AFAD
REPUBLIC OF TÜRKİYE- MINISTRY OF INTERIOR
DISASTER AND EMERGENCY MANAGEMENT AUTHORITY

Training Workshop X: Feedback on tailor-made training

Feedback on SAR data analysis method training held in Türkiye

Dr. Fatma CANASLAN ÇOMUT

Earthquake and Risk Reduction Branch Manager

Geodesy and Photogrammetry Engineer

February 12th, 2026 Dubai, the United Arab Emirates

OUTLINE

1. BACKGROUND: A BRIEF LOOK AT OUR RECENT WORKSHOPS

2. TECHNICAL CONTENT OF THE SECOND WORKSHOP

3. SKILLS AND KNOWLEDGE ACQUIRED

   WHAT WE LEARNED FROM THE WORKSHOP

4. OUTCOMES AND PRACTICAL APPLICATIONS

   WHAT WE ACHIEVED TOGETHER

5. LOOKING AHEAD: FUTURE WORK AND EXPECTATIONS

Where We Started:
The Background of the Workshop Series

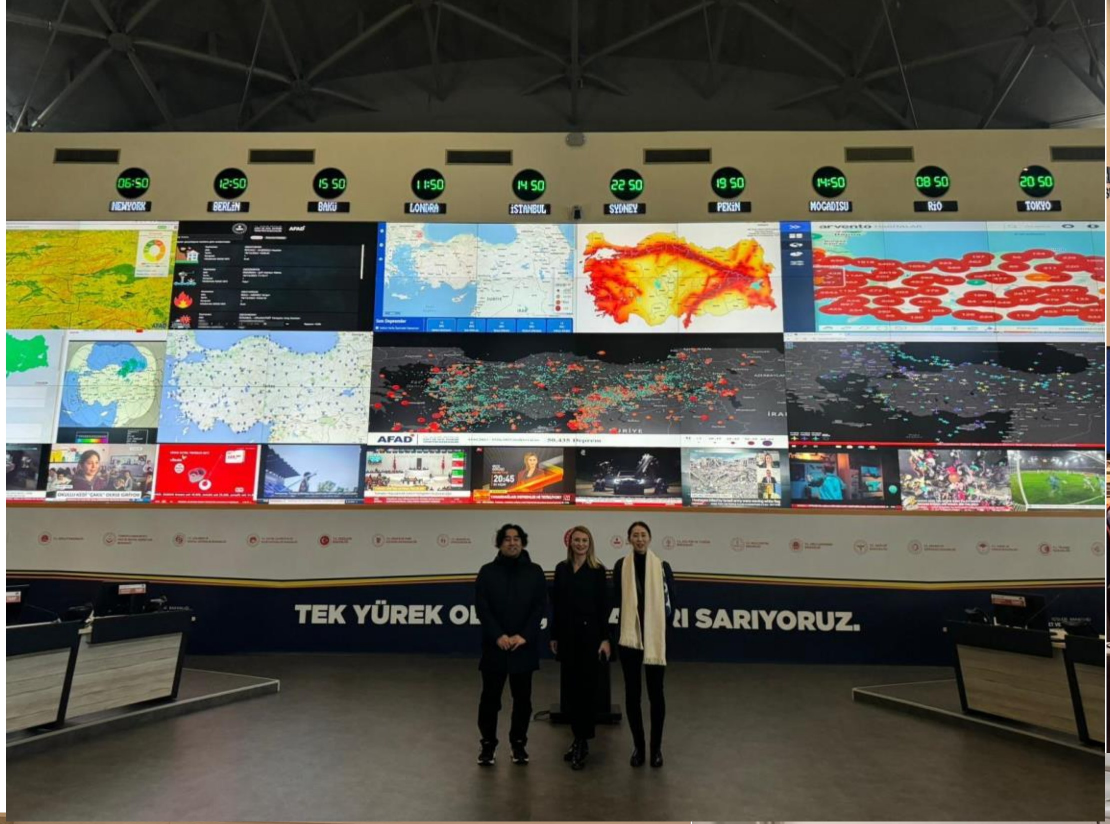
This journey began with a shared need to strengthen capacity and better understand how satellite-based tools can support risk monitoring.

July 2022
Membership agreement with AFAD
and Sentinel Asia

<u>After July 2022</u>

1st WORKSHOP 20.12.2023

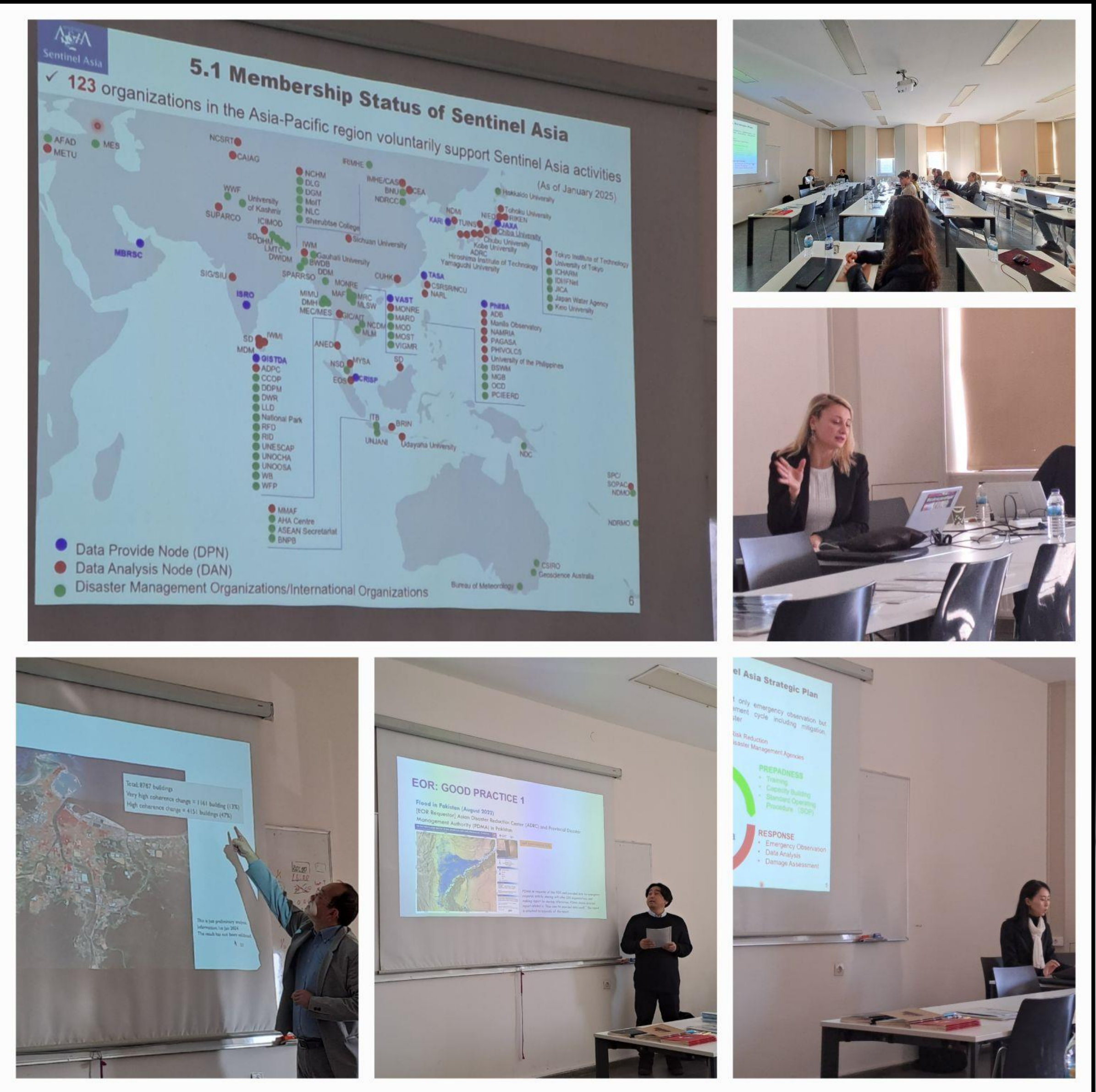
JAXA and ADRC had a SA workshop thanks to support of AFAD and METU. Around 20 participants joined for it. Participants confirmed a concept of SA in this WS.



Preparation Meeting for the Second Workshop in Denizli 24.07.2024

Moving Forward: What Happened in the Second Workshop

2nd workshop - 07.01.2025



Building on the first workshop, the second phase focused on turning concepts into practice through hands-on training and real examples.

TECHNICAL CONTENT OF THE SECOND WORKSHOP

Along the Way: What We Learned

Agenda of 2nd WS

2025/1/7

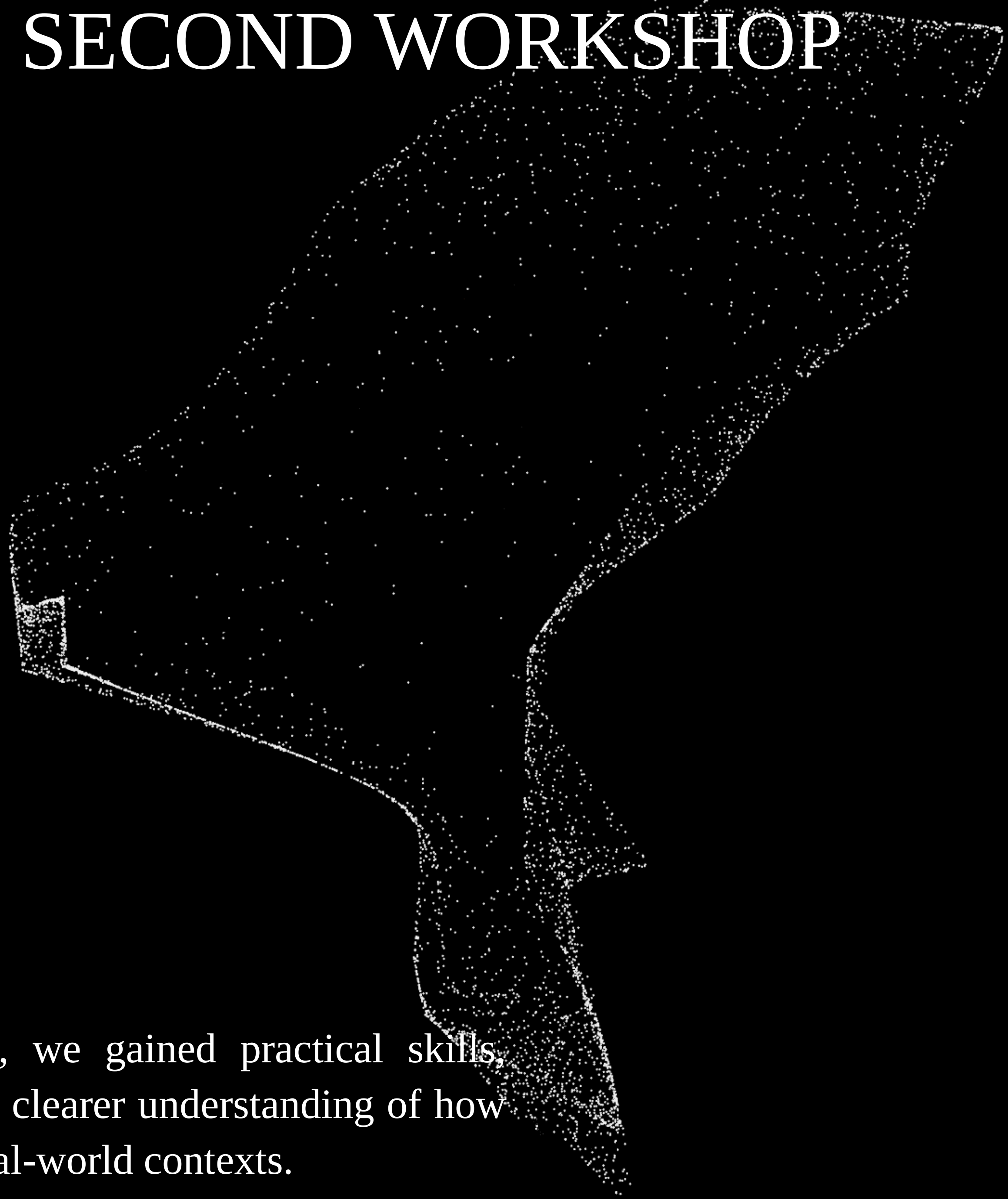
9:30	-	9:40	Opening	Dr. IKEDA Makoto	ADRC
9:40	-	10:10	About Sentinel Asia	Ms. TANAKA Yuki	JAXA
10:10	-	10:50	About OPTEMIS following updated SOP	Dr. IKEDA Makoto	ADRC
10:50	-	11:10	Q & A	All	
11:10	-	11:30	break (and Q & A)		
11:30	-	12:30	AFAD effort on the Türkiye EQ in 2023	Dr. Fatma Canaslan Çomut	AFAD
12:30	-	13:50	Lunch		
13:50	-	15:20	(Lecture) Remote Sensing in Disaster Response	Professor. NAGAI Masahiko	Yamaguchi University
15:20	-	15:50	break (and Q & A)		
15:50	-	17:20	(Lecture) About SAR	Professor. NAGAI Masahiko	Yamaguchi University

2025/1/8

9:30	-	12:30	(Hands-on) Basic of SAR	Professor. NAGAI Masahiko	Yamaguchi University
12:30	-	13:50	Lunch		
13:50	-	15:20	(Hands-on) Estimation of collapsed houses by Coherence Analysis	Professor. NAGAI Masahiko	Yamaguchi University
15:20	-	15:40	break (and Q & A)		
15:40	-	17:20	(Hands-on) Estimation of collapsed houses by Coherence Analysis	Professor. NAGAI Masahiko	Yamaguchi University
17:20	-	17:30	Closing	ADRC	

Technical Scope

- Optical and SAR satellite data
- InSAR processing using SNAP
- GIS-based analysis and visualization (QGIS)



Throughout the workshop, we gained practical skills, technical confidence, and a clearer understanding of how InSAR can be applied in real-world contexts.

Participants

30 Participants – Pre-registered

1 Lecturer
1 Facilitator/ Participant
1 Presenter/Participant
2 Presenter

21 Participant

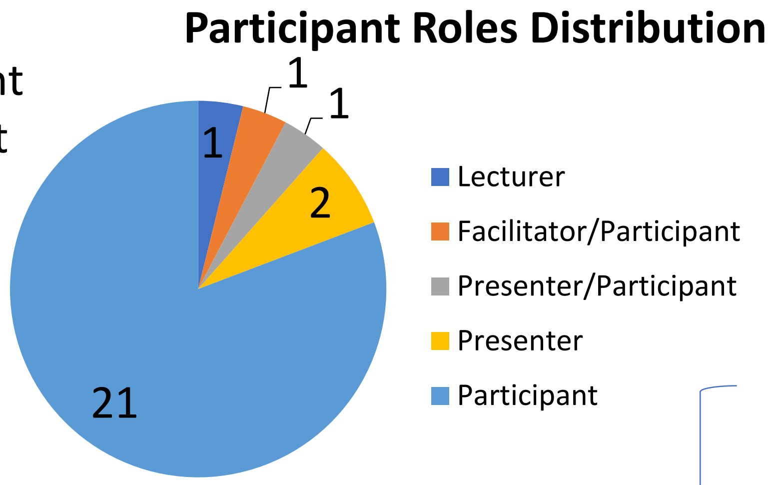
Total : 26 person

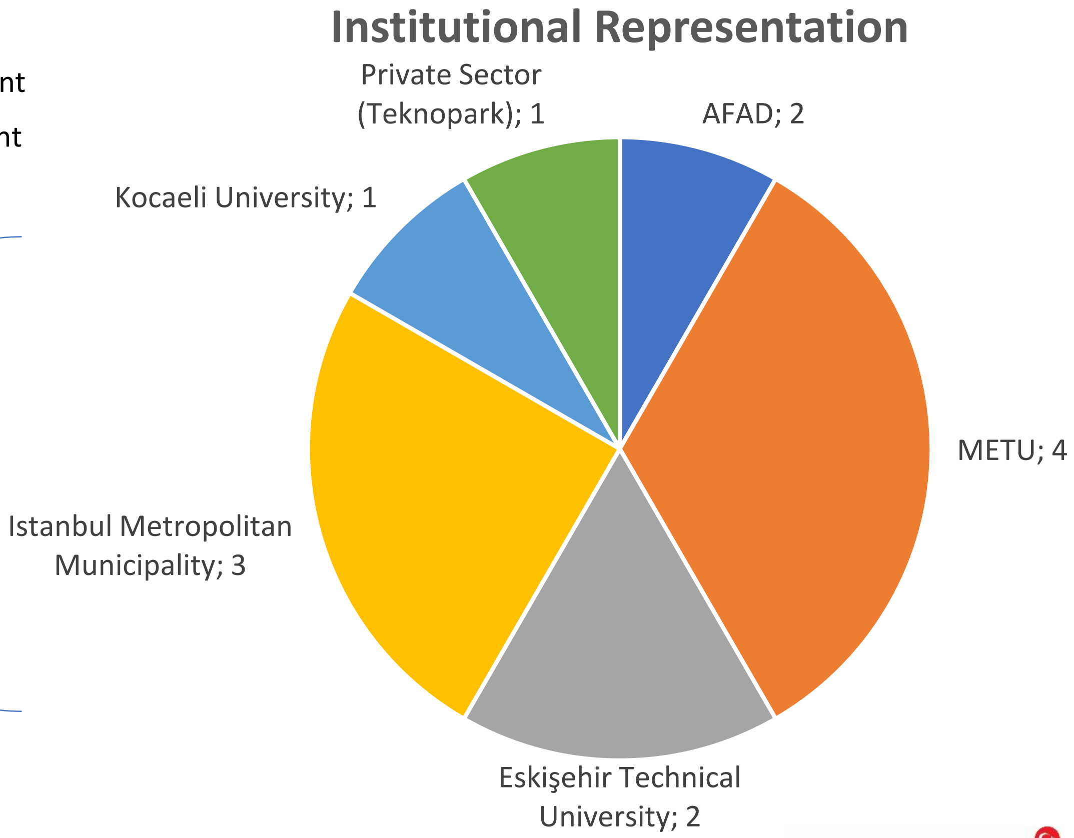
First Day attandance 16

Second Day attandance 17

17 participant -> 5 lecturer/presenter

So feedback from 12 participant





Presentations from ADRC, JAXA AND AFAD

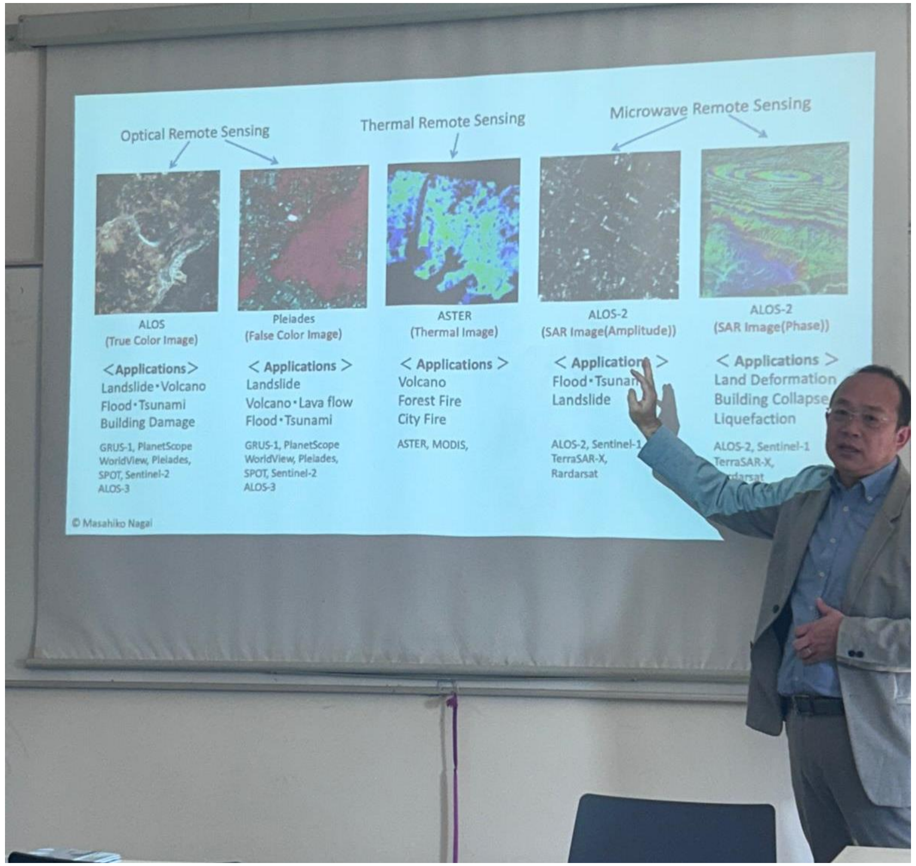
- Opening Dr. IKEDA Makoto ADRC
- About Sentinel Asia Ms. TANAKA Yuki JAXA
- About OPTEMIS following updated SOP Dr. IKEDA Makoto ADRC

AFAD effort on the Türkiye EQ in 2023
Dr. Fatma Canaslan Çomut AFAD

SKILLS AND KNOWLEDGE ACQUIRED

WHAT WE LEARNED FROM THE WORKSHOP

Professor. NAGAI Masahiko from the Center for Research and Application of Satellite Remote Sensing of Yamaguchi University made lectures and hands-on session in this WS.



Basic of SAR

Lecture-1

YAMAGUCHI UNIVERSITY

Remote Sensing for Disaster

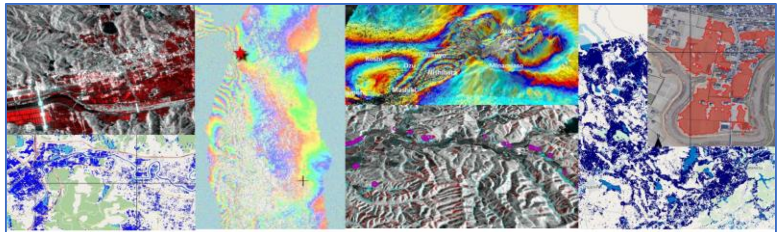
Masahiko Nagai

Director, Center for Research and Application for Satellite Remote Sensing

Professor, Graduate School of Sciences and Technology for Innovation

Yamaguchi University

Lecture-2



How to better understand SAR, interpret SAR products and realize the limitations

Prof. Masahiko Nagai

Graduate School of Sciences and Technology of Innovation

Yamaguchi University, Japan

Sentinel Asia

Estimation of collapsed houses by coherence analysis

Hands-on 1

Hands-on Exercise on Change Detection using Pre and Post Earthquake Images by colour composites

Turkey 06 Feb, 2023

Prof. Masahiko Nagai

Director, Center for Research and Application for Satellite Remote Sensing

Yamaguchi University, Japan

nagaim@yamaguchi-u.ac.jp

YAMAGUCHI UNIVERSITY

Sentinel Asia

1

Hands-on 2

Hands-on Exercise on Estimation of Damaged Buildings post earthquake by ALOS 2 Coherence Image

Turkey 06 Feb, 2023

Prof. Masahiko Nagai

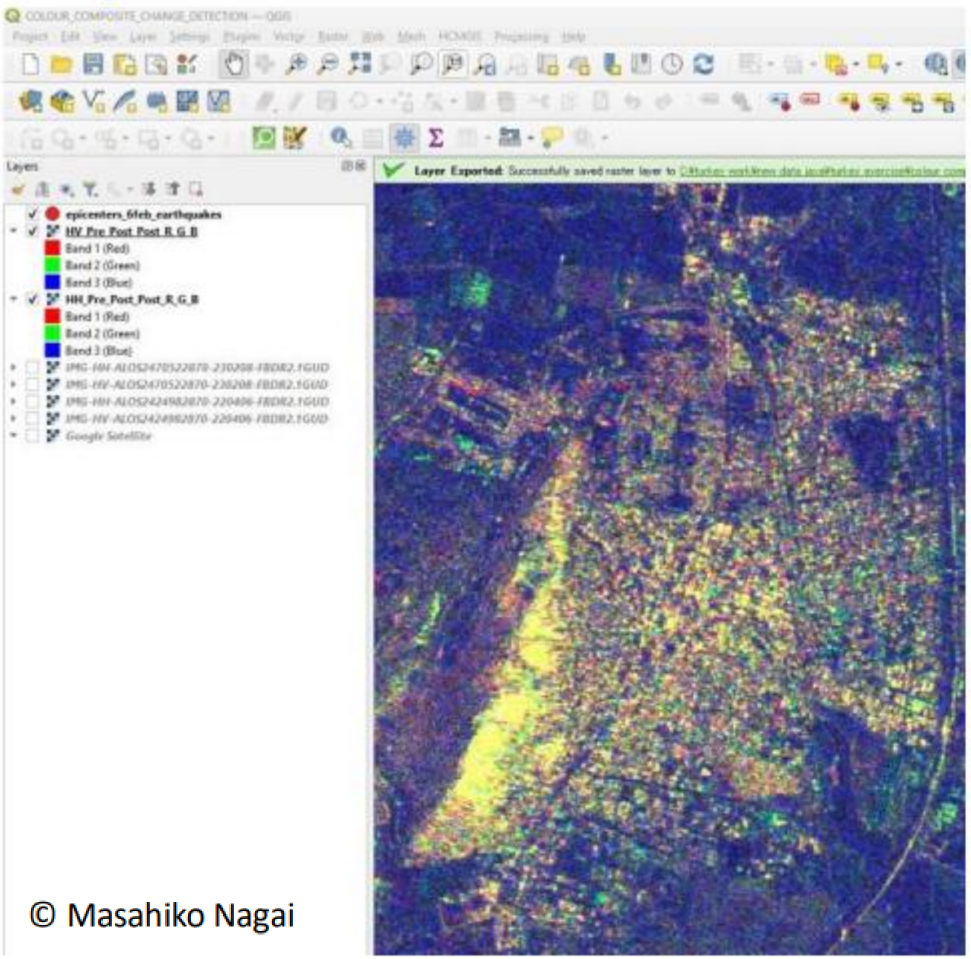
Director, Center for Research and Application for Satellite Remote Sensing

Yamaguchi University, Japan

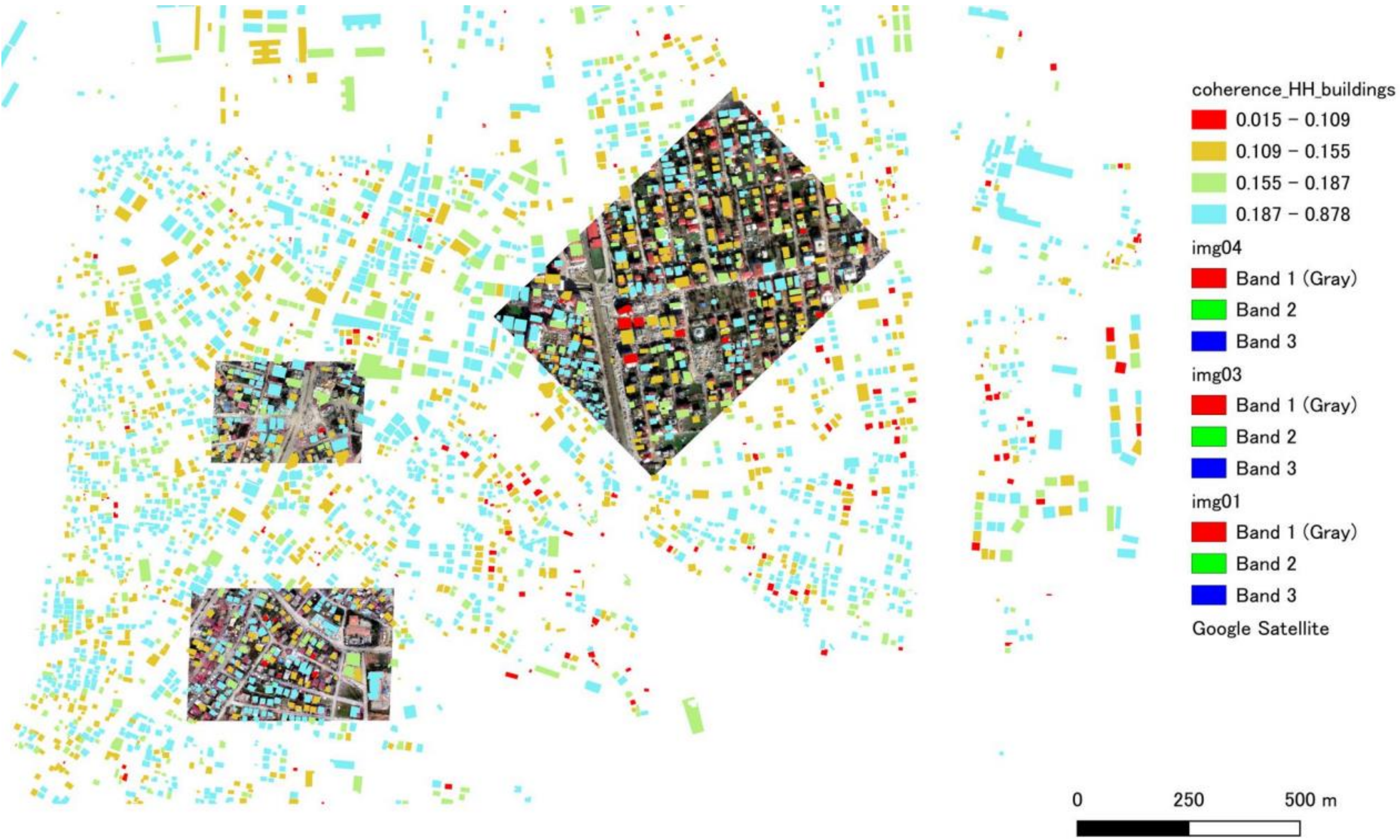
nagaim@yamaguchi-u.ac.jp

The results of sample studies

The colour composites for Pre and Post Earthquake SAR images for both HH and HV polarized bands with their intensity values for a quick search for areas undergoing change due to the earthquake



Building Coherence after Earthquake 06 Feb, 2023 (Kahramanmaraş Province, Türkiye



OUTCOMES AND PRACTICAL APPLICATIONS

WHERE WE ARE NOW: WHAT WE HAVE ACHIEVED

After the training, did the participants use the analysis method for their disaster management activities?

1. ACHIVEMENTS FROM PARTICIPANTS

2. ACHIVEMENTS FROM AFAD’S PERSPECTIVE

ACHIVEMENTS FROM PARTICIPANTS

METU (ODTÜ): Joined as the 1st DAN Member (Post-1st Workshop)

ESTU-IESS (Eskisehir Technical University): Joined as the 2nd DAN Member (Post-2nd Workshop)

AKOM – Istanbul Metropolitan Municipality Disaster Management and Risk Reduction Department: Initiated a LiDAR project proposal in collaboration with ISKA

Strategic Goals

•**Expert Teams:** Forming specialized Remote Sensing & GIS units for rapid disaster response.

•**Sustainable Output:** Commitment to monthly/yearly reporting and performance monitoring.

•**Added Value:** Leveraging ESTU's and METU's expertise to strengthen the Sentinel Asia Network.

•**Institutional Support:**
ESTU University funding has been provided for the Disaster Response project.

ACHIVEMENTS FROM AFAD’S PERSPECTIVE

Advances in Operational InSAR Data Processing for Disaster Monitoring

KAHRAMANMARAŞ EARTHQUAKE

WILL BE PUBLISH SOON

BALIKESİR – SINDIRGI EARTHQUAKE

WILL BE PUBLISH SOON

KONYA CLOSED BASIN LAND SUBSIDENCE

PRESENTED AT MINWAT AND GEOLOGICAL WORKSHOP

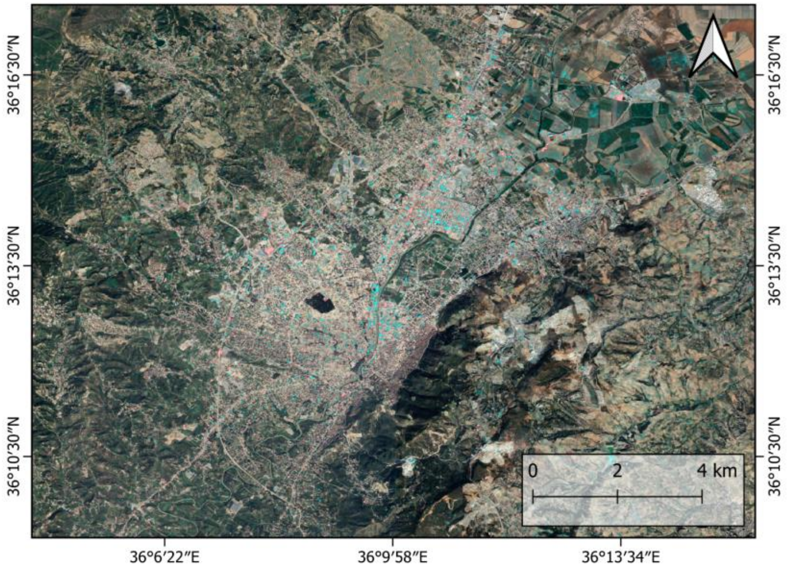
MYANMAR EARTHQUAKE

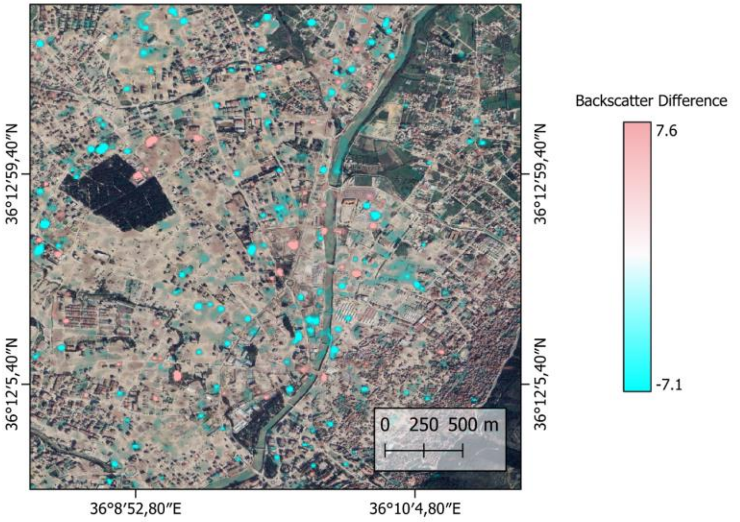
PUBLISHED IN NATURAL SCIENCE AND AGU

PRESENTED AT ATAG AND AGU

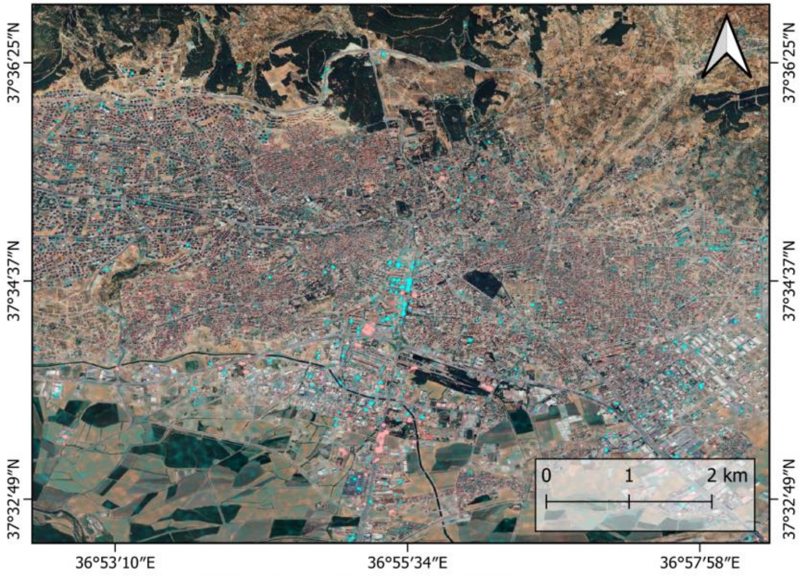
As a result, we moved beyond learning and reached a point where meaningful analyses and comparisons could be carried out across different regions.

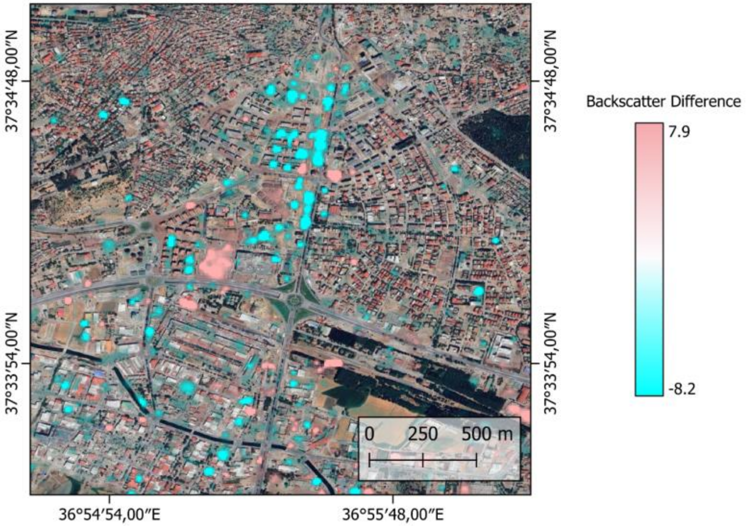
SAR-Based Change Detection for Post-Earthquake Damage Assessment: The 2023 Kahramanmaraş and 2025 Balikesir–Sindirgi Earthquakes



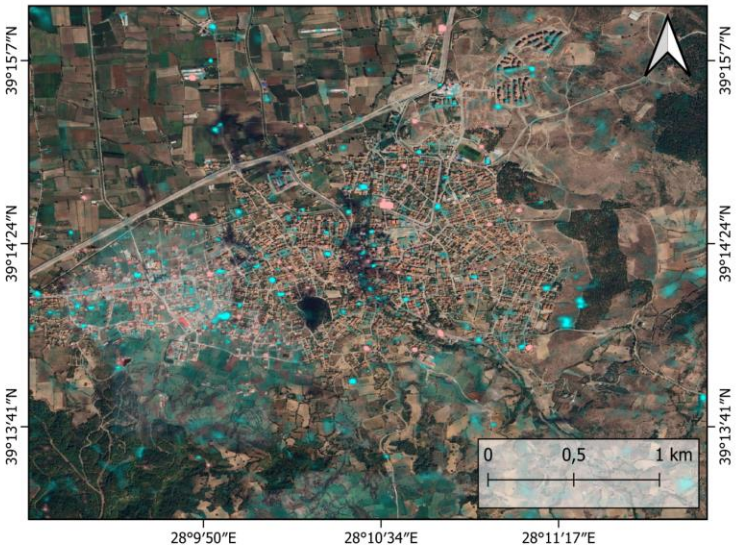


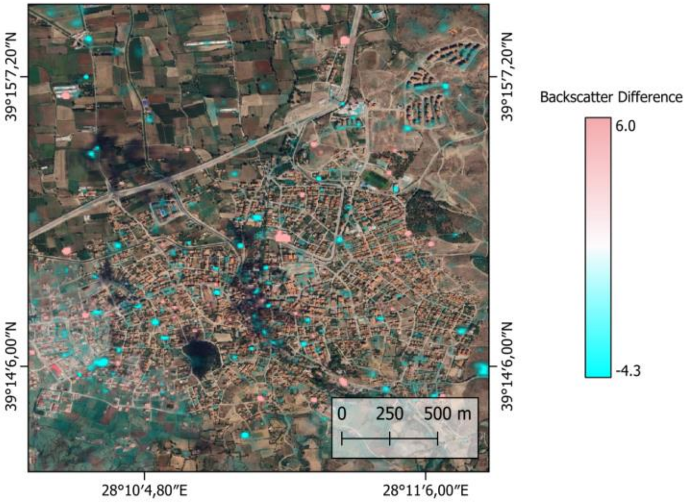
Change detection map for Hatay (asc14)





Change detection map for Kahramanmaras (dsc21)





Change detection map for Sindirgi (asc131)

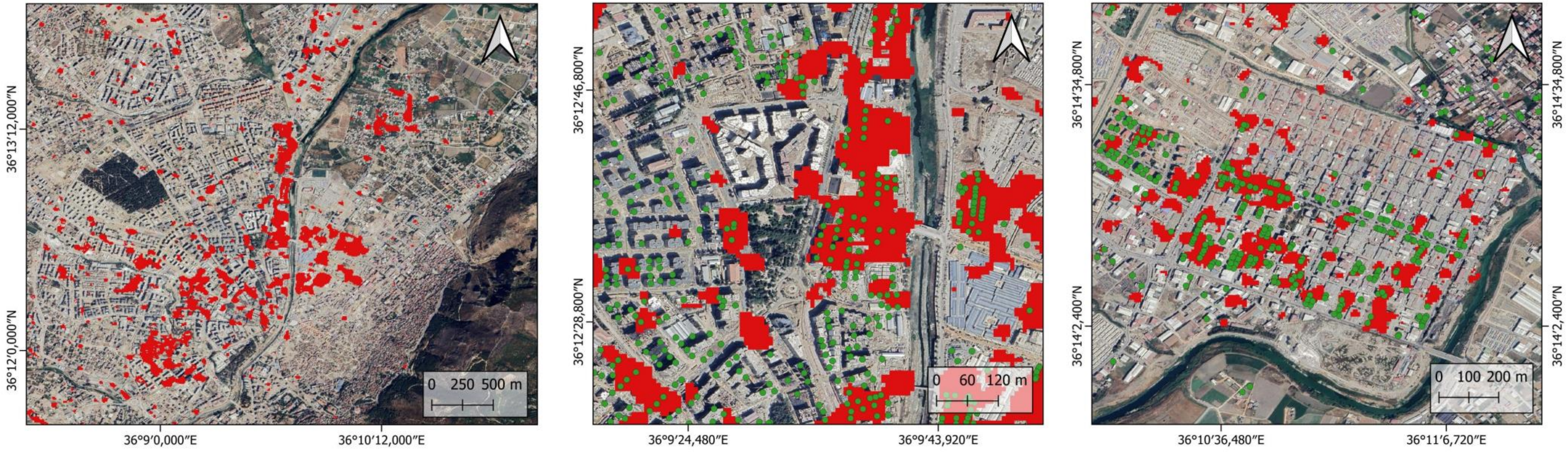
(10 August 2025 - Balıkesir)

Colabrative work with insar.sk

Project: Cynergy4MIE
Supplier: insar.sk s.r.o., Slovakia

SAR-Based Change Detection for Post-Earthquake Damage Assessment: The 2023 Kahramanmaraş and Hatay

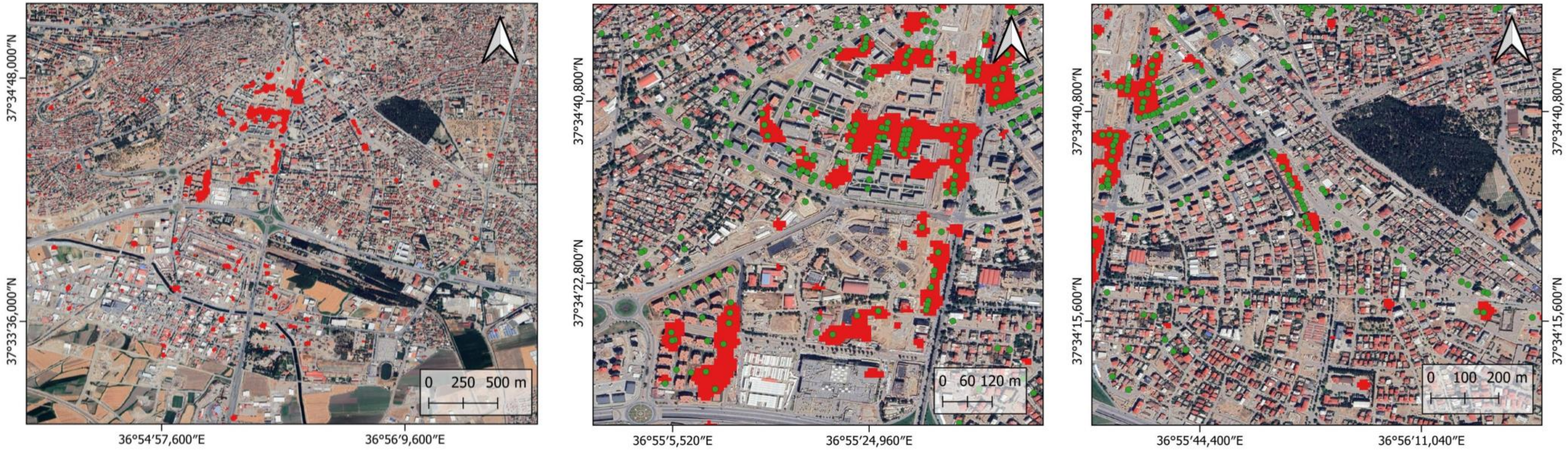
Change detection map for Hatay (dsc21)



Detected damage areas
Damaged buildings (ground truth)

Metrics:
Precision (area-based) = 58.417%
Building Detection Rate (BDR) = 16.08%

Change detection map for Kahramanmaras (dsc21)



Detected damage areas
Damaged buildings (ground truth)

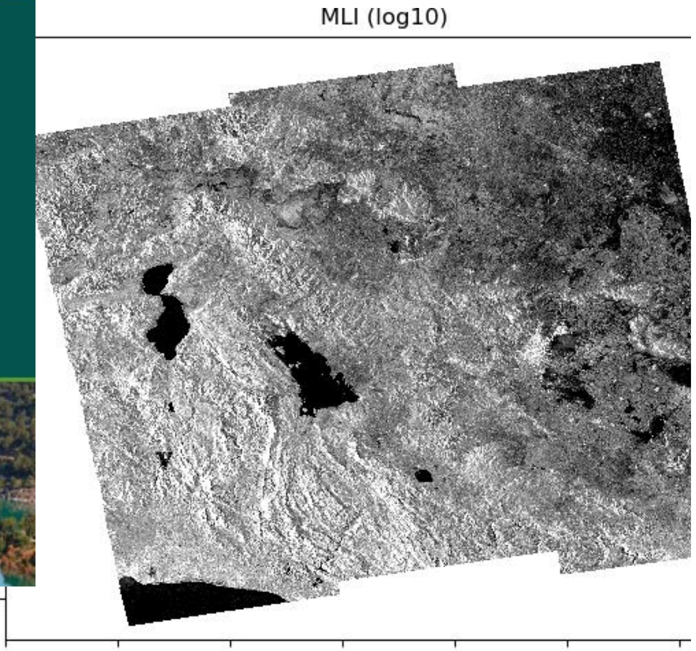
Metrics:
Precision (area-based) = 38.52%
Building Detection Rate (BDR) = 13.11%

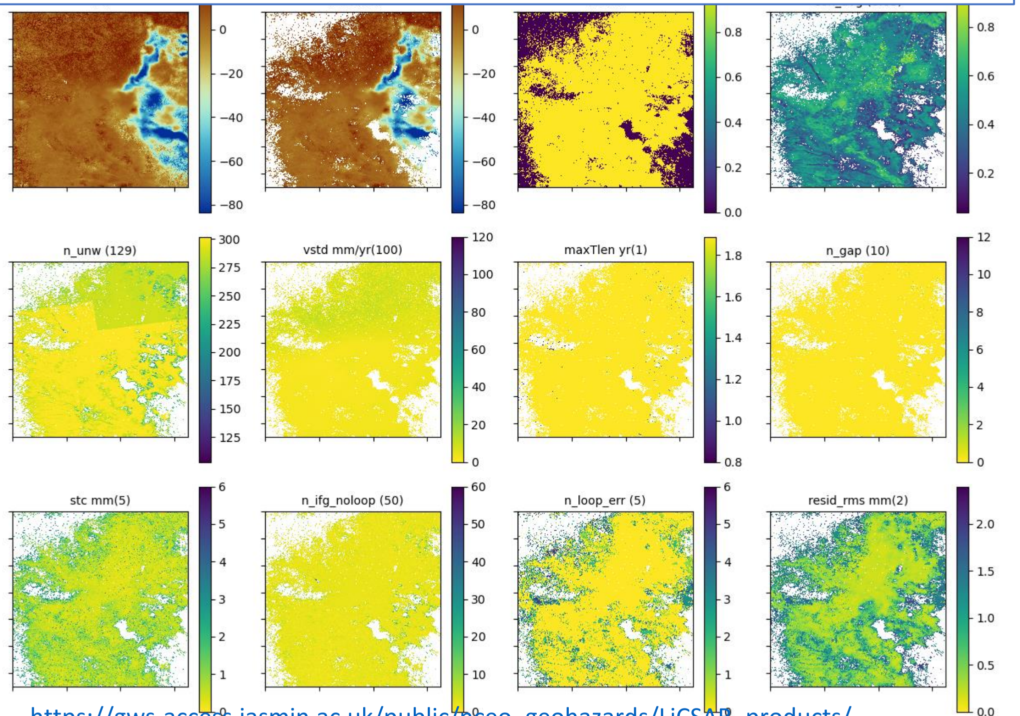
Colabrative work with insar.sk

Project: Cynergy4MIE
Supplier: insar.sk s.r.o., Slovakia

An Analysis of the Relationship Between Sinkhole Formation, Groundwater Depletion, and Surface Deformations in the Konya Province Using SAR Interferometry: A Focus on the 2021-2022 Period

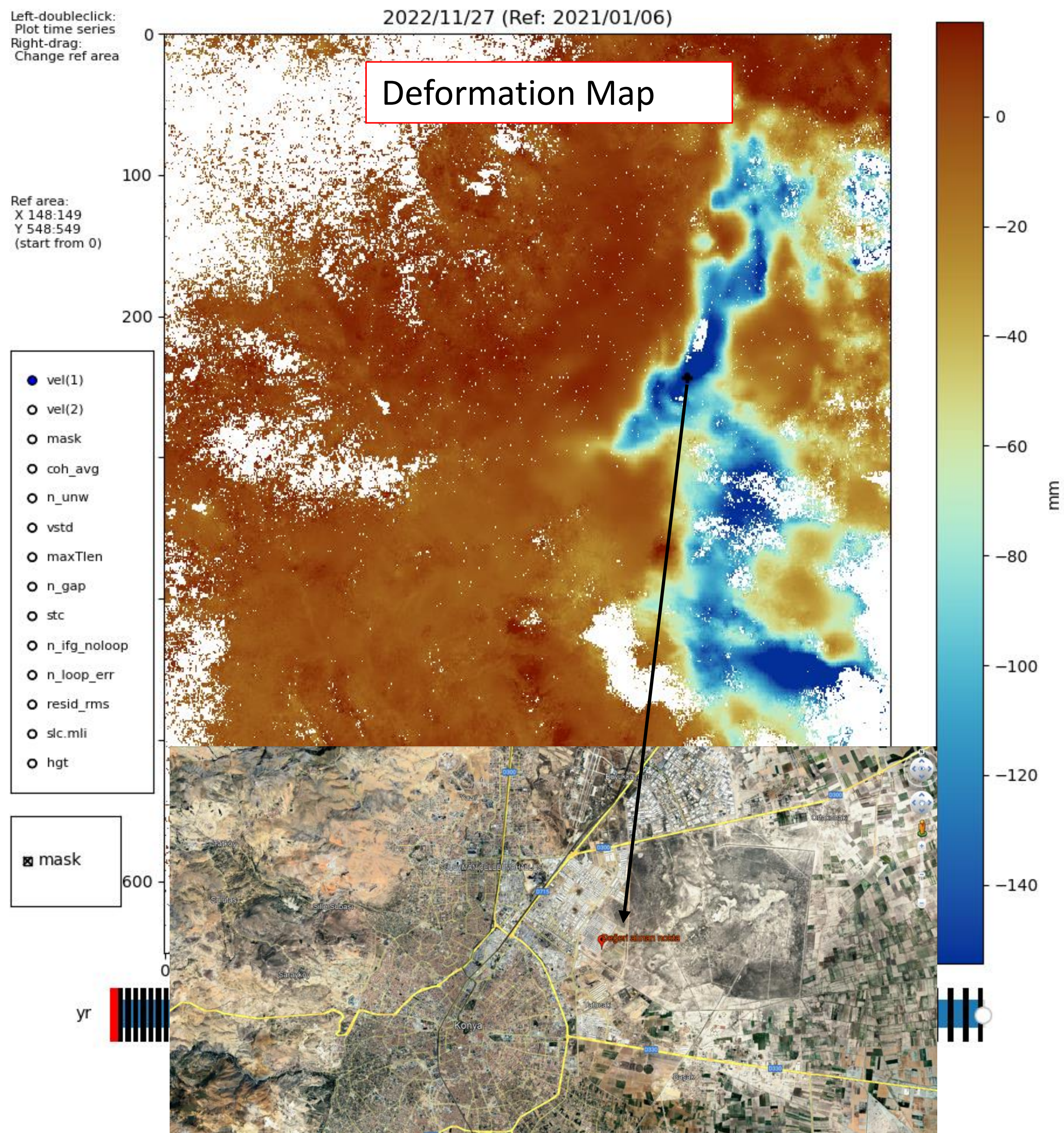
160A_05207_131313 Ascending Frame: **Konya Provincial Center**
A time series was created using a total **of 320 interferograms** for the period from January 1, 2021, to December 31, 2022.



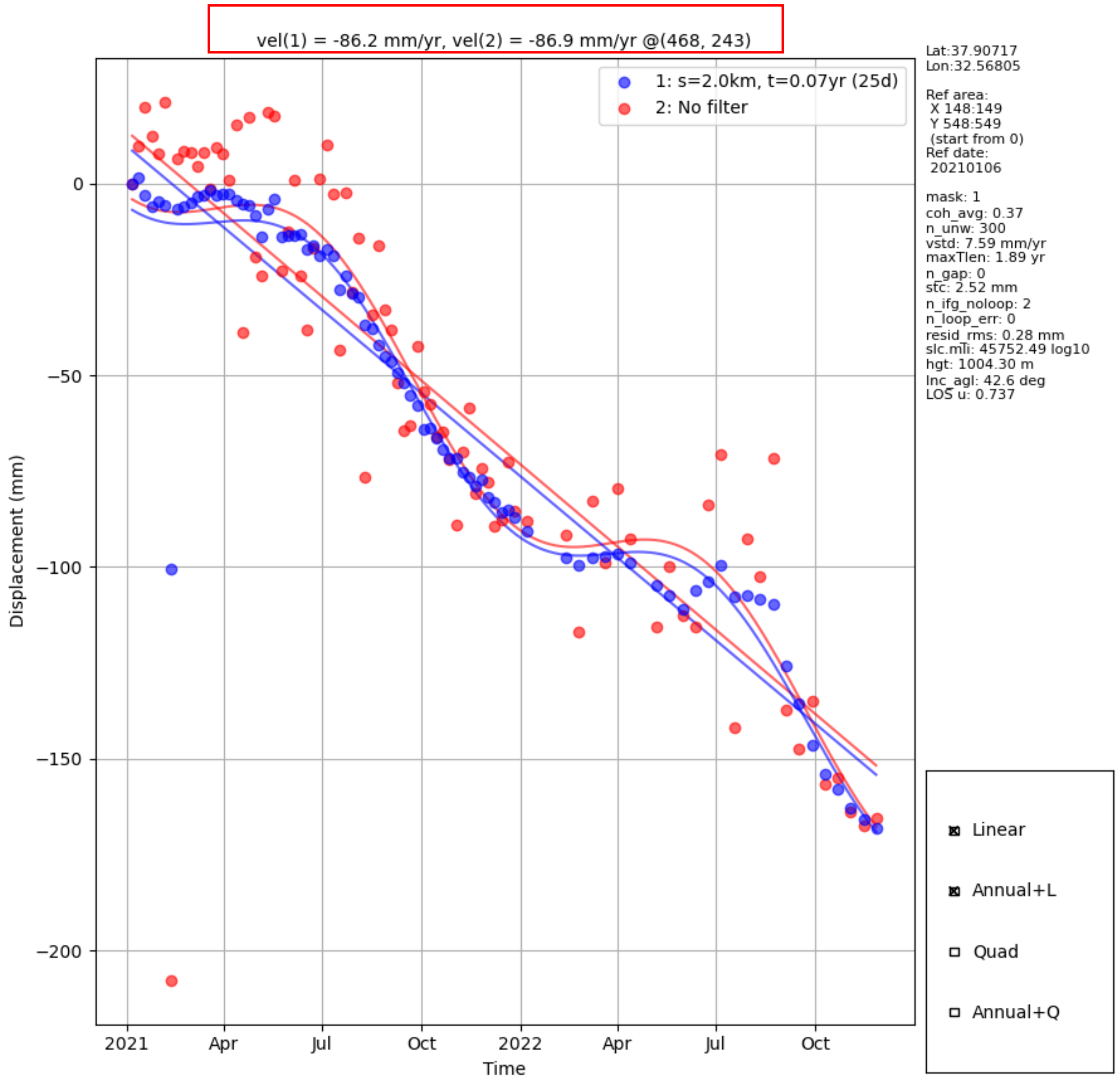


https://gws-access.jasmin.ac.uk/public/nceo_geohazards/LiCSAR_products/

Konya Provincial Center InSAR Deformation Results



Deformation Rate



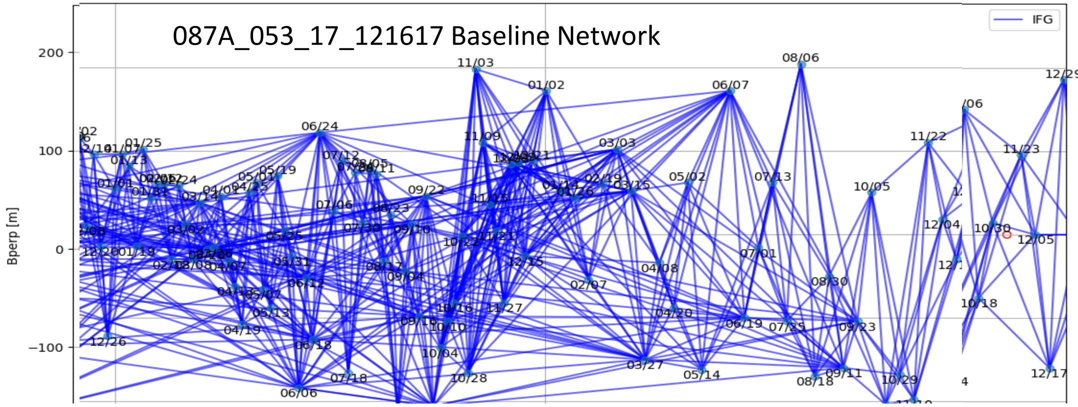
Please be careful for:
Konya Organized Industrial Zone and its surrondings

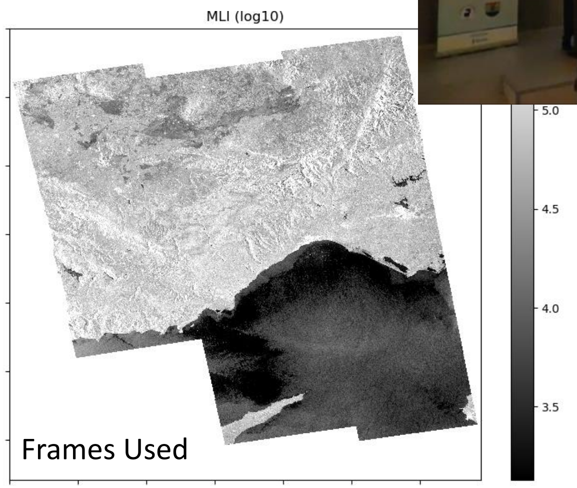
https://gws-access.jasmin.ac.uk/public/nceo_geohazards/LiCSAR_products/

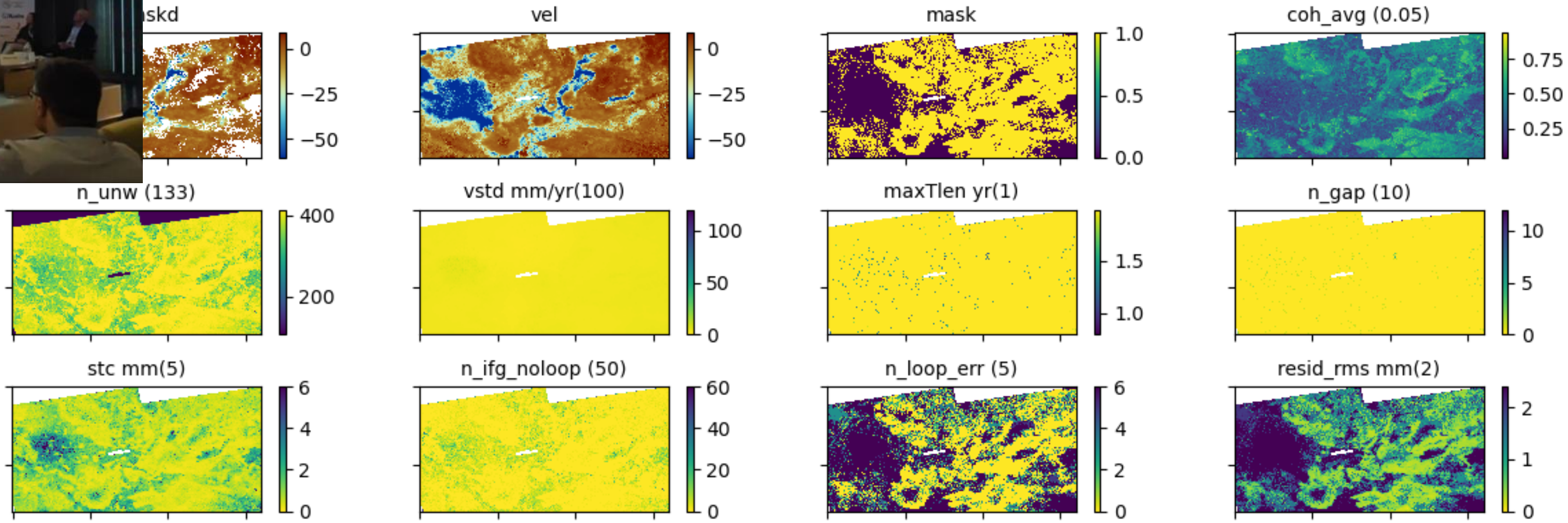
DROUGHT AND GROUNDWATER MANAGEMENT:

AN INSAR-BASED INVESTIGATION OF LAND SUBSIDENCE AND GROUNDWATER DEPLETION IN THE KONYA BASIN

087A_053_17_121617 A time series was created for the **Karapınar region** using a total of **530 interferograms** from the Ascending Frame.

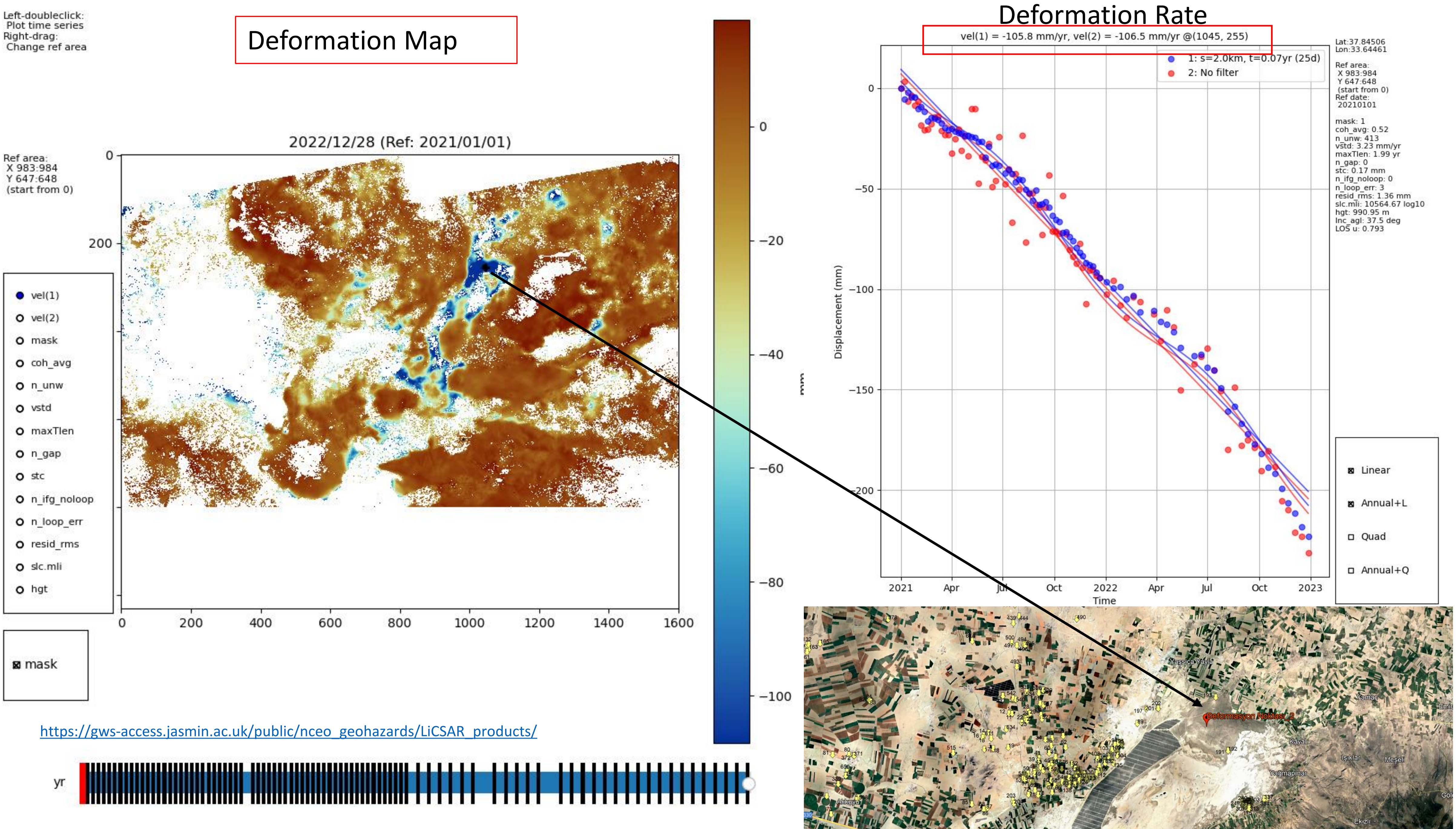






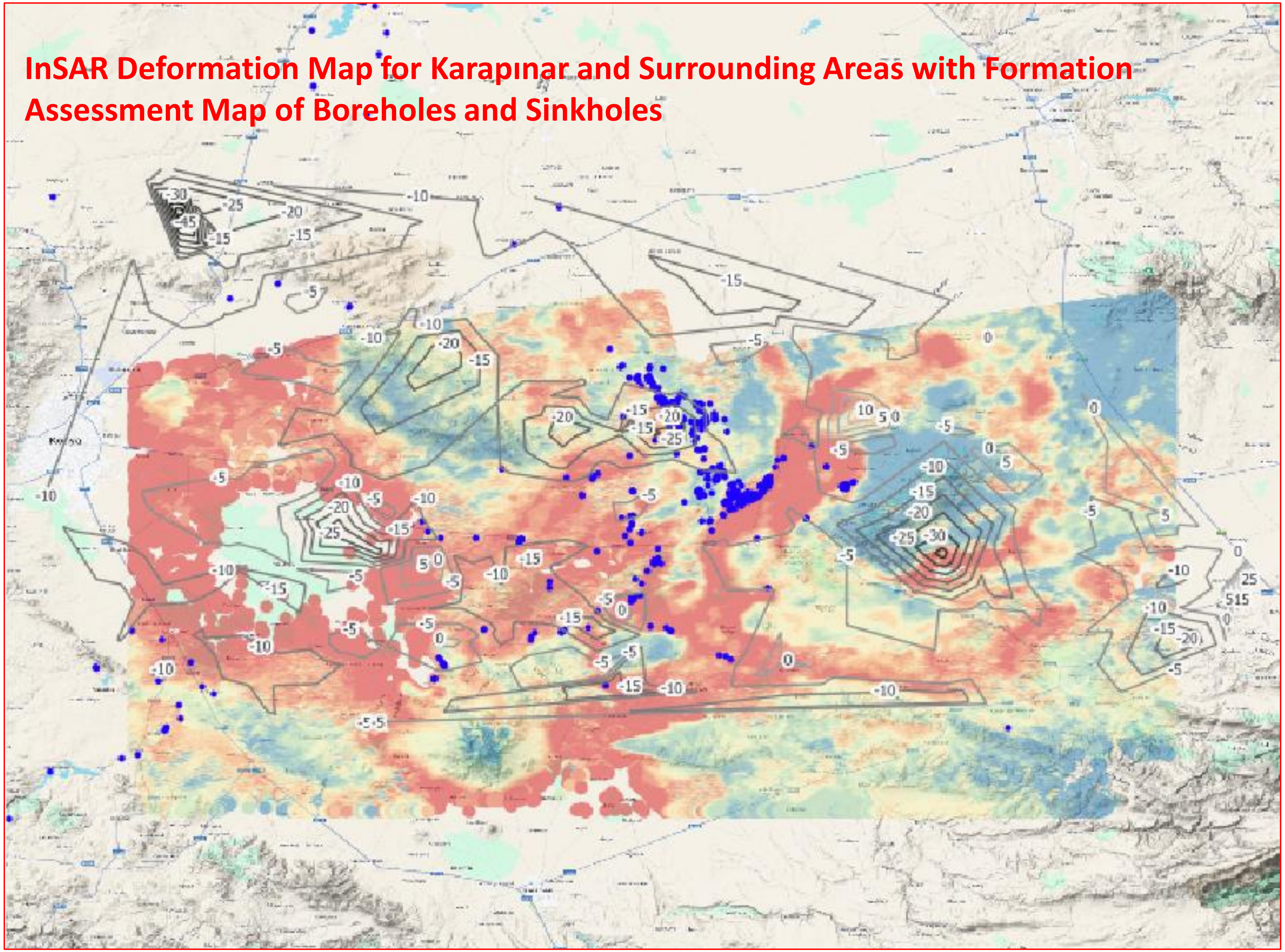
https://gws-access.jasmin.ac.uk/public/nceo_geohazards/LiCSAR_products/87/087A_05317_121617/

InSAR Deformation Results for Karapınar and Surrounding Areas



https://gws-access.jasmin.ac.uk/public/nceo_geohazards/LiCSAR_products/

COMPARISON OF INSAR RESULTS WITH BOREHOLES AND SINKHOLES



Focusing on the period covering 2021 and 2022;

● Sinkhole Locations

Total Deformation (mm)

- -142 - -14.6
- -14.6 - -5.6
- -5.6 - -0.9
- -0.9 - 1.8
- 1.8 - 3.5
- 3.5 - 4.8
- 4.8 - 6
- 6 - 7.4
- 7.4 - 9.6
- 9.6 - 43.1

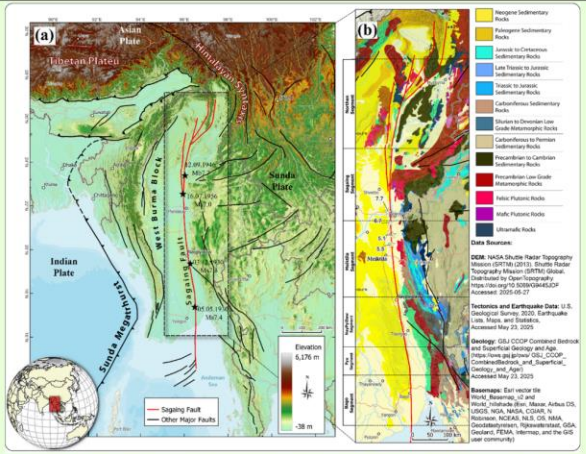
Contour Lines

—— Drilling Well Level Drop (m)

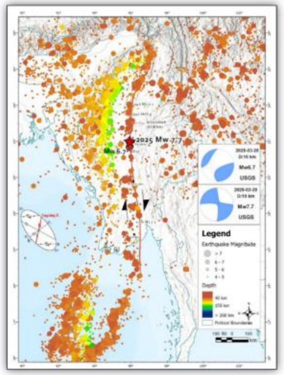
March 28, 2025 Mw 7.7 Myanmar Earthquake's Multi-Segment Fracture Mechanism and Heterogeneous Surface Deformation Distribution

Şule GÜRBOĞA, Fatma CANASLAN ÇOMUT, Sen LYU, Mahdi MOTAGH, Kaung Si THU, Macit KARADAĞLAR

AGU25
New Orleans, LA | 15–19 December 2025

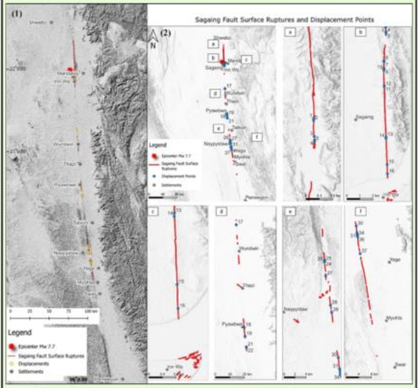


The 28.03.2025 Mw7.7 Myanmar earthquake caused surface rupture along the Sagaing fault, a major right-lateral transform fault between the Indian and Sunda Plates in Myanmar. The event was followed by another Mw6.7 earthquake twelve minutes later near Mandalay. Offset Tracking analysis of SAR satellite images reveals ground displacements exceeding 3 m along the fault, with localized offsets reaching 4–5 m in the Sagaing segment near Mandalay. Moreover, the maximum displacement is measured 4.5 m around Naypyidaw settlement further south during field survey. The heterogeneous displacement patterns and segmented rupture behavior emphasize the importance of pre-existing fault structures in controlling coseismic slip distribution.



Myanmar's seismic activity from oblique plate convergence partitioned along the Sagaing Fault. Seismic records indicate about half the fault ruptured in major earthquakes over the past 90 years, with gaps south of Naypyidaw and Yangon, and a recent event in the north. Instrumental catalogs show abundant intermediate-depth, N–S–oriented earthquakes, mostly >90 km beneath central Myanmar. Focal mechanisms (Mw >4) suggest seismogenic depths shallow southward, from >20 km in the north to ~10 km in the south. Over the last century, plate boundaries and major faults are clearly defined.

The main shock originated in the Sagaing segment north of Mandalay and propagated south. In total, we manually collected 37 on-fault displacements to characterize the surface slip distribution and details of the data from field observations is listed in Table.



OBJECT ID	HD	VD	RW	FS	SFS	Motion	Displaced structure	Source
1	1,2	0,4	1,5	354	34	Right Lateral	Road	Ground Measurement
2	0,4	1,2	1,6	358	31	Right Lateral	Road	Ground Measurement
3	2,1	0,6	6,3	355	30	Right Lateral	Road	Ground Measurement
4	1,5	0,8	6,2	1	38	Right Lateral	Canal	Ground Measurement
5	0,4	1,2	15	358	44	Right Lateral	Road	Ground Measurement
6	1,2	2,5	9	359	45	Right Lateral	Road	Ground Measurement
7	1,8	0,7	2	1	34	Right Lateral	Canal	Ground Measurement
8	0,4	0,5	1,8	5	44	Right Lateral	Road	Ground Measurement
9	0,5	-	1,2	3	43	Right Lateral	Building	Ground Measurement
10	0,6	0,3	2,5	1	34	Left Lateral	Road	Ground Measurement
11	0,4	0,3	25	4	38	Right Lateral	Building	Ground Measurement
12	0,9	0,5	1,2	2	38	Right Lateral	Road	Ground Measurement
13	1,1	0,6	1,5	1	35	Right Lateral	Road	Ground Measurement
14	0,8	0,4	1,2	2	35	Right Lateral	Road	Ground Measurement
15	2,1	0,4	2,85	1	38	Right Lateral	Wall	Ground Measurement
16	1,2	0,6	19	358	41	Right Lateral	Road	Ground Measurement
17	2,1	0,7	2,1	356	45	Right Lateral	Road	Ground Measurement
18	5,6	0,4	3,9	1	34	Right Lateral	Paddy Field	Ground Measurement
19	4,5	0,4	1,2	2	35	Right Lateral	Road	Ground Measurement
20	2,4	1,2	15	350	22	Right Lateral	Paddy Field	Ground Measurement
21	3,5	1,5	0,9	3	39	Right Lateral	Road	Ground Measurement
25	1,2	0,3	1,6	350	40	Right Lateral	Residential Land	Ground Measurement
26	2,7	0,6	4,5	353	45	Right Lateral	Paddy Field	Ground Measurement
33	3,6	0,6	3,2	2	34	Right Lateral	Road	Ground Measurement
37	3,6	1,8	3,3	3	33	Right Lateral	Paddy Field	Ground Measurement

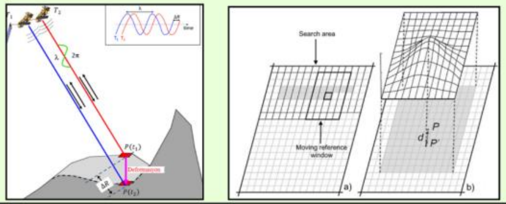
Methods and Data Processing

In this study, a multidisciplinary approach was adopted to investigate the rupture characteristics of the 2025 Myanmar earthquake. Field investigation consists of mapping and measurements of displacements along the surface rupture.

InSAR Technique measures ground displacements at the centimeter scale by using the phase difference between pre- and post-earthquake radar images.

Coherence Analysis clearly identifies areas where surface ruptures occur and where the ground is most disturbed.

Offset Tracking detects slip amounts at the meter scale by locating similar pixel groups in areas of large deformation.

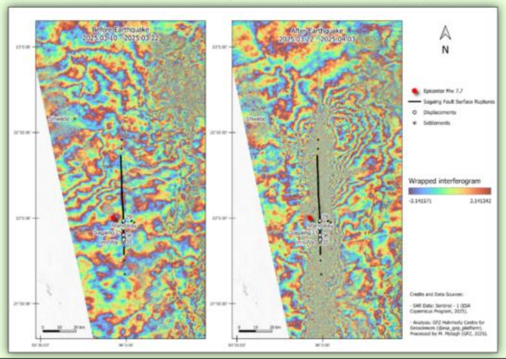


Data Sources

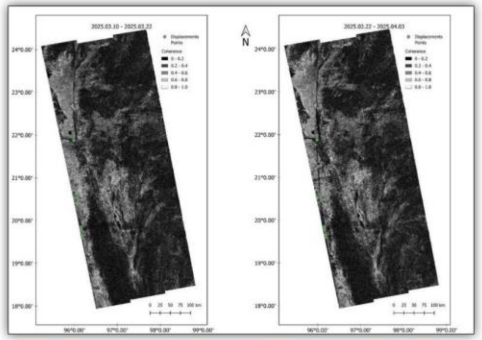
SAR Data: C-band Sentinel-1A satellite imagery provided by the European Space Agency (ESA) was used. The data were downloaded from the Alaska Satellite Facility (ASF) Data Portal.
Field Data: Manual displacement measurements collected at 37 points along the surface rupture following the earthquake.
Earthquake Catalogs: The USGS earthquake catalog was used for epicenter information.

Reference Image		Secondary Image		Specification	
Date	Track	Date	Track	Mode	Method
27.03.2025	143	08.04.2025	143	Ascending	Offset Tracking
24.03.2025	106	05.04.2025	106	Descending	Offset Tracking
10.03.2025	70	22.03.2025	70	Ascending	InSAR
22.03.2025	70	03.04.2025	70	Ascending	InSAR

InSAR (Interferometric Synthetic Aperture Radar) Analysis

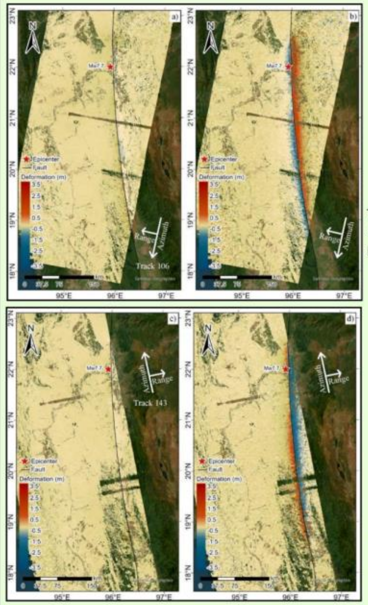


InSAR Coherence Analysis: Revealing Rupture Traces



a) Pre-earthquake interferogram correlation coefficient map. b) Co-seismic interferogram correlation coefficient map. Green points correspond to displacement points given in Supplementary table.

Sentinel-1 Offset Tracking Results: Offset Tracking Analysis: Measurement of Large Displacements



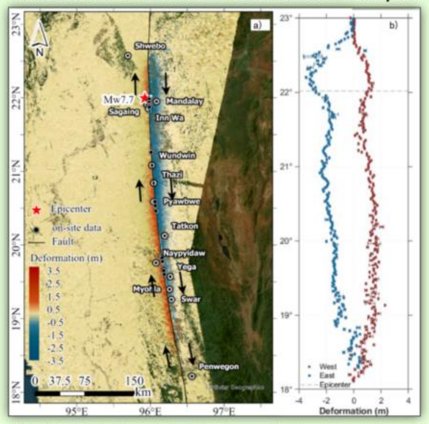
Offset tracking results from Sentinel-1:
a) range offset map (descending),
b) azimuth offset map (descending),
c) range offset map (ascending),
d) azimuth offset map (ascending).

The indicated arrows along the azimuth and range specify the positive deformation directions for each offset component (azimuth/ range).

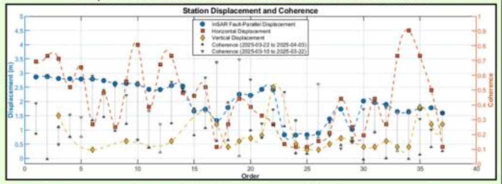
The Offset Tracking analysis conducted for the Myanmar earthquake revealed displacements exceeding 3 meters along the fault. In particular, data obtained from both descending and ascending orbits clearly confirmed the right-lateral strike-slip character of the fault. Slip movements in the azimuth direction indicate that the two blocks on either side of the fault moved in opposite directions relative to each other.

The resulting fault-parallel deformation field reveals over 1 m of displacement along a ~ 500-km-long rupture, with deformation spanning a total width of 50 km across the fault. To characterize the spatial pattern of slip, we extracted fault-parallel displacement profiles bilaterally along the fault trace. The profiles indicate peak deformation near the epicentral region, with maximum relative displacements of ~ 6 m.

Fault-Parallel Deformation: The True Scale of the Rupture



a) Fault-parallel offset derived by the combination of ascending and descending images in Fig. 6. Positive values denote fault-parallel motion of the western block towards north, while negative values denote opposite motion of the eastern block towards south, both corresponding to right-lateral slip. Major settlements are overlain on the deformation map to facilitate the interpretation of the spatial distribution of deformation in the main text b) The profile of fault offset extracted at 3 km from the fault.



The coherence values and relation with ground displacement points values.

Discussion and Conclusion

Shallow faulting, damage zones, low-velocity zones, and ground-rupture hazards depend on near-surface deformation kinematics around earthquake ruptures. Surface ruptures show persistent (inelastic) deformation based on differing rheology and alongside elastic processes; key issues include the amount of inelastic strain, related structures (surface cracks, mole tracks, secondary failures), and factors controlling their size.

Two major ruptures (Mw 7.7 and Mw 6.7) in Sagaing–Meiktila segments show preferred southward rupture direction, likely governed by material property changes within a 5–20 km damage zone.

Field + SAR data: rupture initiated near Sagaing, terminated north against Precambrian basement barrier; continued south through basin with up to ~4.5 m displacement far south of Meiktila; geometry includes left-stepping en echelon Riedel shears and mole tracks; wider/deeper rupture zones centrally and southward; Bago segment showed no surface rupture (possible strain accumulation).

Total rupture length mapped ~363 km by field, ~500 km by SAR—implies unobserved subsurface fracturing due to rheology; maximum horizontal offset ~4.5 m; continuous deformation from north of Mandalay to south of Naypyidaw.

Satellite offset tracking is crucial for resolving complex dynamics; possible supershear characteristics and heterogeneous slip argue for updated seismic hazard models and multi-sensor integration in future studies.

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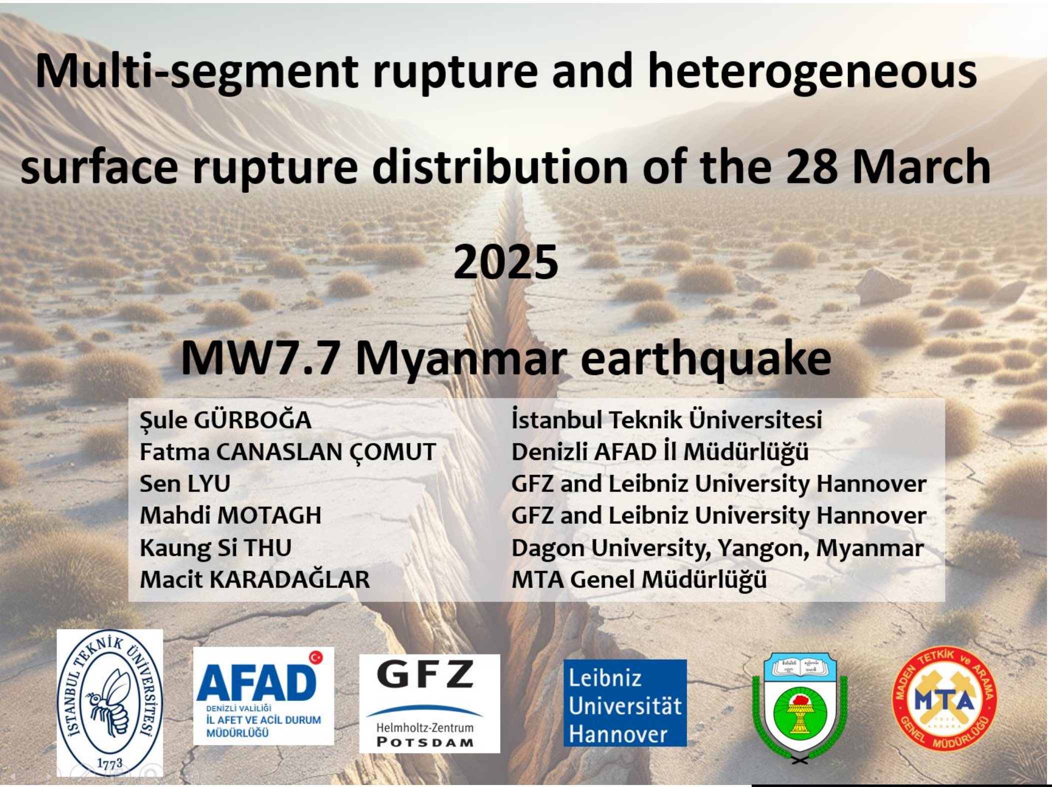

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Heterogeneous rupturing and barrier mechanism during the 2025 Mw7.7 Myanmar earthquake

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Multi-segment rupture and heterogeneous surface rupture distribution of the 28 March 2025 Mw7.7 Myanmar earthquake

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The Mw7.7 Myanmar earthquake on March 28, 2025, triggered significant surface rupture along the Sagaing Fault, a prominent right-lateral transform fault dividing the Indian and Sunda Plates in Myanmar. Twelve minutes after the mainshock, an Mw6.7 earthquake occurred near Mandalay, further complicating the seismic activity. This study integrates field survey data and Sentinel-1 synthetic aperture radar (SAR) imagery to analyze surface fault offsets associated with the event. Even the first shock started in Sagaing

AFAD utilized remote sensing technologies and conducted extensive engineering studies to address the aftermath of the 6th February 2023 earthquakes.

These efforts are vital for assessing damage, planning recovery, and mitigating future risks.

Looking Ahead: What Comes Next

Through sustained capacity building, InSAR is now an operational tool for disaster monitoring among key national actors. To strengthen this capacity, ongoing training and systematic remote sensing data use remain essential.

Capacity building works:

Today, InSAR is not only learned, but operationally used by disaster experts in our country—and continuous learning remains essential.

With this foundation in place, we are now ready to expand the work, strengthen collaboration, and move towards more systematic monitoring.

EXPECTATIONS

Strengthening institutional capacity

Enhanced international cooperation

AFAD

REPUBLIC OF TÜRKİYE- MINISTRY OF INTERIOR
DISASTER AND EMERGENCY MANAGEMENT AUTHORITY

Thank you for your attention!

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