New observations obtained via applying remote sensing methods in geological hazard assessment, Southern Ethiopia

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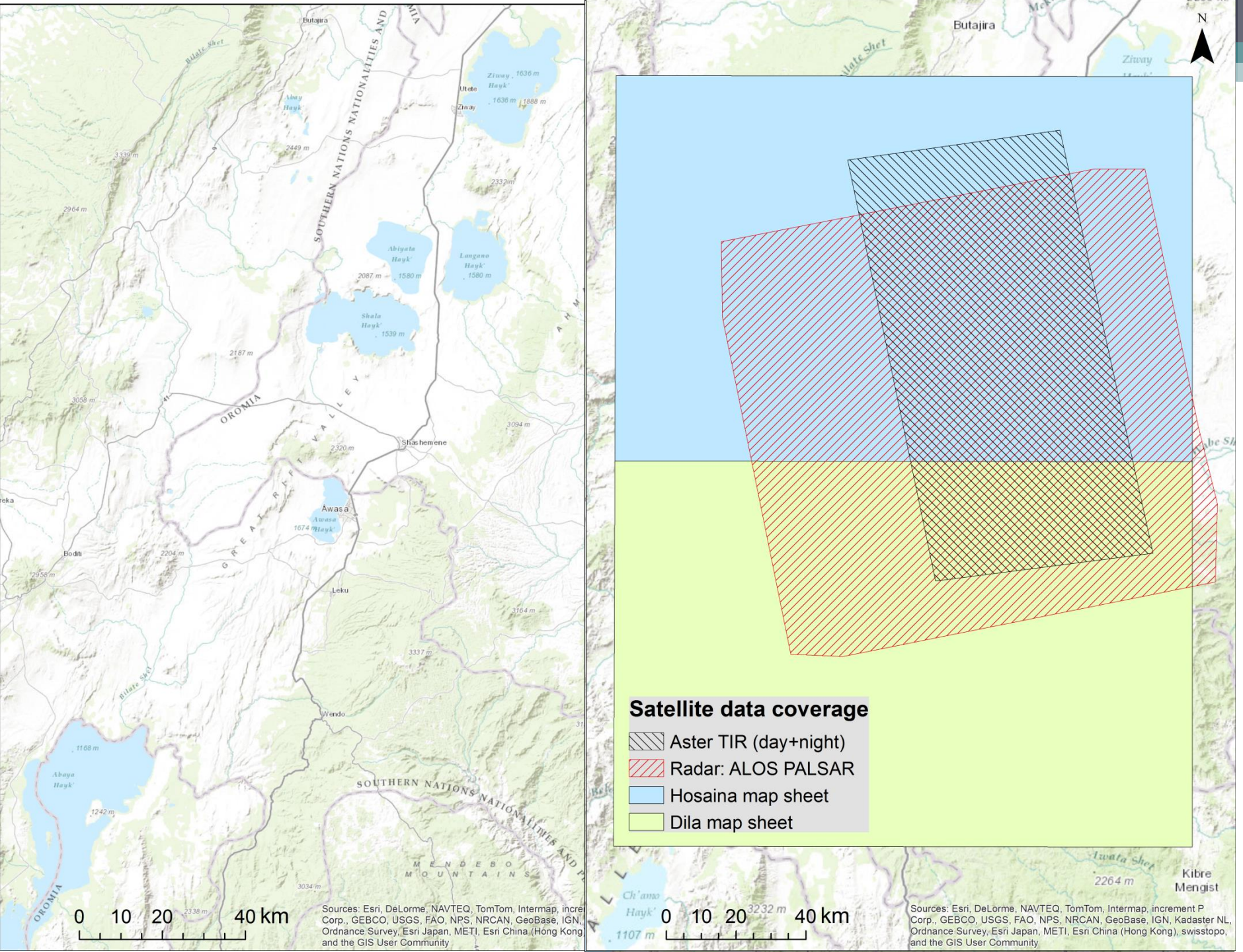
Overview

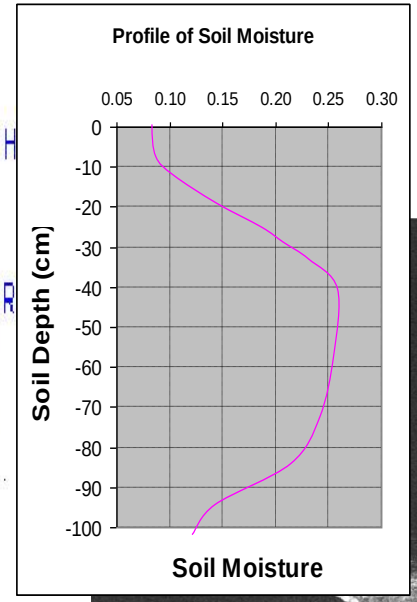
- Remote sensing data
- Applications
  - Morphotectonics
  - Mapping moist soils (near-subsurface water)
  - Thermal anomalies, gradients
- Summary, future remarks

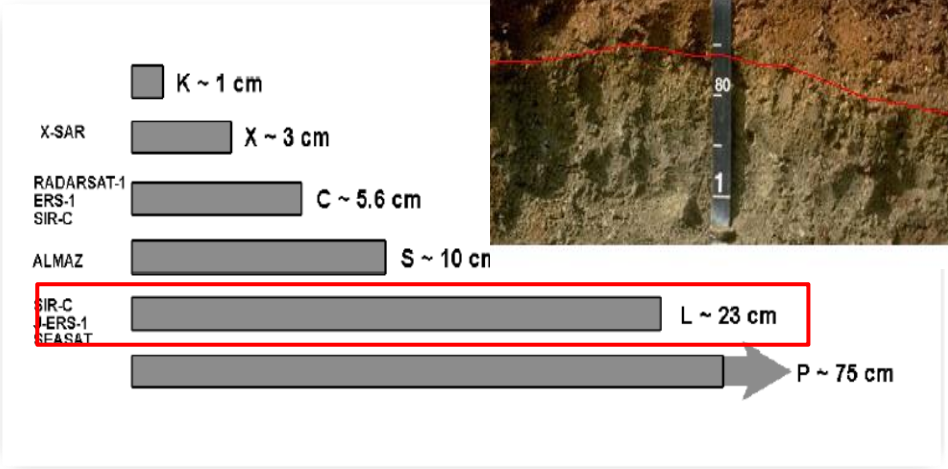
Overview on the RS data

- Digital elevation models (DEM)
- **Satellite Radar data (active):**
  - **ALOS PALSAR**
- **Satellite optical data (passive) :**
  - **Aster data (thermal sensing: day, night)**
  - Landsat multi-temporal data


Butajira
Ziway
Ulete
Shashemene
Awasa
Boditi
Leku
Wendo
SOUTHERN NATIONS NATIONALITIES AND
OROMIA
GREAT RIFT VALLEY
MENDEBO MOUNTAINS
Abaya Hayk'
Ziway Hayk'
Abiyata Hayk'
Langano Hayk'
Shala Hayk'
Awasa Hayk'
Ch'amo Hayk'
Kibre Mengist
N
Satellite data coverage
Aster TIR (day+night)
Radar: ALOS PALSAR
Hosaina map sheet
Dila map sheet
0 10 20 40 km
Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community

Radar dat





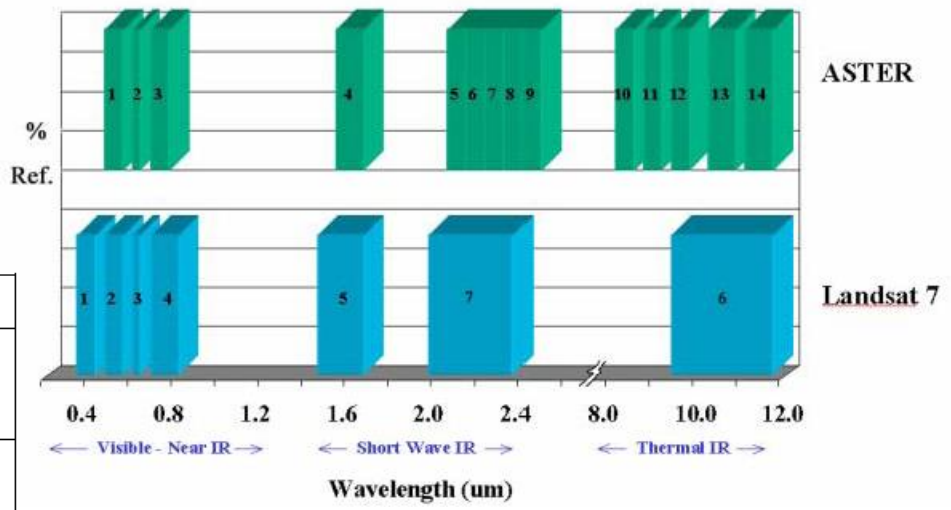
- Active microwave sensor using L band frequencies to archive data
- Joint project of JAXA and JAROS
- Cloud-free, night/day images
- Dual (HV, HH) polarisation
- 12.5 m

Optical/Thermal data: ASTER

Aster The Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) is an advanced multispectral imager that was launched on board NASA's Terra spacecraft in December, 1999.

full scene 185km x 185 km

Subsystem	Band No.	Spectral Range (μm)	Spatial Resolution, m	Quantization Levels
VNIR	1	0.52-0.60	15	8 bits
	2	0.63-0.69		
	3N	0.78-0.86		
	3B	0.78-0.86		
SWIR	4	1.60-1.70	30	8 bits
	5	2.145-2.185		
	6	2.185-2.225		
	7	2.235-2.285		
	8	2.295-2.365		
	9	2.360-2.430		
TIR	10	8.125-8.475	90	12 bits
	11	8.475-8.825		
	12	8.925-9.275		
	13	10.25-10.95		
	14	10.95-11.65		



2001-2008 : VNIR/SWIR/TIR
Since 2008: VNIR/TIR

ALOS PALSAR

- Detection of lineamnets of geological /hydrogelogical origine
- Detecton of moist soils/near subsurface water

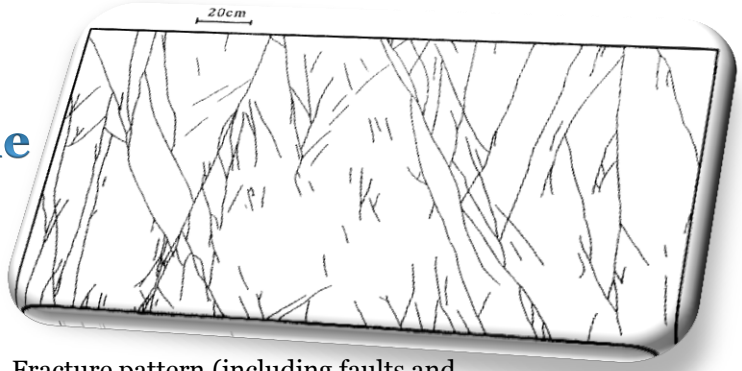
ALOS PALSAR data processing

- Computer based technique to automatically extract linear features from ALOS PALSAR image and to further assess their spatial pattern
- Validation (Czech Rep.):
  - Structural field investigations
  - Field geophysics: Symmetric Resistivity Profiling (SRP), Seismic refraction (SR)

Hypothesis

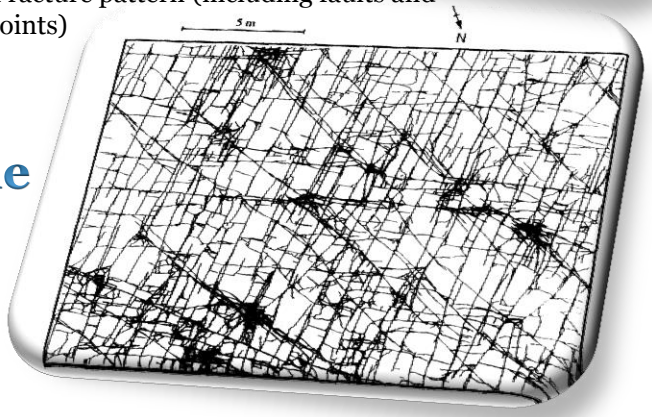
- that real fractural systems, discontinuity and fault planes appear in a digital image as spatially structured and oriented systems of small linear features (micro-lineaments)

cm-scale



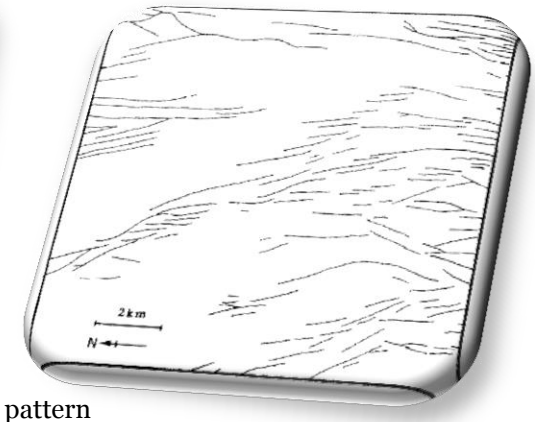
Fracture pattern (including faults and joints)

m-scale



Map of joints exposed on a sandstone bedding plane

km-scale



Fault pattern

ALOS PALSAR processing

ALOS PALSAR

⇩

Orthorectification

⇩

Double transformation

⇩

Lineament detection

⇩

Lineament extraction

⇩

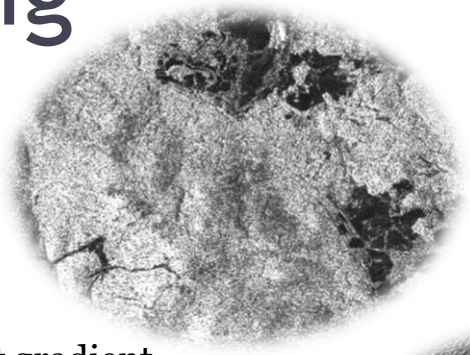
Correction of line geometry

⇩

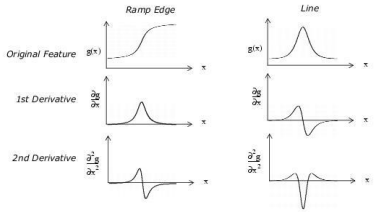
Geostatistical analysis

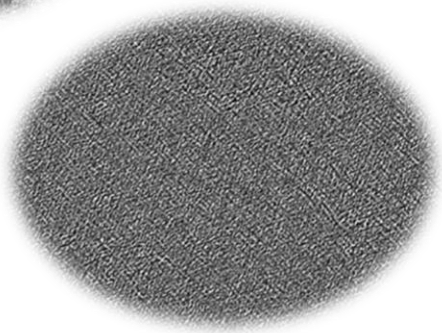
⇩ ⇩

Structural interpretation ⇨ Validation



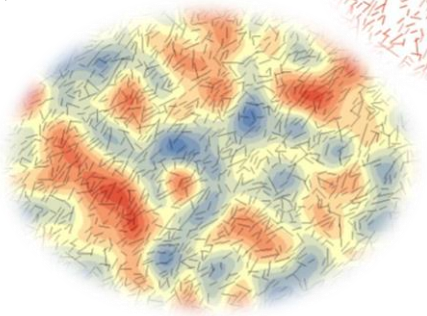
-Azimuth dependent gradient images
-2nd order derivation Kernel filter



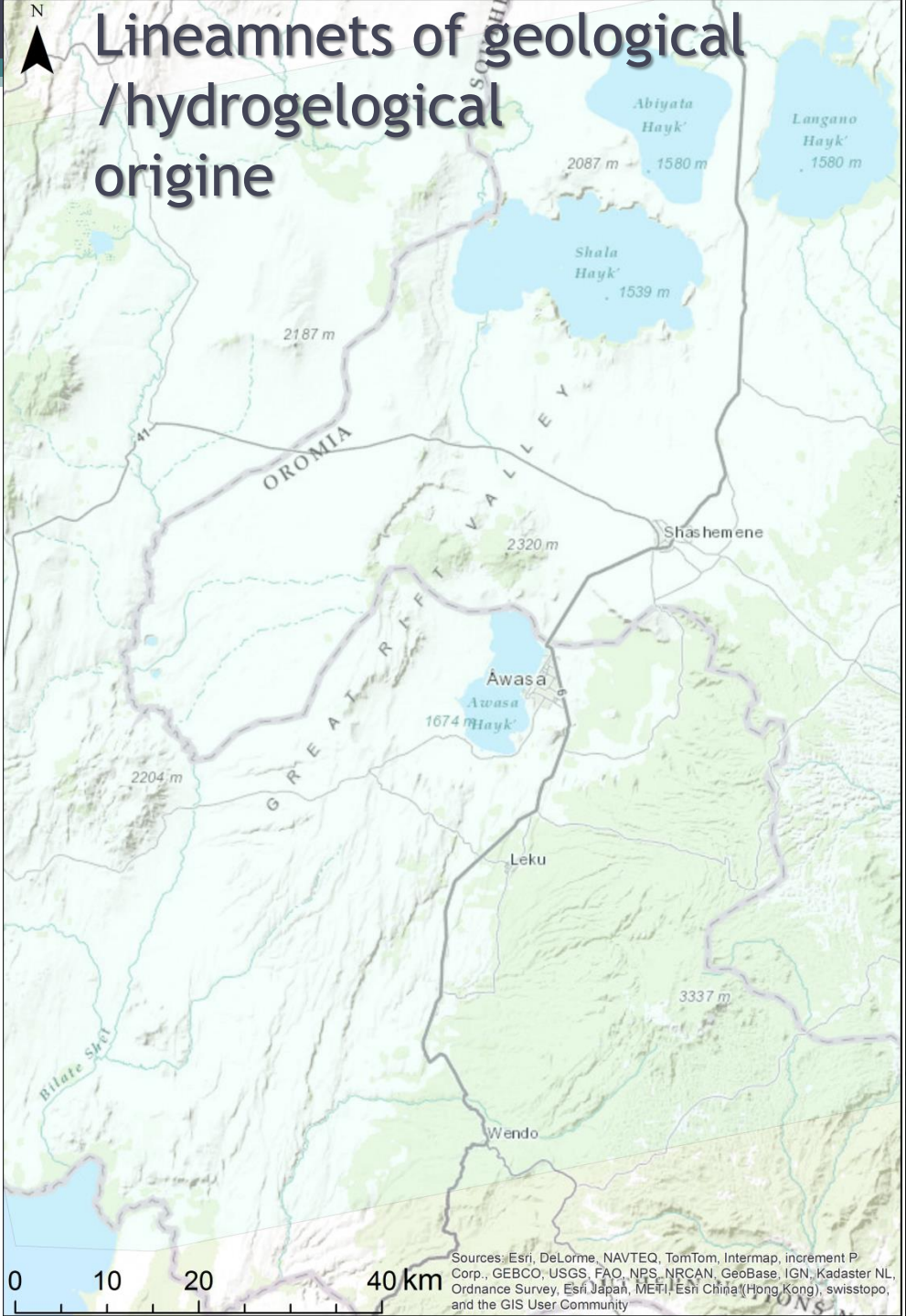


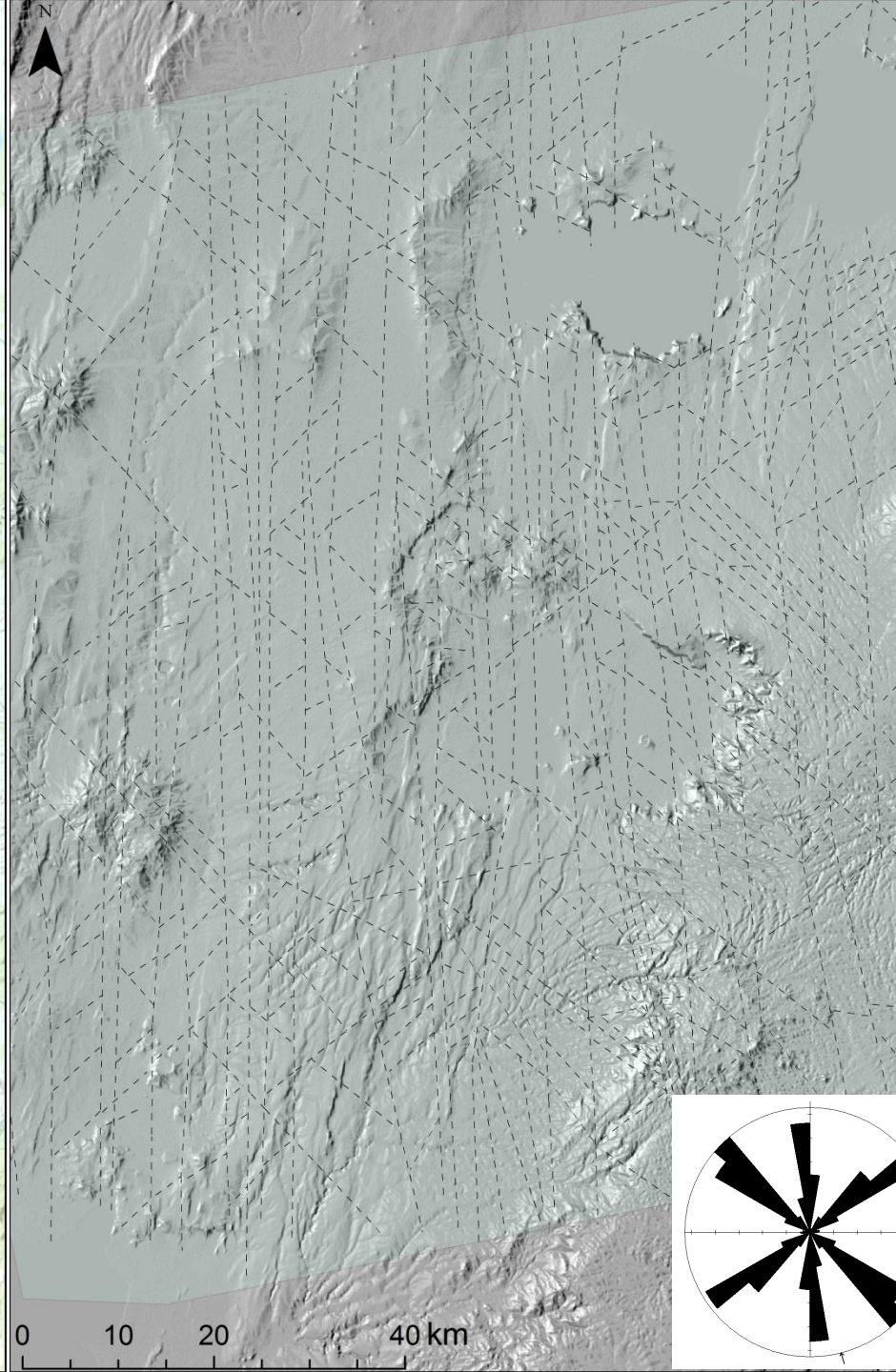
-line topology, orientation (azimuth), length

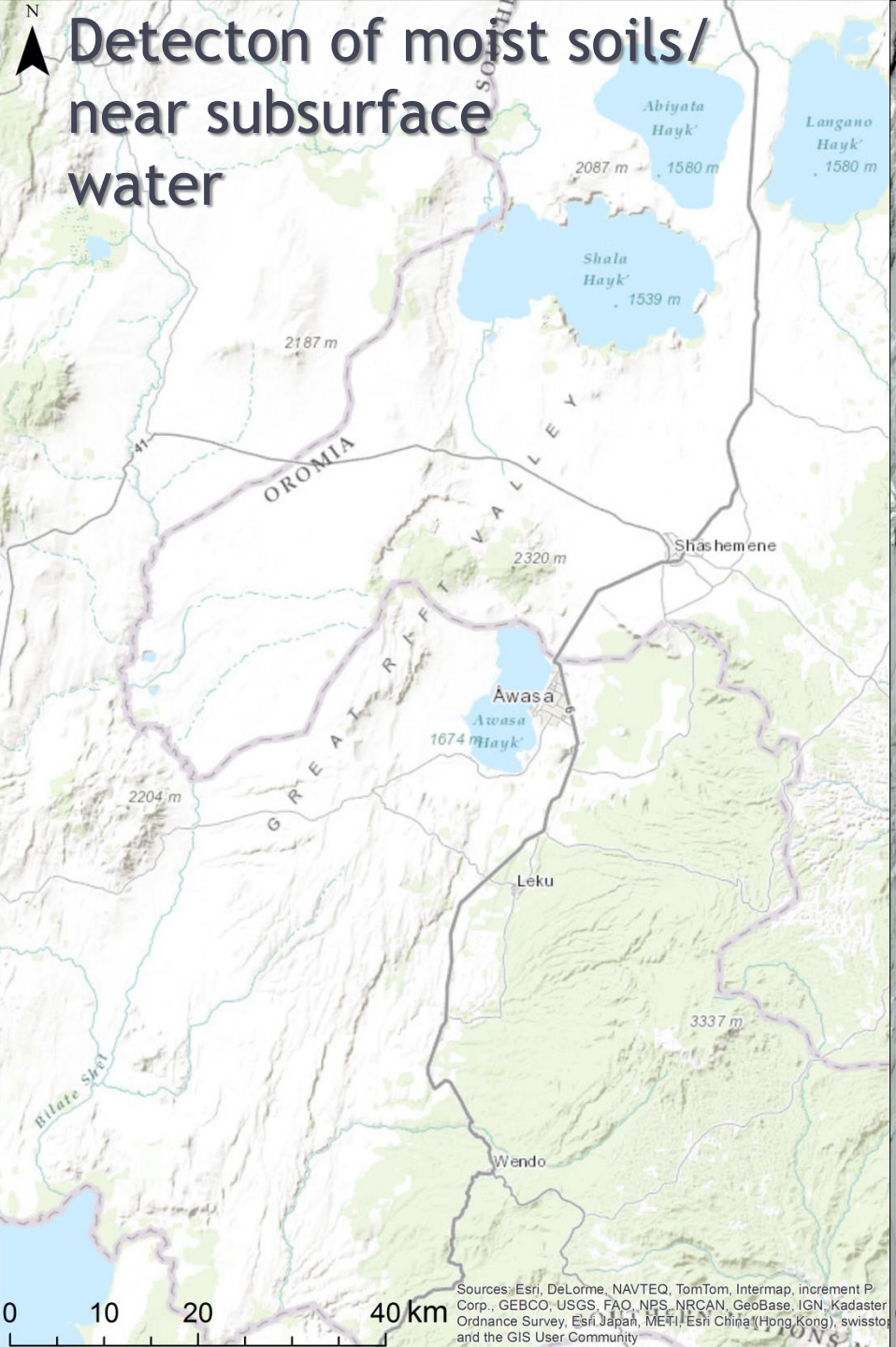
-Lineament Density

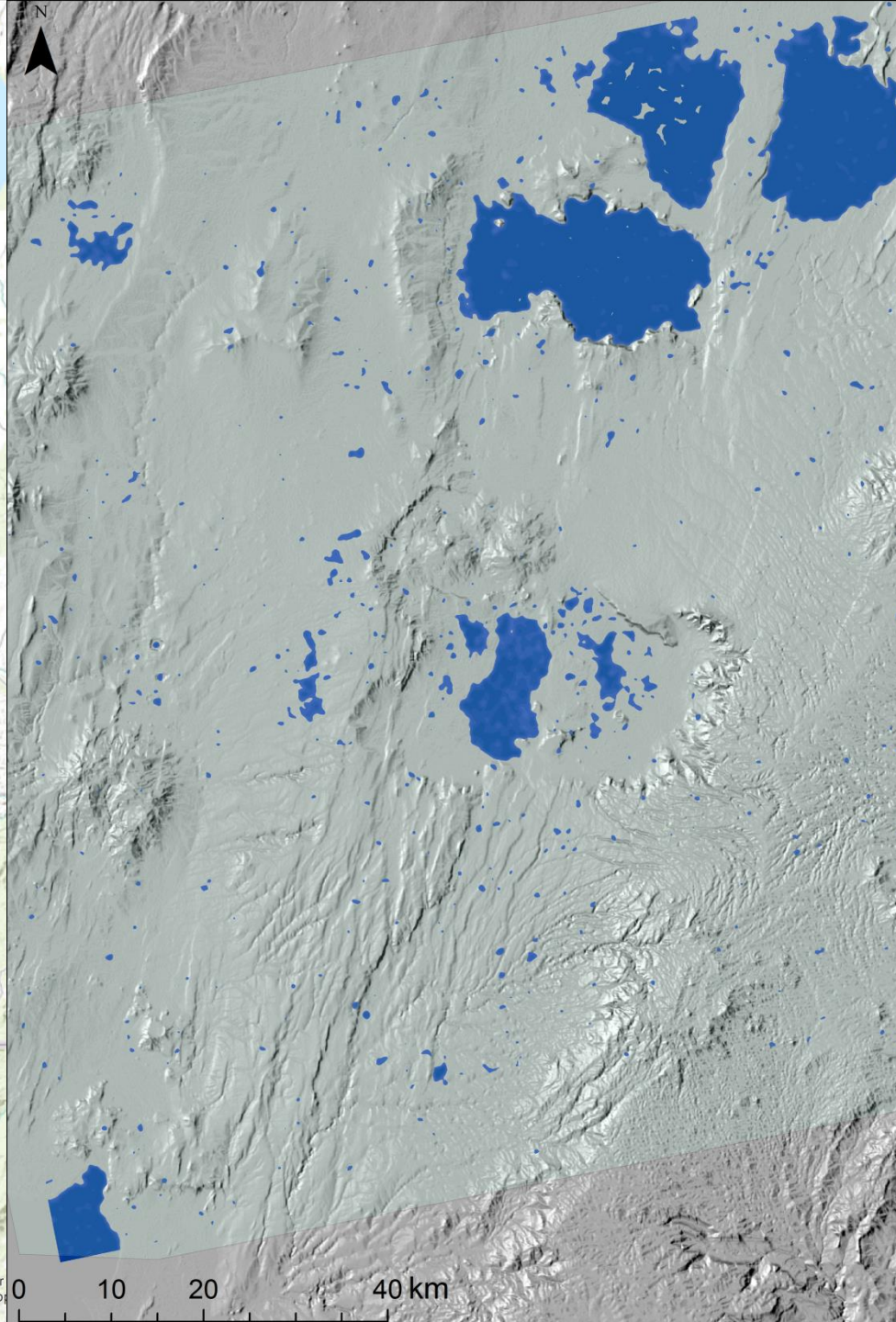


Lineamnets of geological /hydrogeological origine






N
Detecton of moist soils/ near subsurface water
Abiyata Hayk'
1580 m
Langano Hayk'
1580 m
2087 m
Shala Hayk'
1539 m
2187 m
41
OROMIA
GREAT RIFT VALLEY
Shashemene
2320 m
Awasa
Awasa Hayk'
1674 m
2204 m
Leku
3337 m
Bilate Shet
Wendo
0
10
20
40 km
Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstop and the GIS User Community


N
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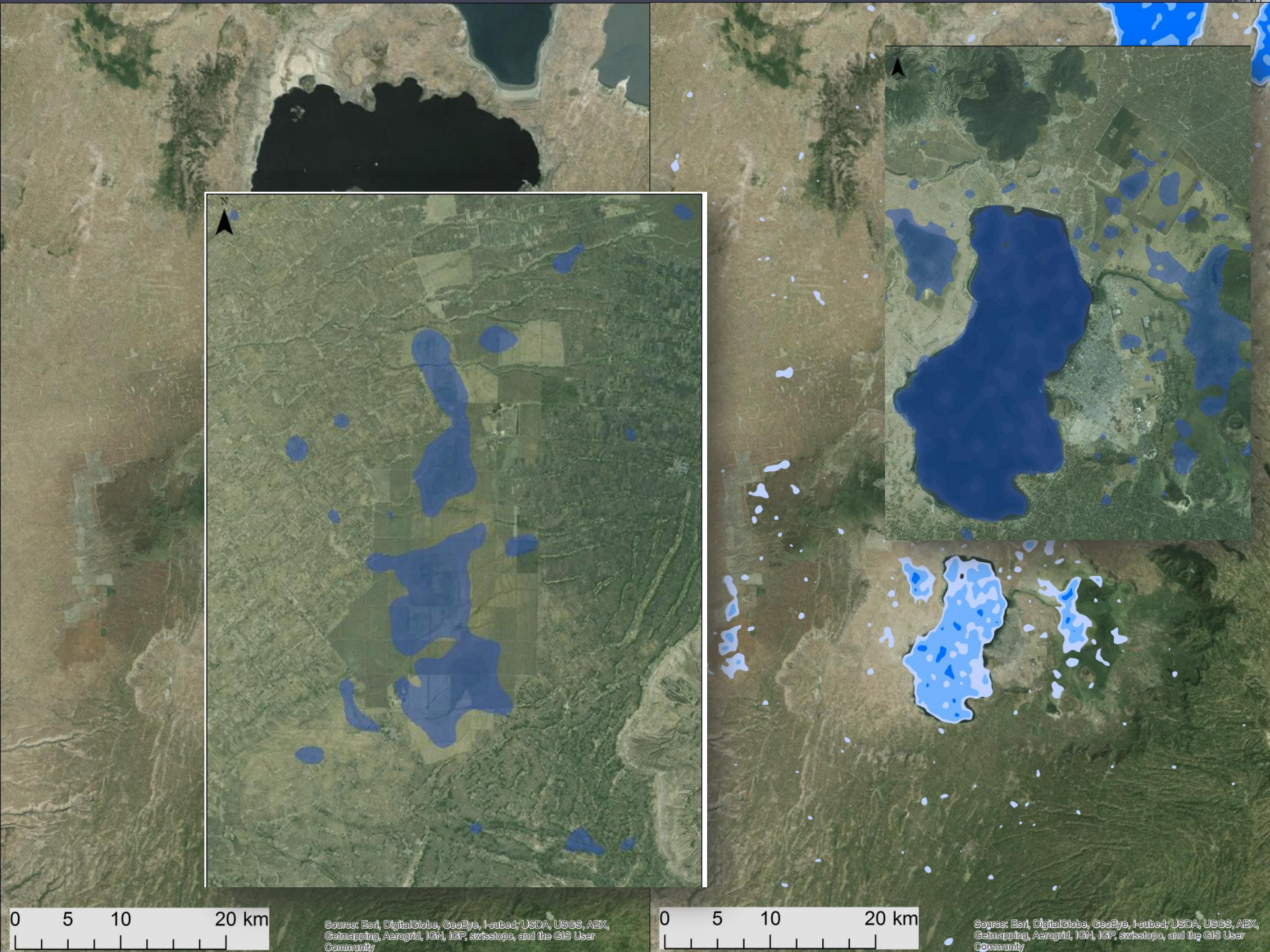
40 km


N
0 5 10 20 km
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
N
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0 0,1 0,2 0,4 km
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community


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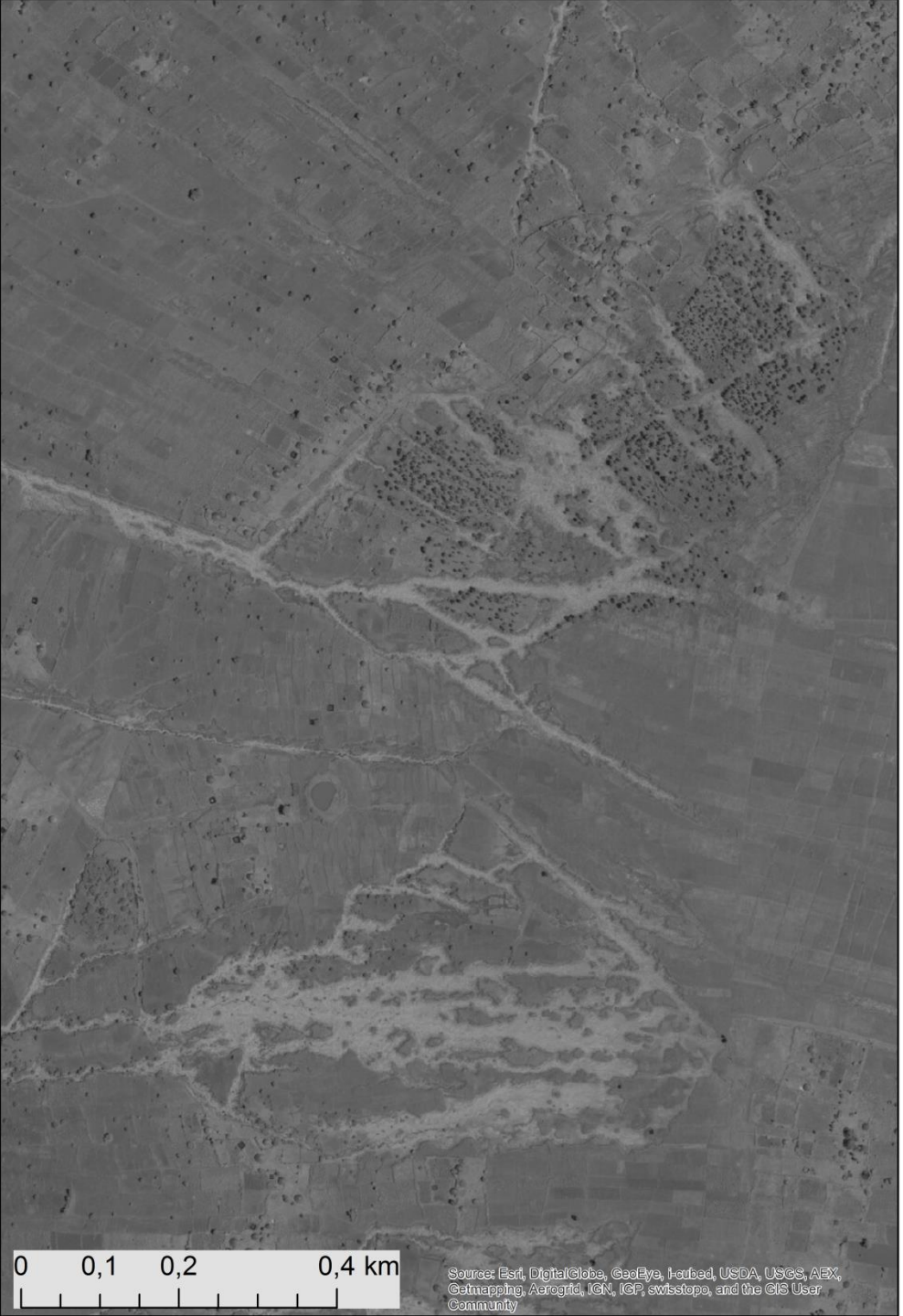
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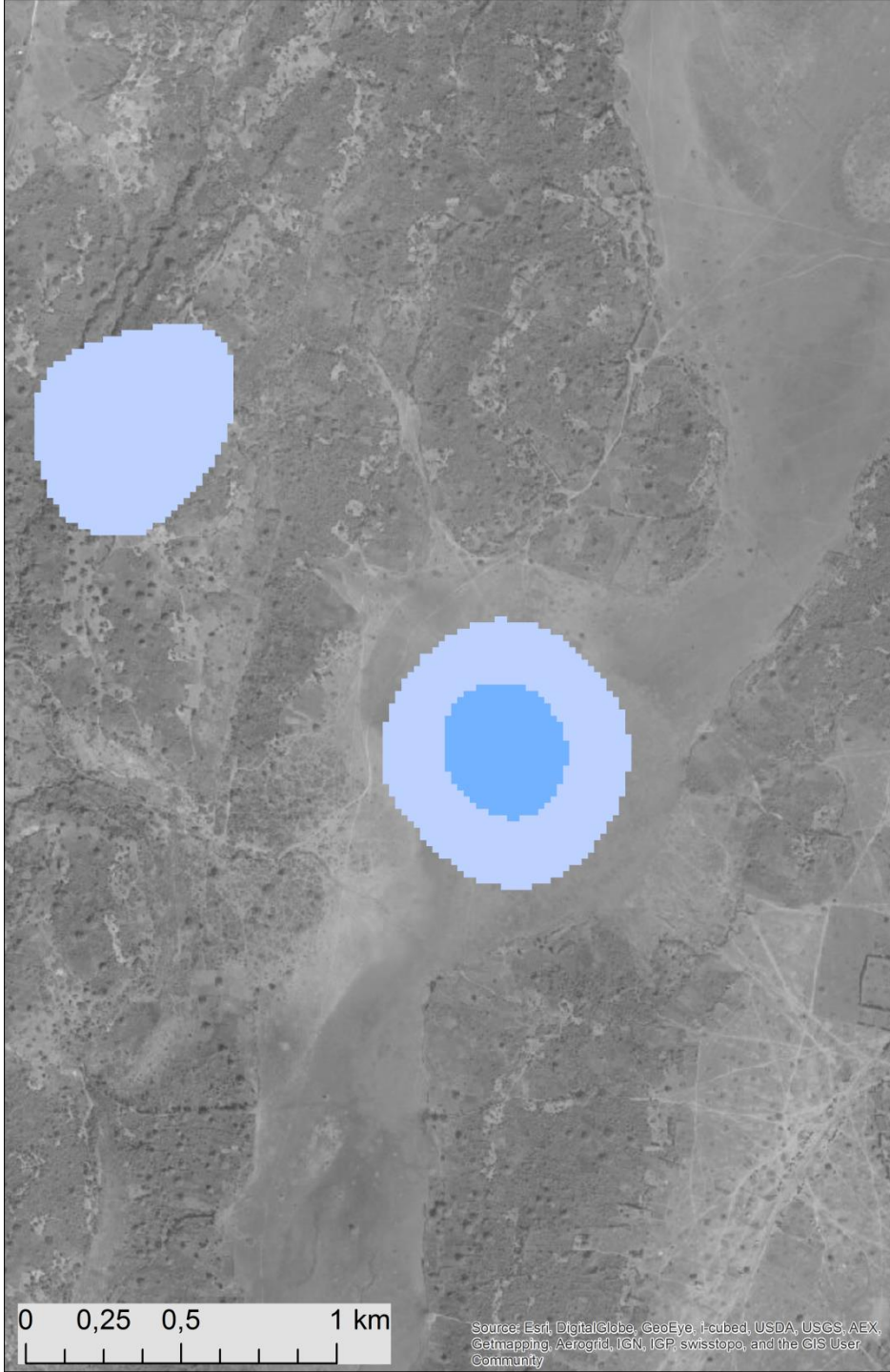
0 0,25 0,5 1 km
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community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ASTER – thermal analysis (night/day images)

Water bodies

Day: colder from other surfaces
Night: warmer than other surfaces → **Smaller differences** between night/day temperature (2-5 °C)

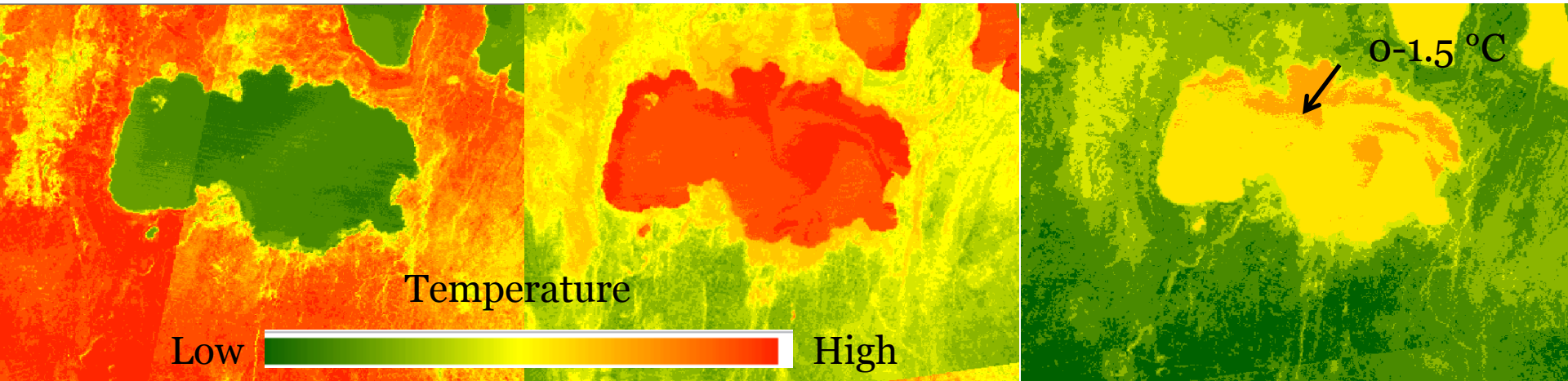
Thermal hot spots

→ Stable night/day temperature → Smaller differences between night/day temperature close to 0 °C)

ASTER day thermal gradient

ASTER night thermal gradient

ASTER night/day thermal gradient difference



Aster thermal data

- Corrected to atmospheric and topographic effect (ATCOR)

- Normalized to albedo (day scenes):
- Apparent Thermal Inertia (ATI):
- **ATI=(1-Albedo)/ΔT (day-night)**
- is commonly used to describe the resistance of a material to temperature changes:
  - higher resistance→ smaller ΔT→ larger ATI

Water – soil moisture

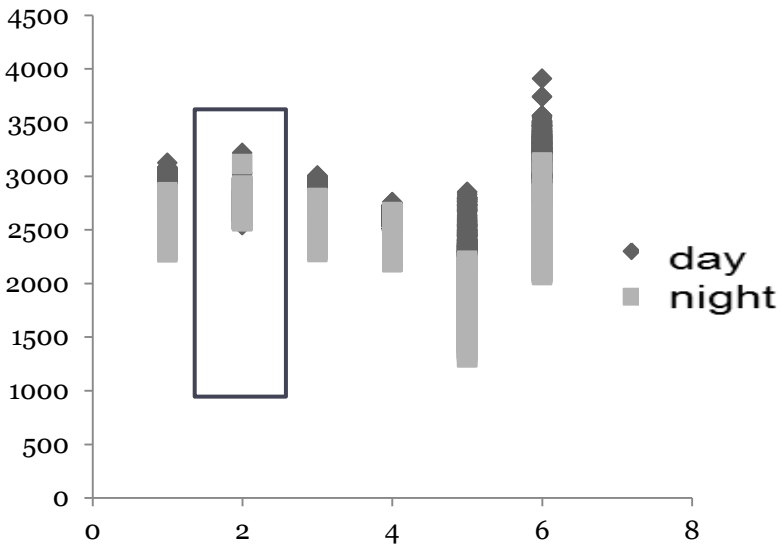
Day: colder from other surfaces
Night: warmer than other surfaces

Smaller differences between night/day temperature (2-5 °C)

Apparent Thermal Inertia (ATI):

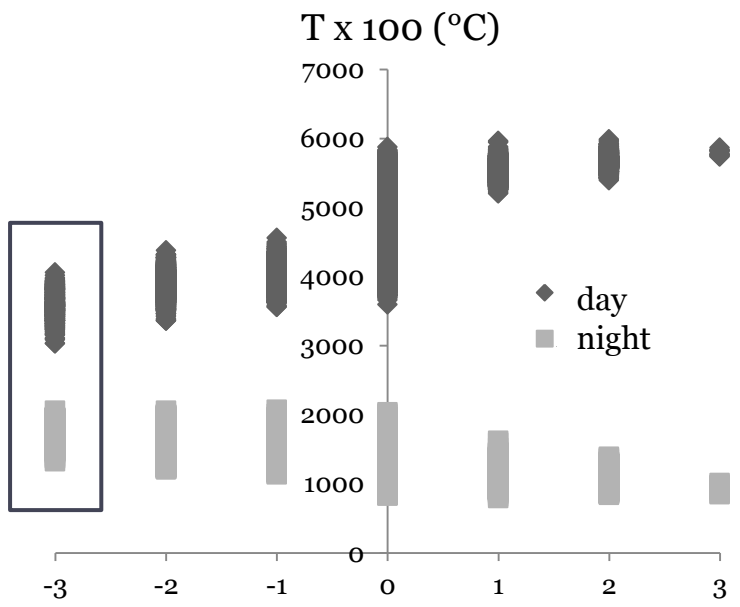
Water bodies

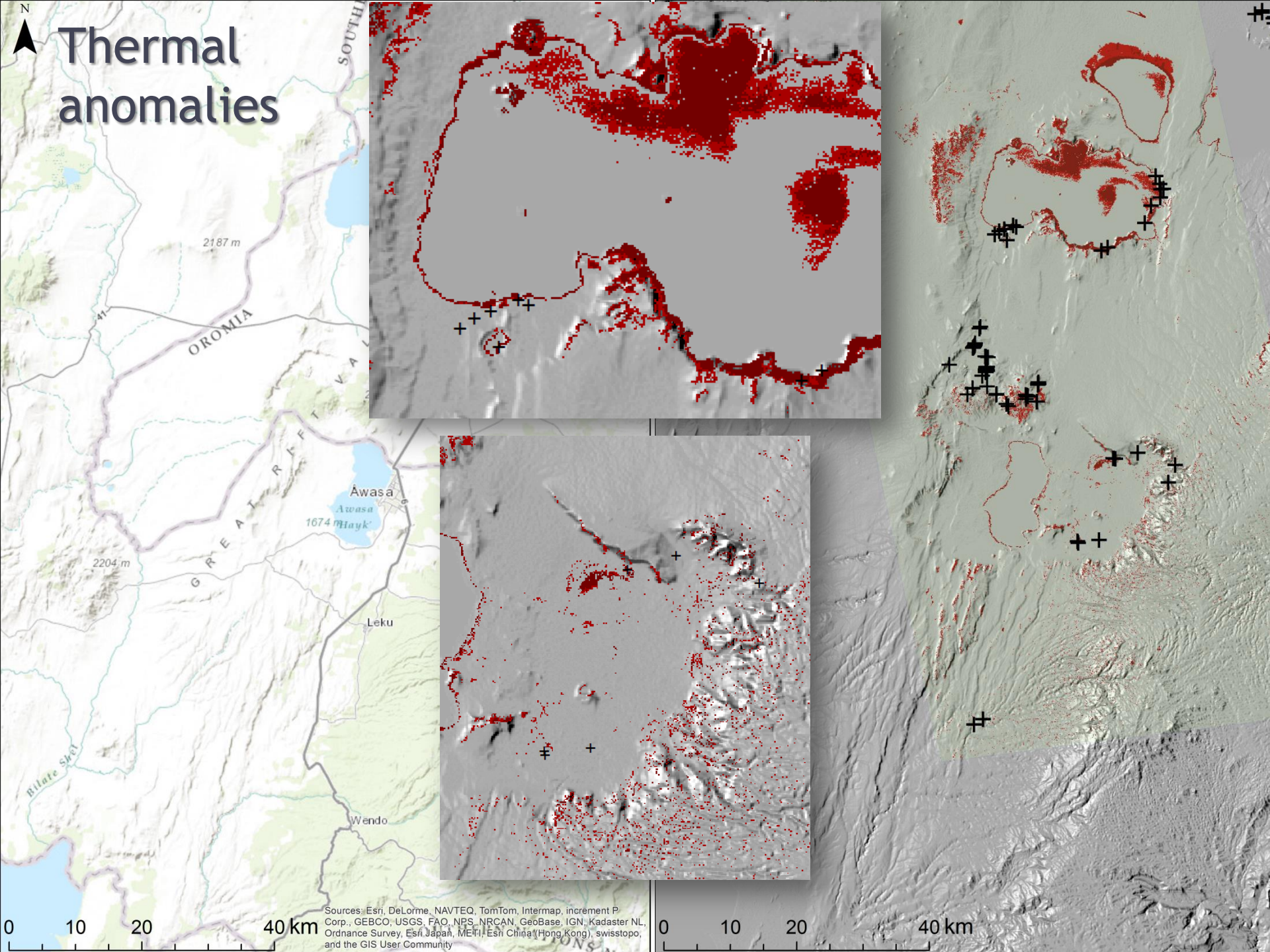
T x 100 (°C)



Exposed surfaces

T x 100 (°C)




Thermal anomalies
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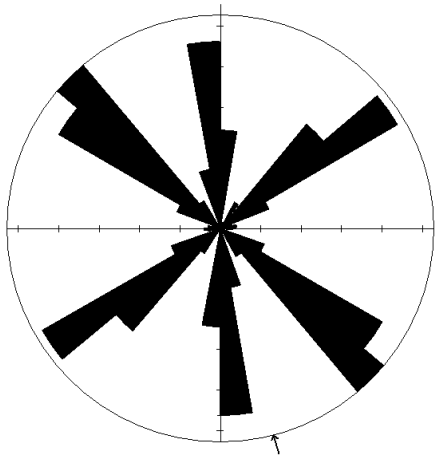
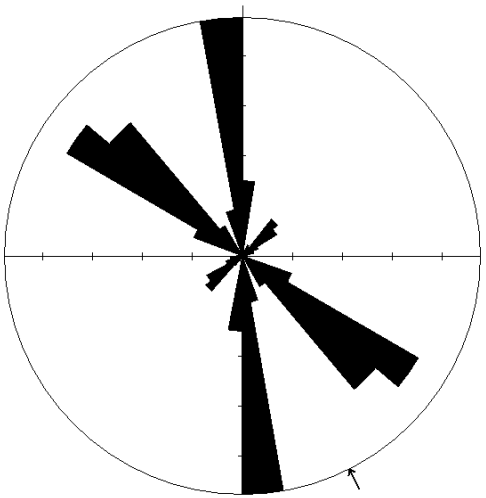
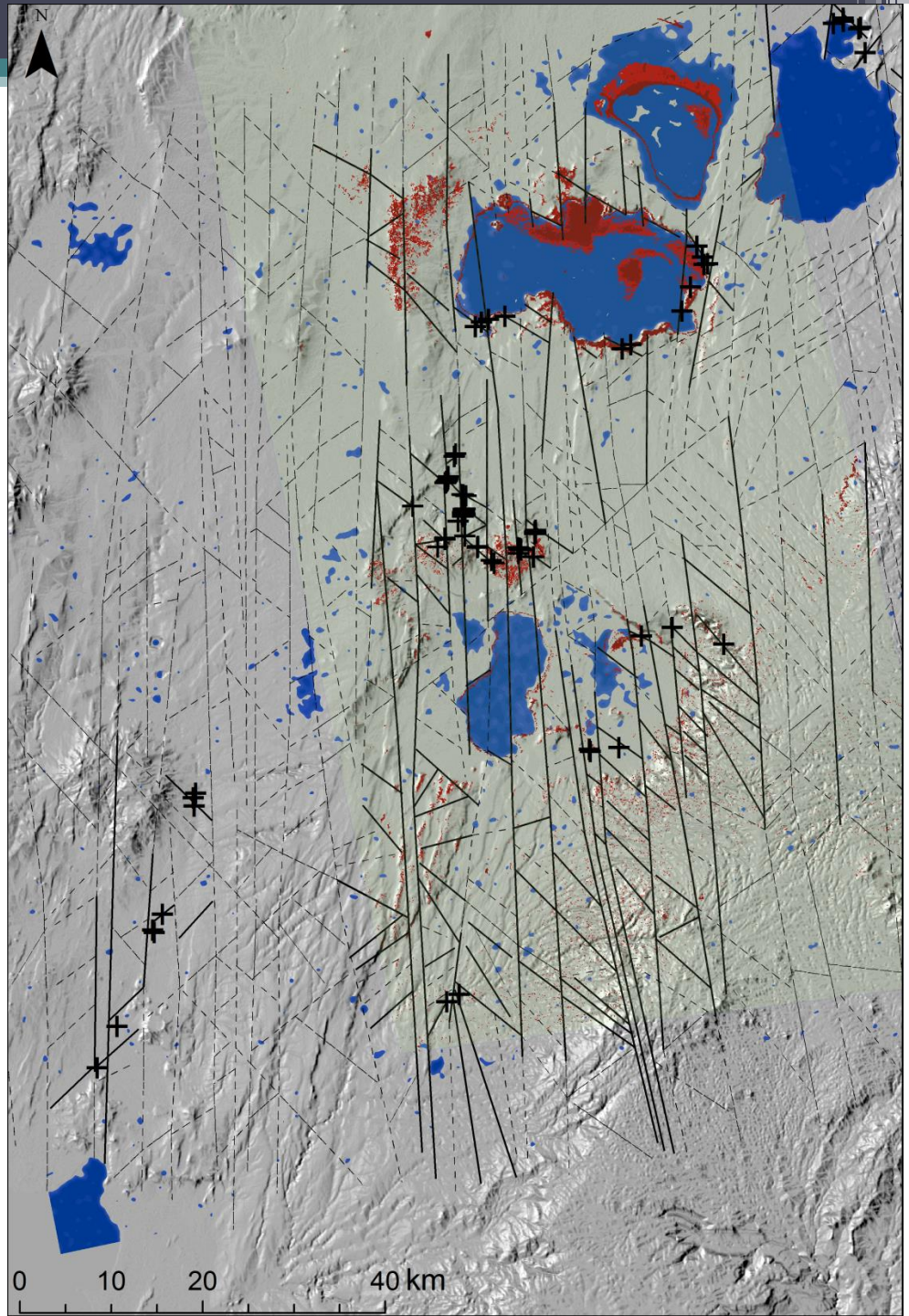
Synthesis







Summary

- Combination of passive and active remote sensing data brings big benefits
- Morphometry has further implications for land form mapping, geomorphology, erosion and slope stability assesment
- Structures interpreted on the basis of radar ALOS PALSAR data needs to be correlated with the field structural data (extrapolation, synthesis)
- ASTER thermal images suitable for mapping surface/subsurface water, this could be correlated with water table level, implications for agriculture (?)
- ASTER night/day diference images suitable for mapping water bodies as well as hot spots
- Final results with the end of the projects