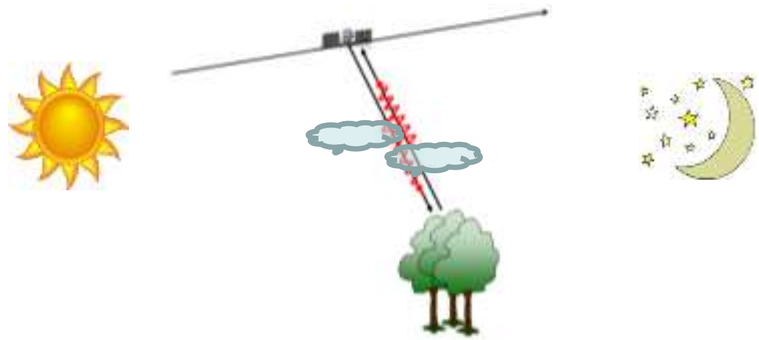
SAR Project - TAT 2023



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EO.Lab
Earth Observation
& Geospatial Applications Lab

?

- How to combine/transfer the applicability of optical imagery to the operationality of SAR for LC mapping
- SAR-Optical fusion?

Active microwave remote sensing properties

1. **Pros**
    a. Day and night observation capability
    b. Insensitive to cloud coverage
    c. High “operationability”
2. **Cons**
    a. Human eyes not “trained” for microwaves
    b. Technology is more demanding than for optical remote sensing
    ~~c. More expensive than optical RS~~
    ~~d. Needs high power~~

Optical vs. Microwave Remote Sensing

Parameter	Optical RS	Active microwave RS
Wavelength	λ << object	λ ~ object
Frequency	Several bands	A few bands (frequencies)
Polarisation	None	Up to fully polarimetric
Illumination	Passive (sun)	Active (antenna)
Observation times	Day only	Day and night
Cloud coverage	Very sensitive	Independent
Data calibration	Difficult	Difficult
Ground resolution	~ decameters	~ deca-hectometers
Image quality	No speckle	Speckle
Incidence angle	~ Nadir	20-60^o
Measurements	Chemical & physical processes	Roughness, geometry, water content, dielectric constant

	ERS-1/2	Envisat/ASAR (IM)	Envisat/ASAR (WSM)	Sum	Probability*
1991	22	-	-	22	6,0%
1992	11	-	-	11	3,0%
1993	12	-	-	12	3,3%
1994	17	-	-	17	4,7%
1995	17	-	-	17	4,7%
1996	20	-	-	20	5,5%
1997	15	-	-	15	4,1%
1998	8	-	-	8	2,2%
1999	17	-	-	17	4,7%
2000	10	-	-	10	2,7%
2001	8	-	-	8	2,2%
2002	11	1	3	15	4,1%
2003	21	13	30	64	17,5%
2004	23	17	41	81	22,2%
2005	21	17	40	78	21,4%
2006	20	12	72	104	28,5%
2007	14	8	85	107	29,3%
2008	18	7	66	91	24,9%
2009	14	10	82	106	29,0%
2010	14	11	69	94	25,8%
Sum	313	96	488	897	Center Lat/Lon (dd:mm:ss)
Acquisitions/yr	16	10,7	54,2	Area (Height x Width)	40:42:50/23:18:16
Probability*	4,3%	2,9%	14,9%	10km x 10km	

Indicative statistics of available SAR data (source: EOLI Catalogue/ESA).

Considerations: size of the area of interest, acquisition strategy.

Probability* = Probability of having 1 image within the day of the flood.

C-band SAR comparison

PARAMETERS	ERS 1/2	ENVISAT	Radarsat 1/2	Sentinel 1A/B
Centre frequency (GHz)	5,300	5,331	5,3 / 5,405	5,405
Polarization	VV	HH/VV, HH/VH, VV/HH	HH / HH, HV, VV, VH	HH+HV, VV+VH
Incidence angles (°)	23	15 - 45	20 - 49	20 - 45
Orbit (km)	800	800 → 783 (2010+mission)	793-821 / 798	693
Inclination (°)	98,5	98,5	98,6	98,18
Repeat cycle (day)	35	35	24	12 (6)
Launch date	17 Jul. 1991 / 21 Apr. 1995	1 March 2002	4 Nov. 1995 / 14 Dec. 2007	3 April 2014 / 2016
Spatial resolution (m)	25	25	30	20
Swath width (m)	100	100	100	250

SAR-Optical Fusion

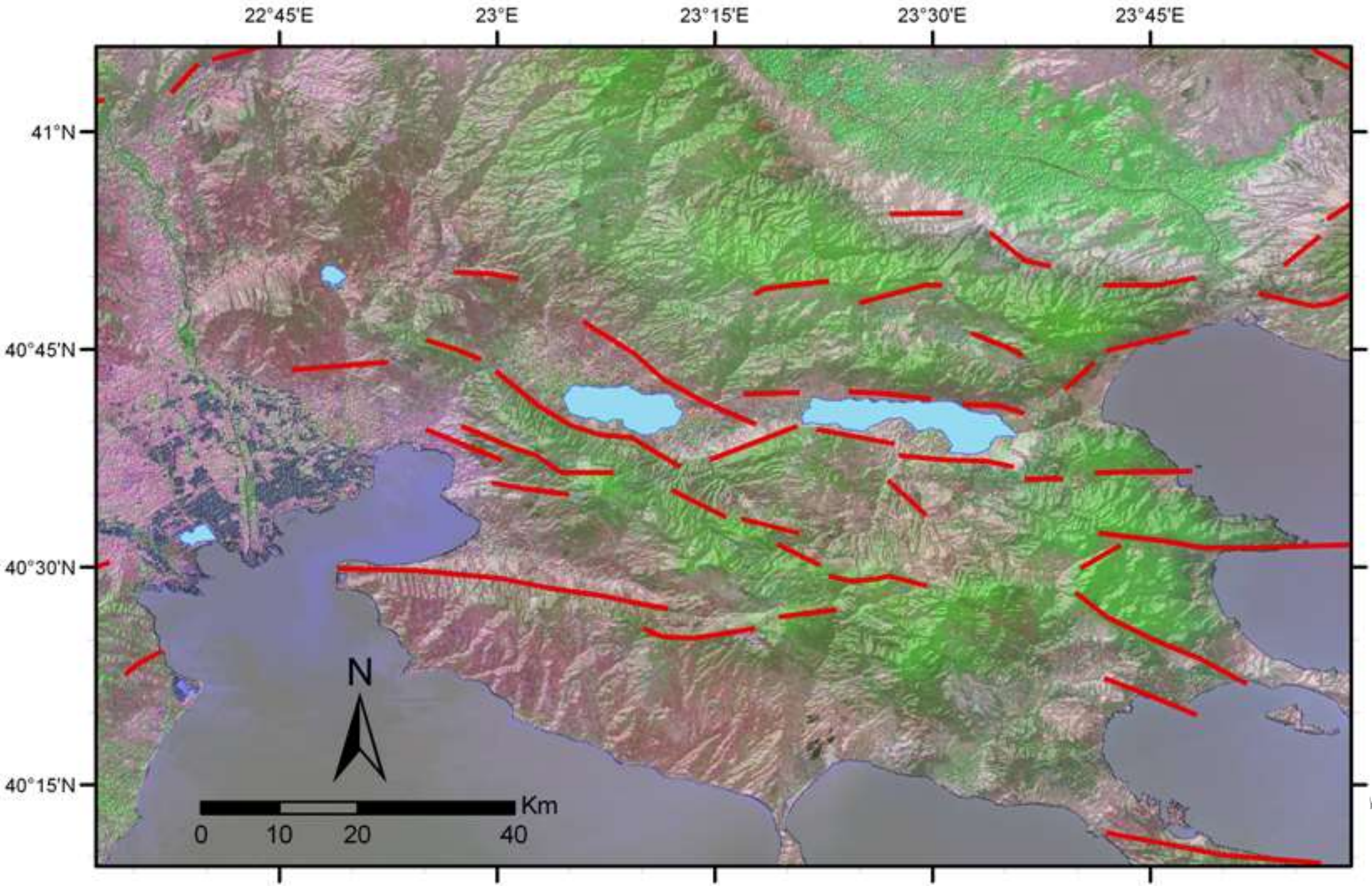
SAR – Optical Fusion Considerations

1. Completely different “nature” of data
2. Physical properties (SAR) vs chemical properties (Optical)
3. Different data distribution
4. Solution: Fusion at results level?

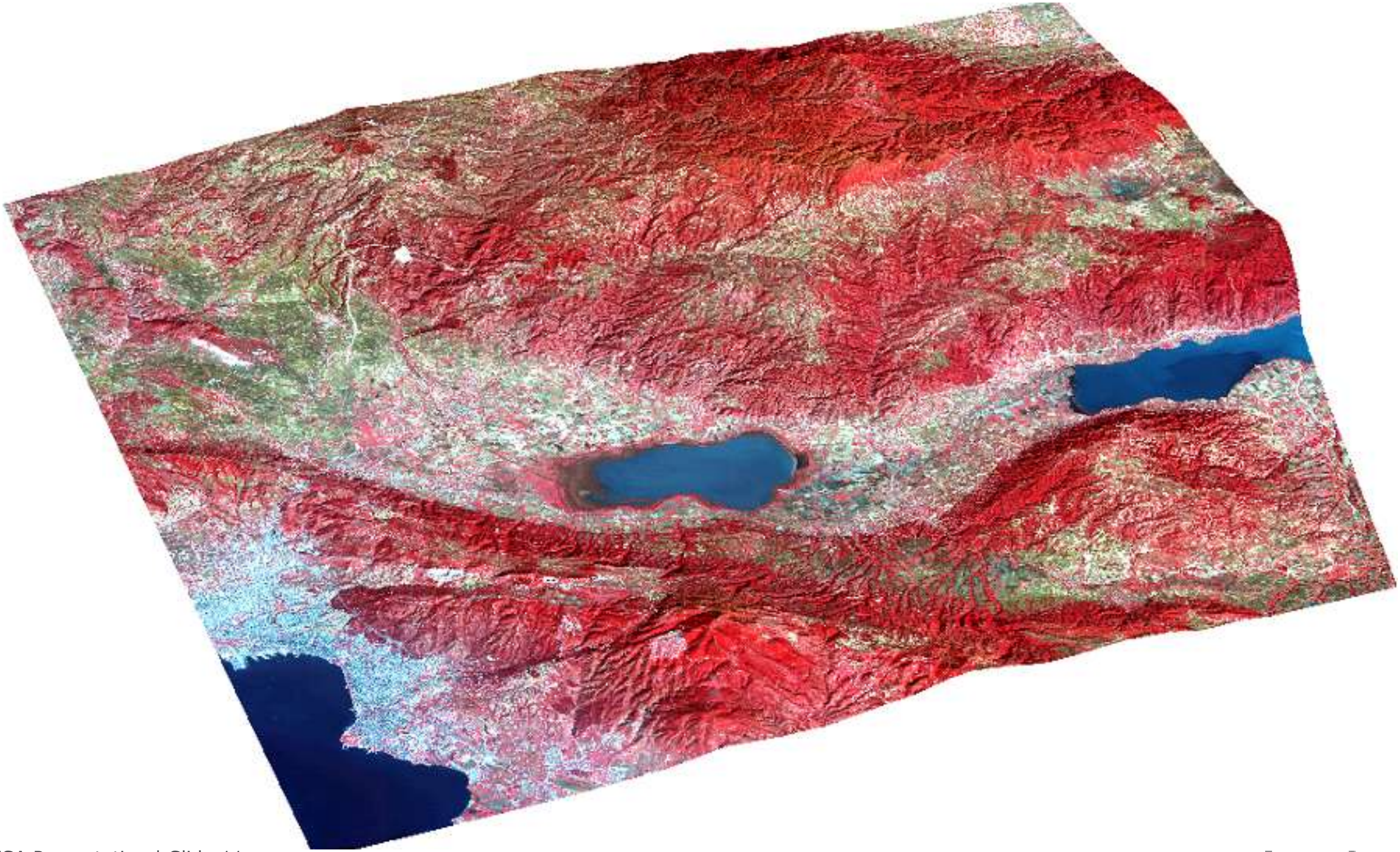
SAR-Optical Fusion
at results level

An example from Morphotectonics

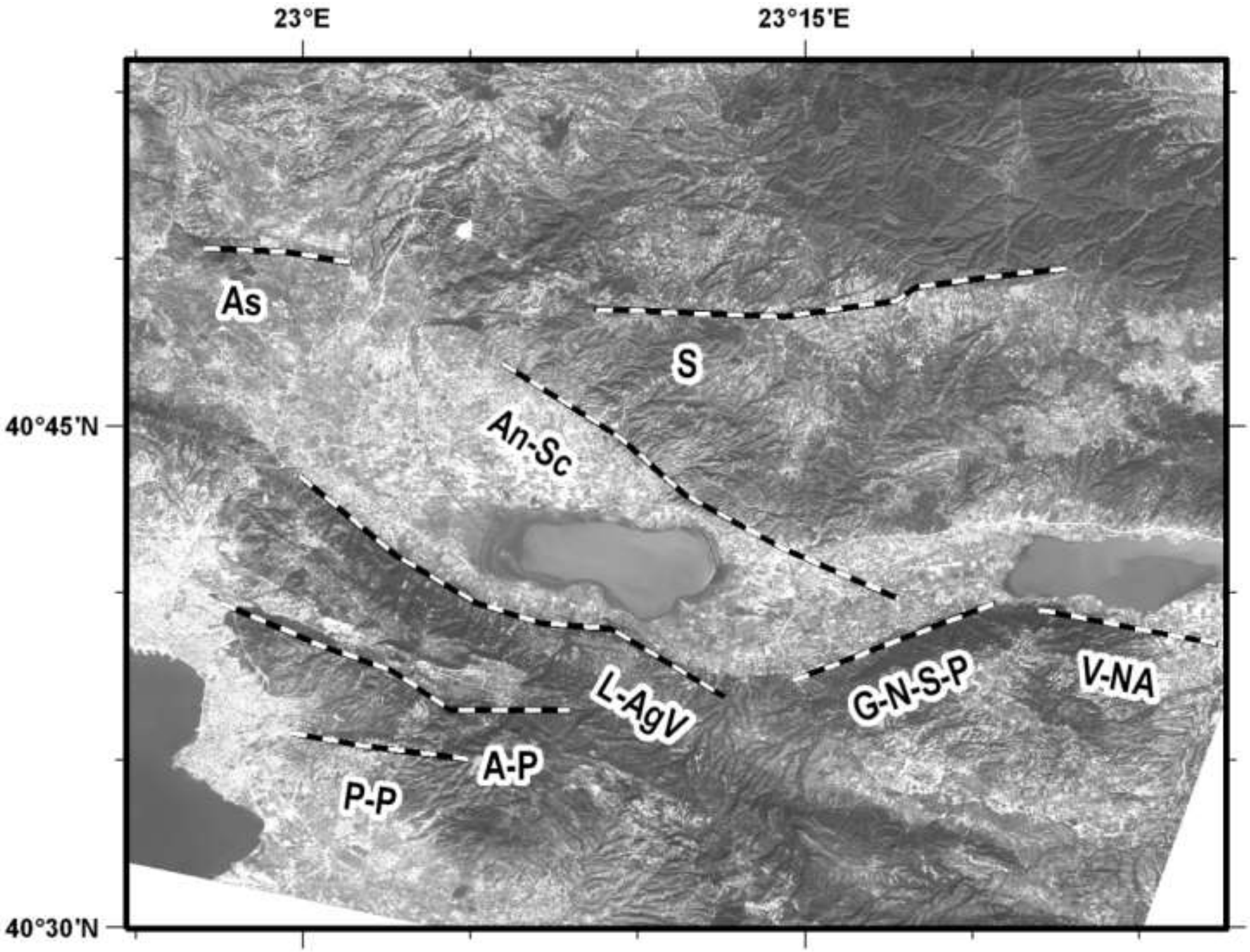
Neotectonic (active) faults



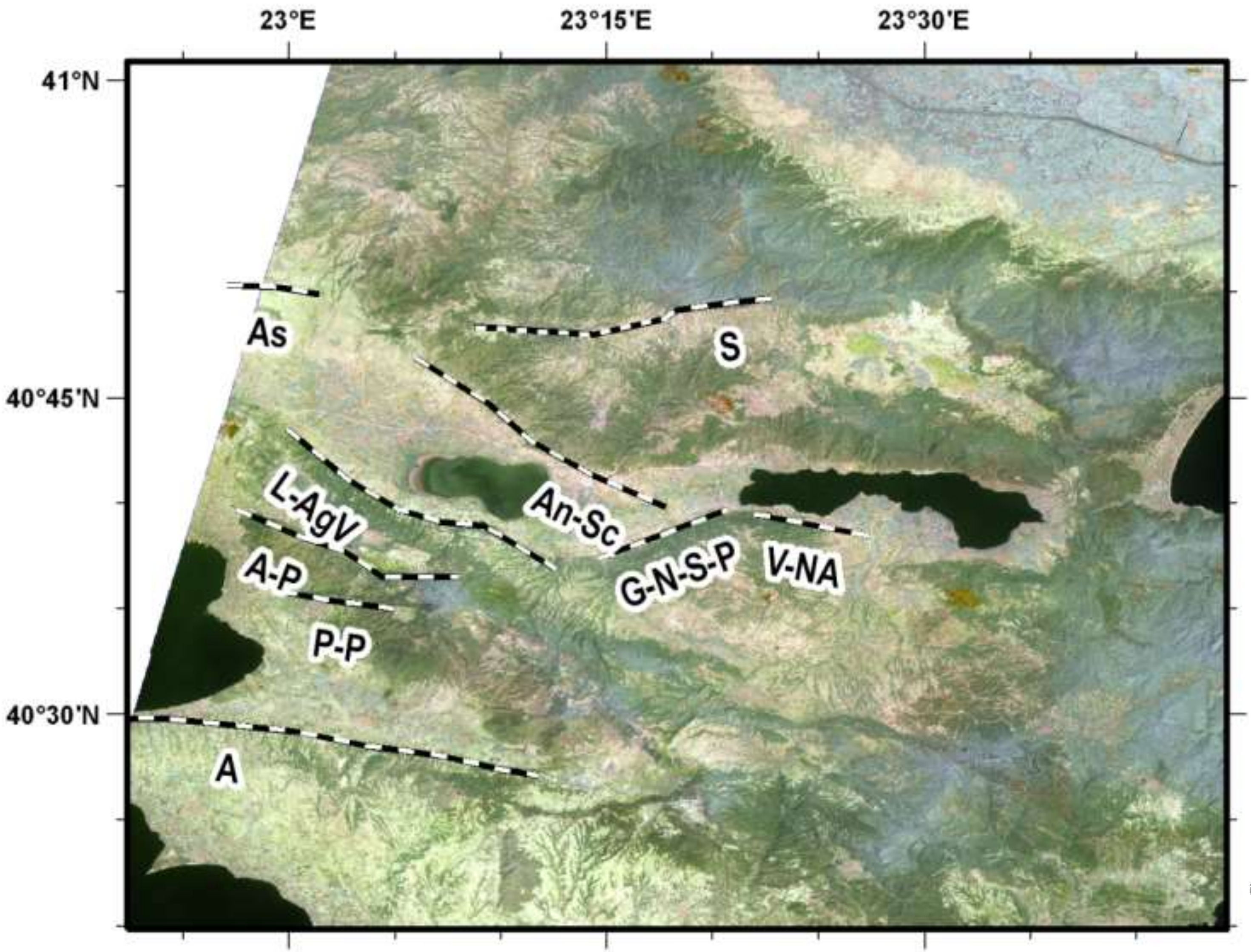
SPOT-5/HRG (in 3D, using a DEM)



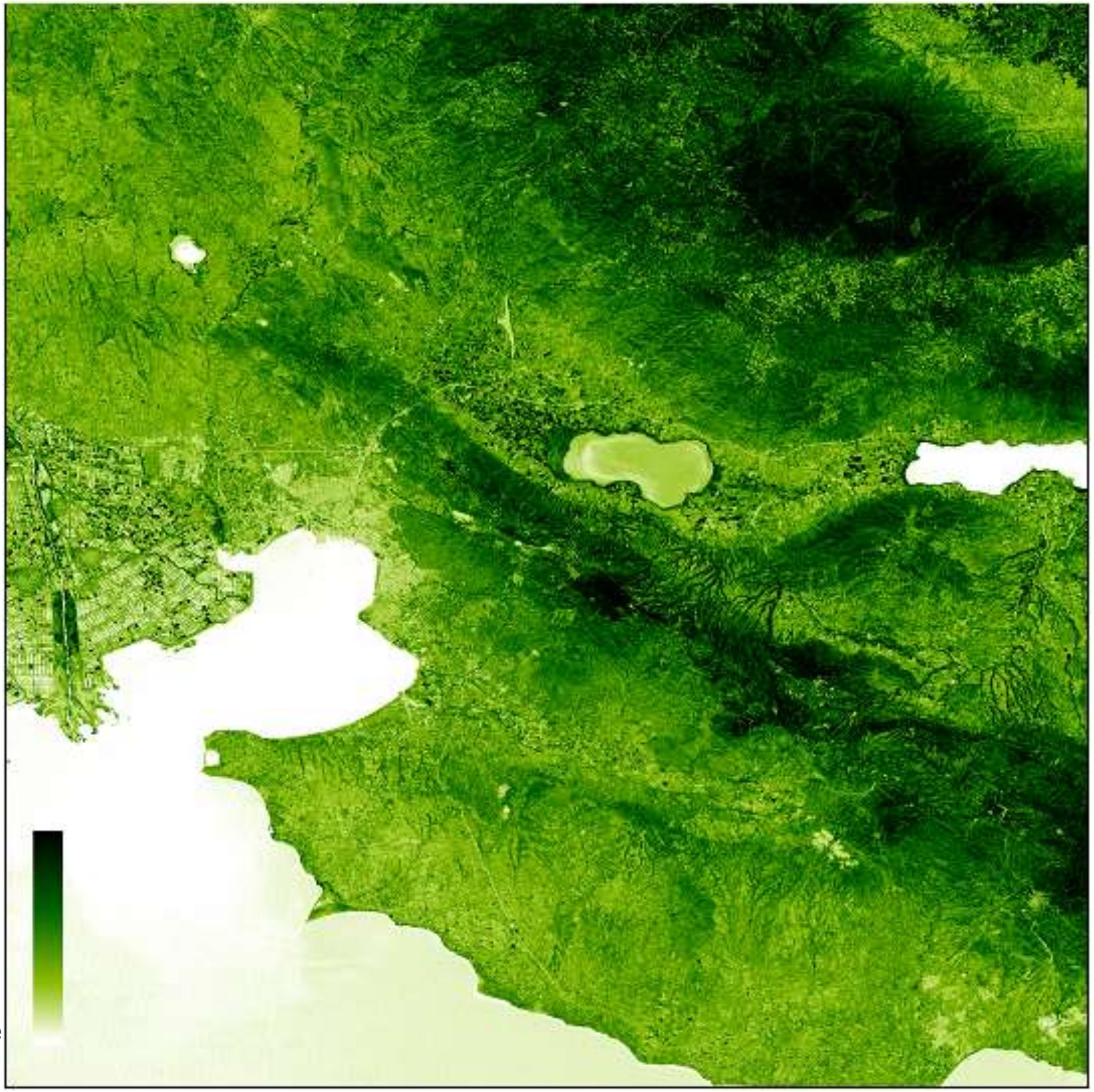
SPOT-5/HRG (pan)



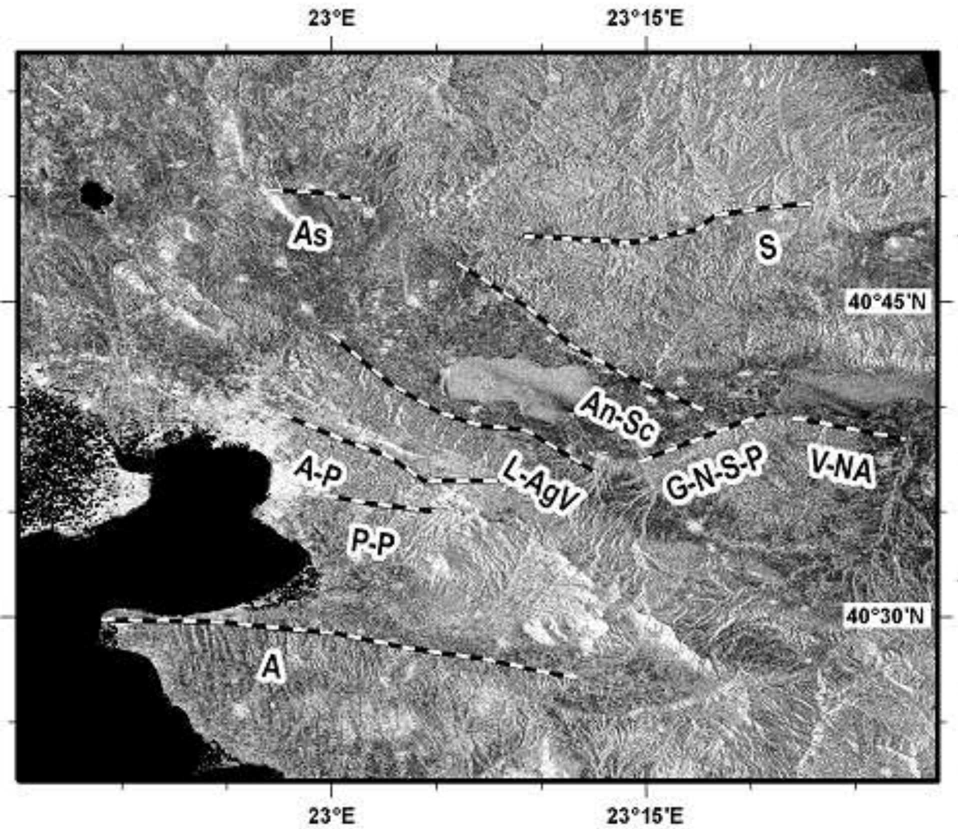
LANDSAT-7/ETM+



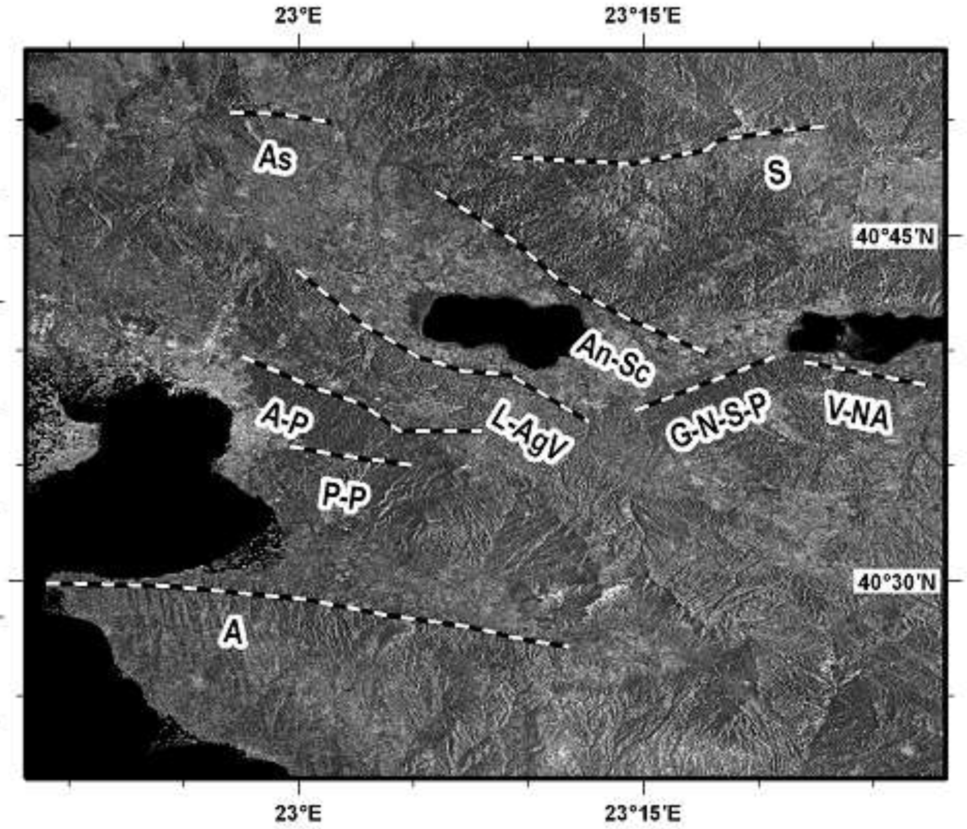
NORMALIZED DIFFERENCE VEGATATION INDEX (NDVI) - LANDSAT IMAGE



ERS-2

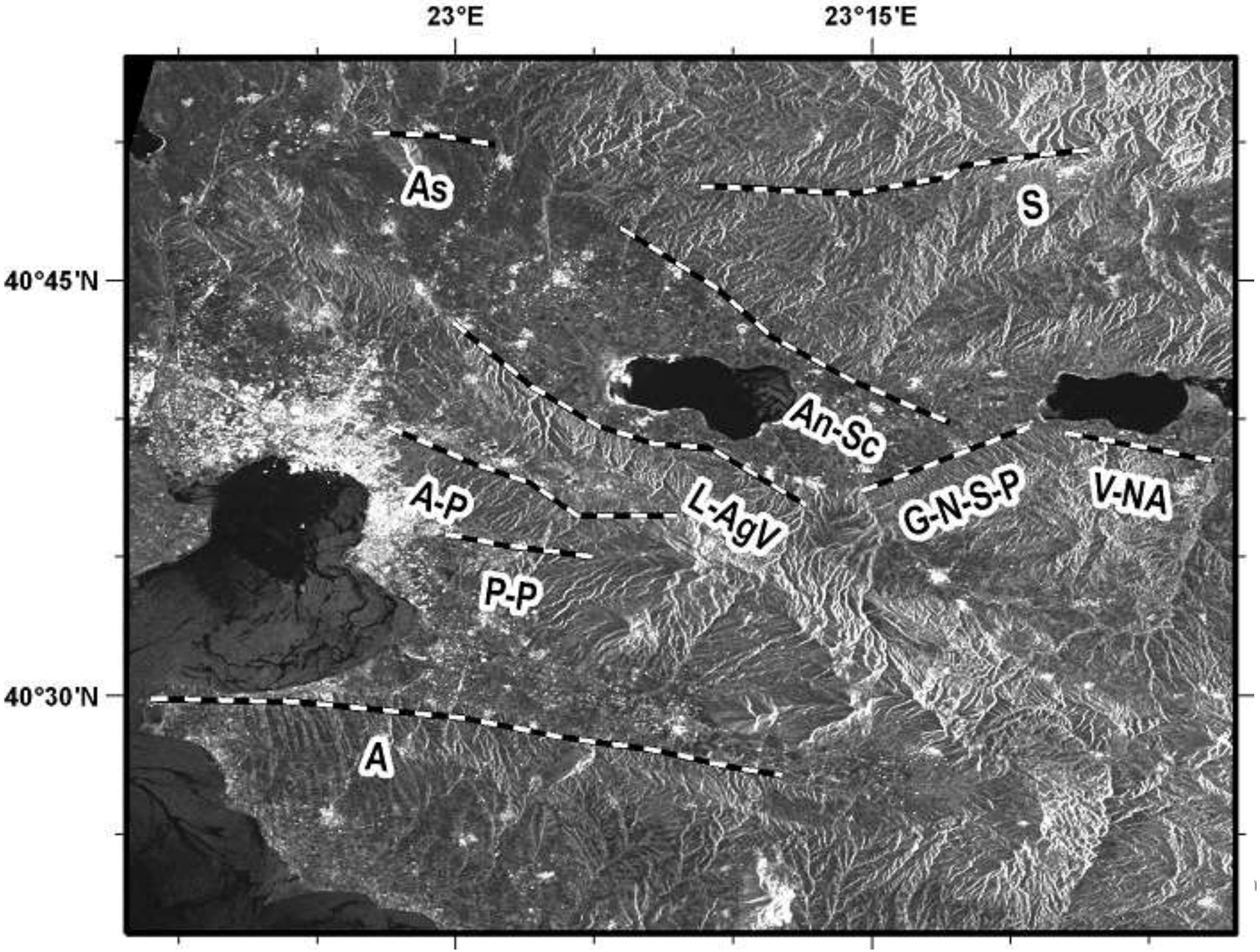


ASCENDING

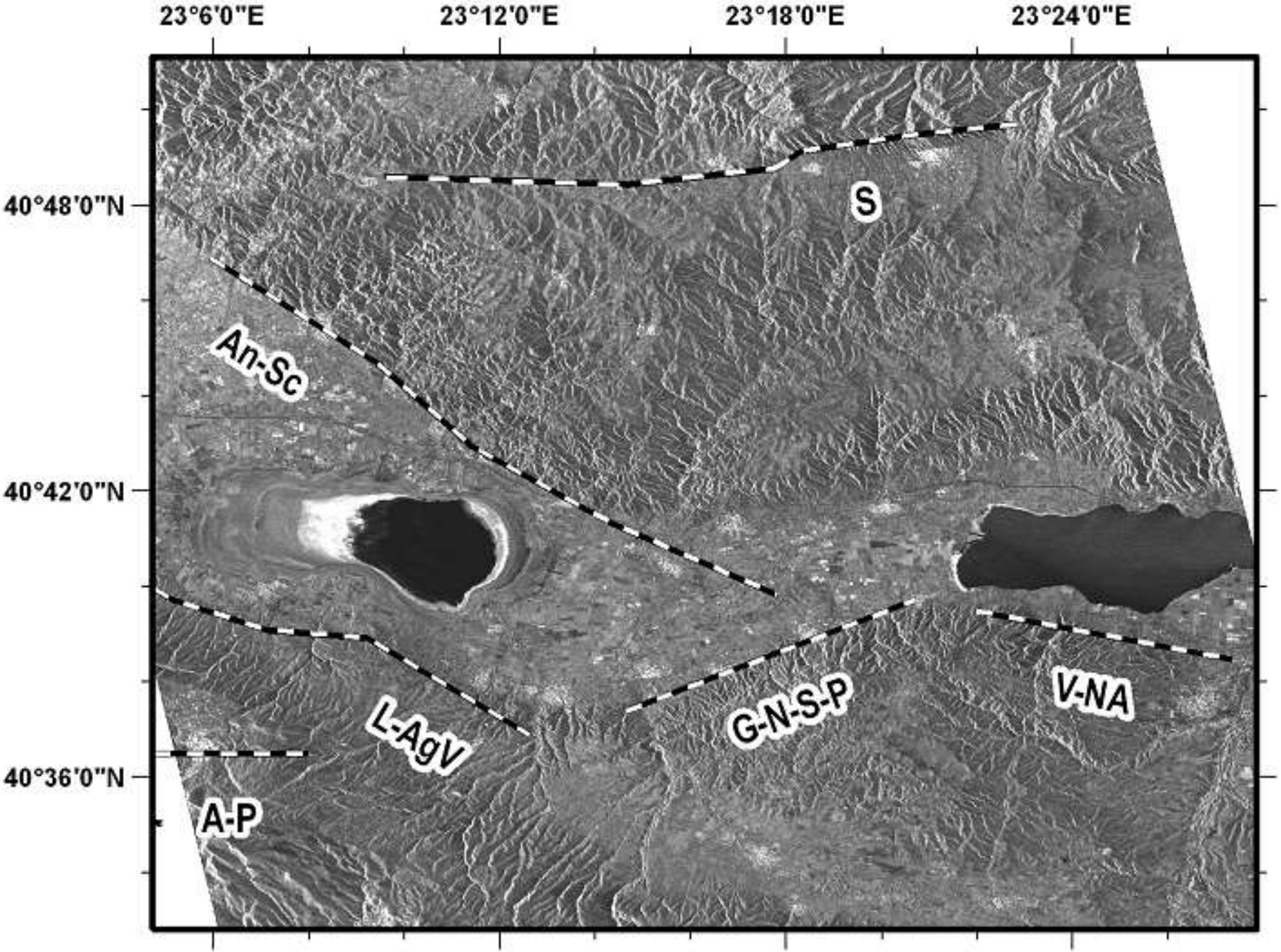


DESCENDING

ENVISAT/ASAR



TerraSAR-X



23°6'0"E
23°12'0"E
23°18'0"E
23°24'0"E
40°48'0"N
40°42'0"N
40°36'0"N
S
An-Sc
L-AgV
G-N-S-P
V-NA
A-P

Seismotectonic analysis

Using the data from the processed satellite images and the available DEMs, the lengths of 9 faults were estimated.

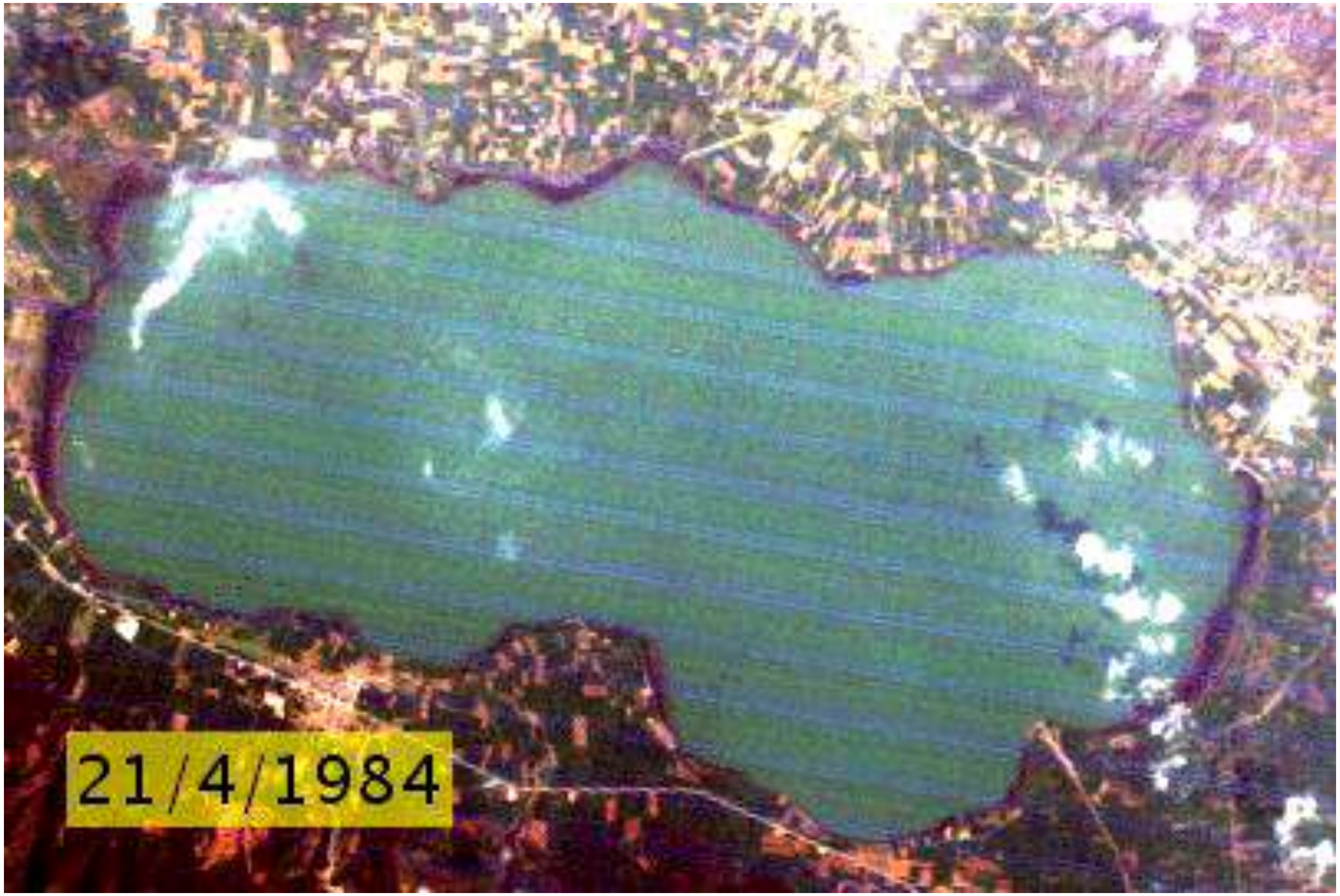
Seismotectonic analysis

Calculation of the maximum expected magnitude using the equation of Pavlides & Caputo (2004) for the faults in question, according to their Surface Rupture Length (SLR) as estimated from the available satellite images.

Fault	Surface Rupture Length (SLR)	Expected magnitude ($M_s = 0.90\log(SRL) + 5.48$)
Asvestohori-Polihni	15-16Km	6.5-6.6
Lagina-Agios Vasilios	22Km	6.7
Pilea-Panorama	8Km	6.3
Anthemountas	33Km	6.8
Assiros	6Km	6.2
Analipsi-Scholari	21Km	6.7
Gerakarou-Nikomidino-Stivos-Peristeronas	10Km	6.4
Sohos	20-27Km	6.7-6.8
Loutra Volvis-Nea Apollonia	8Km	6.3

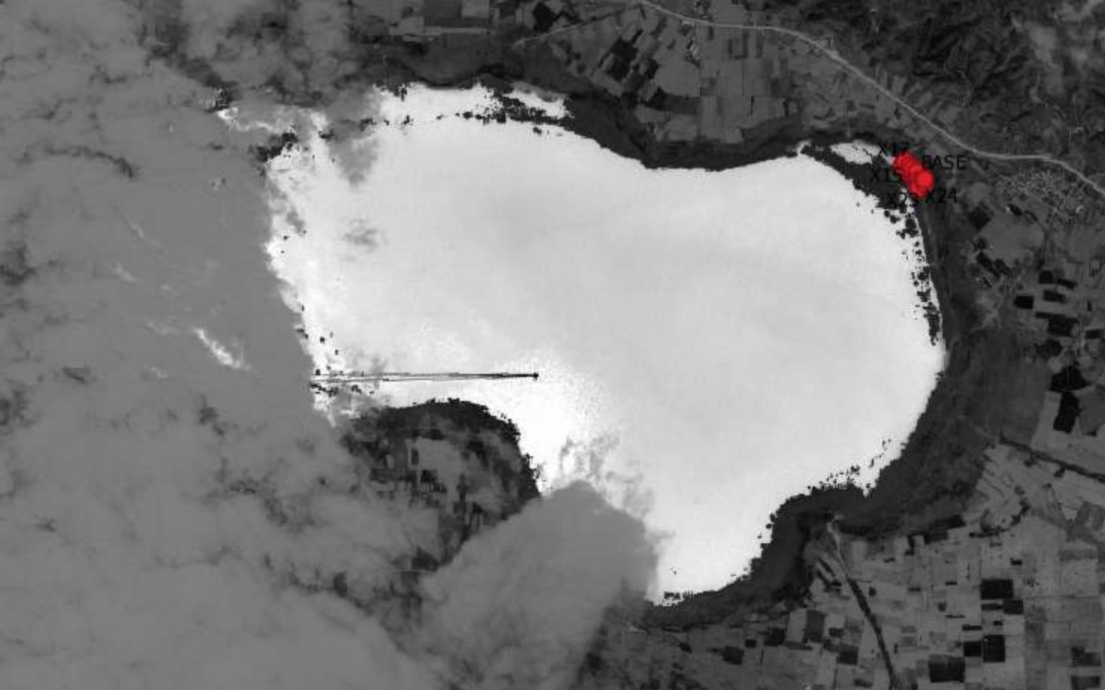
Cal/Val Concept

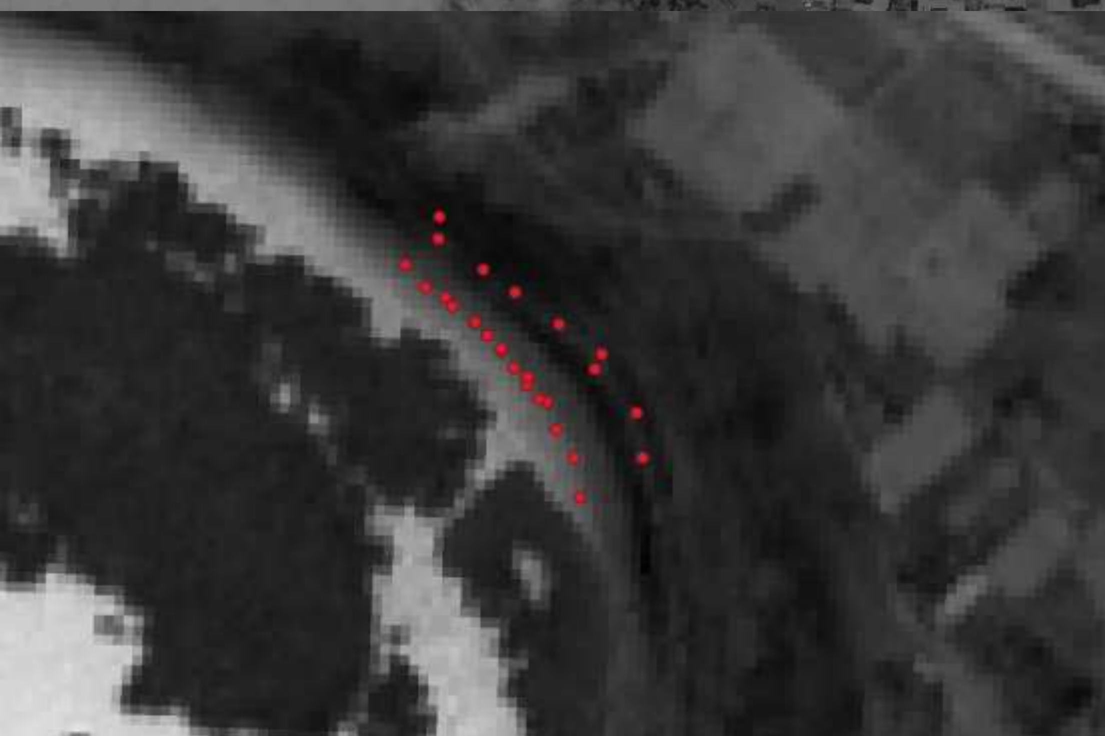
- Exploit Sentinel-1 + Sentinel 2
- Testing around the water-land boundary
- In-situ (incl. UAV, GNSS) where possible (triplet of simultaneous data, i.e. SAR-Optical-in situ)
- Implications for flood mapping, coastal erosion, lake/river monitoring (morphometry) etc.


21/4/1984

Lake Koroneia (Lagkadas)
September 2011

Lake Koroneia (Lagkadas)
November 2016


BASE
X24

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Jun 2022
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THEMES, TIME-LAPSES, HIGH-RESOLUTION
IMAGES AND MORE. VISIT EO BROWSER!
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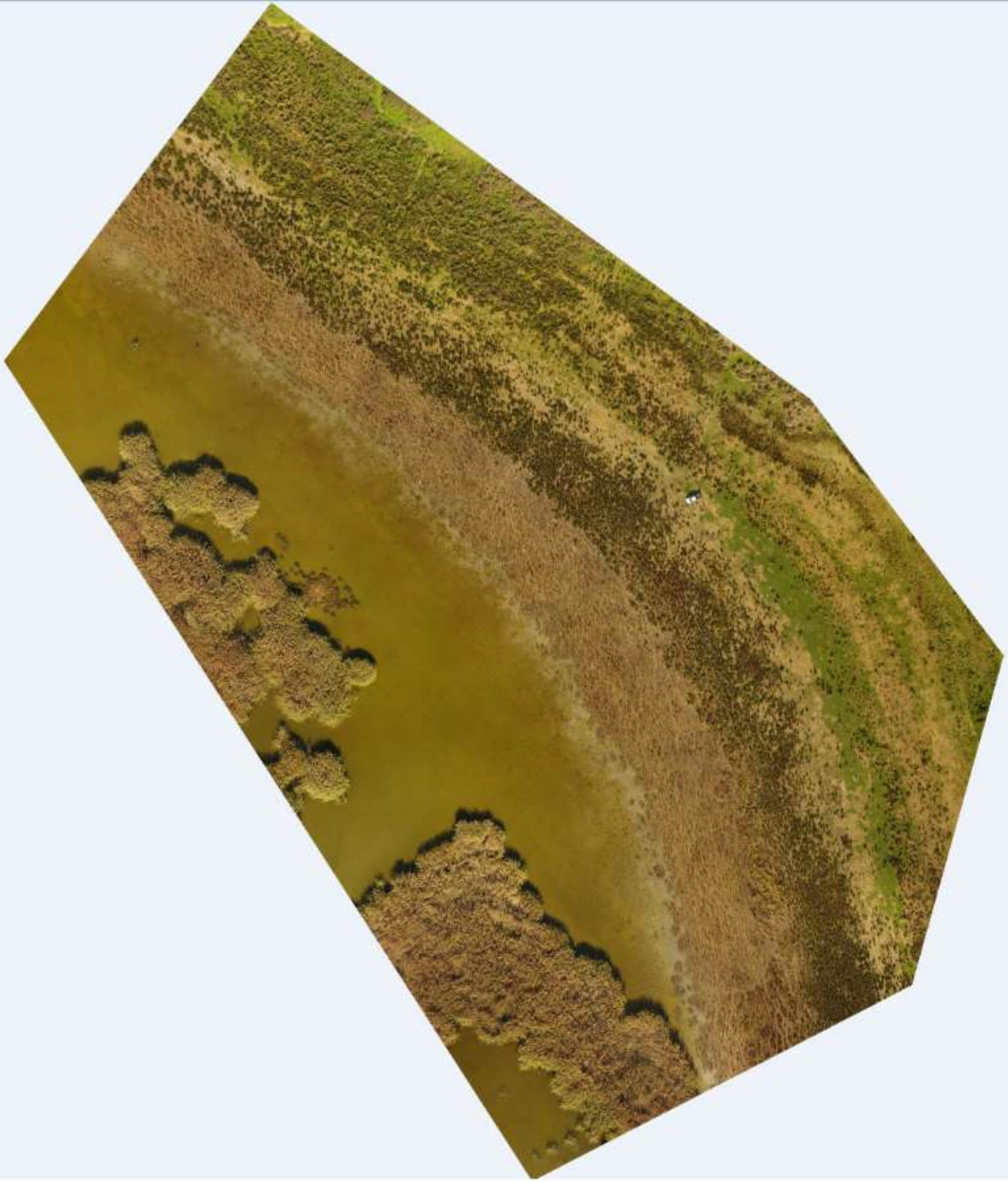
UAV/Drone data



Steps (1)

1. Identify AOI that includes sea shoreline, lake, (major) river or other (major) water-land boundary
2. AOI must be well known & accessible
3. Identify dates of S-1 + S-2 overlapping overpass (min 1/month)
4. 2018-2021 (S1A/B + S2A/B availability)
5. Consider ascending and descending SAR acquisitions

Steps (2)

6. Follow protocol for SAR-Optical processing
7. Consider in-situ (for future dates)
8. Split between cal/val blind experiments
9. Data analysis
10. Ensemble journal publication (early 2024)

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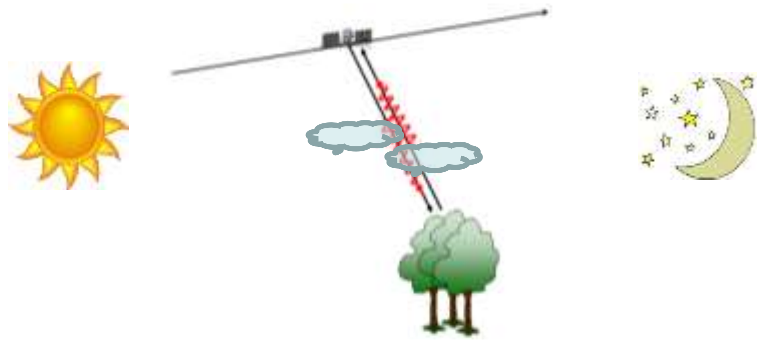

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