Salinization management using advanced information technologies and non-conventional water resources

P. Guillermo*, J. Alarcón** & F. Pedrero**

*Chemical engineering student at University of Murcia
**Irrigation Department, Centro de Edafología y Biología Aplicada del Segura (CEBAS-CSIC)

INTRODUCTION

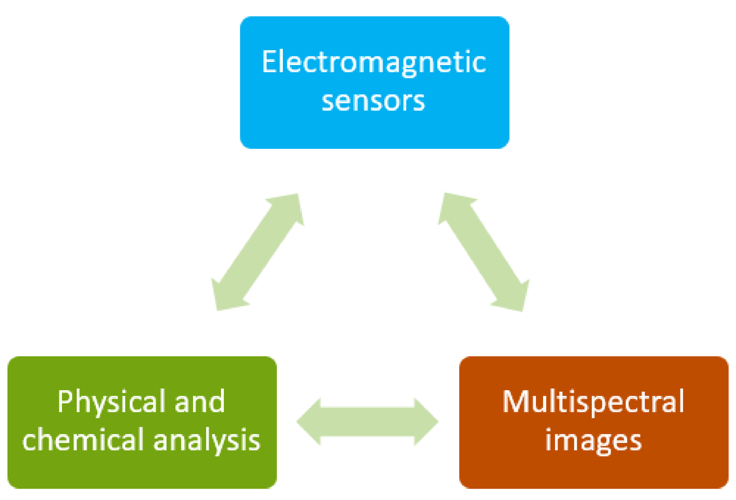
In the Mediterranean Region, irrigated agriculture contributes 75% to the final production. The continued use of these water resources for irrigation will probably put the agro-systems and the environment at risk from salinization, soil compaction and undesirable ions toxicity. Soil secondary salinization affects an estimated 1 to 3 million hectares in the enlarged EU, mainly in the Mediterranean countries (FAO, 2008). It is regarded as a major cause of desertification. A new strategy of water management it could be a key method for desertification prevention. Actually, there is a need for technologies that increase water use efficiency and make additional (non-conventional) water resources available for fertigation, thereby decreasing water sacarcity and the discharge of water and nutrients to the environment.

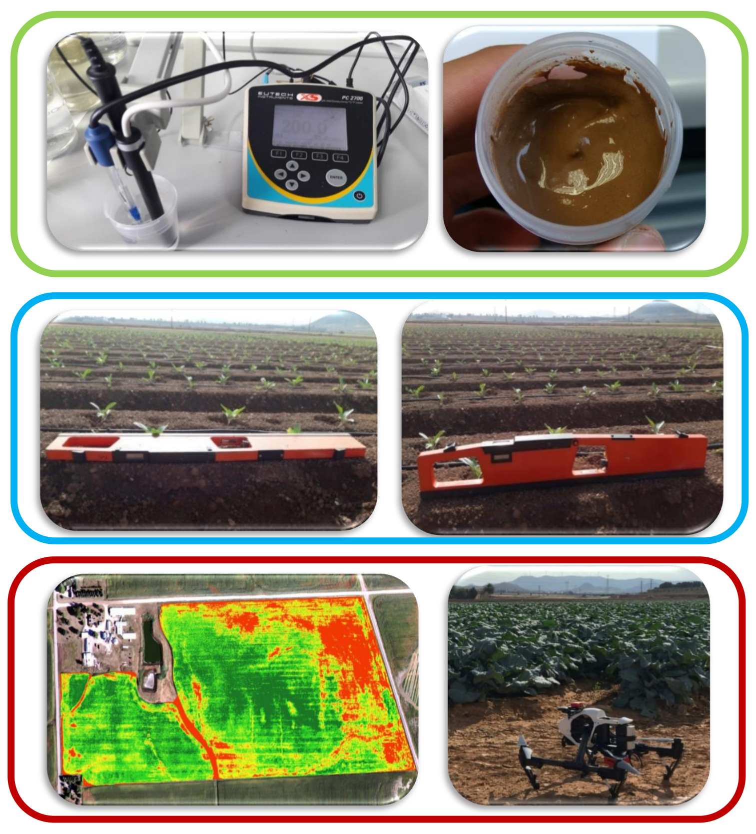
AIM

The aim of the project is to lay the foundations of a novel integrated system for regional salinity assessment using advanced information technologies for an efficient crop production management by enabling the degraded water use for irrigation. Inside this project, a first-year experiment was developped in a broccoli and cauliflower cropping system in Campo de Cartagena (Murcia, Spain).

METHODS

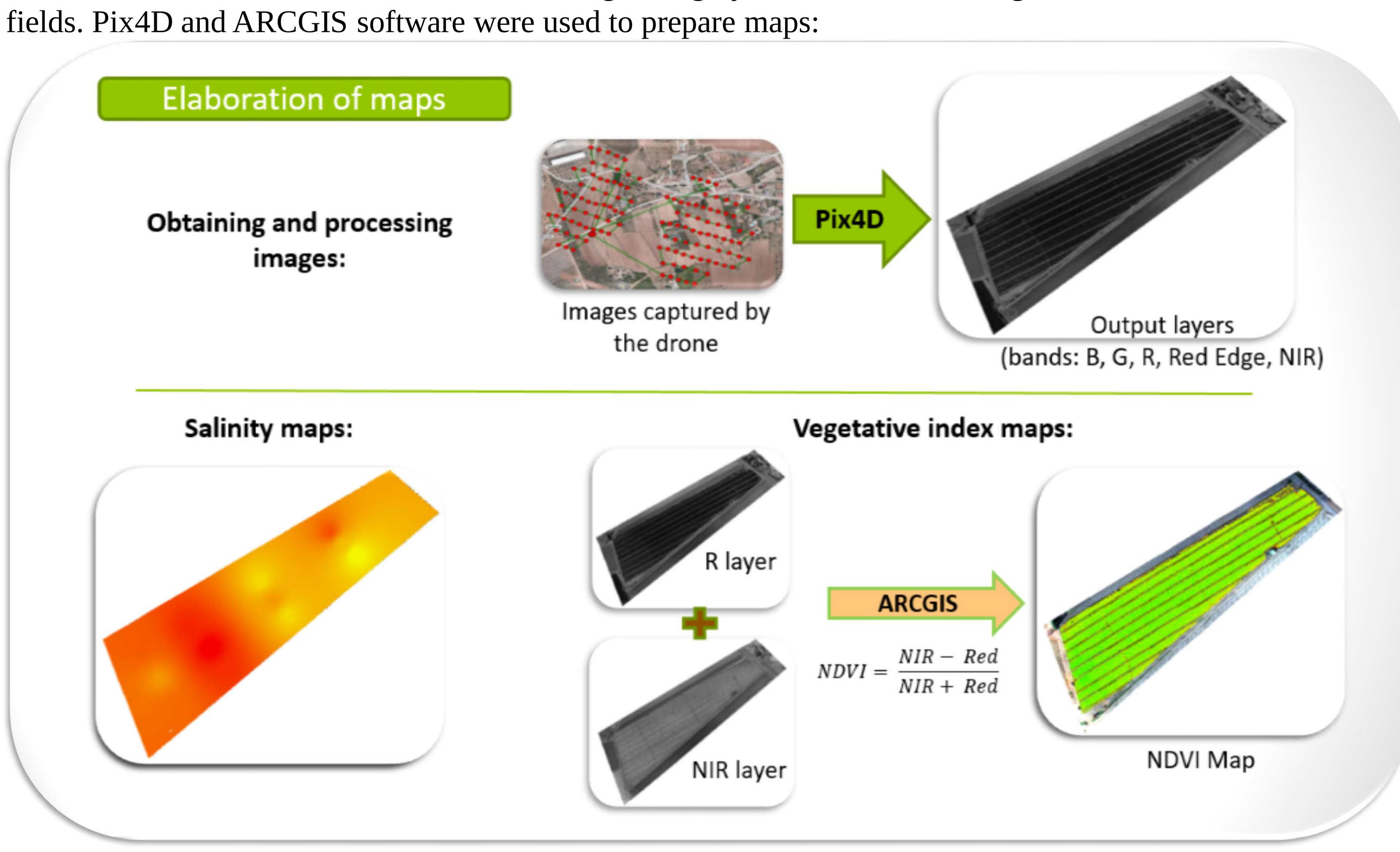
For this purpose, we studied the relationships between:





The broccoli plot was irrigated with mixed water from different sources (brackish groundwater, transfer water or reclaimed water), while the cauliflower plot was irrigated only with reclaimed water.

In order to monitor broccoli and cauliflower growing systems, two drone flights were conducted for both fields. Pix4D and ARCGIS software were used to prepare maps:



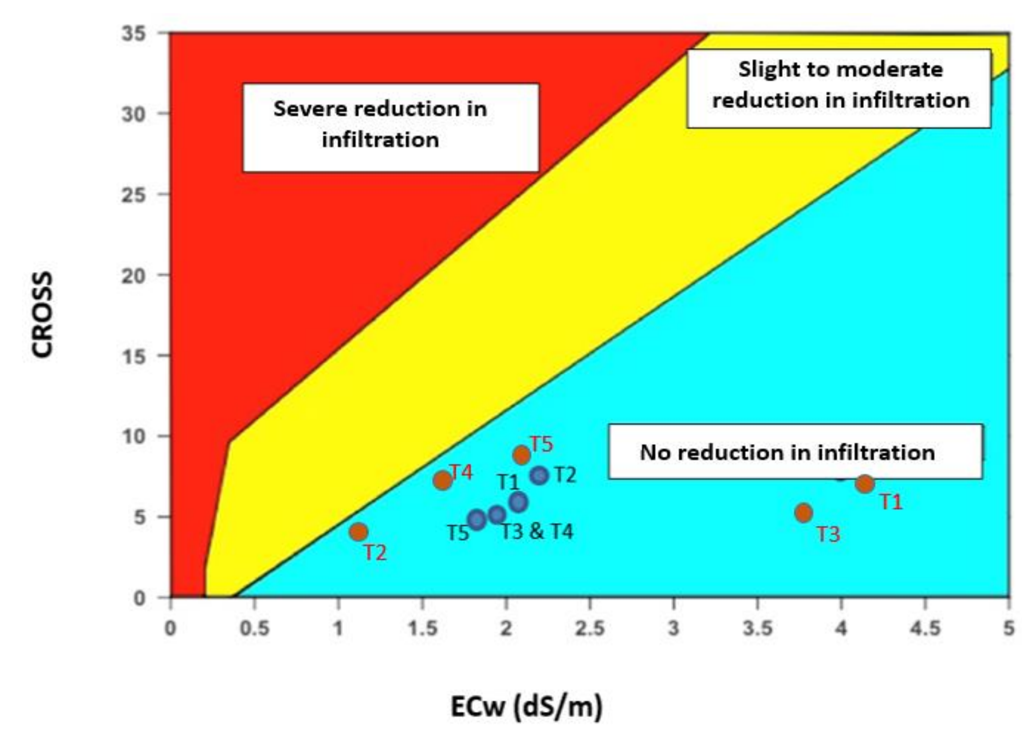
For performing the salinity maps, geographic coordinates of each of the sampling points were introduced together with the corresponding EC value and they were interpolated, while for vegetation index maps, the five spectral bands were combined to calculate the following vegetation indexes:

Vegetation index	Formulation	Reference
NDVI	$NDVI = \frac{NIR - Red}{NIR + Red}$	(STARS, 2017)
EVI	$EVI = g * \frac{NIR - R}{(NIR + c1 * R - c2 * B + l)}$	(NASA, 2000)
GARI	$GARI = \frac{NIR - (G + \gamma * (B - R))}{NIR + (G + \gamma * (B - R))}$	(Vina et al., 2004)
CRSI	$CRSI = \sqrt{\frac{(NIR * R) - (G * B)}{(NIR * R) + (G * B)}}$	(Scudiero, Skaggs & Corwin, 2014)

The NDVI was selected because it gives information about the greenness and biomass of the vegetation and it is one of the most widely used remote sensing-based indexes. The EVI is an index which was formulated by the MODIS Science Team and it is an improvement on the NDVI. The EVI corrects for distortions in the reflected light caused by air particles as well as the ground cover below the vegetation, and the GARI was chosen because it can give an indication of crop coverage. Lastly, the CRSI was selected because it could provide more details about the plant health under saline stress.

RESULTS

Irrigation water



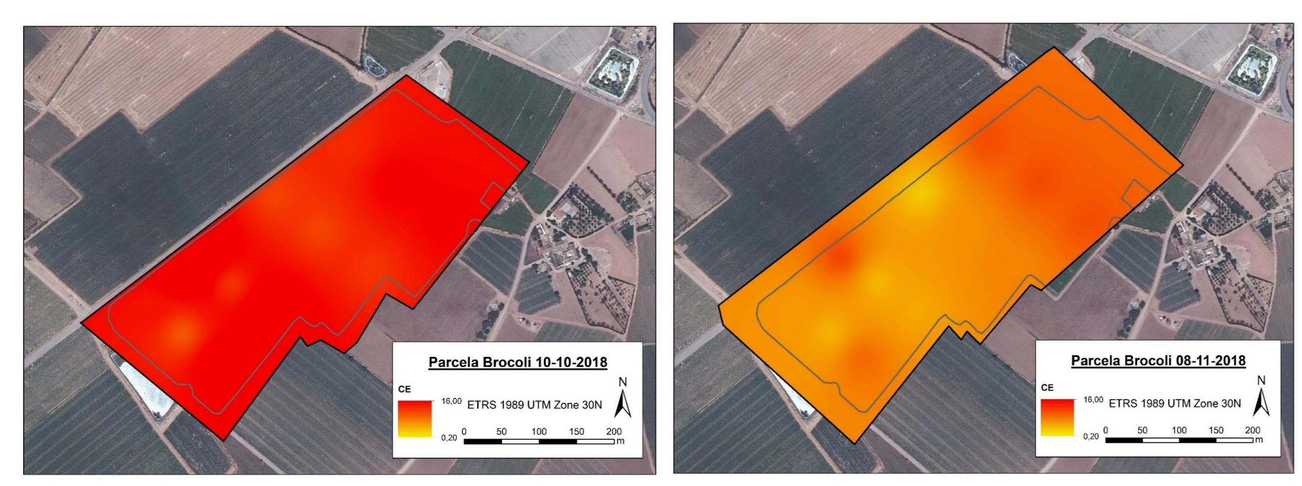
The values obtained in the reclaimed water (blue points) remained constant, while quality of the mixed water (red points) varied considerably. Despite of this, there was no risk of infiltration reduction in any case.

*Graph adapted from Oster et al. (2016).

Salinity maps

First fligth | Second flight

Broccoli plot:



In both broccoli plot and cauliflower plot a decrease in the EC values was observed, which was due to the salt leaching originated because of the precipitations.

Vegetation index maps

First fligth | Second flight

Cauliflower plot:

Due to the high rainfall occurred before the second flight, the salinity of the soil decreased and therefore the plant did not absorb a large concentration of salts and developed correctly, which is reflected in the high CRSI values obtained.

In all the studied indexes, a very similar behaviour to the one obtained in the CRSI was observed, reaching correlations between CRSI and EC of the same order (R2 ≤ 0.50) for both the cauliflower and the broccoli plots.

CONCLUSIONS

- The high rainfall served to evaluate the equipment used in face of rapid changes with respect to salinity and other nutrients.
- Due to the distribution of rainfall (both spatially and temporally) during the crop cycle, the variability of the plots did not influence the final production and masked the adverse effects of salinization.
- Moderate correlations (R2 ≤ 0.50) were obtained between the EC and the different indexes related to salinity, highlighting none. Therefore, more flights would be needed, as well as soil and plant analysis, in order to discover which of the indexes provides the best results.

Future perspectives:

- ✓In future research, and to avoid the absence of data in face of unusual weather events, we will look for more flights during the entire crop cycle to look for more accurate correlations and be able to select the indexes that provide more information.
- ✓it will be looked to be able to relate in a fast and simple way, saline stresses in crops to environmental factors, to develop good agricultural practices in each specific plot.

References:

FAO (2008). *Global Network on Integrated Soil Management for Sustainable Use of Salt-affected Soils.* Roma: Autor.
NASA, Earth Observatory (2000). *Measuring vegetation (NDVI & EVI). Enhanced Vegetation Index (EVI).* Retrieved from: https://earthobservatory.nasa.gov/Features/MeasuringVegetation/measuring_vegetation_4.php
Oster, J., Sposito, G. y Smith, C. (2016). Accounting for potassium and magnesium in irrigation water quality assessment. *California Agriculture, 70*(2), 71-76.
Scudiero, E., Skaggs, T. H. y Corwin, D. L. (2014). Regional scale soil salinity evaluation using Landsat 7, western San Joaquin Valley, California, USA. *Geoderma Regional, 2*, 82-90.
STARS (2017). *Potential uses of remote sensing in smallholder context.* Retrieved from: https://www.stars-project.org/en/knowledgeportal/magazine/potential-uses-of-remote-sensing-in-smallholder-context/monitoring-crop-growth-and-performance/vegetation-indices/
Vina, A., Gitelson, A. A., Rundquist, D. C., Keydan, G., Leavitt, B. y Schepers, J. (2004). Monitoring maize (Zea mays L.) Phenology with Remote Sensing. *Agronomy Journal, 96*, 1139-1147.