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Synergie Sentinel 1 / Sentinel 2 for the characterization of agricultural land conditions in the Kairouan plain.

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(1) : UCAR/ INAT/Lr GREEN-TEAM

(2): CESBIO

- **UCAR team working in ACCWA:** some members from lab GREEN_TEAM (INAT) and 2 colleagues from INRGREF + PhD students, most of them are members of the LMI NAILA
- **Lr GREEN-TEAM: Merguellil case study**
  - Zeineb Kassouk (Remote Sensing, agricultural crop characterization)
  - Jalel Aouissi (Eco- Hydrology modeling)
  - Ines Oueslati (agricultural water use, irrigation)
  - Aicha Chahbi Bellakanji (remote sensing, yield estimation)
  - Mehdi Ben Mimoun (Agronomy, CC impacts and agriculture adaptation measures)
  - Hamadi Habaieb (Hydrology modeling)
  - Zohra Lili Chabaane (Remote Sensing, Bioclimatology, water management, agricultural water use)
- **INRGREF: Lebna case study**
  - Insaf Mekki (agricultural water use)
  - Rim Zitouna (Biclimatology)
- PhD Students:
  - Nesrine Farhani
  - Safa Bousbih
  - 4 new PhD Students (Emna Ayari, Hayfa Zayani + 2 others to be identified .)

ACCWA / UCAR TEAM: multidisciplinary team

Synergies between different methods, data, tools and programs

Surveys

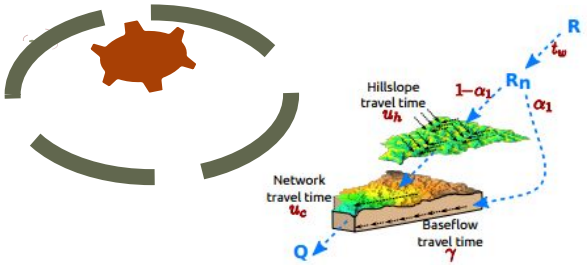
Remote sensing

Archives

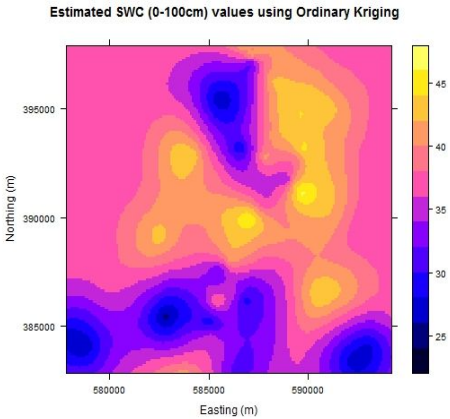

Les inondations
de septembre-octobre 1969
en Tunisie:
Partie I: Etude pédologique
par J. Pias
Partie II: Effets morphologiques
par G. Stuckmann
décembre 1969

Ground measurements

Modelling



Geostatistic

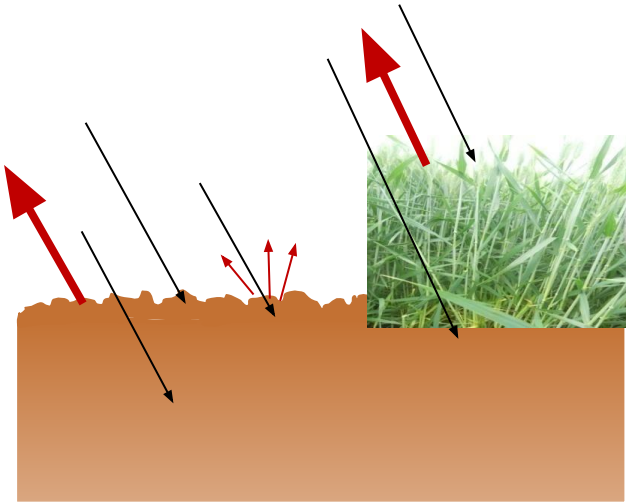


Merguellil CS: a pilot site for the characterization of agricultural land conditions by RS in collaboration with CESBIO

Large spatial and temporal scales

Synergy multi-sensors, multi-resolution

VHR	HR	LR
Pleiades, TERRASAR-X, COSMO-SKYMED, …	SPOT5, ENVISAT, ALOS, LANDSAT, SENTINEL 1 et 2	SPOT/VEGETATION, MODIS, SMOS, ASCAT

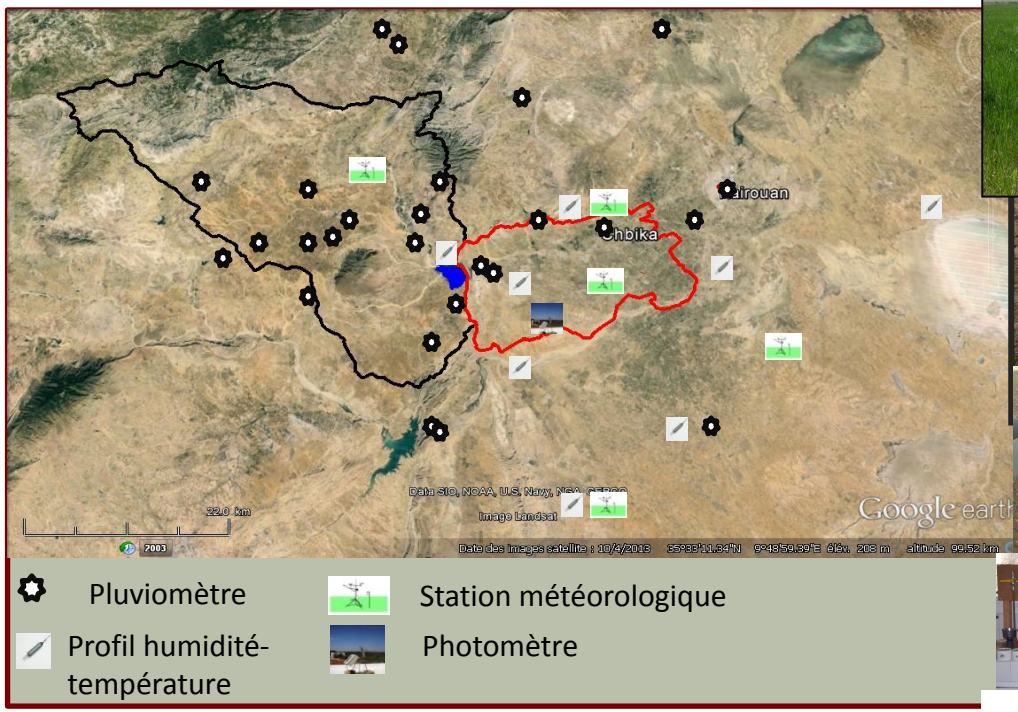


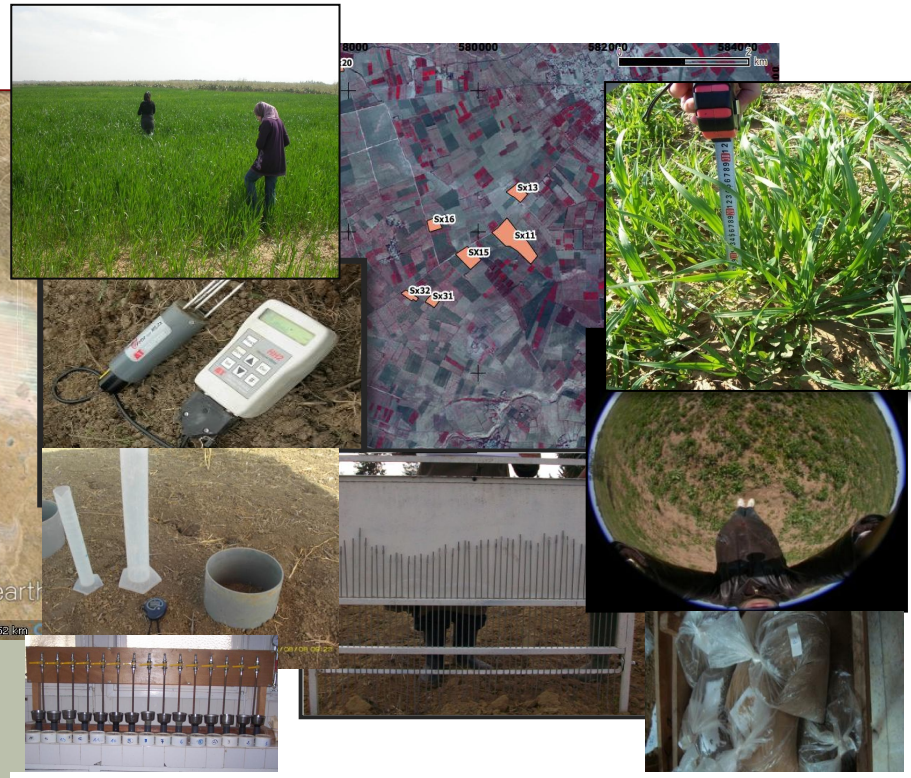
- Soil moisture;
- Agricultural crops identification;
- Soil characteristics (texture and roughness)
- Monitoring vegetation cover and tree plantations;
- Evaluation of the actual evapotranspiration
- Cereal yields estimation
- Agricultural water needs evaluation

Field data collection and protocole on the Merguellil site (with CESBIO)

Irregular local measurements

Continuous local measurements (BV Merguellil)





- single pilot site (SMAP/NASA, SMOS, SENTINEL, ASCAT/METOP)
- Part of research networks (JECAM, SICMED, ..)
- the flow measurements (Eddy covariance method, soil moisture, radiance, ITR)

Since 2008 :

- 8 à 12 images SPOT/year, 60 images ASAR/ENVISAT, 20 images TERRASAR-X,
- LANDSAT image series since 2009, Série SPOT5 et SPOT4 take5, the SENTIENEL series 1 and 2 since their acquisitions

UCAR is involved in all WPs

- WP1: Know-how transfer
- WP2: EO / Soil Moisture
- WP3: EO / ET
- WP4: EO / VEG
- WP5: water use
- WP6: Yield estimation
- WP7: hazards: Leader
- WP8: Validation
- WP9: Climate Change Impact
- WP11: Technical Management

UCAR is Leader of WP7 and strongly involved in WP3, WP4, WP6, WP7 and WP8

Secondments 2019

Safa Bousbih (PhD Student) -> 2 months IsardSat

Jalel Aouissi -> UCAM 1 month

Planned Secondments 2020

PhD Student to be identified (with Rim Zitouna)-> 2 months Labferer

PhD student to be identified (with Mehdi Ben Mimoun) -> IsardSat / IRTA ?2 months

PhD Emna Ayari (with Z Lili Chabaane)-> 2 months IsardSat

PhD Hayfa Zayani (with Z Lili and Z Kassouk) -> 2 months IsardSat

Nesrine Farhani (PhD Srudent) -> UCAM(2 months)

Rim Zitouan -> Labferer 1 month

Jalel Aouissi -> Agrhymet 1 month

Zeineb Kassouk -> Agrhymet (1 month)

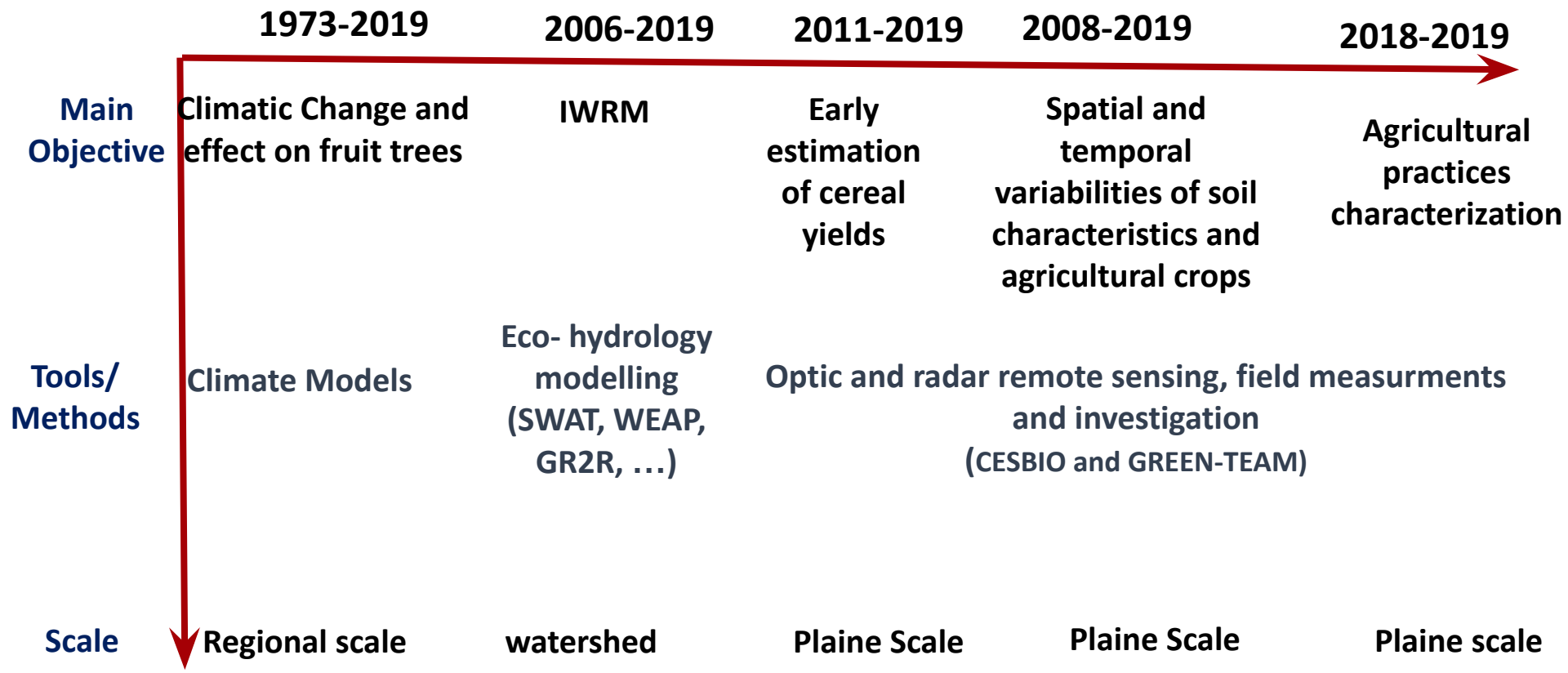
Zohra Lili Chabaane -> IsardSat/ Labferer/ IRTEA ? (1 month)

Ines Oueslati -> LabFerrer /IRTA ? (1 month)

Aicha Chabi -> IsardSat/ IRTA ?(1 month)

….. Insaf Mekki ?, Mehdi Ben Mimoun ? Hamadi Habaieb ?

Overview of GREEN-TEAM research investigations in Merguellil Area



Scientific context

Contribution of radar images

- Sensitivity to soil parameters
- Independence to climatic conditions
- High spatial and temporal resolution

Contribution of optical images

- Vegetation cover characterizing
- High spatial and temporal resolution

Satellite imagery

Sentinel-1

Launch

Sentinel-1A : April 3th 2014

Sentinel-1B : April 25th 2016

Spatial resolution

10 up to 40 m

Revisit

6 days

Instrument

Synthetic Aperature Radar with C-band

Sentinel-2

Launch

Sentinel-2A : June 23th 2015

Sentinel-2B : March 7th 2017

Spatial resolution

10 m up to 60 m

Revisit

5 days

Instrument

Multi-spectral imager with 13 bands

Why Sentinel constellation?

Sentinel-1

1. Systematic time series across several regions: 12 days to 6 days with S1A & B with time tracking applications

2. Free data access

3. Calibrated data

4. A wide swath, high spatial resolution
Mode IW: 250 Km , pixel of 10 m

5. SAR interferometry (up to 12 or 6 days)

6. Accessible processing tools

Satellite data

- Optical and radar time series images derived from the Sentinel-1 and Sentinel-2 constellations over two agricultural period between 2015-2016 et 2016-2017, acquired over the Kairouan plain.

Ground measurements

Thetaprobe measurements

Hemispherical images

1 m profiler

Which data? Soil moisture Thetaprobe measurements, roughness measurements with 1 m profiler, LAI measurements, vegetation height and water content

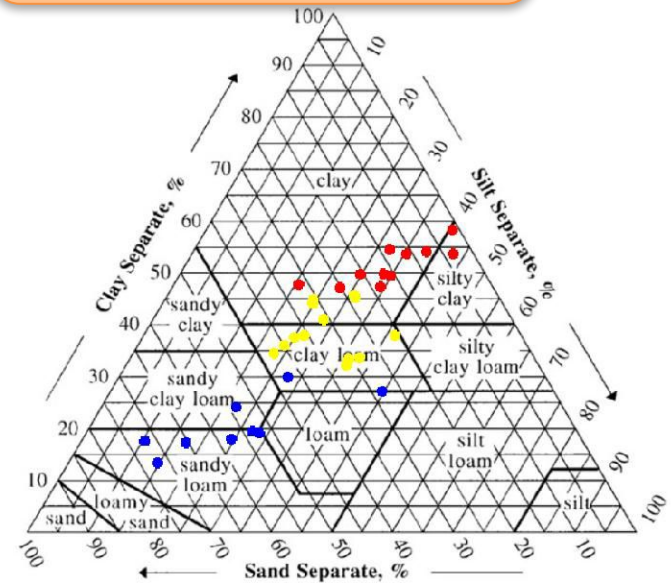
Sites of Kairouan - **5 meteorological stations** : air temperature (°C), relative moisture (%), wind speed (m/s), global radiation (W/m2) and precipitation (mm). **5 soil moisture stations** measuring soil moisture and soil temperature

Specific measurements- Surveys and location of irrigated cereal and rainfed plots

Satellite data

- Optical and radar time series images derived from the Sentinel-1 and Sentinel-2 constellations over two agricultural period between 2015-2016 et 2016-2017, acquired over the Kairouan plain.

Ground measurements



Which data? Soil texture measurements based on the Robinson pipette laboratory technique.

3 classes of clay content were identified over the reference fields :

- Sandy soils with low values of clay content :

15-30 %

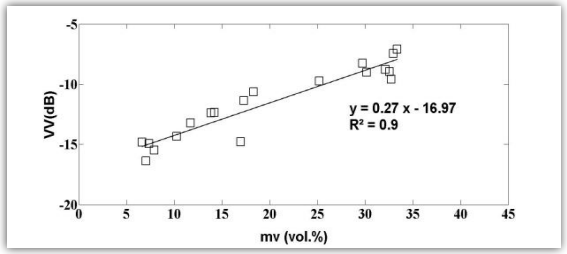
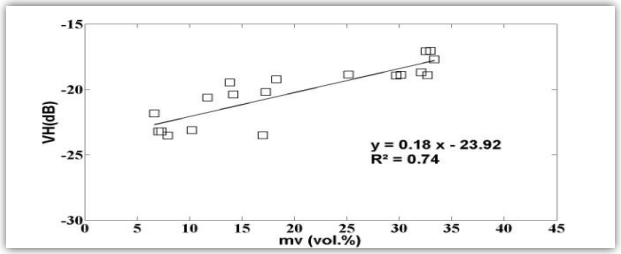
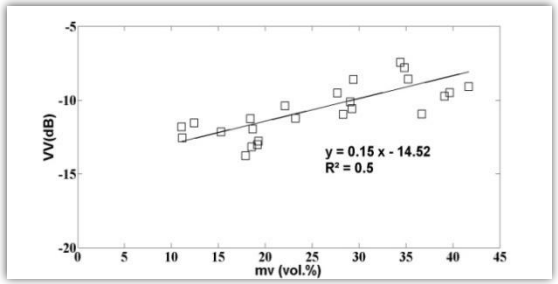
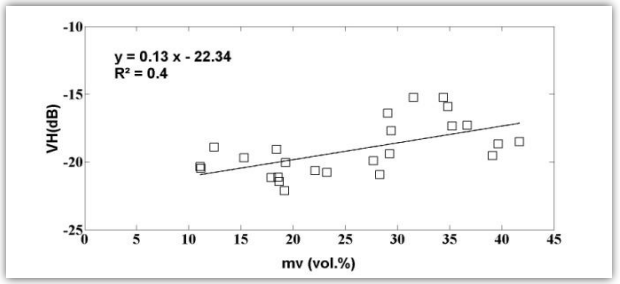
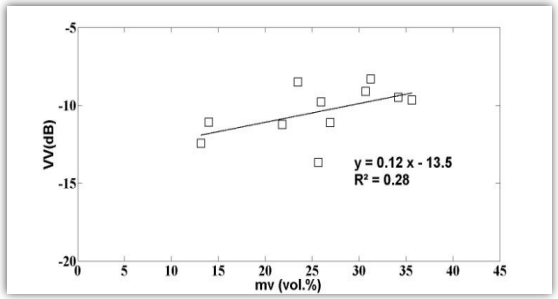
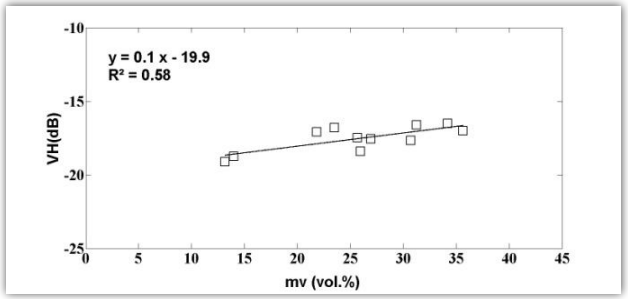
- Loamy clay soils:

30-45 %

-Clay soils:

-45-60 %

Sensitivity analysis of S1 data: sensitivity to soil moisture

	VV polarization	VH polarization
NDVI<0.25		
0.25<NDVI<0.5		
NDVI>0.5		

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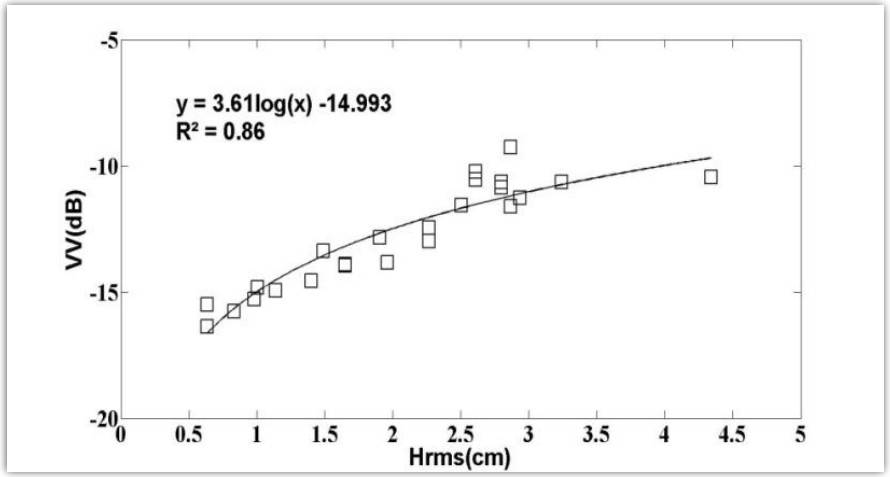
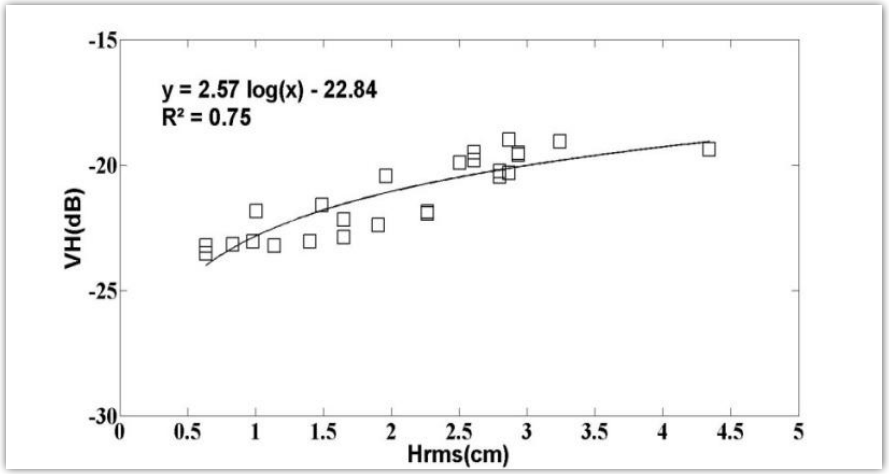
Sensitivity analysis of S1 data: sensitivity to soil roughness

VV polarization



VH polarization



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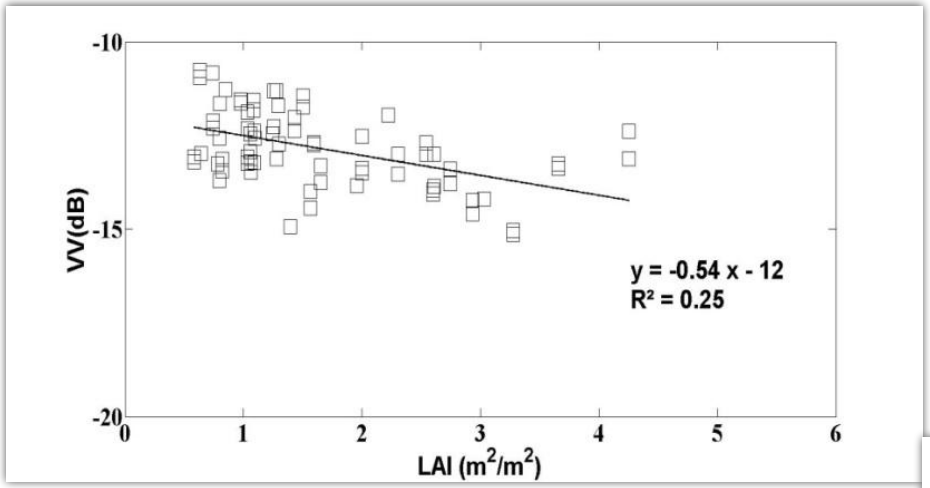
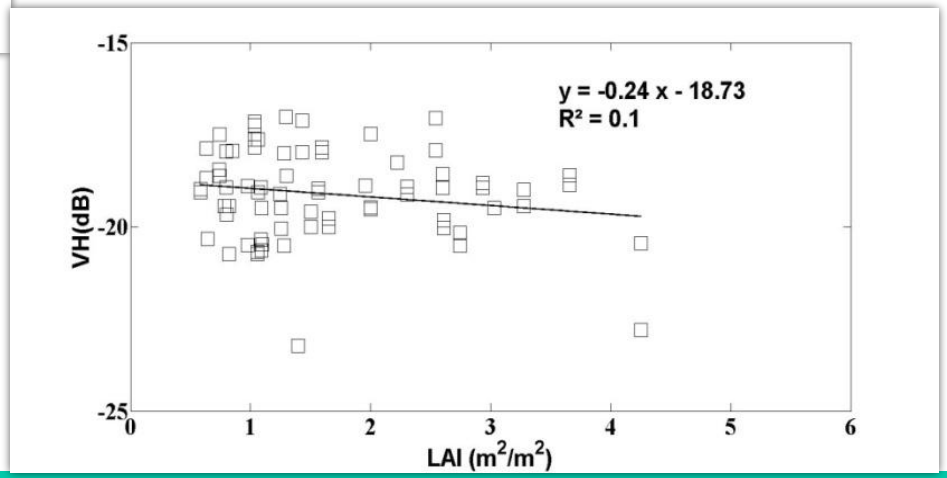
Sensitivity analysis of S1 data: Sensitivity to vegetation parameters (LAI)

VV polarization



VH polarization



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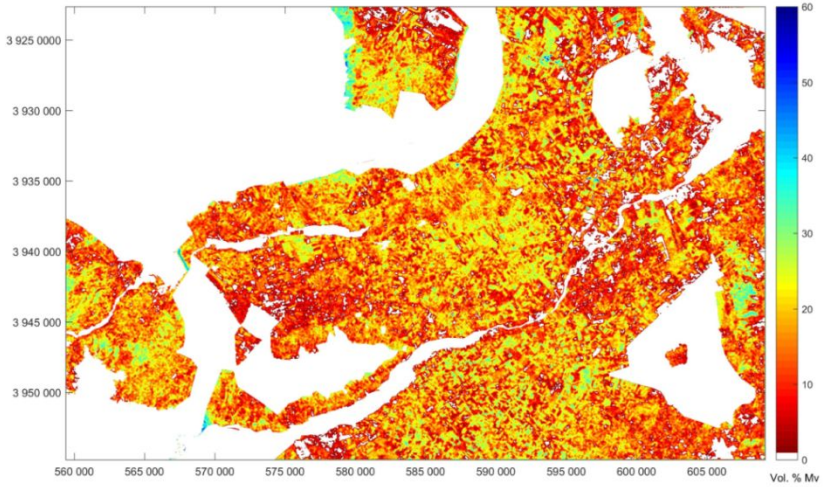
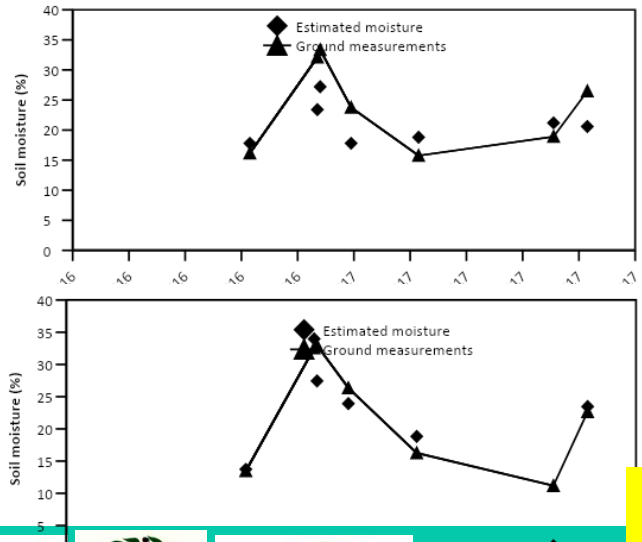
Soil moisture mapping

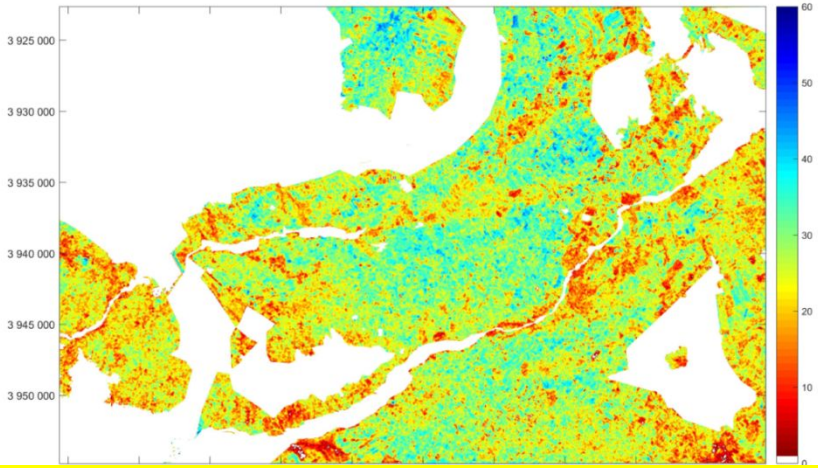
20/07/2016





Two specific soil moisture maps were selected to represent two different moisture conditions: a dry condition for 20/01/2016 and a wet condition for 24/12/2016

24/12/2016



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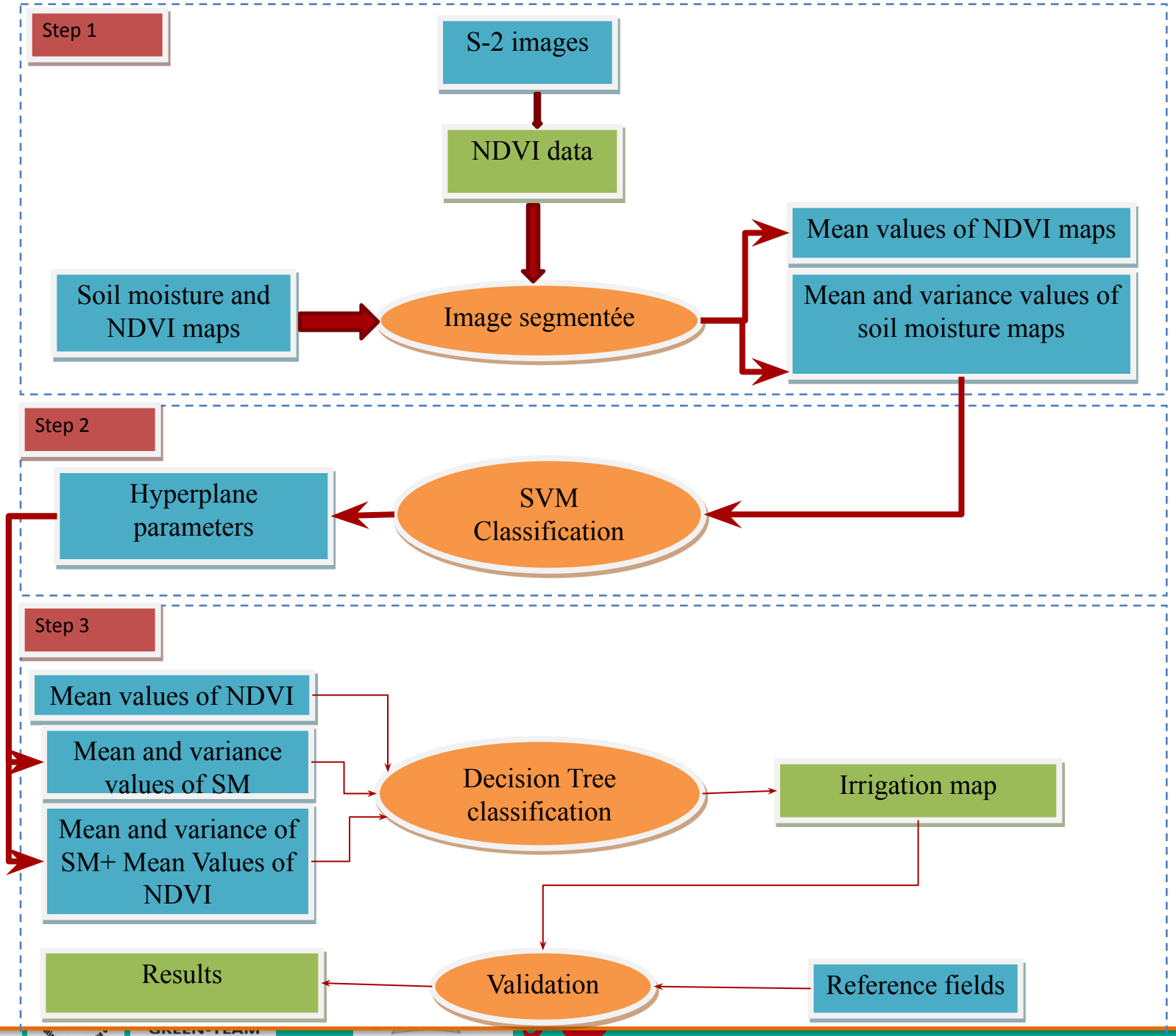
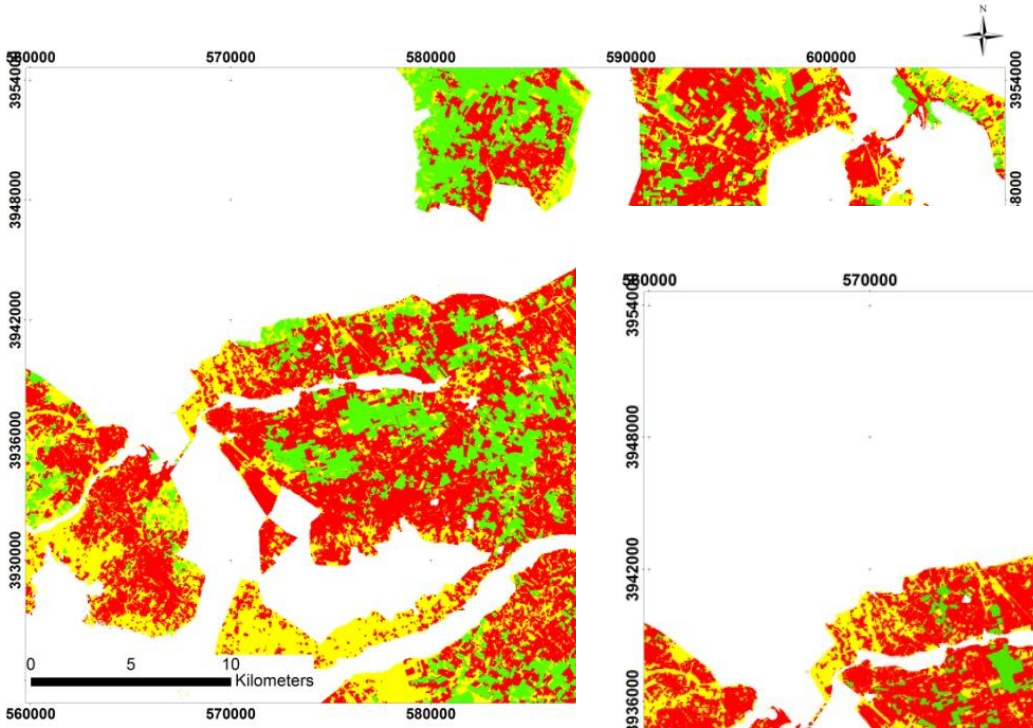
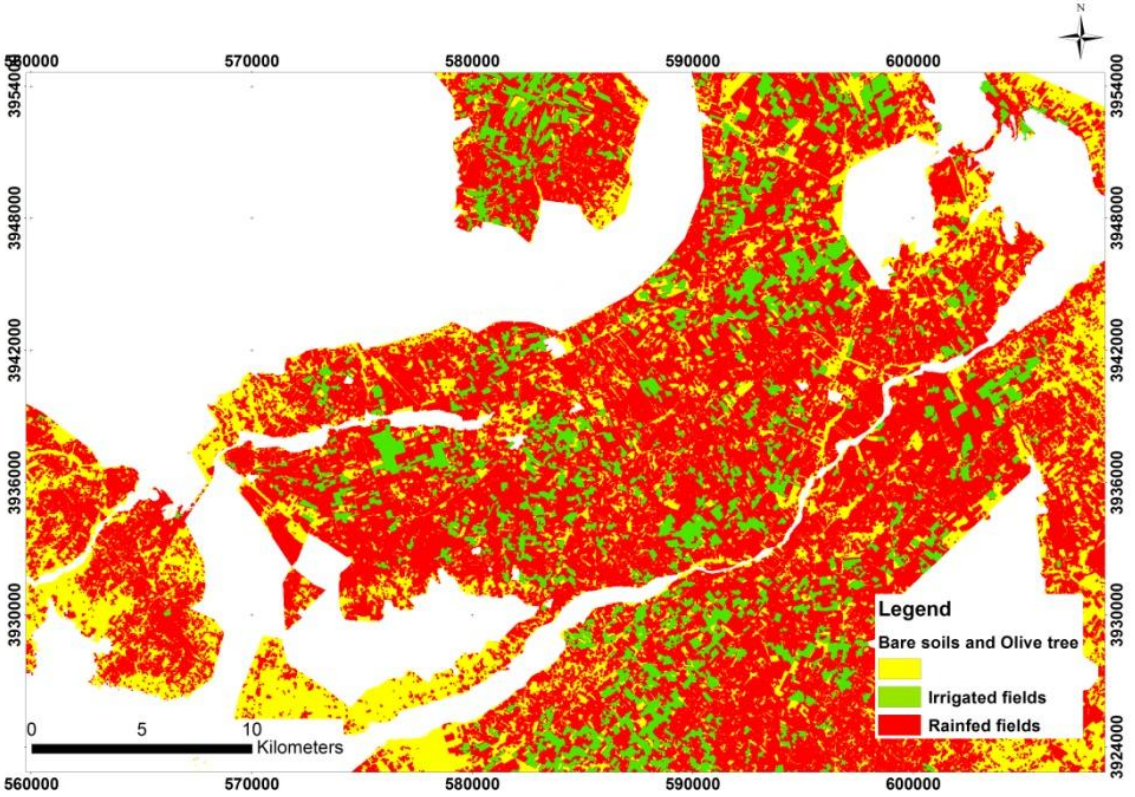
IRRIGATION MAPPING



Irrigation mapping



2015/2016



2016/2017

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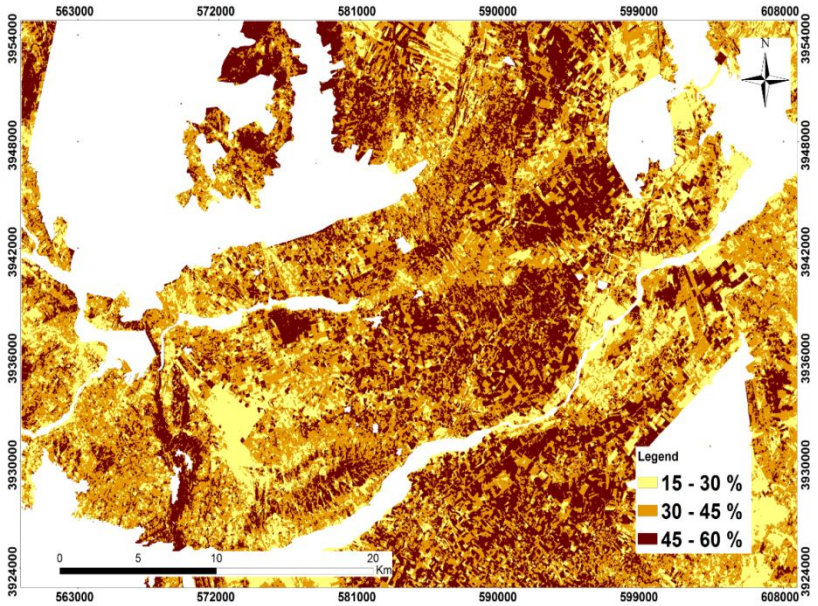
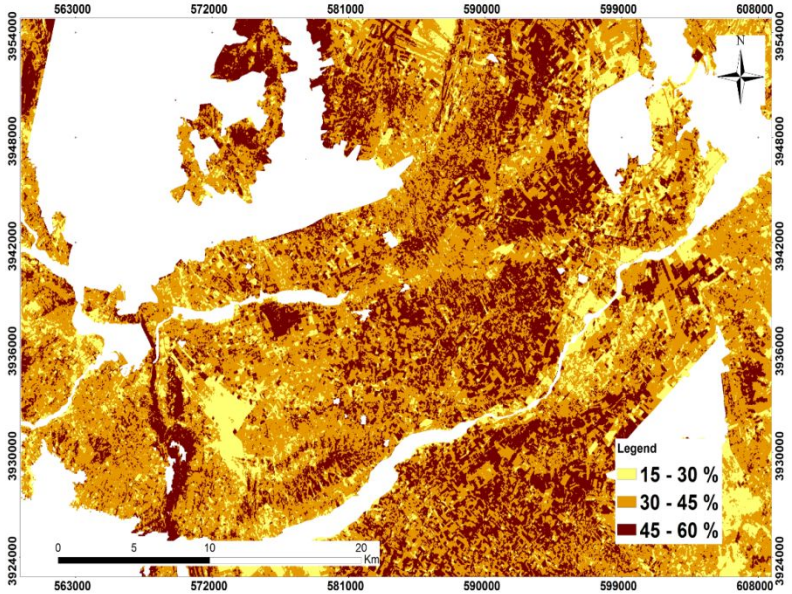
Clay content maps

Clay content maps using SVM (a) and RF (b) algorithms



(a)



(b)

The analyzes of the maps show a good agreement with the measurements on the reference plots. The validation of the maps show an overall accuracy of 63% using the SVM classification and 65% by the RF. Both classifications showed similar results.

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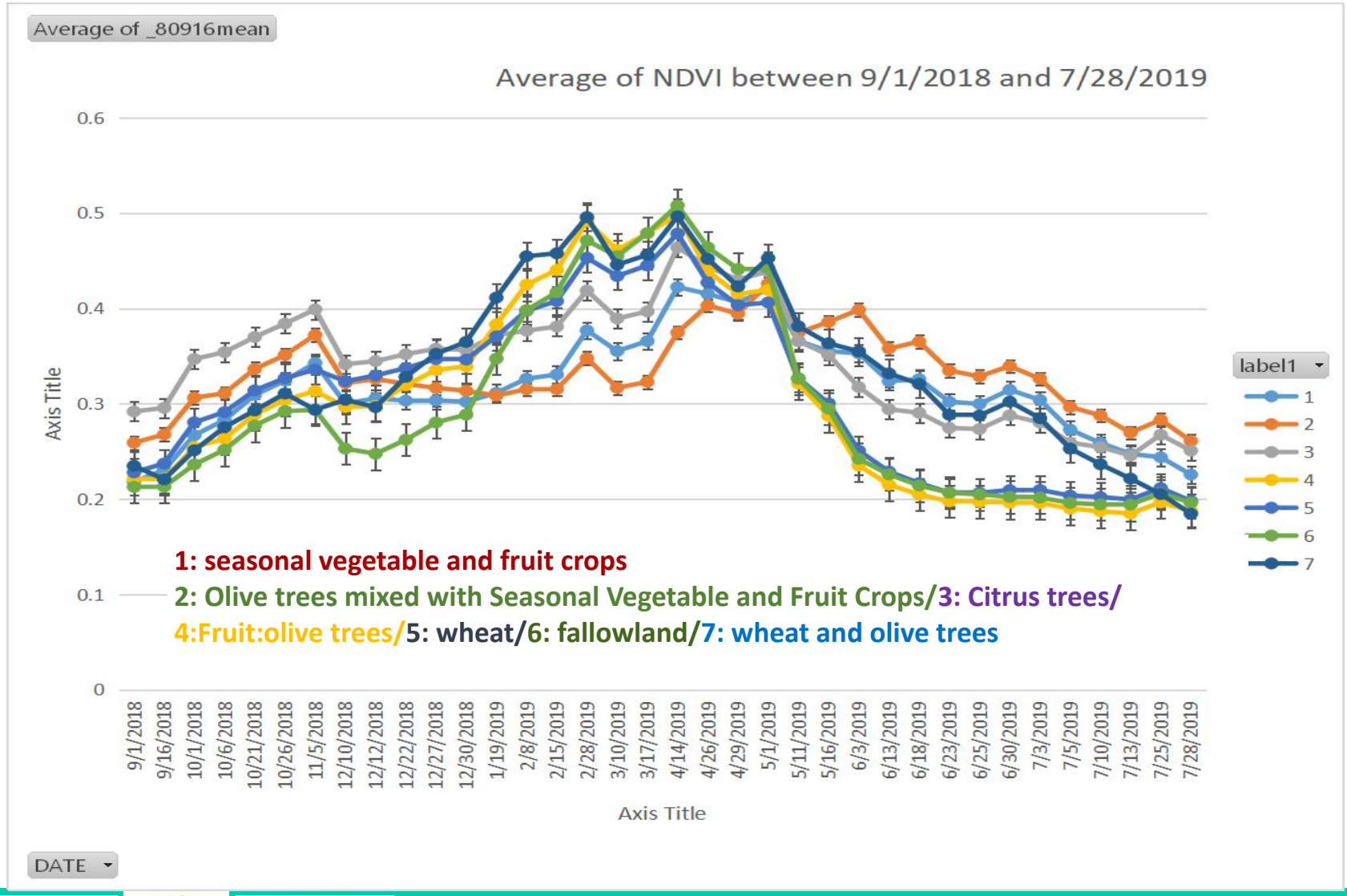
Average of _80916mean
Average of NDVI between 9/1/2018 and 7/28/2019
0.6
0.5
0.4
0.3
0.2
0.1
0
Axis Title
label1
1
2
3
4
5
6
7
1: seasonal vegetable and fruit crops
2: Olive trees mixed with Seasonal Vegetable and Fruit Crops/3: Citrus trees/
4:Fruit:olive trees/5: wheat/6: fallowland/7: wheat and olive trees
9/1/2018
9/16/2018
10/1/2018
10/6/2018
10/21/2018
10/26/2018
11/5/2018
12/10/2018
12/12/2018
12/22/2018
12/27/2018
12/30/2018
1/19/2019
2/8/2019
2/15/2019
2/28/2019
3/10/2019
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4/14/2019
4/26/2019
4/29/2019
5/1/2019
5/11/2019
5/16/2019
6/3/2019
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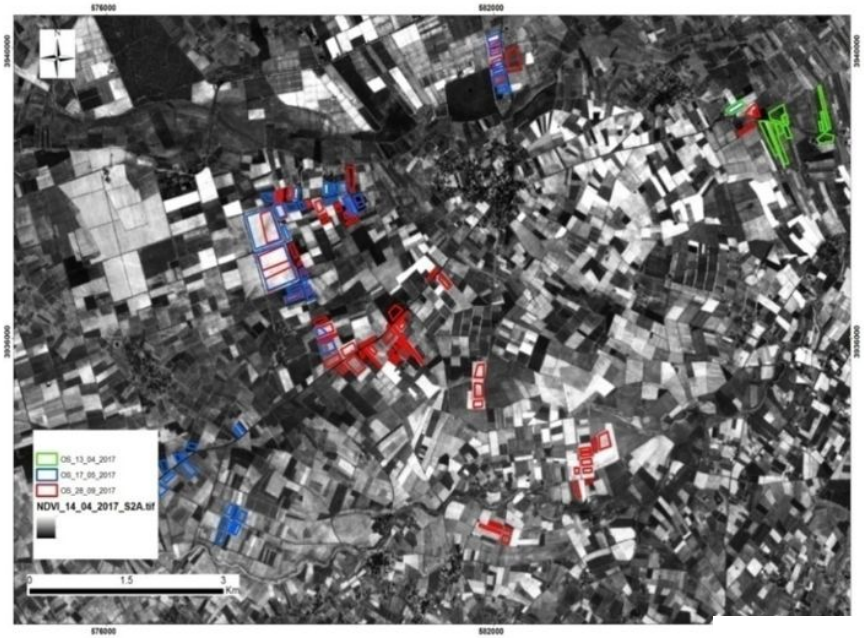
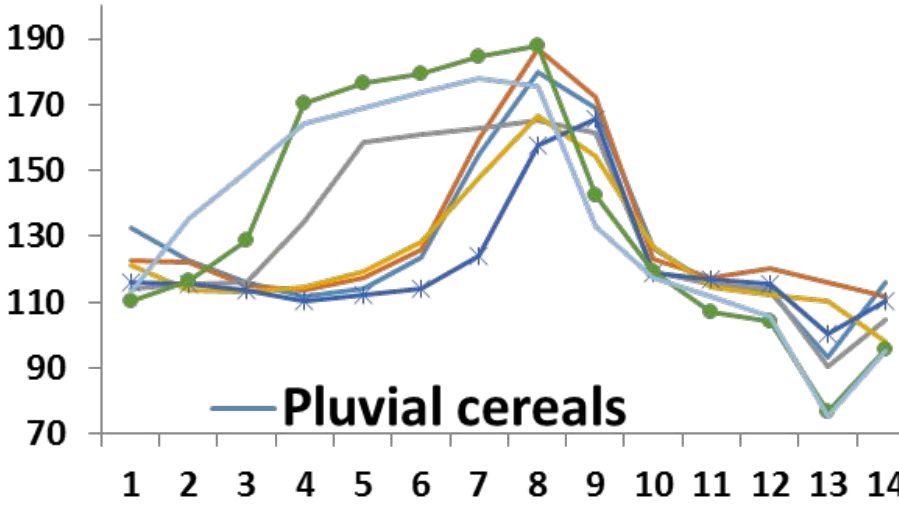
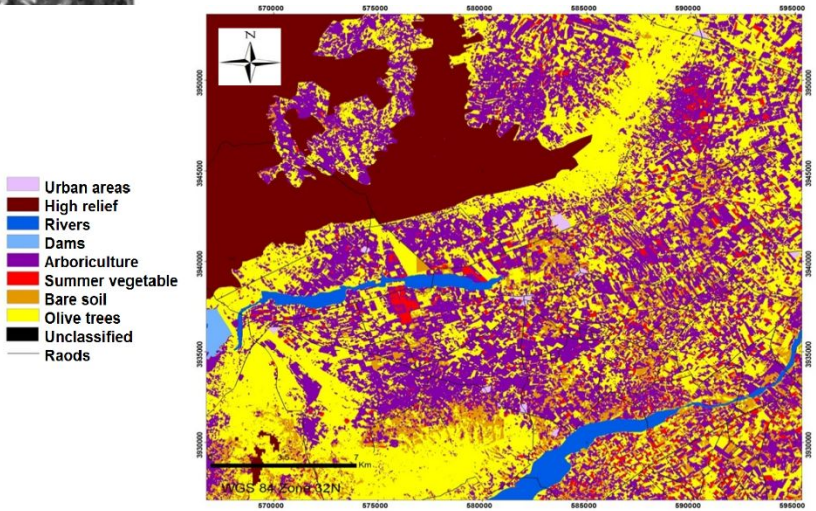
6/18/2019
6/23/2019
6/25/2019
6/30/2019
7/3/2019
7/5/2019
7/10/2019
7/13/2019
7/25/2019
7/28/2019
Axis Title
DATE

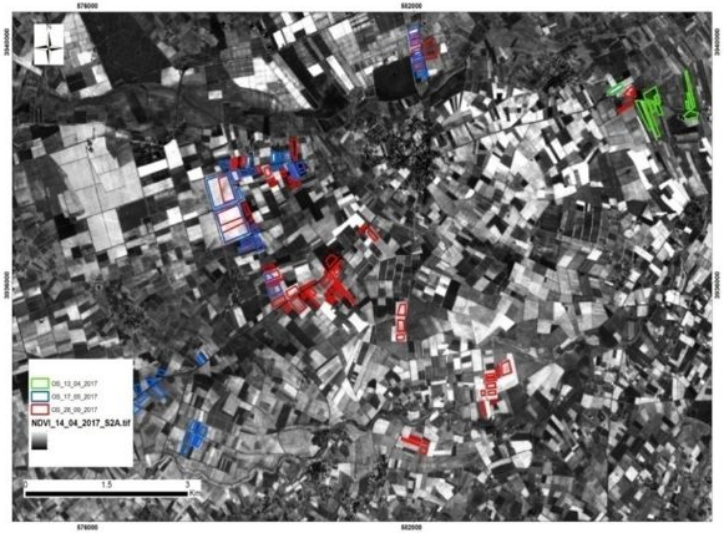
annual crops in Kairouan plain

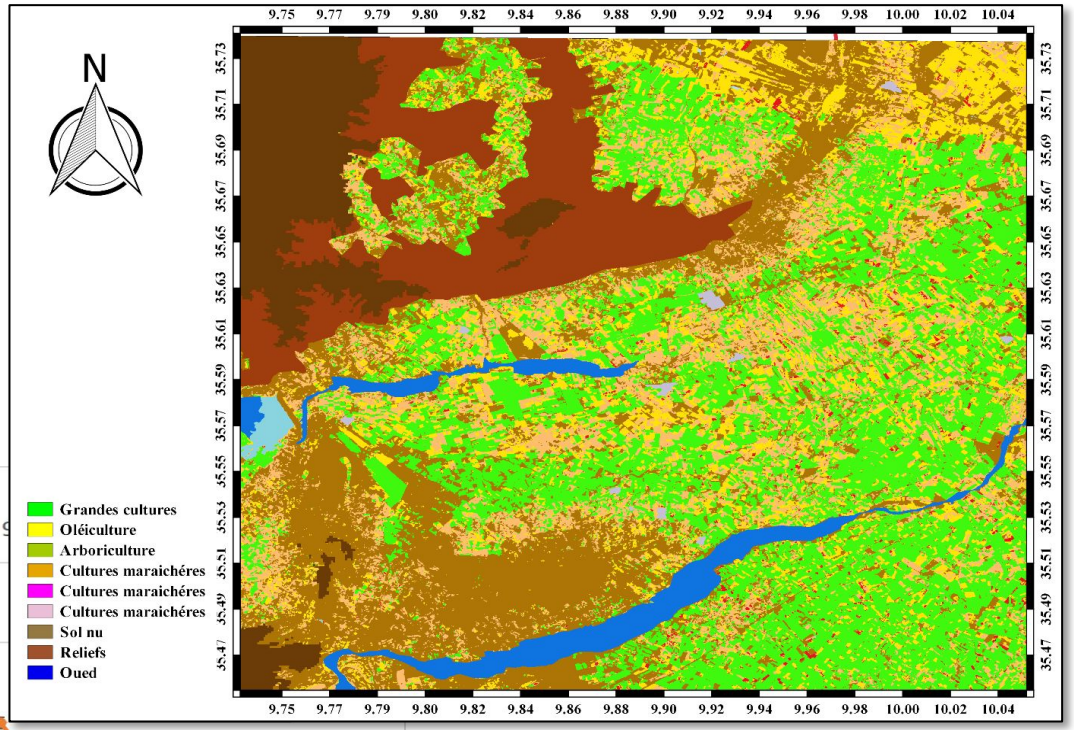


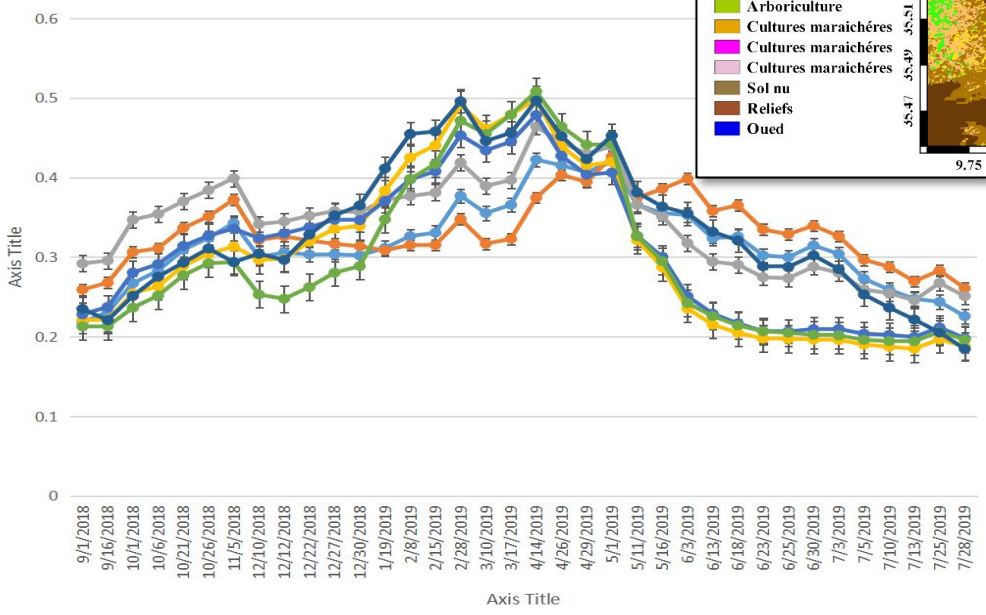




Seasonal agricultural Crops







1: seasonal vegetable and fruit crops
2: Olive trees mixed with Seasonal Vegetable and Fruit Crops/3: Citrus trees/
4:Fruit:olive trees/5: wheat/6: fallowland/7: wheat and olive trees

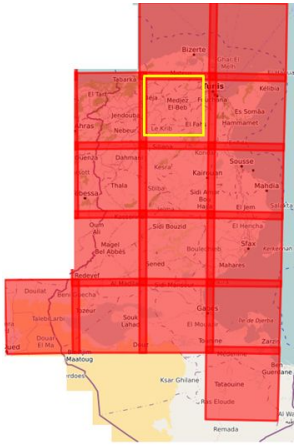
Agricultural practices characterization

Tillage practices present a major element of crop management techniques. They can significantly alter the amount of rain and irrigation water available for plant growth (Ahuja et al., 1998). Knowing and detecting the type of tillage according to the type of crop is a very important element for predicting agricultural water use and crop yield and therefore the production potential of the farms

Data collection

Satellite data

Sentinel-2 (A and B)
Treatment level : L2A



Observations

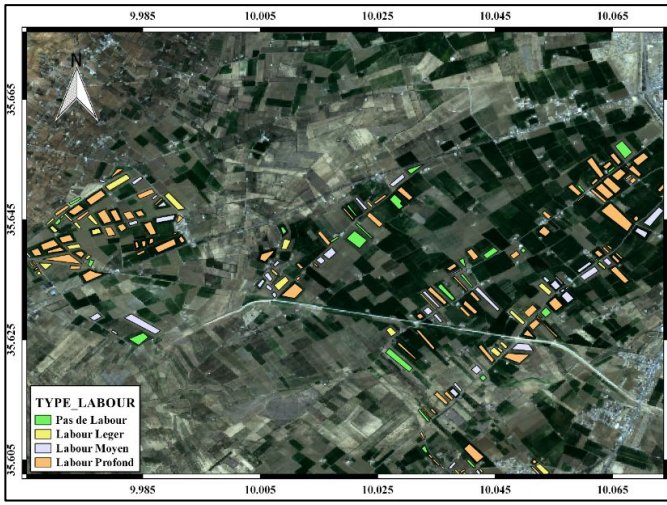
Deep tillage

Shallow tillage

Old tillage

Very old tillage

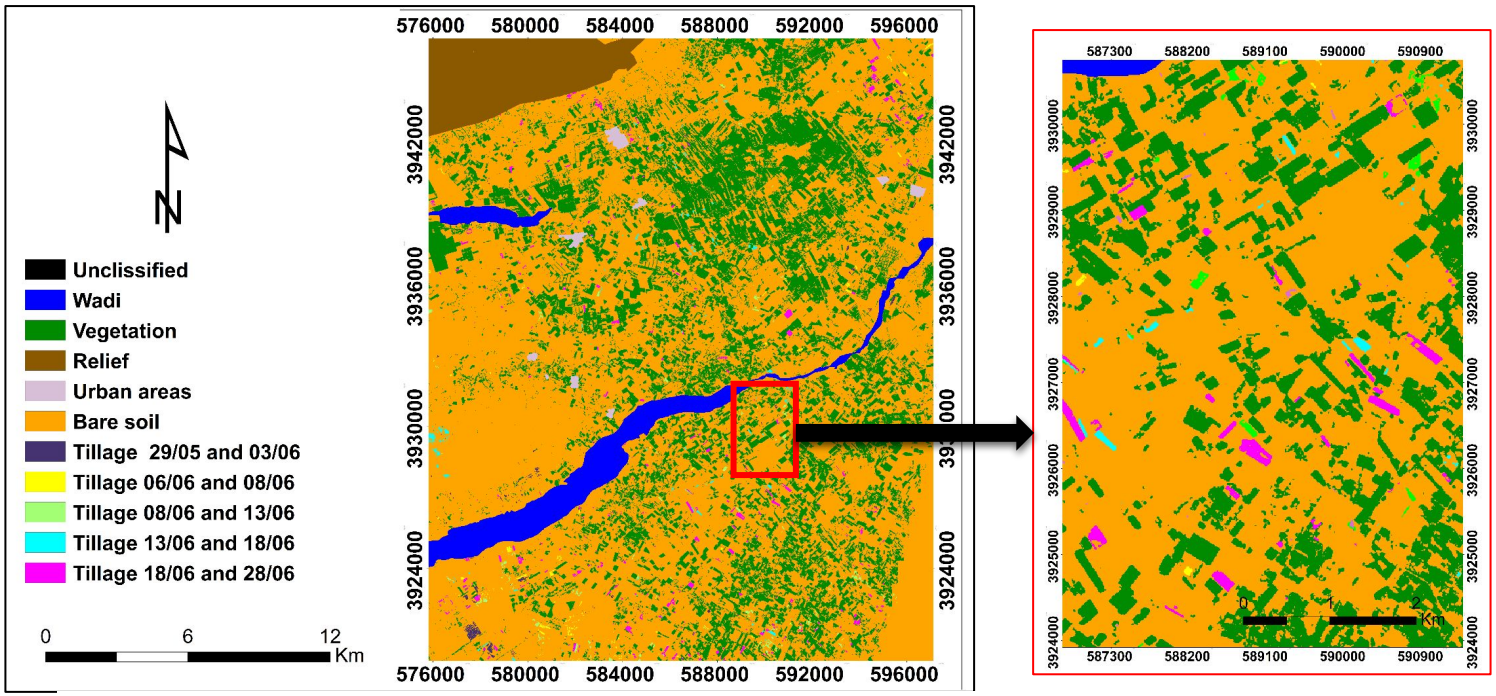
432 fields observations and 125 farmer surveys (Agronomic questionary)



Tillage detection

7 tillage maps, over the plain of Merguellil, are produced with an overall accuracy of 92.3% and a kappa coefficient of 0.68.

Tillage map overall the Merguellil plain (June 2018)



Detected tillage of the 2017-2018 agricultural season

ACCWA

جامعة قرطاج
Université de Carthage

Thank you for you attention