CROP WATER PRODUCTIVITY UNDER CLIMATE FORCING AND IRRIGATION STATEGY IN THE IRRIGATED ZONE OF DOUKKALA, MOROCCO

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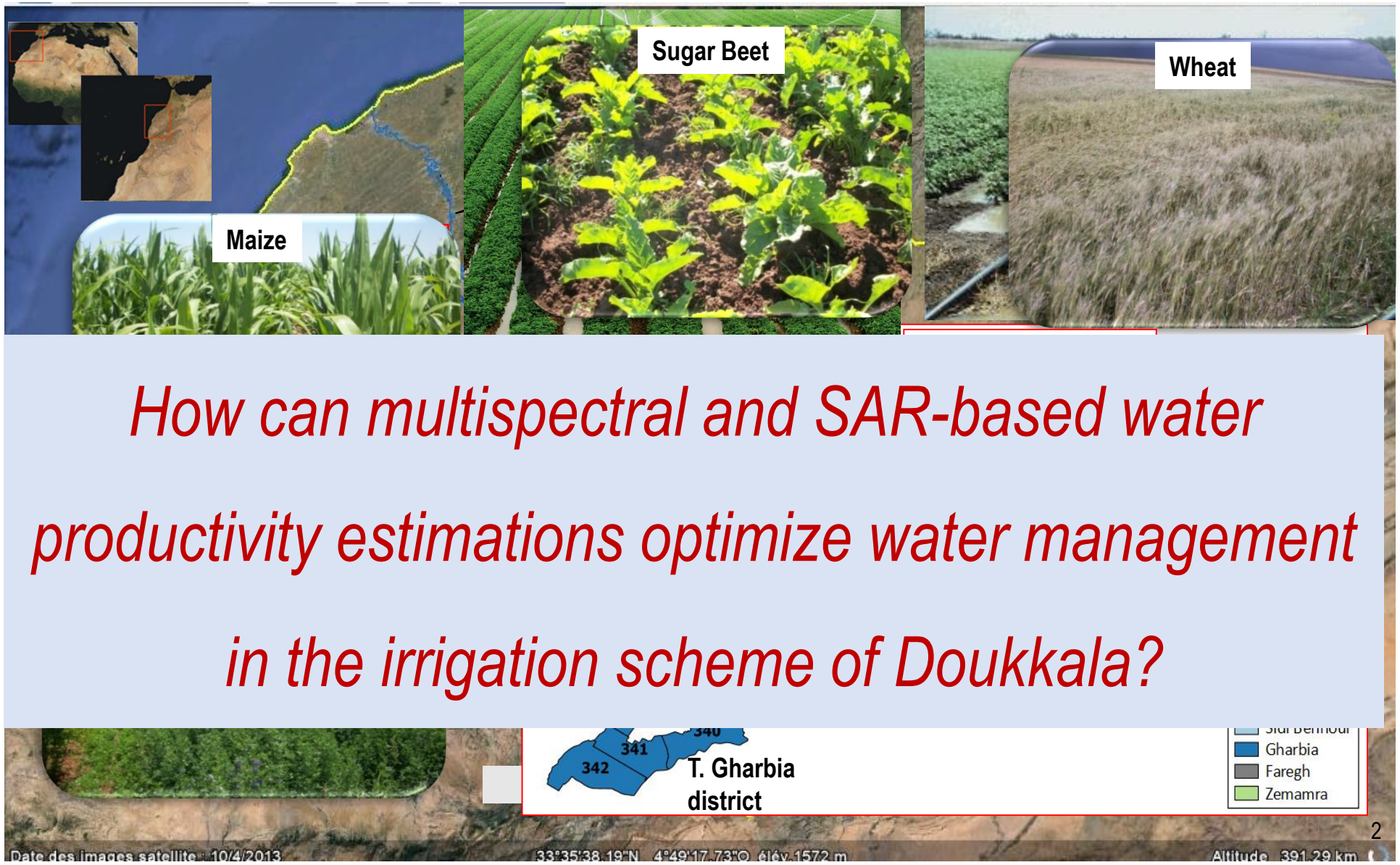
INTRODUCTION & BACKGROUND



RESEARCH OBJECTIVES

1) Investigate whether the climate variability effect is reflected on crop water productivity (CWP)

2) Evaluate multispectral and SAR-based water productivity estimates

3) Identify the irrigation strategy to be applied to achieve the required level of water productivity

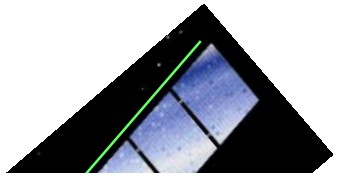
ESA_TIGER project

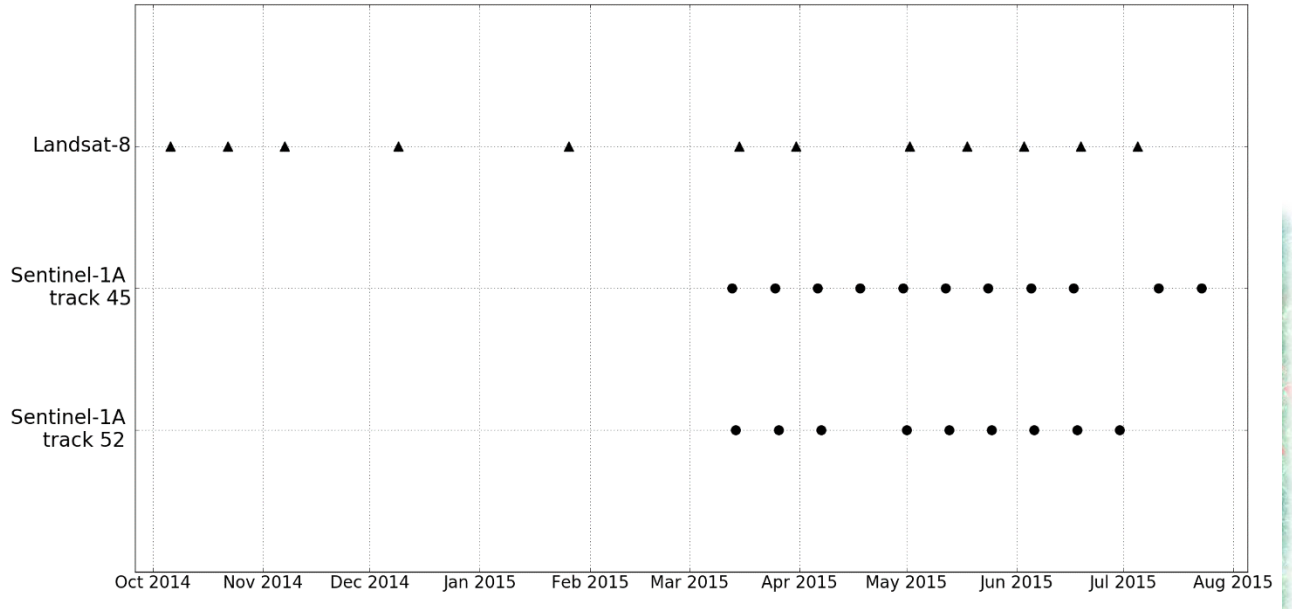
H2020_ MOSES project

SATELLITE DATA (2014-2015):

LANDSAT 8 (OLI) DATA

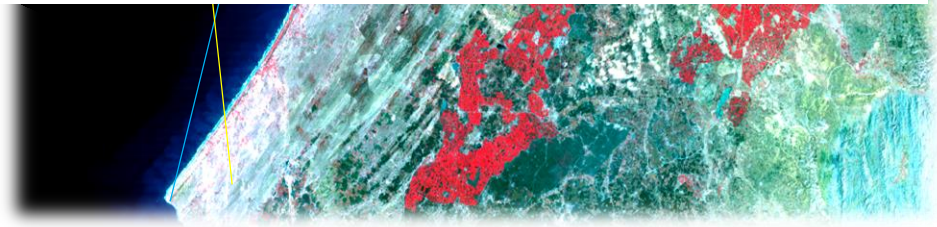
- ❑ Spatial Resolution: 30m
- ❑ Revisit Time: 16 days
- ❑ Radiometric Resolution: 12 bit
- ❑ Spectral Sampling :
  - Blue: 0.450 - 0.515 um
  - Green: 0.525 - 0.60 um
  - Red: 0.63 - 0.68 um
  - NIR: 0.845 - 0.885 um
  - SWIR: 1.56 - 1.66 um
  - SWIR: 2.10 - 2.30 um
  - Panchromatic: 0.50 - 0.68 um





SENTINEL 1A (SAR) DA

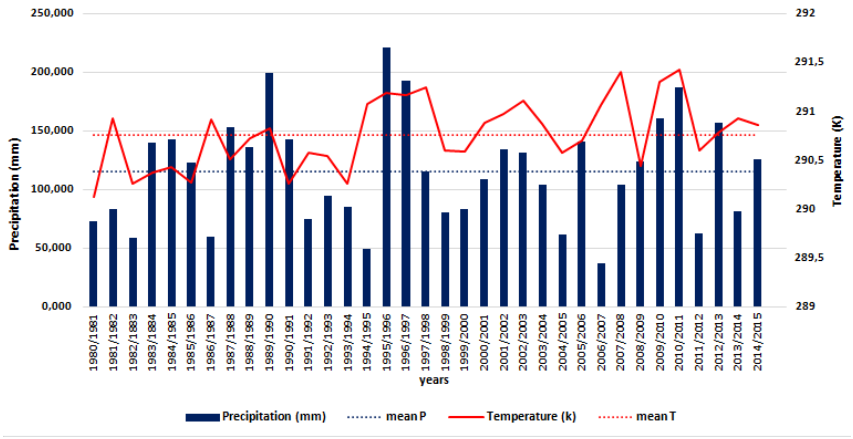
- ❑ Waveband: C – band
- ❑ Polarization: Dual VV+VH, HH+HV
  Single: HH, VV
- ❑ Available polarization over Morocco VV+VH
- ❑ Orbital tracks : 45, 52
- ❑ Spatial Resolution: 5 x 20 m
- ❑ Revisit Time: 10 days



Doukkala Area

DATA ACQUISITION : ECMWF-ERA-Interim / land + ground station data

Seasonal anomalies (ECMWF-ERA-Interim data)



seasonal evolution of P and T anomalies over 35 years on the basis of ERA-Interim data analysis.

Seasonal ET0-P (ground station data)

	2013-2014	*2014-2015*	*2015-2016*
ET0-P (mm)	987.1910045	1018.124266	1202.292614

WET

MEAN

DRY

METHODOLOGY

- Crop classification: -ISODATA (Unsupervised) Classification
  -Support Vector Machine on radar imagery from Sentinel-1A

- Time series of multispectral images (Landsat-8/Landsat 7) → HANTS (Cloud removal and reconstruction) → ISODATA → Validation

- Time series of multispectral images (Landsat-8)
- Hourly/daily meteo data (e.g. temperature, humidity, wind speed)

Physically-based

Thermal, Multispectral data

SEBAL → Crop water use → $LE = R_n - H - G$

- Single C-band radar images (Sentinel-1A)
- Field measurements of yield

Radar model → Biomass, Crop Yield

$$B_{acc} = \varepsilon \cdot \sum(APAR(t) \cdot t),$$

$$yield = B_{acc} \cdot \frac{HI}{1-m},$$

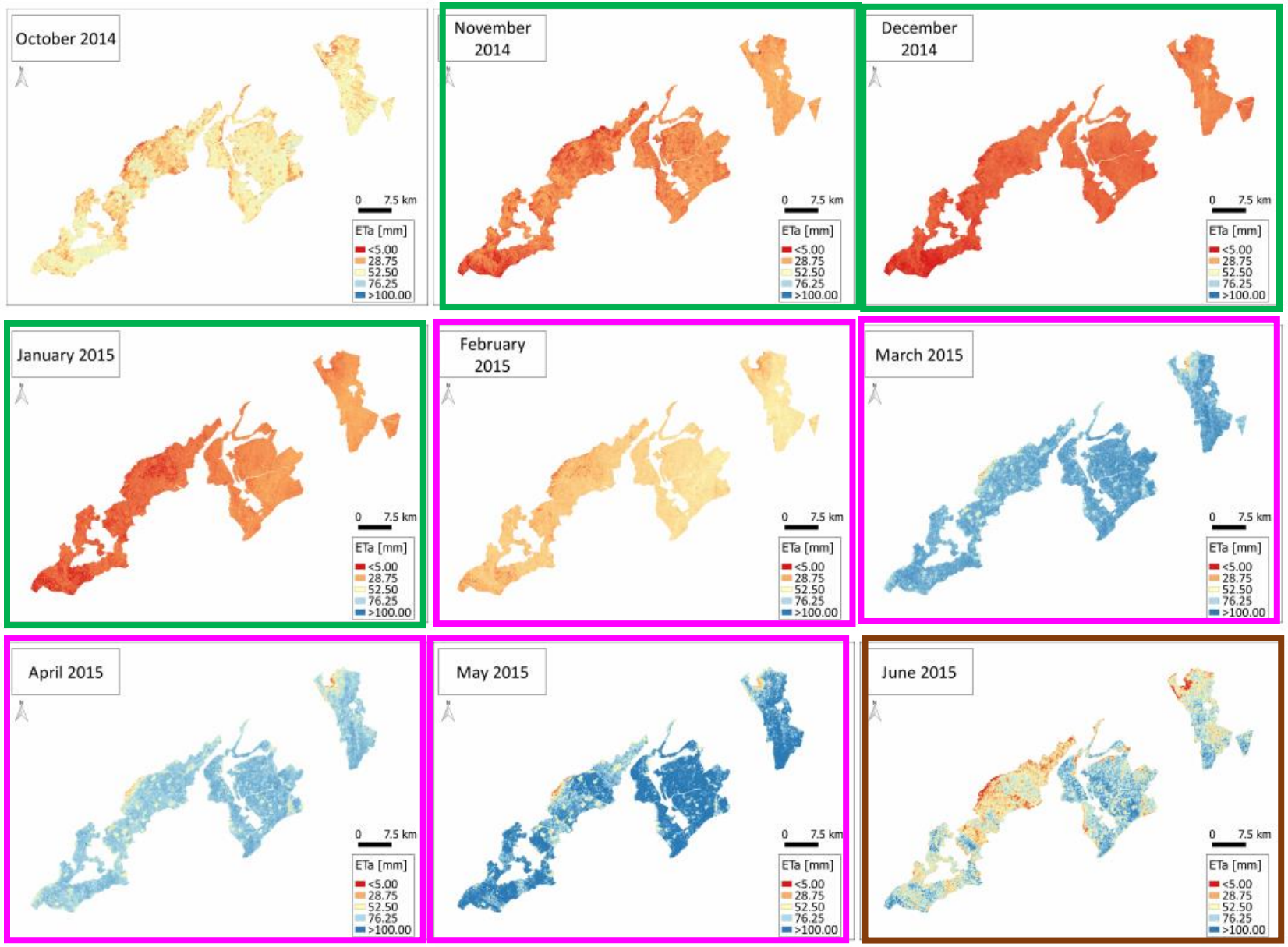
Water productivity

$$WP = \frac{\text{crop yield } [\frac{kg}{ha}]}{\text{crop water use } [\frac{m^3}{ha}]}$$

Radar method

Calibration

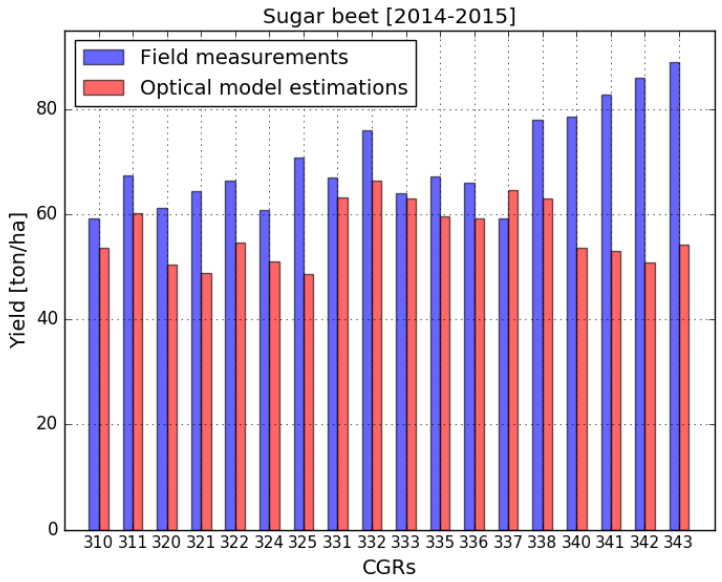
Results: Multispectral model
crop water use (SEBAL)



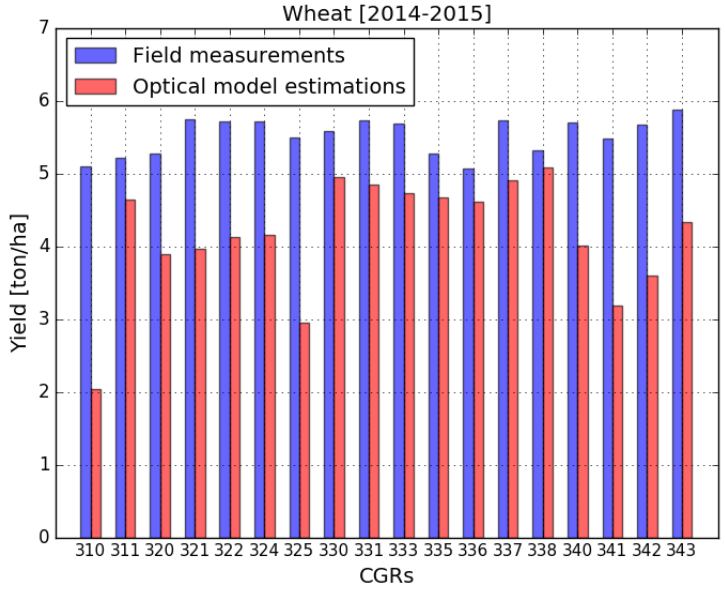
RESULTS

Evaluation of multispectral and SAR-based water productivity estimate

Results: Multispectral model, Crop Yield estimation

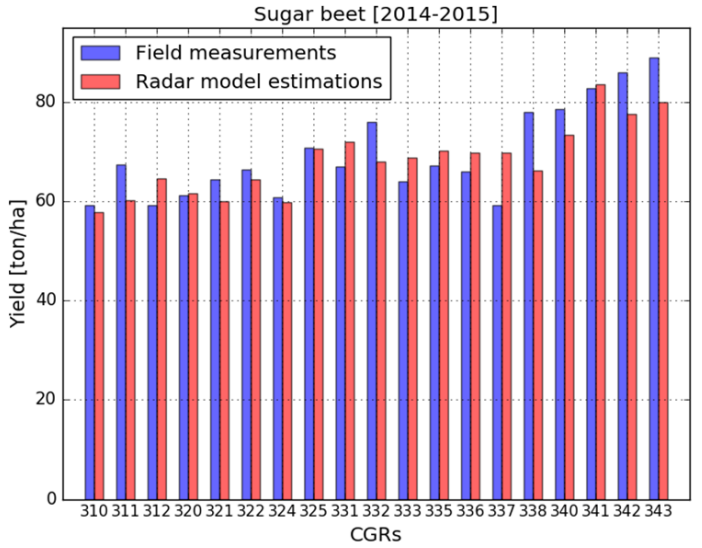


	Sugar beet	Wheat
RMSE [ton/ha]	17.63	1.57
NRMSE [%]	59.02	192.99
MRD [%]	18.15	24.82

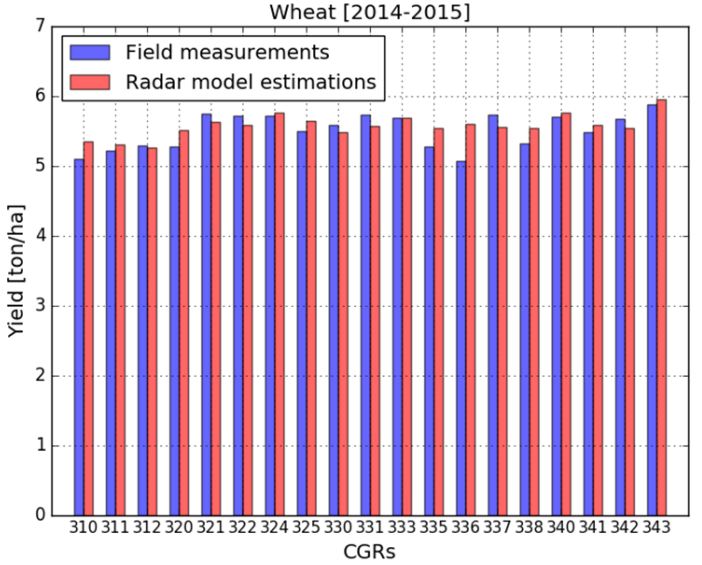


- Medium accuracy for sugar beet, lower for wheat
- General underestimation of yield
- Sign that the models calibration parameters chosen for sugar beet and wheat in Doukkala need to be adjusted
- In particular, the HIs should be increased

Results: RADAR model, Crop Yield estimation



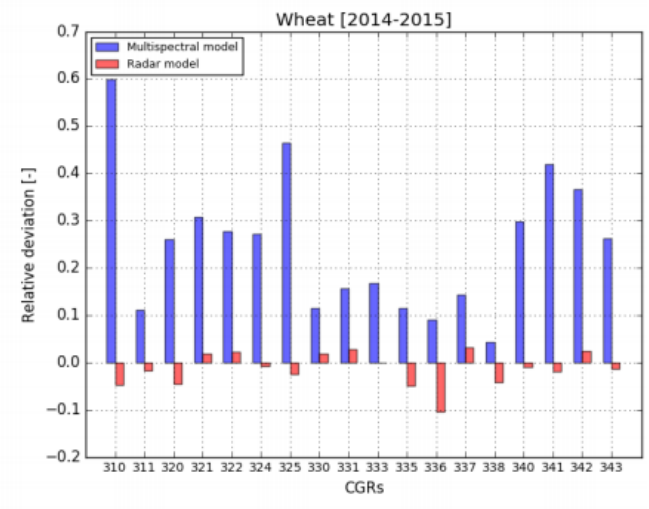
	Sugarbeet	Wheat
	Radar-main	Radar-main
RMSE [ton/ha]	5.96	0.19
NRMSE [-]	19.96%	23.35%
MRD [-]	1.21%	-1.24%

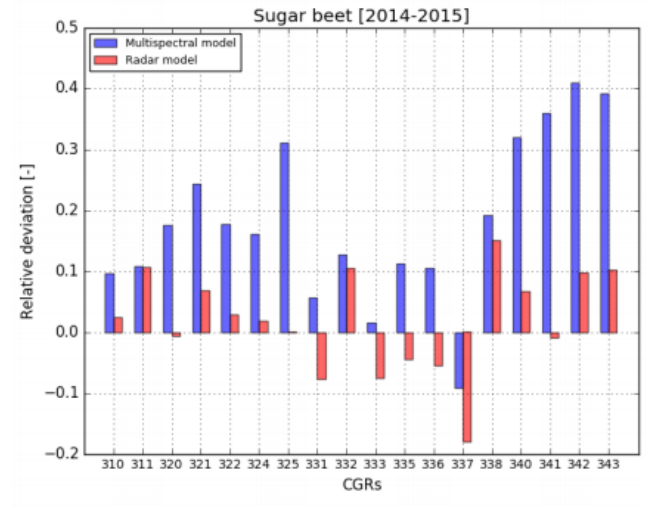


- wide range of pixel values. Compared with the range of official yield predictions at the pixel level using this model seem to lack accuracy
- good at the CGR level with a RMSE of 6 ton/ha for Sugar Beet

Results: Models comparison

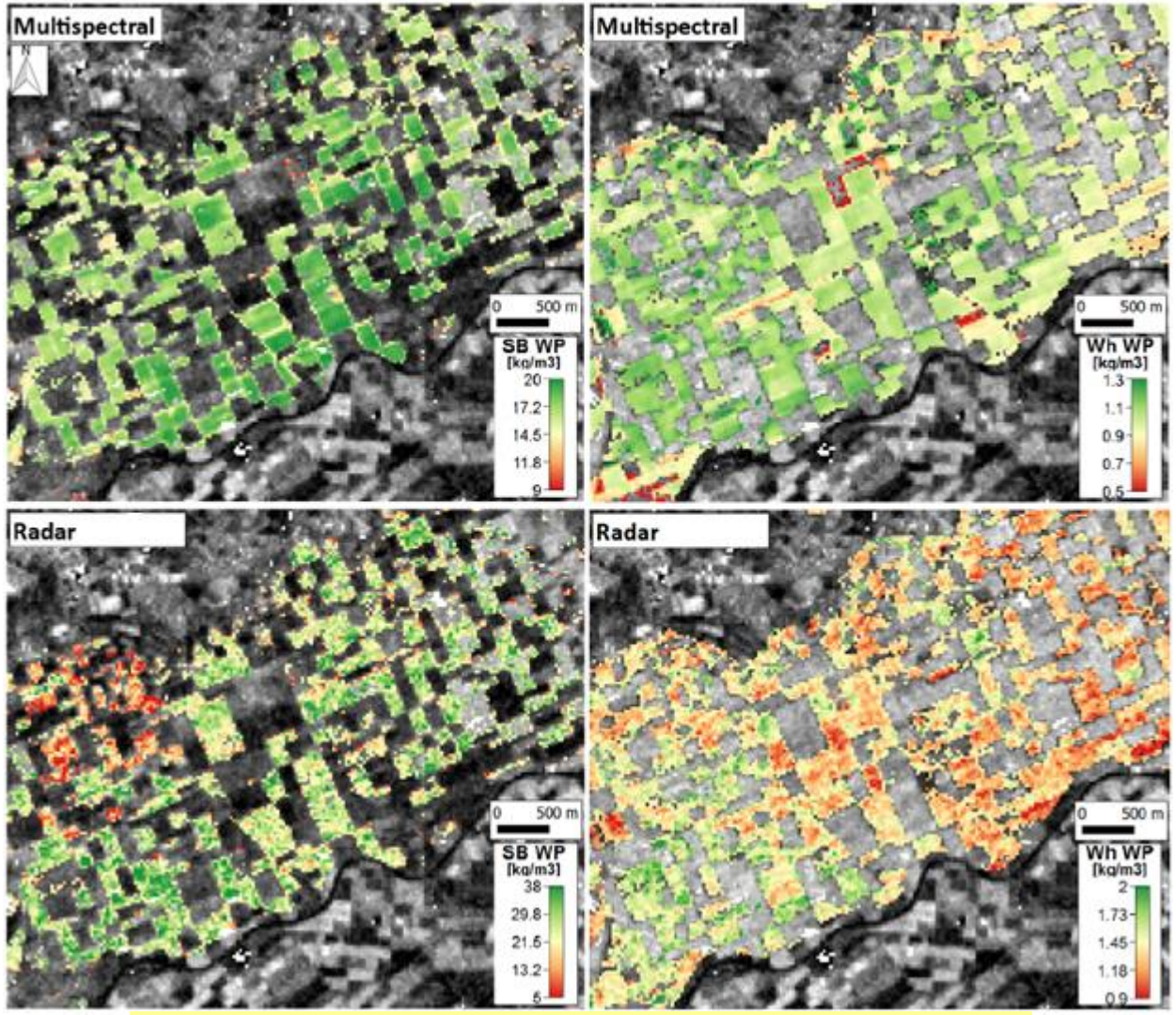
Multispectral VS SAR estimations





Sugar beet

Wheat



Example of intra- and inter-field variability of WP in CGR 340

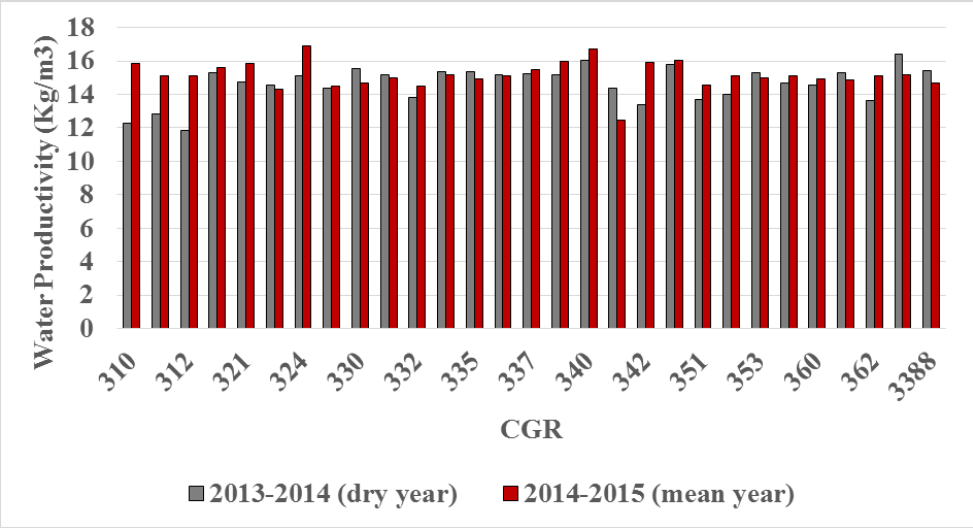
RESULTS

Is the climate variability effect reflected on crop water productivity (CWP)?

Which irrigation strategy has to be applied to achieve the highest level of water productivity?

RESULTS: effect of climate on Crop Water productivity

Sugarbeet Water productivity



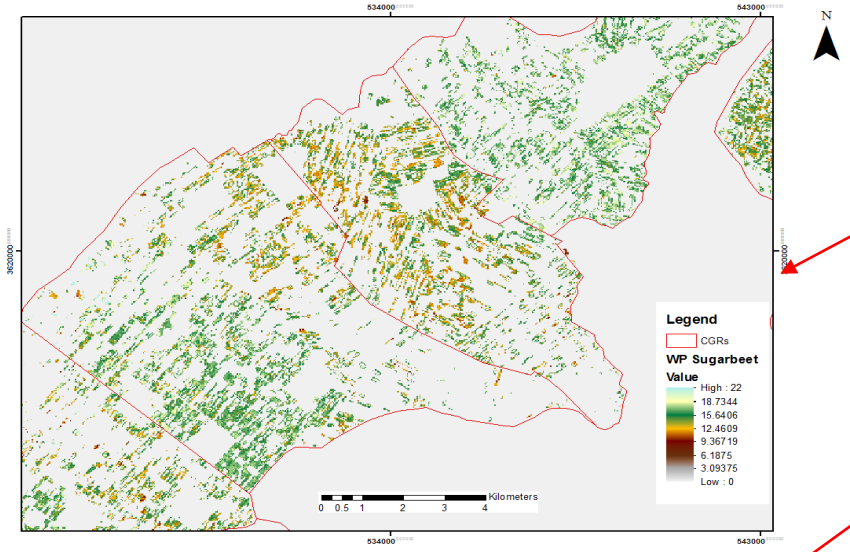
CWP averaged over the Centre of Irrigation management

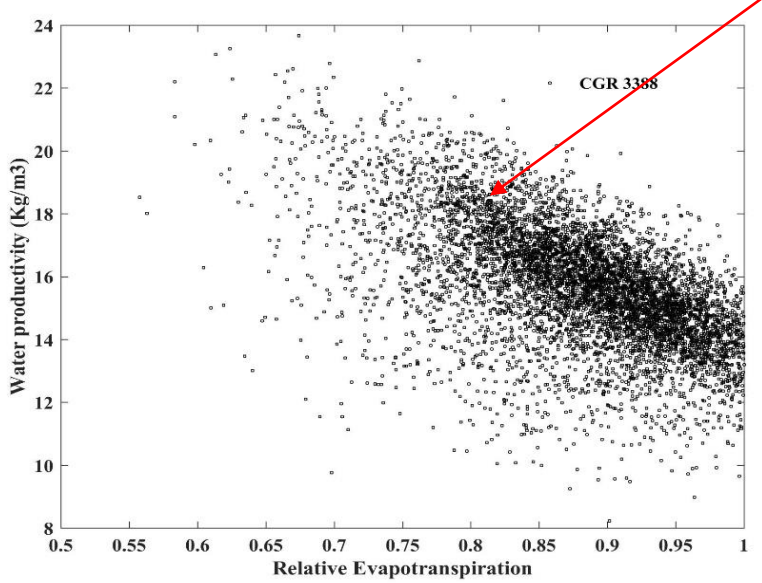
LOW INTERANNUAL VARIABILITY of CWP WITH THE EXCEPTION OF FEW CGRs

The comparison with water allocation in the analyzed years suggests that the low inter-annual variability of CWP is probably due to the tuning of the water allocation to the climate conditions during the growing season, operated by ORMVAD

RESULTS: irrigation strategy vs water productivity

Sugarbeet Water Productivity vs ReTD (indicator of irrigation strategy)





Large inter-field variability of CWP

The level of ReTD to attain maximum CWP is within 0.7 and 0.75

More efficient use of irrigation water could be reached by reducing the allocation of about 15% in 2013-2014 and 30% in 2014-2015

	Max CWP Allocations	Allocation (ORMVAD)
2013-2014	340	391
2014-2015	252	270

Conclusions

✓L7, L8, S1 data were combined to monitor crop water requirements and use and to estimate water productivity with both multi – spectral and SAR data

✓The radar method based on empirical relations between C-band backscatter of the Sentinel-1A sensor and field measurements of yield was proven to have potential in the Doukkala irrigated system.

✓The accuracy of the multispectral model was reasonable for sugar beet yields but quite low for wheat. We attribute the inaccuracies to classification errors and to an under-estimation of the yielding potential of sugar beet and wheat fields in Doukkala.

✓ Low inter-annual variability of CWP probably due to the tuning of the water allocation to the climate conditions

✓The level of ReTD to attain maximum CWP was found to be within 0.7 and 0.75

THANK YOU