TU Clausthal
Clausthal University of Technology

GeoMonitoring

# Use of optical remote sensing data for soil moisture monitoring

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# Motivation

- In the monitoring of the surface soil moisture by optical remote sensing:
  - A more reliable index to estimate the surface soil moisture;
  - First validation of the new soil moisture index;
  - Estimation of the spatial distribution of surface soil moisture;

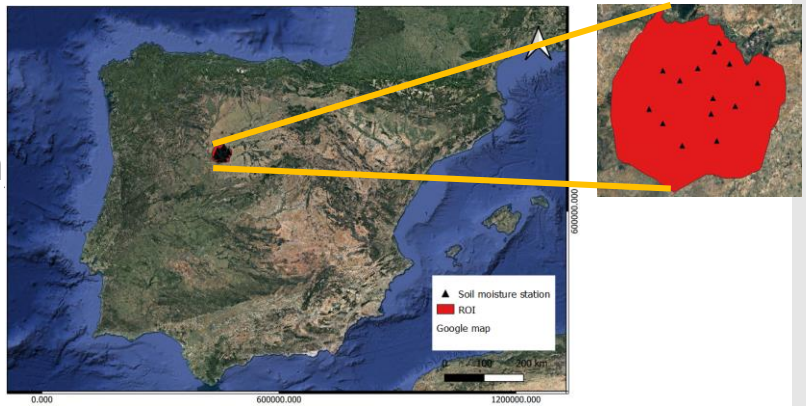
Source: https://campus.usal.es/~hidrus/infraestructura.php#

# Outline

- Study area & data
- Methodology
- Validation and regression based on in-situ measurement
- Spatial distribution of soil moisture
- Conclusion & outlook

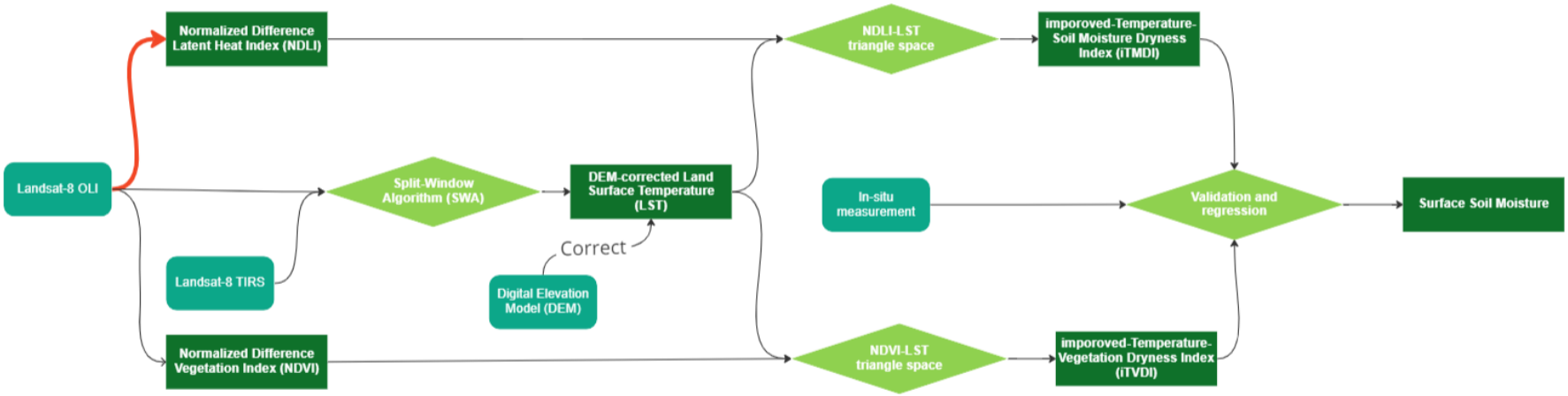
# Study area & data

- Study area: Guareña river basin, REMEDHUS Soil Moisture Measurement Stations, Spain
  - Average Precipitation (August): 10~15mm
  - Average Precipitation (November): 40~45mm;
- Data:
  - Landsat-8 OLI&TIRS (In the table);
  - EU-DEM data from Copernicus Land Monitoring Service;




| Capture Date | Resolution(OLI) | Resolution(TIRS) |
|---|---|---|
| 15-08-2021 | 30m | 100m |
| 19-11-2021 | 30m | 100m |

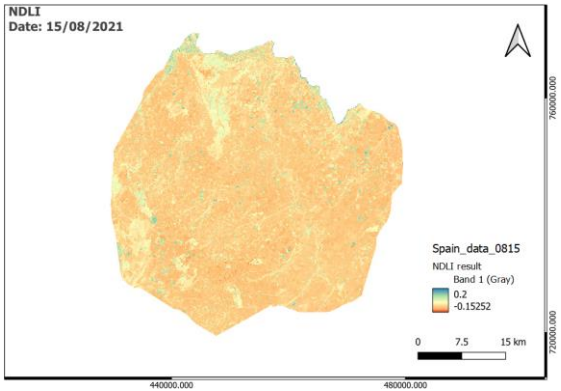
# Methodology

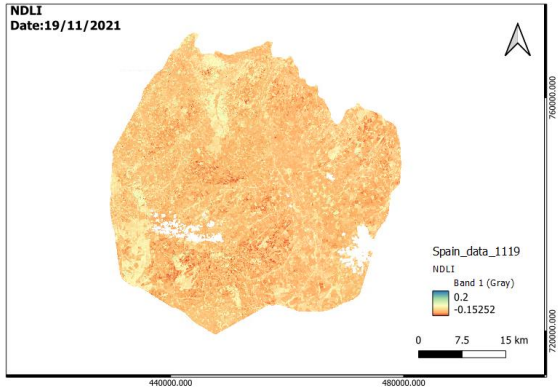


# NDLI

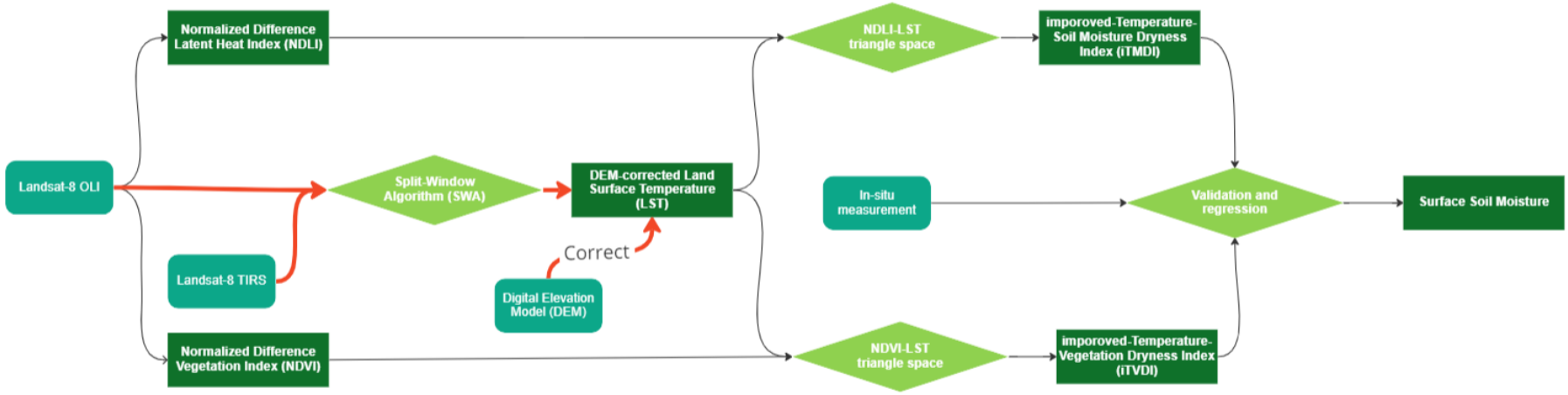
$$NDLI = \frac{\rho_3 - \rho_4}{\rho_3 + \rho_4 + \rho_5}$$

- $\rho_3$ corresponds to the reflectance of green bands (0.53–0.59 μm)
- $\rho_4$ corresponds to the reflectance of red bands (0.64–0.67 μm)
- $\rho_5$ corresponds to the near-infrared bands (0.85–0.88 μm)



# Methodology



# DEM-Corrected LST

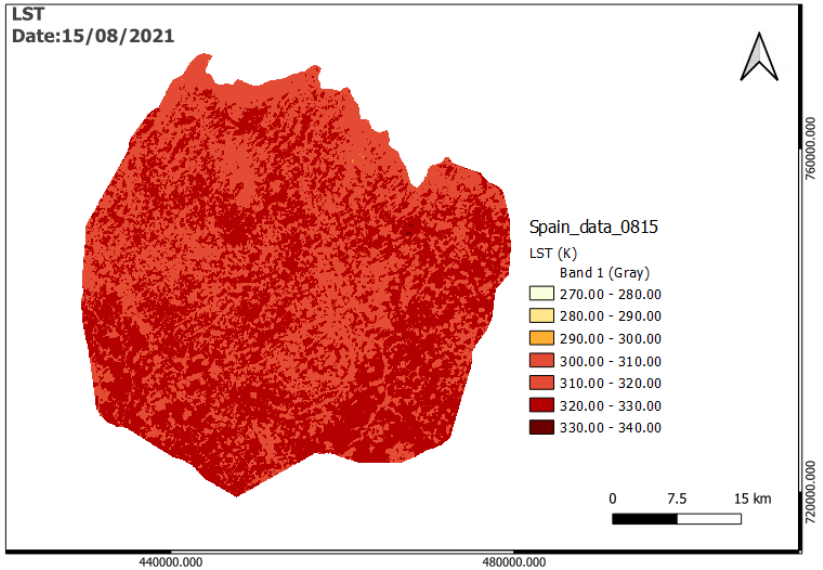
$$T_s = A_0 + A_1 T_{10} - A_2 T_{11}$$

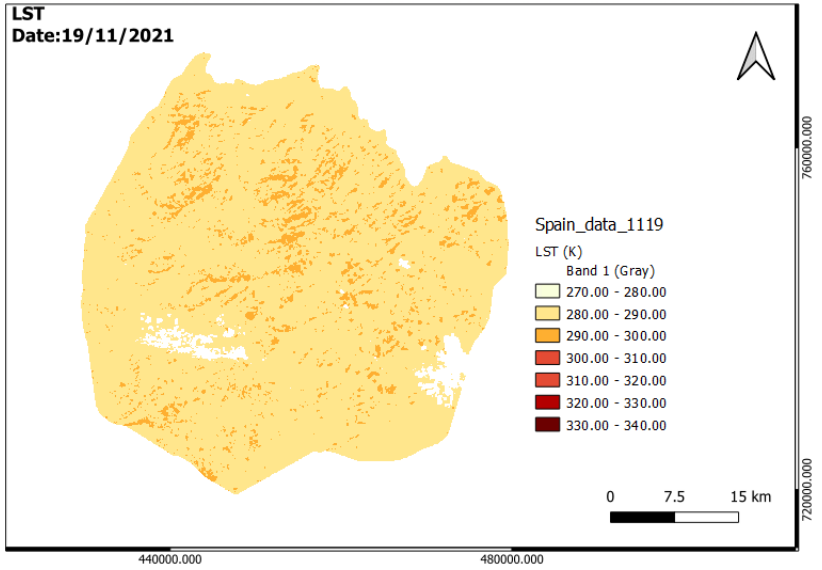
- $T_s$ is land surface temperature
- $T_{10}$ and $T_{11}$ are the brightness temperature of the band 10 and band 11(TIRS)
- $A_0$, $A_1$, $A_2$ are calculated from land surface emissivity (LSE) and atmospheric transmittance (Rozenstein et al. 2014)

$$T(H) = T_s + a \cdot H$$

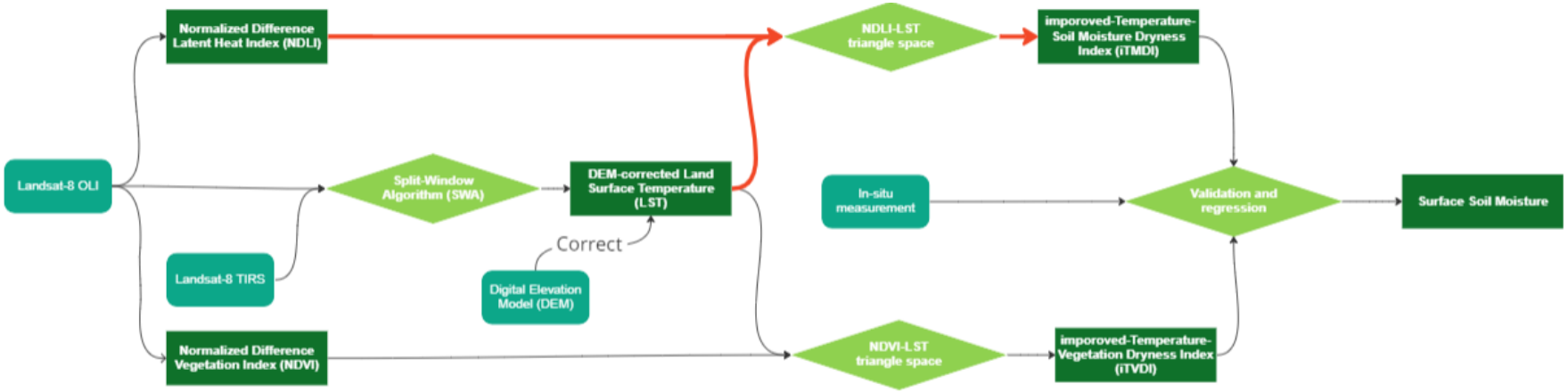
- $T(H)$ is DEM-Corrected land surface temperature
- $a$ is Elevation correction coefficient (0.006)
- $H$ is Elevation (Wee et al. 2009)

# DEM-Corrected LST



# Methodology



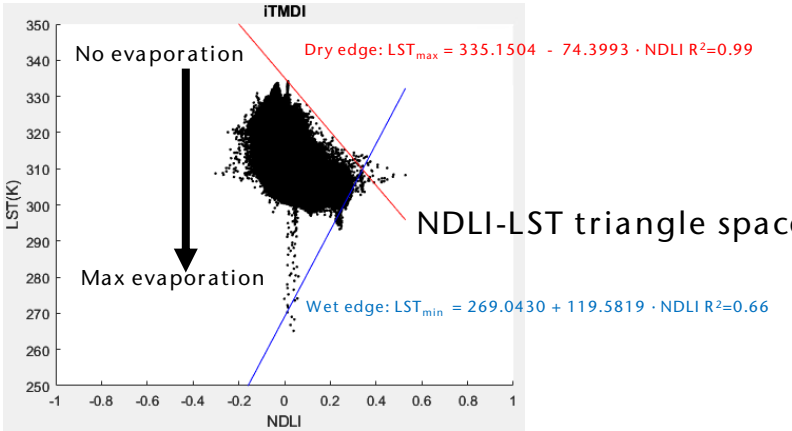
# iTMDI

$$iTMDI = \frac{(LST - LST_{min})}{(LST_{max} - LST_{min})} \quad (1)$$

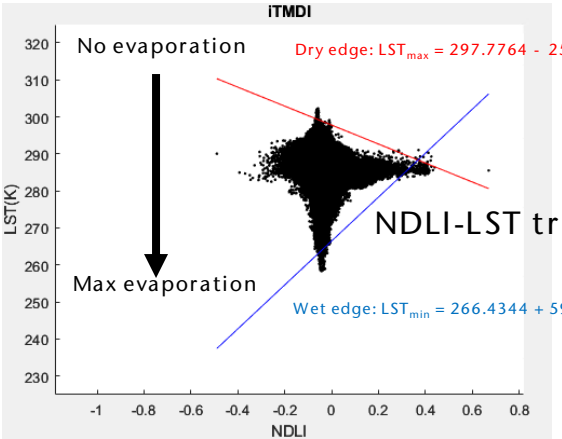
$$LST_{max} = a_1 + b_1 \cdot NDLI\ (Dry\ edge) \quad (2)$$

$$LST_{min} = a_2 + b_2 \cdot NDLI\ (Wet\ edge) \quad (3)$$

- $a_1, b_1, a_2\ and\ b_2$ are the coefficients of dry edge and wet edge fitting equation (Le et al. 2021)

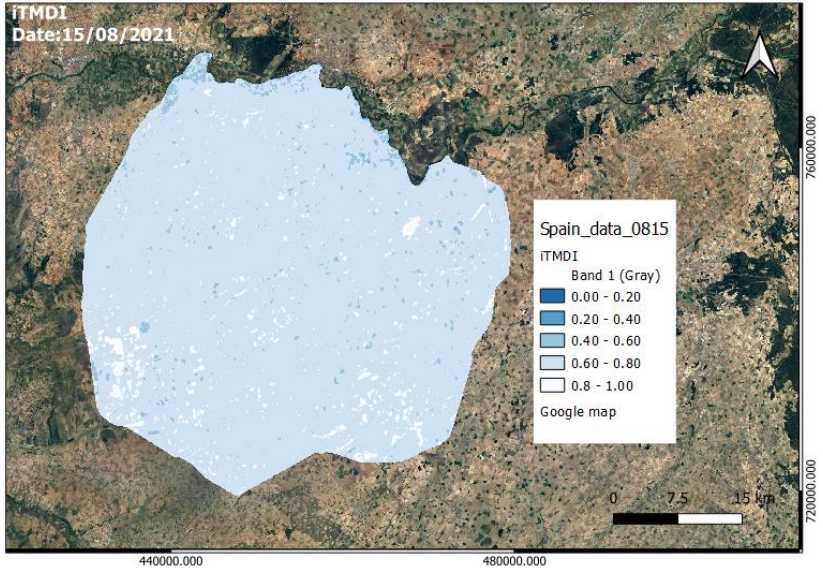


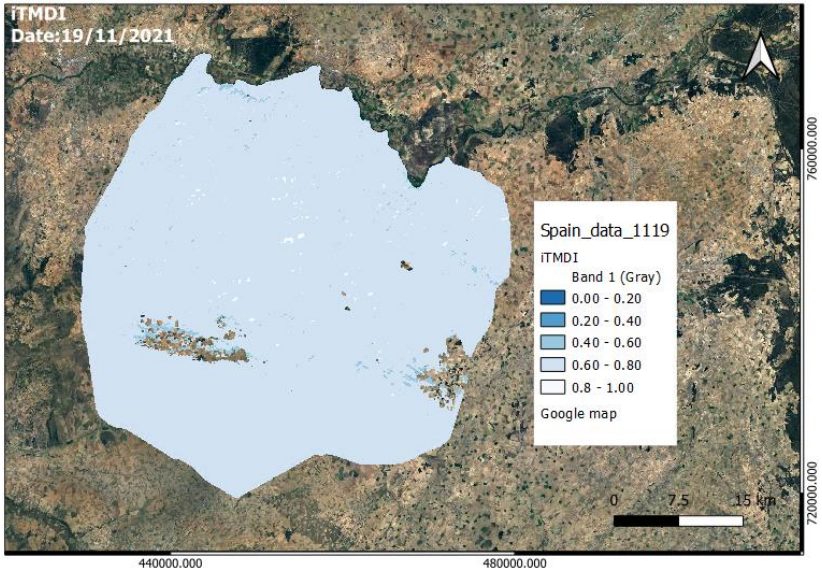

NDLI-LST triangle space




NDLI-LST triangle space

# iTMDI – Results for August and November 2021



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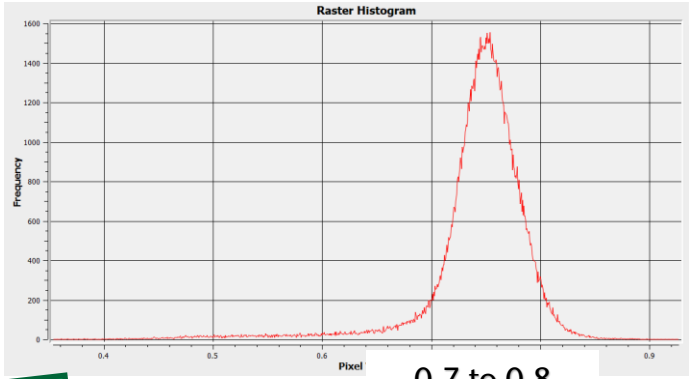
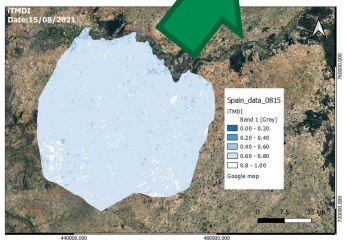
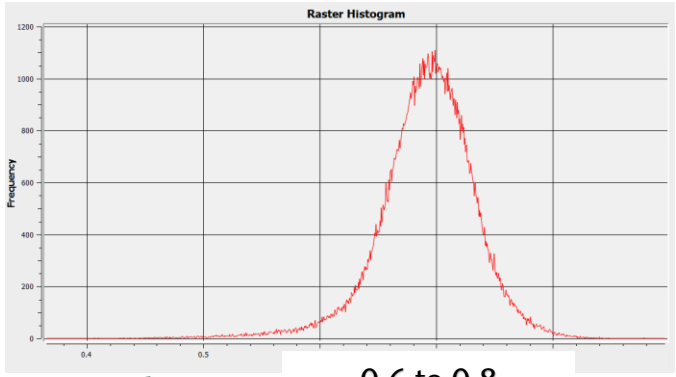


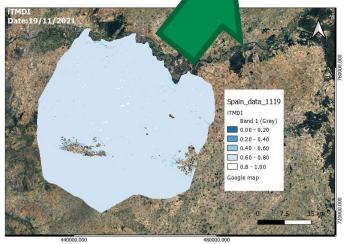

0.7 to 0.8




15/08/2021

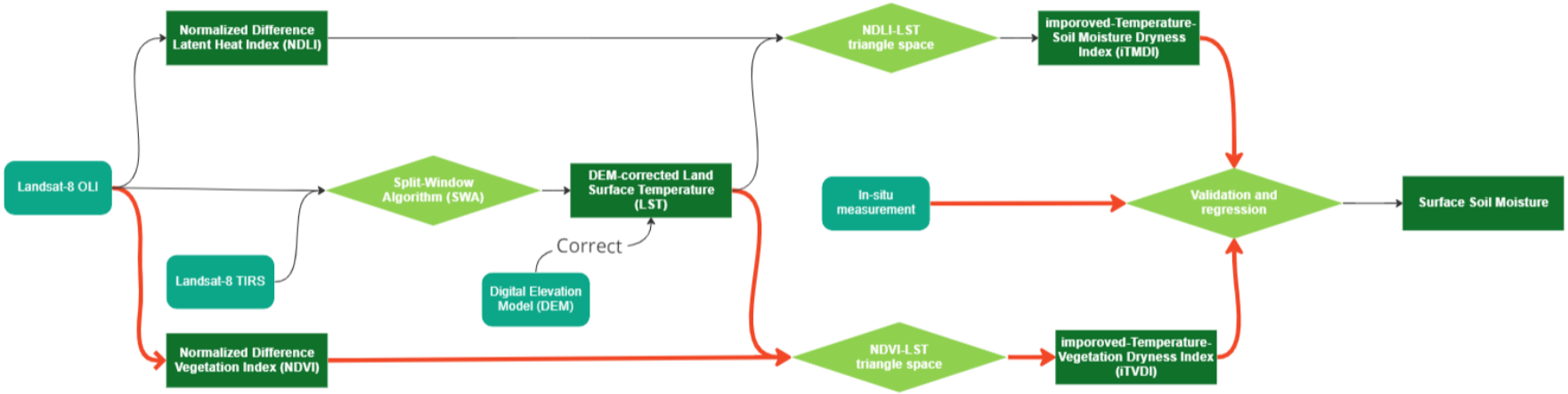



0.6 to 0.8

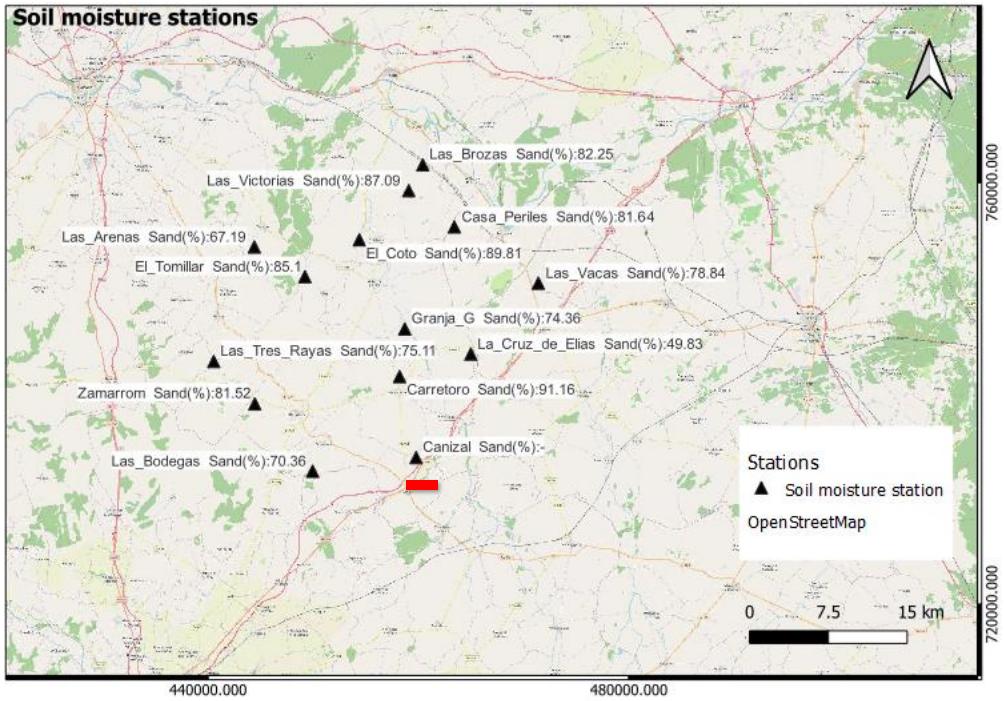



19/11/2021

# Methodology

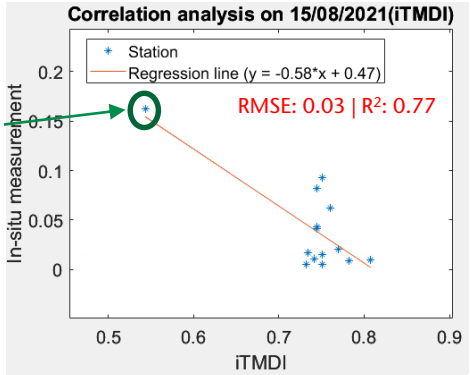


# Validation and regression based on in-situ measurement - Guareña river basin

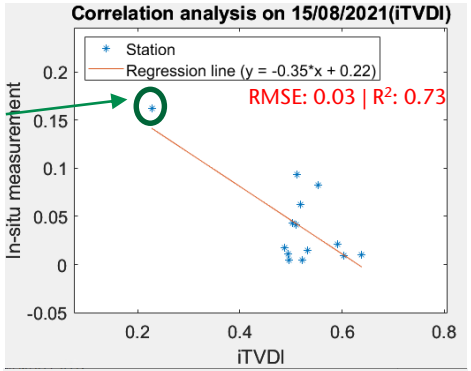


# Validation and regression based on in-situ measurement

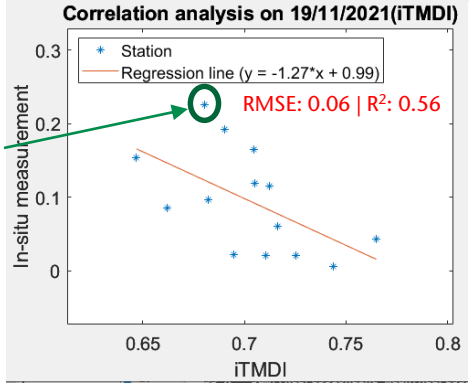
Canizal station value



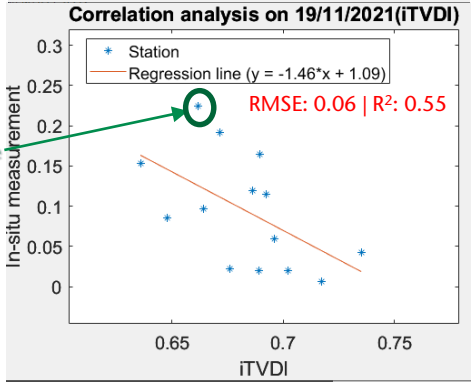

Canizal station value



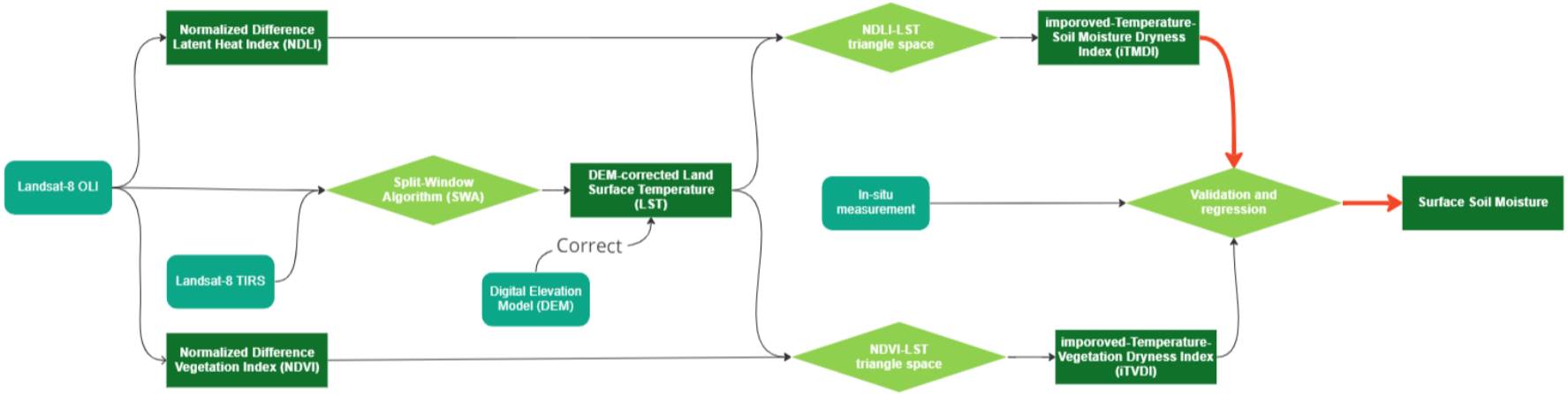

Canizal station value



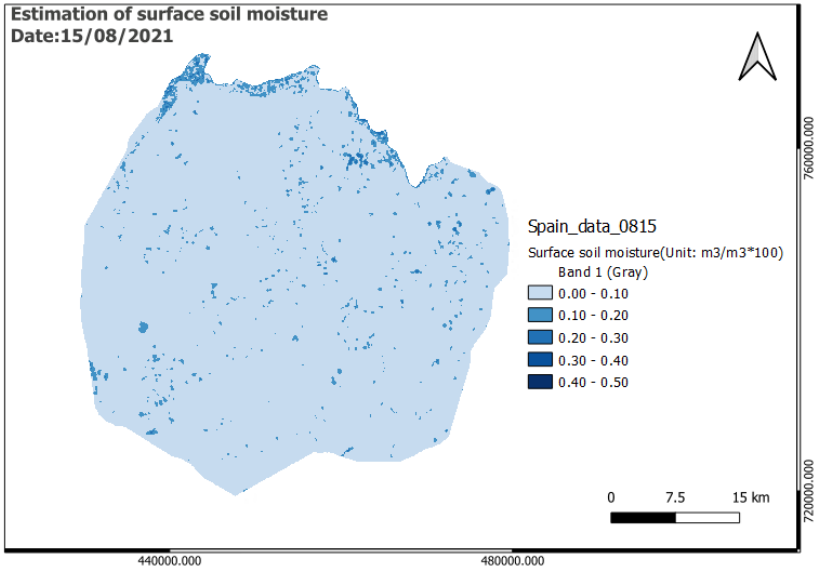

Canizal station value

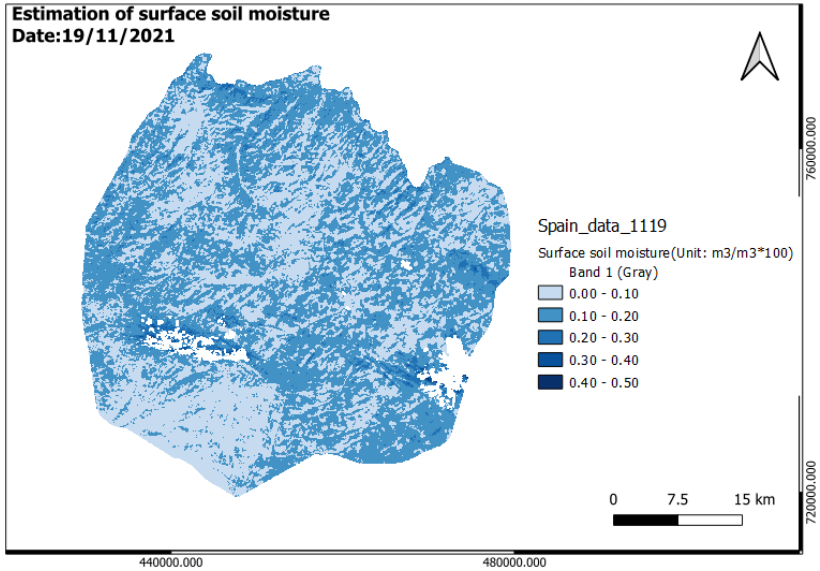


# Methodology



# Spatial distribution of surface soil moisture



# Conclusion

- According to the result of the regression and validation, the new index iTMDI can be used to estimate the surface soil moisture;
- iTMDI can performance better than iTVDI in the estimation of the surface soil moisture;
- In the regression and validation, $R^2$ was not perfect because of scaling effects in the iTMDI index retrieved from satellite images;

# Outlook

- Combine with SAR Backscattering Ratio Method to get more accurate soil moisture result;
- Soil moiture is very low in Guareña river basin, in the future select the region with higher soil moisture variability → More accurate iTMDI classification ranges;
- The accuracy of the index iTMDI still needs to be improved;
- The land use and land cover classification should be improved in the future, the bare soil and built-up area could not be correctly classified;

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# Thank you for your attention


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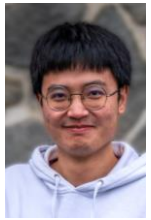

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# Reference


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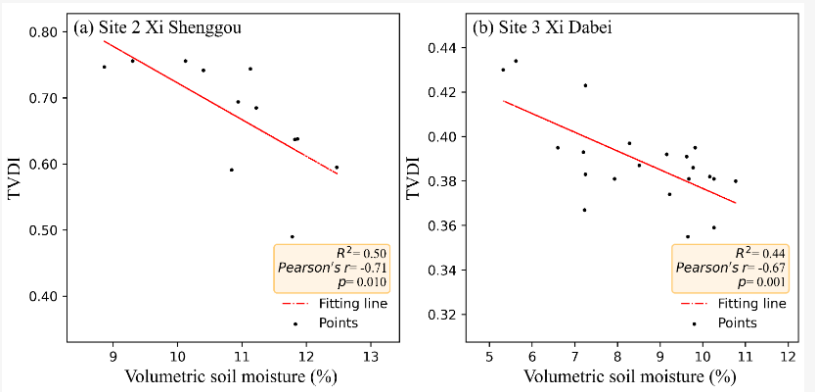
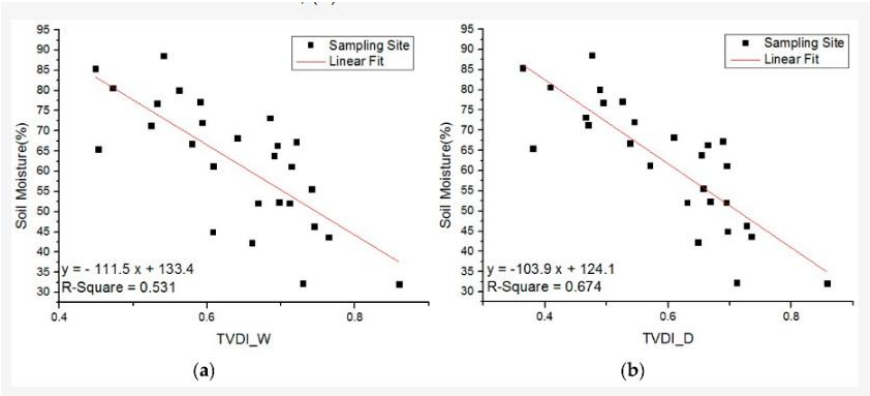
# Other research validation and regression based on in-situ measurement

Correlation analysis between TVDI and soil moisture




(Cheng et al. 2023)

Fit between the calculated TVDI and the soil moisture.




(Liu et al. 2016)

# Other research validation and regression based on in-situ measurement

The correlation coefficients between 0 and 10 cm soil moisture and two TVDIs in different subregions

| Subregion | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| $TVDI_{NDVI}$ | − 0.81 | − 0.15 | − 0.52 | − 0.33 | − 0.65 | − 0.12 | − 0.79 |
| $TVDI_{EVI}$ | − 0.82 | − 0.026 | − 0.43 | − 0.13 | − 0.56 | − 0.10 | − 0.79 |

(Zhao et al. 2021)

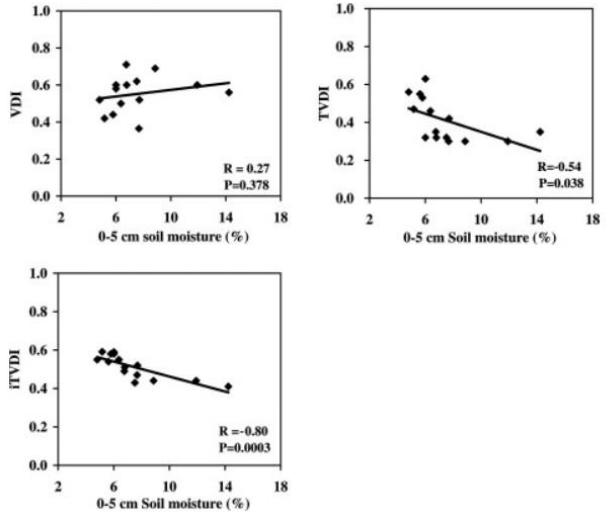
Regression model of soil moisture estimation in the transition zone from the Chengdu Plain region to the Longmen Mountains

| Regression model | Correlation coefficient | $R^2$ | P |
|---|---|---|---|
| $y = -1.1249TVDI + 1.1509$ | 0.710 | 0.5043 | 0.000 |

(Peng et al. 2020)

# Other research validation and regression based on in-situ measurement

Linear correlation between the VDI, the TVDI, the iTVDI, and soil moisture content measured at depth of 0–5 cm in August 2008.




(Rahimzadeh-Bajgiran et al. 2012)