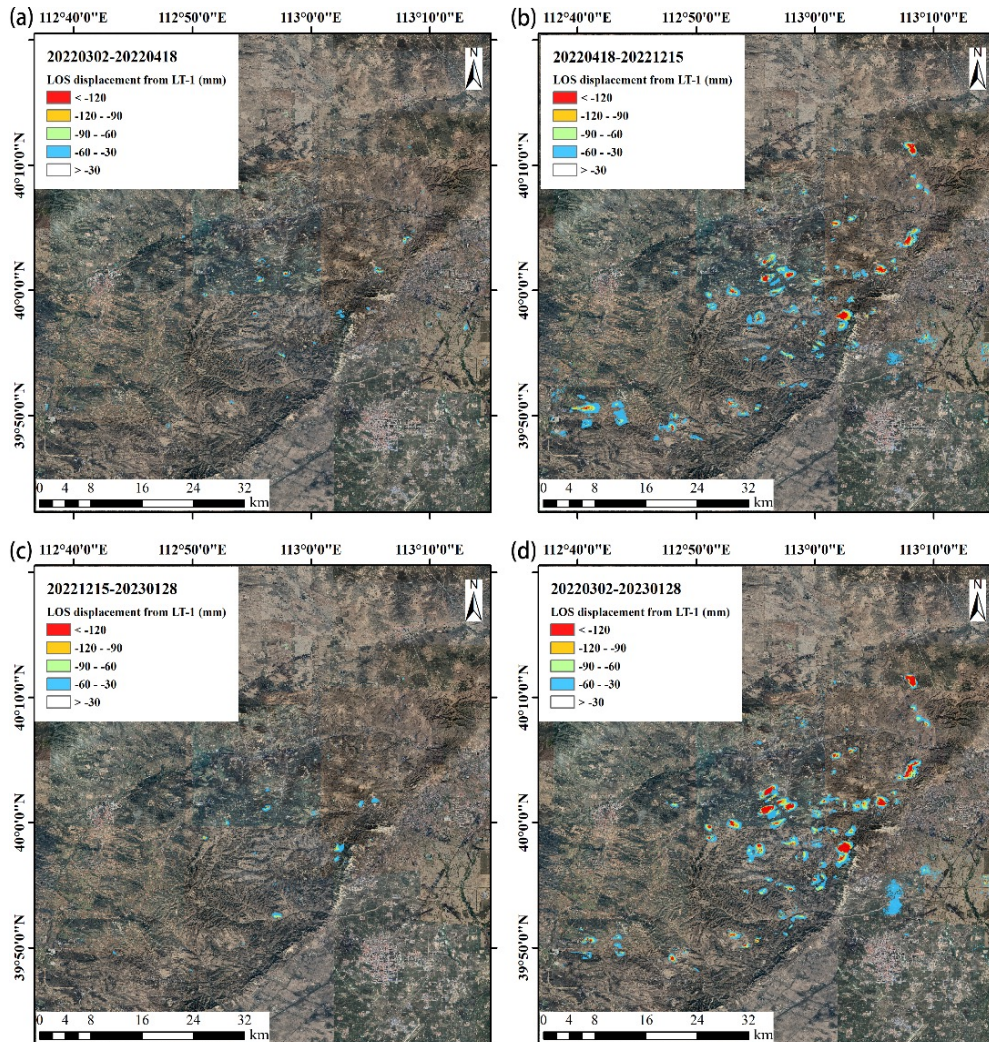
Monitoring large gradient mining subsidence using LT-1 InSAR



Other results:

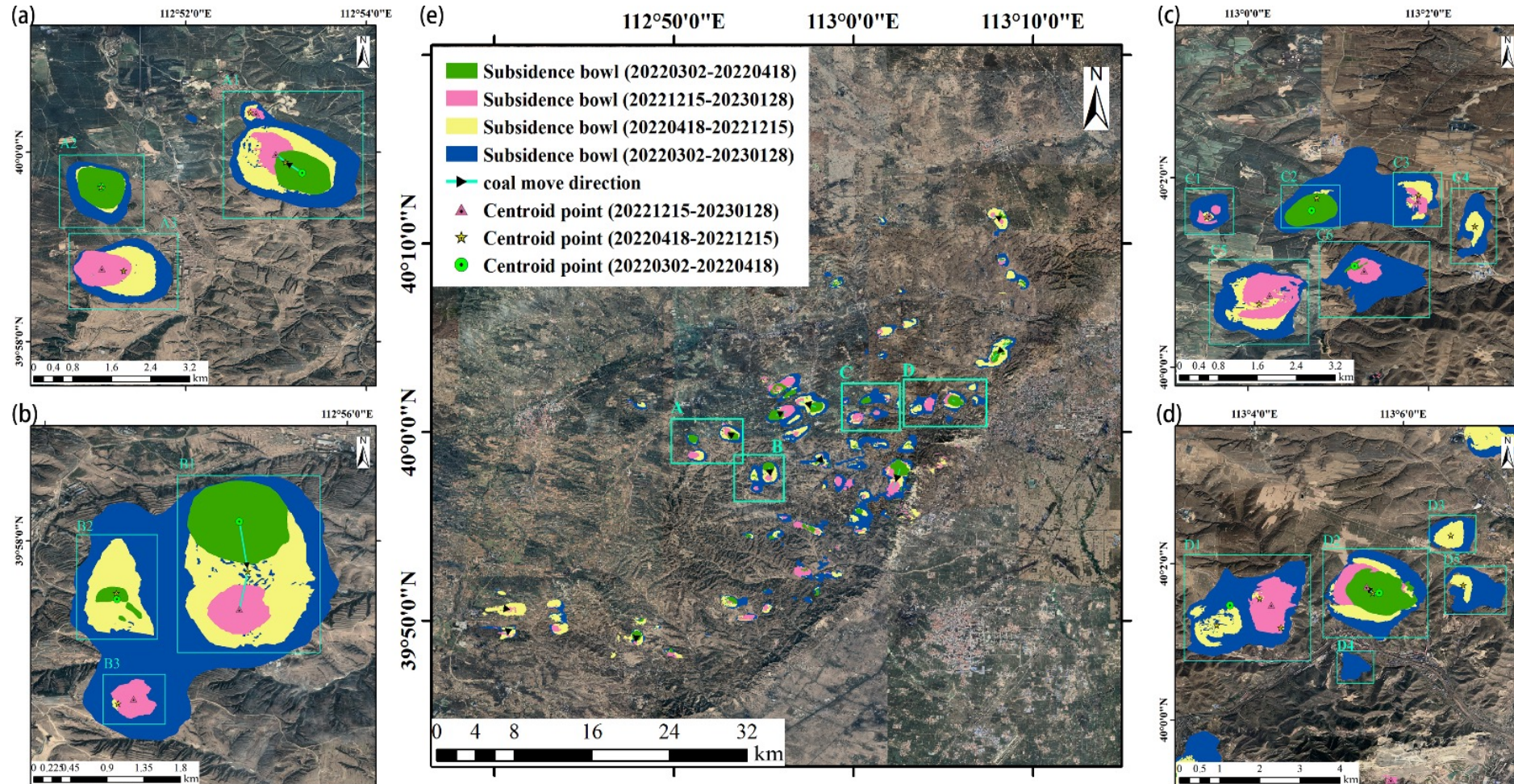


Other results:



	Dates	Maximum displacement (mm)	Number of subsidence bowls	Area of subsidence bowls (km ²)
Sentinel-1	20220228-20220417	-126.8791	48	13.3438
LT-1	20220302-20220418	-179.5473	38	12.1378
	20220418-20221215	-373.1613	88	45.0541
	20221215-20230128	-206.2706	82	17.9120
	20220302-20230128	-385.0004	66	101.0827

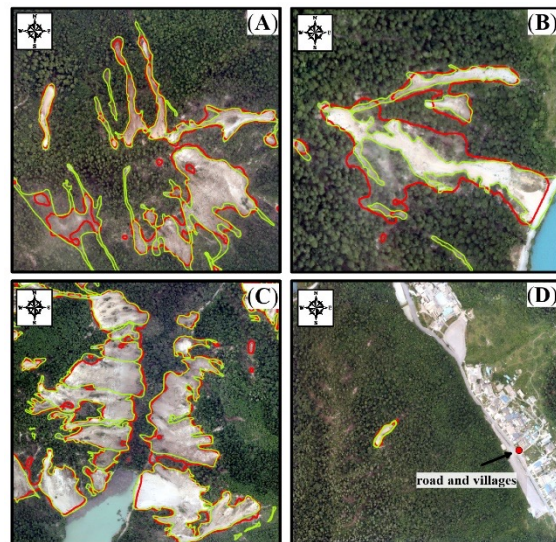
Other results:



Project's schedule, planning & contribution of the partners for the following year

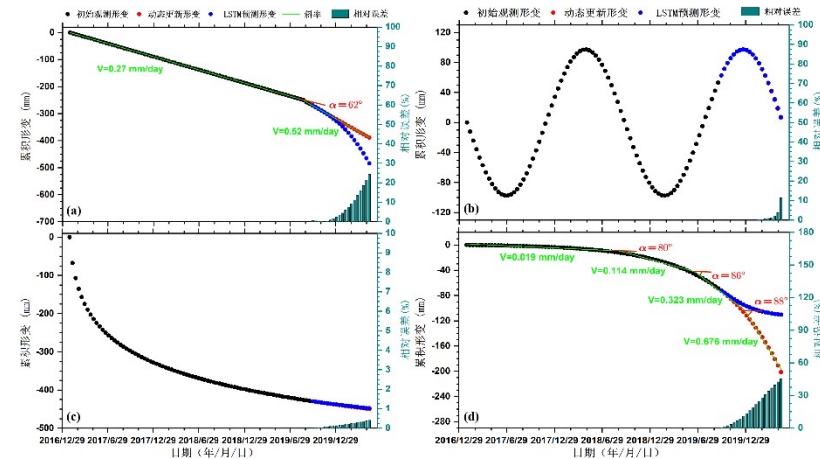
Ongoing tasks...

- Automatic landslide detection method based on deep learning.
- InSAR time series prediction method based on deep learning.
- Validation of the developed method.



Identified Landslide Area Actual Landslide Area 0 0.1 0.2 km

Landslide mapping using DL









InSAR time series prediction using deep learning

Young reasearchers



Name	Institution	Poster title	Contribution including period of research
Cristina Reyes-Carmona	University of Alicante	ID123: Integration of Satellite Interferometry and Landscape Analysis to Detect Large Landslides in Mountainous Areas	This contribution is part of her PhD thesis.
Liuru Hu	University of Alicante, Land Satellite Remote Sensing Application Center, & The First Topographic Surveying Brigade of Ministry of Natural Resources of the People's Republic of China	ID130: Dynamic Process Inversion Using DInSAR of Surface Deformation in Mining Subsidence Bowl by LT-1 Satellite: a Case Study of Datong, China	InSAR and GNSS data processing, implementation of slope stability model and analysis of results. This contribution is part of her PhD thesis.

Report on the level and training of young scientists on the project achievements, including plans for academic exchanges

- 11 Young scientists involved in the project:
 -  3 EU (2 MSc + 1 Postdoc)
 -  1 UK
 -  1 Colombian
 -  6 Chinese
- 1 International (EU-China) cotutelle PhD thesis finished
- 1 International (EU-China) cotutelle PhD thesis ongoing
- 2 International PhD thesis ongoing
- Participation in 15 papers published
- Exchanges:
 -  6 China → EU
 -  1 EU → China (planned)

YOUNG SCIENTIST	TRAINING ACTIVITY	HOST/ORGANIZING INSTITUTION	TIME PERIOD
 M.I. Navarro-Hernández (PhD student UA)	<ul style="list-style-type: none"> • Researcher contract • Exchange - Erasmus+ trainership • 11 Courses/seminars • 4 journal paper • 9 conference contributions 	University of Alicante University of Pavia, Italy UA, FECYT, UNESCO, RUS, Willey IEEE JSTARS, Land, RS IUACA, Living planet, EGU, E3S Web of Conferences, CIGEO, IAH	25/01/2021-present 16/04/2022 - 20/07/2022
 L. Hu (PhD student UA)	<ul style="list-style-type: none"> • Exchange – CSC scholarship • 10 Courses/seminars • 2 journal paper • 3 conference contributions 	University of Alicante ICTP, ESA, ICEYE, COMET, UA, IEEE, RUS, WILEY RSE and RS Living planet, ICTP and Dragon 5 workshop.	16/09/2021-17/09/2022
 X. Liu (PhD student Chang'an university and UA - cotutelle)	<ul style="list-style-type: none"> • Exchange – CSC scholarship • 3 Courses/seminars • 5 journal paper • 2 conference contribution • PhD finished 	University of Alicante Chang'an University and UA ENGEO, GRL, RE, Landslides and RSE Dragon 5 workshop, Spanish Symposium slope stability	13/03/2021 – 03/09/2022   December 2022
 J. Luo (PhD student UA)	<ul style="list-style-type: none"> • Researcher contract • 8 Courses/seminars • 2 journal paper • 2 conference contribution 	University of Alicante ESA, UA and CUMT IEEE JSTARS Dragon 5 workshop	01/12/2021-present

YOUNG SCIENTIST	TRAINING ACTIVITY	HOST/ORGANIZING INSTITUTION	TIME PERIOD
W.T. Szeibert (MSc student- currently employed in an InSAR company) 	<ul style="list-style-type: none"> • 1 conference contribution • 1 paper • 1 MSc thesis 	Simposio Nacional Taludes Landslides Universidad de Alicante	-
S. García-Pozo (MSc student- currently employed in a geotechnics company)  	<ul style="list-style-type: none"> • 1 MSc thesis 	-	-
H. Chen (PhD student Chang'an university and UA - cotutelle) 	Exchange – CSC scholarship 1 paper 2 seminars	University of Alicante Remote Sensing University of Alicante	October 2022-present
D. Orlandi (PhD student University of Pisa)  	Exchange	University of Alicante	October 2022-present
C. Reyes-Carmona (Postdoc UA)  	<ul style="list-style-type: none"> • Conferences & papers • Planning a research stay in China 	University of Alicante	September 2023-present
G. Zhuo (PhD student Chengdu University of Technology) 	<ul style="list-style-type: none"> • Exchange – CSC scholarship 	University of Alicante	October 2023-September 2024

YOUNG SCIENTIST	TRAINING ACTIVITY	HOST/ORGANIZING INSTITUTION	TIME PERIOD
J. Du (PhD student Chang'an University) 	<ul style="list-style-type: none">Exchange – CSC scholarship	University of Alicante	October 2023-September 2024



Dragon 5 3rd Year Results Reporting



Results

Academic publications (summary)

■ Journals ■ Conferences

13 × Q1

2 × Q2

4 × national

3 × international

Academic publications (journals)

- Navarro-Hernández, M.I., Valdes-Abellan, J., Tomás, J., Tessitore, S., Ezquerro, P., Herrera, P. (2023). Analysing the Impact of Land Subsidence on the Flooding Risk: Evaluation Through InSAR and modelling. *Water Resources Management*,
- Hu, L., Tomás, R., Tang, X., López Vinielles, J., Herrera, G., Li, T., Liu, Z. (2023). Updating Active Deformation Inventory Maps in Mining Areas by Integrating InSAR and LiDAR Datasets. *Remote Sensing*, 15, 996
- Wen, N., Dai, K., Tomás, R., Chen C., Deng, J., Shi, X., Wu, M., Feng, W., (2023). Revealing the time lag between slope stability and reservoir water fluctuation from InSAR observations and wavelet tools— a case study in Maoergai Reservoir (China). *GIScience & Remote Sensing*, 60, 2170125
- Chen, H., Zhao, C., Tomás, R., Chen, L., Yang, C., Zhang, Y. (2023). Retrieving the Kinematic Process of Repeated-Mining-Induced Landslides by Fusing SAR/InSAR Displacement, Logistic Model, and Probability Integral Method. *Remote Sensing*, 15, 3145.
- Tomás, R., Pinheiro, M., Pinto, P., Pereira, E. and Miranda, T. (2023). Preliminary analysis of the mechanisms, characteristics, and causes of a recent catastrophic structurally controlled rock planar slide in Esposende (northern Portugal). *Landslides*, 20, 1657-1665.

Academic publications (journals)

- Dai, K., Li, Z., Xu, Q., Tomás, R., Li, T., Jiang, L., Zhang, J., Yin, T., Wang, H. (2023). Identification and evaluation of the high mountain upper slope potential landslide based on multi-source remote sensing: the Aniangzhai landslide case study. *Landslides*, 20, 1405-1417
- Tomás, R., Díaz, E., Szeibert, W.T., Liu, X., Lopez-Sanchez, J.M., Zhao, C. (2023). Geomorphological characterization, remote sensing monitoring, and modeling of a slow-moving landslide in Alcoy (Southern Spain). *Landslides*, 20, 1293-1301
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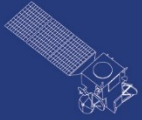
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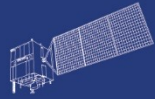
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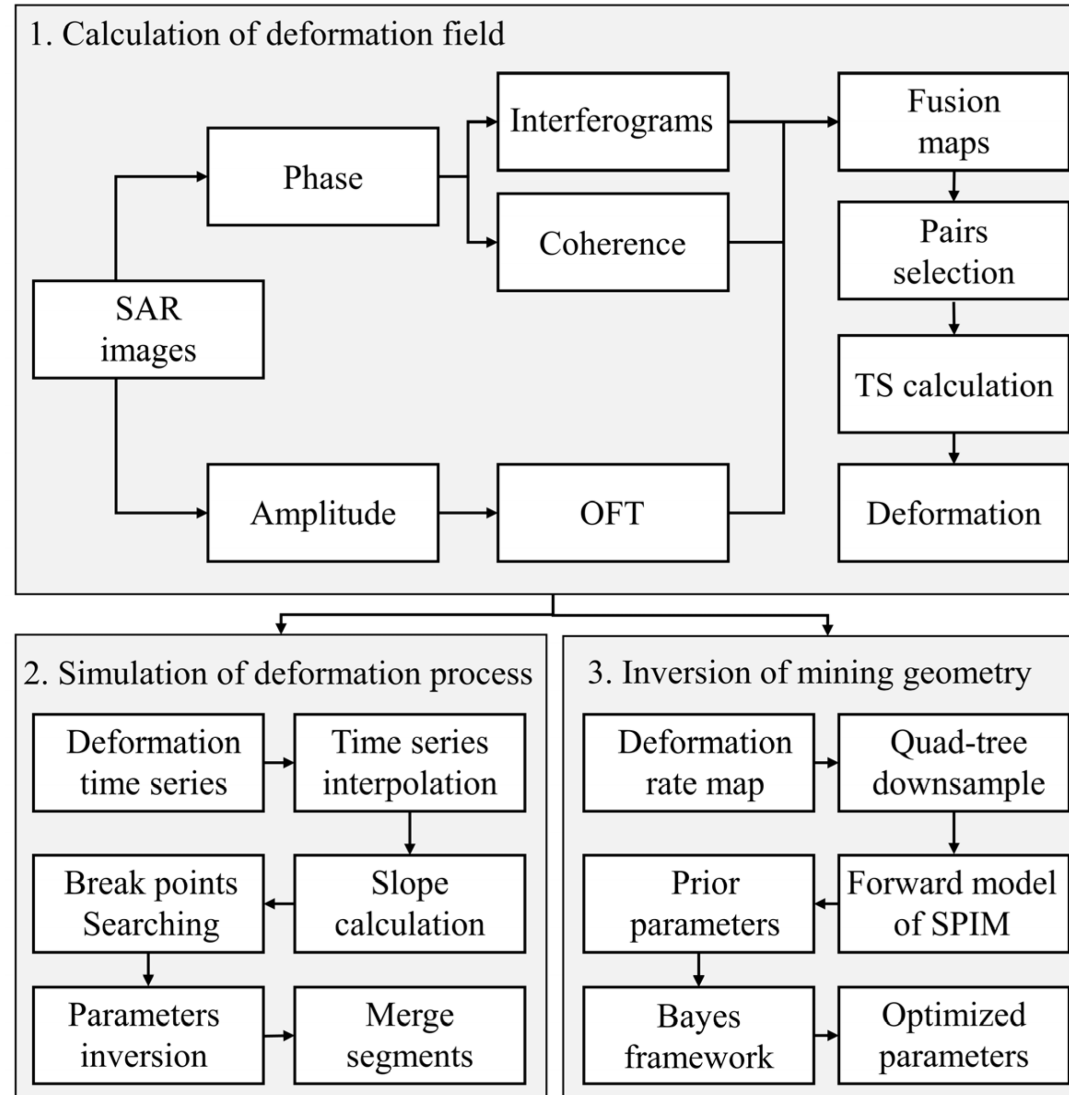
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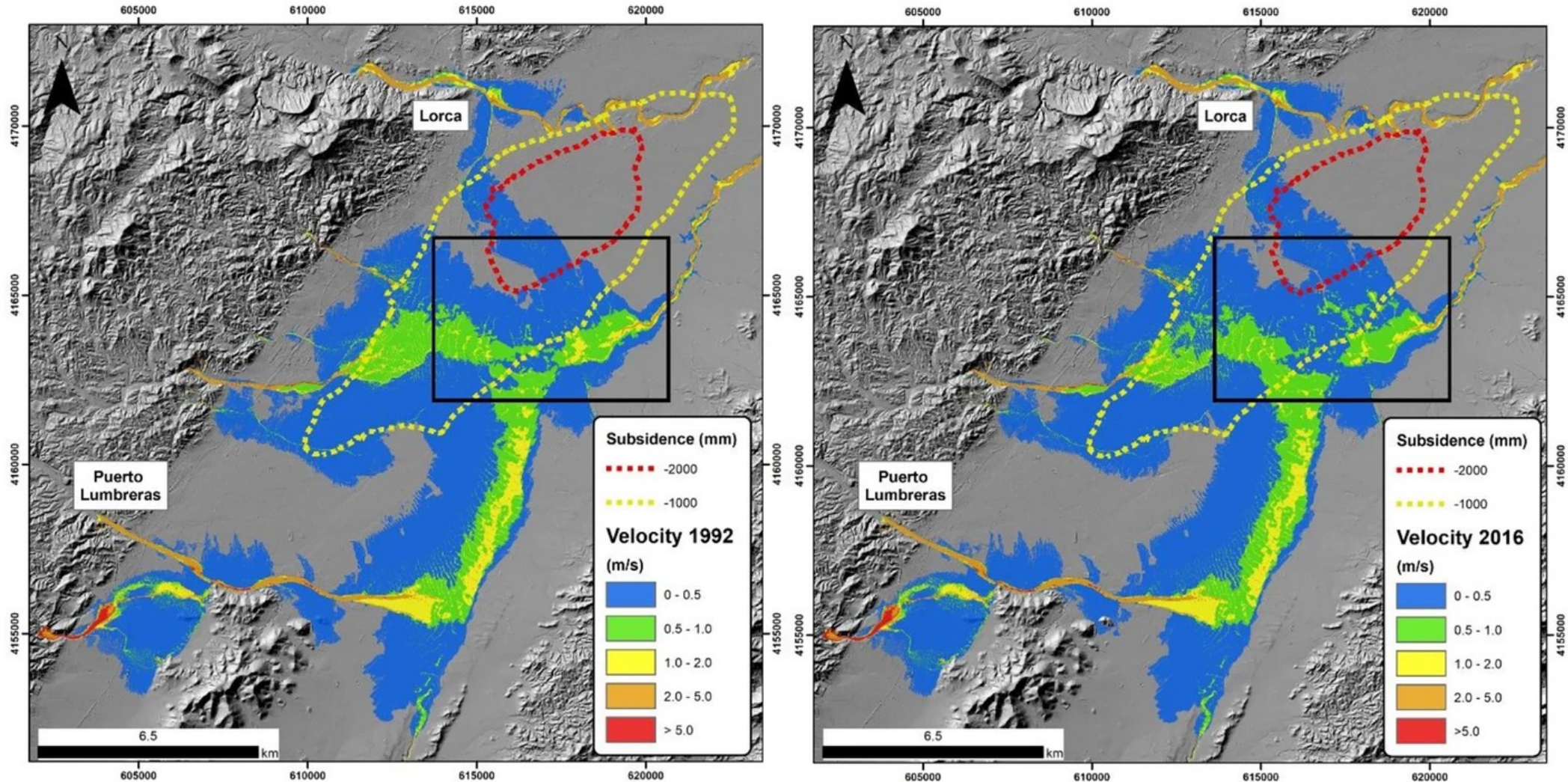
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Annex



Annex



Annex

