D4.3 Co-evaluation and validation report (1)

WP4 Pilot deployment, monitoring, and co-evaluation

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Executive summary

Participatory evaluation of the new DIANA services jointly with users and other stakeholders is the core element of the project. The campaigns are a basic piece in this evaluation. First, they are the mechanism to provide the required datasets (field measurements, EO data, additional data, stakeholder data and perceptions) that are needed to generate DIANA portfolio products for stakeholder test group. Second, they provide the frame of reference for the stakeholder co-evaluation process.

The purpose of this document is to describe the initial activities in the process of co-evaluation and validation of the DIANA platform, which have been centered around the alpha-version of the platform viewer and comprehensive dataset of the 2017 growing season in all pilots.

The following eight necessary steps were executed in the pilot deployment and co-evaluation process:

Step 1. A common set of definitions of products for upload and display has been elaborated in order to ensure consistency between all pilots.

Step 2. Complete datasets of these products for one growing season (2017, latest available) have been prepared offline using a combination of pre-alpha platforms (SPIDERwebGIS, MOSES/Minaret, Irrisat) and standard GIS software.

Step 3. Upload of these products to the platform via an FTP bridge. In most pilots, these products are available both as annual and monthly data.

Step 4. Elaboration of the User's Guide of the DIANA platform viewer in an iterative way (as soon as the DIANA platform viewer allowed to produce the corresponding screenshots). The "DIANA User's Guide" (D4.2) is a well-tailored tutorial, consisting of ready to use training material on how to utilize the platform and exploit the information services provided.

Step 5. The technical teams provided training of platform viewer to users, both in person and via skype. These training meetings were found to be more effective than webinars. In addition, several meetings between the partners with further target groups were carried out during the second year (see WP6) to explain the services provided by DIANA platform and how it can be useful for their work in the future.

Step 6. As soon as pilot campaign data products were available for viewing on the DIANA platform, the Core Users have started to evaluate the performance, usefulness and benefits of DIANA tools, as compared to their routine operations and decision-making. This part of the evaluation has been supported by members of pilot area teams. It will continue in the third year. Feedback has been collected from Core Users through questionnaires and interviews.

Step 7. Along the same lines and in parallel, the technical aspects of the platform have been evaluated mainly by AgriSat and Ariespace technicians, who are experts in the use of EO agriculture platforms. They have been continuously working hand-in-hand with

DIANA platform developers AgroApps, helping to improve the technical aspects of the platform, such as appearance, accessibility, usability, functionality, and adaptability.

Step 8. The technical and user feedback has led to iterations with the platform developer team and will be the basis for the next (beta) version of the platform.

In conclusion, the first release of the platform (alpha version) has taken place successfully in a good state of usability and the evaluation in an operational environment have provided the first ideas of improvements from different user perspectives for the second release of the platform. The feedback collected from users' stresses that the information provided by DIANA products has a high level of interest and is very useful for them. The interest raised has led to more water user associations joining the co-evaluation process. In particular, the Spanish Ministry of Ecological Transition, in collaboration with the Ministry of Agriculture, has started to play a more active role in implementing and co-evaluating DIANA services in more river basins.

1. Introduction

1.1. Purpose and scope of the document

Participatory evaluation of the new DIANA services jointly with users and other stakeholders is the core element of the project. The corresponding activities are assembled in Work package 4 (WP4), which is closely interrelated with WP1 (co-creation). The principal objective is here to evaluate in a participatory process the use and performance of the three DIANA services (irrigation water abstractions, drought monitoring and drought forecast, and support to the implementation of the Water Framework Directive) in our pilot Case Studies (Spain, Italy, Romania).

The campaigns are a basic piece in this evaluation. First, they are the mechanism to provide the required datasets (field measurements, EO data, additional data, stakeholder data and perceptions) that are needed to generate DIANA portfolio products for stakeholder test groups (Task 4.2). Second, they provide the frame of reference for the stakeholder co-evaluation process (Task 4.3).

The core philosophy of DIANA is to make the project a joint venture of stakeholders and project team. The objective is to establish a sense or fact of co-ownership, which is an indispensable condition for true empowerment of stakeholders and for sustainable implementation (i.e., continuity of DIANA services beyond the project end) of any tool or measure.

Therefore, users and other stakeholders in all pilot areas have been consulted from the very beginning of the project, embedded in a process of co-creating the DIANA products, tools, and services together with users and other stakeholders.

The purpose of this document is to describe the initial status of the second and third step in the pilot deployment and co-evaluation, Tasks 4.2 and 4.3, which are dedicated to "*Deployment of the pilots"* and *"Pilot co-evaluation and co-validation".*

It provides a brief summary of the basic pilot deployment and co-evaluation concepts, followed by details of the pilot campaign implementation and execution in the three pilot areas and the subsequent first phase of verification and participatory evaluation with users.

The first step in the pilot deployment and co-evaluation process was described in D4.1 (DIANA pilot deployment, monitoring, and co-evaluation plan). The companion document D4.2 (User guide and training material) has supported the pilot deployment and co-evaluation process, the final status of which will be documented in D4.4 (Co-evaluation and validation report 2).

1.2. Context of DIANA users and services

Much of the work in DIANA is based on the comprehensive work carried out in precursor projects (e.g., SIRIUS[1], ERMOT[2], Irrisat[3]) and in particular the Copernicus study "Applying Earth observation to support the detection of non-authorized water abstractions" (DG-ENV 2014).

Users and other stakeholders in all pilot areas have been consulted from the very beginning of the project. This builds on long-standing collaboration during past and ongoing projects of the local partners. In all pilot areas, some stakeholders are already familiar with EO-assisted information products, since all technical partners have a long and outstanding tradition in the development of EO methodology and its practical use in agricultural and water-related applications.

In order to accelerate and dynamize the co-creation process, activities of WP4 (pilot deployment, see D4.1) have been started in parallel with the co-creation process (WP1).

In each pilot area an existing pre-alpha version of the platform (see Task 1.3) was implemented during the first project months, with level-0 DIANA information products provided to the core users during the irrigation season of 2017. Consequently, the co-creation discussions were focused around concrete cases of direct relevance to the core users (displaying their own data).

In accordance with the specific nature of DIANA users (public authorities in many cases), the co-creation activities were focused on small group or one-to-one meetings with the core users. The users were shown the available information products (maps of irrigated areas, maps of irrigation and crop water requirements, color composite maps) on the existing platforms (SPIDER, Irrisat, Minaret) during these meetings and also got access to these platforms (some of them have already had access for a significant period of time), so they could evaluate for themselves the usefulness and suitability for their routine tasks and give input to the service and platform development.

1.3. The eight steps of pilot deployment and co-evaluation

This section summarizes the steps needed in the pilot deployment and co-evaluation process. It serves as a document structure and also provides a preview of outcomes. The details of procedures and results are given in the corresponding section in the rest of the document (Steps 1-3 in section 2 (pilot deployment and execution), steps 4-6 in section 3.3 (participatory evaluation), and steps 7-8 in section 3.2 (technical verification)).

Step 1. A common set of definitions of products for upload and display has been elaborated in order to ensure consistency between all pilots.

[1] www.sirius-gmes.es

[2] http://maps.spiderwebgis.org/login/?custom=ermot

[3] www.irrisat.it

Step 2. Complete datasets of these products for one growing season (2017, latest available) have been prepared offline using a combination of pre-alpha platforms (SPIDERwebGIS, MOSES/Minaret, Irrisat) and standard GIS software.

Step 3. Upload of these products to the platform via an FTP bridge. In most pilots, these products are available both as annual and monthly data.

Step 4. Elaboration of the User's Guide of the DIANA platform viewer in an iterative way (as soon as the DIANA platform viewer allowed to produce the corresponding screenshots). The "DIANA User's Guide" (D4.2) is a well-tailored tutorial, consisting of ready to use training material on how to utilize the platform and exploit the information services provided.

Step 5. The technical teams provided training of platform viewer to users, both in person and via skype. These training meetings were found to be more effective than webinars. In addition, several meetings between the partners with further target groups were carried out during the second year (see WP6) to explain the services provided by DIANA platform and how it can be useful for their work in the future.

Step 6. As soon as pilot campaign data products were available for viewing on the DIANA platform, the Core Users have started to evaluate the performance, usefulness and benefits of DIANA tools, as compared to their routine operations and decision-making. This part of the evaluation has been supported by members of pilot area teams. It will continue in the third year. Feedback has been collected from Core Users through questionnaires and interviews.

Step 7. Along the same lines and in parallel, the technical aspects of the platform have been evaluated mainly by AgriSat and Ariespace technicians, who are experts in the use of EO agriculture platforms. They have been continuously working hand-in-hand with DIANA platform developers AgroApps, helping to improve the technical aspects of the platform, such as appearance, accessibility, usability, functionality, and adaptability.

Step 8. The technical and user feedback has led to iterations with the platform developer team and will be the basis for the next (beta) version of the platform. Figure 1 illustrates this interaction.

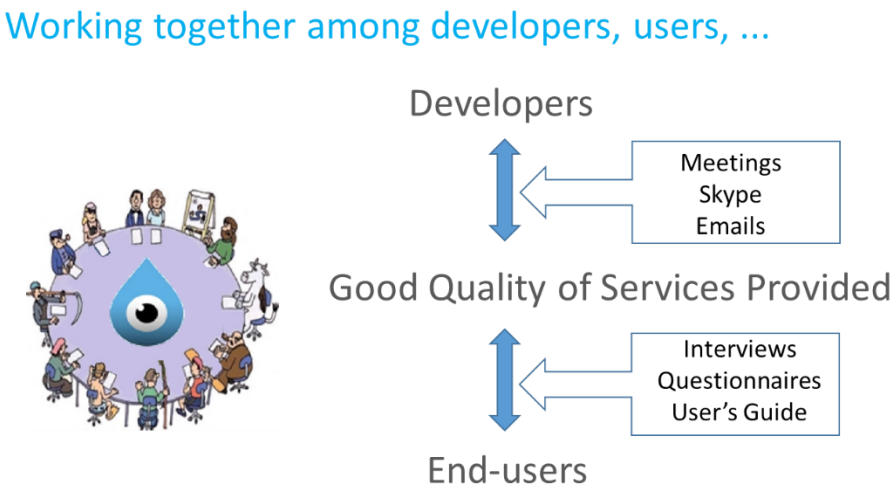

Figure 1. Schematic illustration of interactive co-development and co-evaluation process.

2. The DIANA pilot deployment and campaign execution

As explained in D4.1, the deployment of DIANA tools and services is effected in three phases, each covering one growing season (or hydrological year, depending on each user's internal functioning), roughly coinciding with one project year. These are:

Phase 1 - Pre-campaign (2017): Deployment of pre-alpha version of DIANA platform during co-creation process with Core Users.

Phase 2 - Pilot campaign (2018): Deployment of alpha version, co-creation continuing, evaluation with Core Users ("alpha users") starting.

Phase 3 - Validation campaign (2019): Deployment of beta version, evaluation with alpha- and beta users.

2.1. The concept of pilot deployment, campaigns and Core Users

Participatory evaluation of the new DIANA services jointly with users and other stakeholders is the core element of the project. The principal objective is here to evaluate in a participatory process the use and performance of the DIANA services in our pilot Case Studies (Spain, Italy, Romania).

The campaigns are a basic piece in this evaluation. First, they are the mechanism to provide the required datasets (field measurements, EO data, additional data, stakeholder data and perceptions) that are needed to generate DIANA portfolio products for stakeholder test groups (Task 4.2). Second, they provide the frame of reference for the stakeholder evaluation process (Task 4.3).

In the three DIANA pilot area countries Spain (ES), Italy (IT), and Romania (RO), DIANA Core Users are listed in Table 1 (from D1.2). In the case of Spain, the objective has been to assemble all Core User levels, in order to explore and demonstrate possible ways of scaling the DIANA services to the national level.

Table 1. DIANA Core Users (from D1.2).

	Name	Identification	Involved in Copernicus study	Consortium partner or liaison partner
ES	Bembézar Margen Derecha	Irrigation scheme WUA*	N	FERAGUA
ES	Junta Central de Regantes La Mancha Oriental	Aquifer WUA	Y	AgriSat
IT	Consorzio di Bonifica del Sannio Alifano	Irrigation scheme WUA	Y	Sannio Alifano
RO	S.C. Emiliana West (Banat)	Irrigation scheme WUA	N	NARW
ES	MAPAMA (Ministry of Agriculture)	National government	Y	AgriSat
ES	Tierra del Vino (Duero)	Irrigation scheme WUA/ river-basin authority	Y	AgriSat / MAPAMA
ES	Bajo Jalón (Ebro)	Irrigation scheme WUA/ river-basin authority	Y	AgriSat / MAPAMA

**WUA = Water Users Association*

The pilot areas have been selected according to the most promising precursor applications and implementation conditions on one hand and on the other hand for having contributed to the Copernicus study.

The implementation has been carried out by the partners in charge of technology development: FERAGUA (assisted by CSIC Institute of Sustainable Agriculture) in Bembézar Margen Derecho, AgriSat (assisted by subcontractor University of Castilla-La Mancha, the original developer of SPIDERwebGIS®) in the remaining Spanish pilots, ROSA (in collaboration with AgriSat and UCLM) in Romania, and Ariespace in Sannio Alifano. A corresponding methodology harmonization and training workshop was held in Albacete in July 2017 with all pilot areas present.

The campaigns have been conceived in a flexible way, in order to adapt to the specific character of each pilot area. Depending on each pilot area, the technical campaigns will be conducted for different purposes and under different configurations and the stakeholder component will be tuned to the water-related problems or conflicts in the area.

The central DIANA Integrated Water Abstractions Service (DIWAS) has been implemented and evaluated in all pilots during the second project year. It has become available after the summer. Therefore, the growing season for evaluation was selected as 2017, where a complete dataset is

available. This was the operational pilot campaign (2018). It will be followed by the operational validation campaign (2019).

All pilot areas are also serving to test and further develop the other services. The Júcar river-basin in Spain is one of the EU Water Framework Directive pilot areas. All river-basin management plans include drought management as a key issue, which makes them ideal for testing the Drought Monitoring and Forecast Service. The Spanish national ministry is actively collaborating in developing and testing the WFD implementation support service.

The Sannio Alifano irrigation scheme in Italy has been supported by our Italian partners (again users and EO experts at the same time) for several years, with university spin-off company Ariespace providing commercial services and the national ministry providing the institutional support.

In Romania, partner NARW is the water agency at national level, collaborating with WUAs in different parts of the territory. Partner ROSA (national space agency) was involved in the Copernicus study and in precursor FP7 project SIRIUS.

The campaign-related tasks are split into technical issues (technical data collection and analysis, product generation and webGIS upload) and non-technical issues (framework, training, stakeholder process and evaluation).

2.2. Pre-campaign implementation and execution (2017)

The existing set of platforms (SPIDERwebGIS®[4], Irrisat[5], MOSES[6], Minaret[7]) have been serving as the pre-alpha version of the DIANA platform on one hand. They will continue forming part of the final DIANA platform configuration (available for more detailed requests of expert users) on the other hand (see D1.3).

The pre-campaign has been focused on the main DIANA service (water abstractions). According to the responses of all Core Users to the set of questionnaires distributed to them and discussed with them (see D1.1 Annex B), their initial ("level 1") requirements of information products for water abstractions monitoring are summarized in Table 2 (from D1.1). These products were generated and uploaded on the existing platforms and discussed with the Core Users in each pilot.

The user feedback from this phase has been included in section 3 below.

[4] www.SPIDERwebGIS.org

[5] www.irrisat.it

[6] moses-project.eu/moses_website

[7] Mateos et al. (2013); González-Dugo et al. (2013)

Table 2. DIANA level 1 information products.

Information product	***Periodicity***
Maps of irrigated areas	Once per season
Crop inventory (map)	Annual
Maps of crop water requirements	Weekly to monthly
Maps of crop water consumption	Idem
Prediction of crop water requirements	Weekly, one week ahead
Maps of abstracted volumes	Once per season
Prediction of crop water requirements	Seasonal scenarios
Gridded water balance	Weekly to monthly

2.3. Pilot campaign implementation and execution (2018)

The pilot campaign (phase 2) was conducted in each pilot area with products provided by the technical teams (see Table 3) during one growing season with the support of the DIANA's stakeholders. The year 2017 was selected for this purpose, as it allowed the use of a comprehensive dataset in each pilot area. The pilot campaign implementation and execution entailed the first three steps of the scheme defined in section 1.3.

(Step 1) A common set of definitions of products for upload and display has been elaborated in order to ensure consistency between all pilots. Box 1 summarizes the result.

Box 1. Standardized definition of basic data products for upload and display in the DIANA platform viewer.

Crop Evapotranspiration: ET_C = Kc* x ET_0, where Kc* is the reflectance-based crop coefficient and ET_0 is the reference evapotranspiration. ET_C is the value of evapotranspiration under standard conditions, as defined by FAO56: disease-free, well-fertilized crops, under optimum soil water conditions.

Net Irrigation Water Requirement: NWIR = ET_C - PP, where ET_C has been defined above and PP is the effective precipitation. This product is calculated through a Soil Water Balance assisted by satellite data.

Gross irrigation water requirements: GIWR = NIWR/Ɛ. This product is obtained by applying an irrigation efficiency coefficient (Ɛ) to the net irrigation water requirements (NIWR). In the case of La Mancha Oriental this coefficient (0.85) has been estimated for the whole pilot area in order to have an estimation of the abstracted volumes for the total of the pilot. However, it is important to keep in mind that these coefficients are very specific parameters depending mainly on the type of irrigation system and on the efficiency of the application of the water (open channels, pumping, sprinkling, dripping, irrigating climate conditions, etc).

(Step 2 and Step 3) Complete datasets of these products for one growing season (2017, latest available) have been prepared offline using a combination of pre-alpha platforms (SPIDERwebGIS, MOSES/Minaret, Irrisat) and standard GIS software. These products have been uploaded to the platform via an FTP bridge (Table 4). In most pilots, these products are available both as annual

and monthly data. Figure 2 shows an example screenshot of the DIANA platform viewer for the La Mancha Oriental pilot area (Spain).

Table 3. Pilot areas currently included in the DIANA platform.

	Pilot area	Assisted by	Core User	Included/uploaded in DIANA platform
ES	Mancha Oriental	AgriSat /UCLM	Irrigation Users Association	✓
ES	Tierra del Vino	AgriSat /UCLM	Ebro River Basin Authority	✓
ES	Bajo Jalón	AgriSat /UCLM	Duero River Basin Authority	✓
ES	Bembézar Margen Derecha	FERAGUA	Irrigation Users Association	✓
IT	Sannio Alifano	Ariespace	Consorzio di Bonifica Sannio Alifano	✓
RO	Banat Area	AgriSat/ UCLM ROSA/ NARW	Emiliana	✓

Table 4. Products from Pilot Areas uploaded to DIANA platform.

Pilot area partners involved		Crop Classification	Maps of Irrigated Areas	Crop Evapotranspiration (ETc)	Net Irrigation Water Requirements (NIWR)	Gross Irrigation Water Requirements (GIWR)
ES	Mancha Oriental (AgriSat/UCLM)	✓	✓	✓	✓	✓
ES	Tierra del Vino (AgriSat/UCLM)	✓	✓	✓	✓	✓
ES	Bajo Jalón (AgriSat/UCLM)	✓	✓	✓	✓	✓
ES	Bembézar MD (Feragua)	✓	✓	Tbd*	✓	✓
IT	Sannio Alifano (Ariespace, Sannio Alifano)	✓	✓	✓	✓	✓
RO	Banat Area (AgriSat/UCLM ROSA/NARW)	✓	✓	✓	✓	✓

* working on methodology for crops under stress

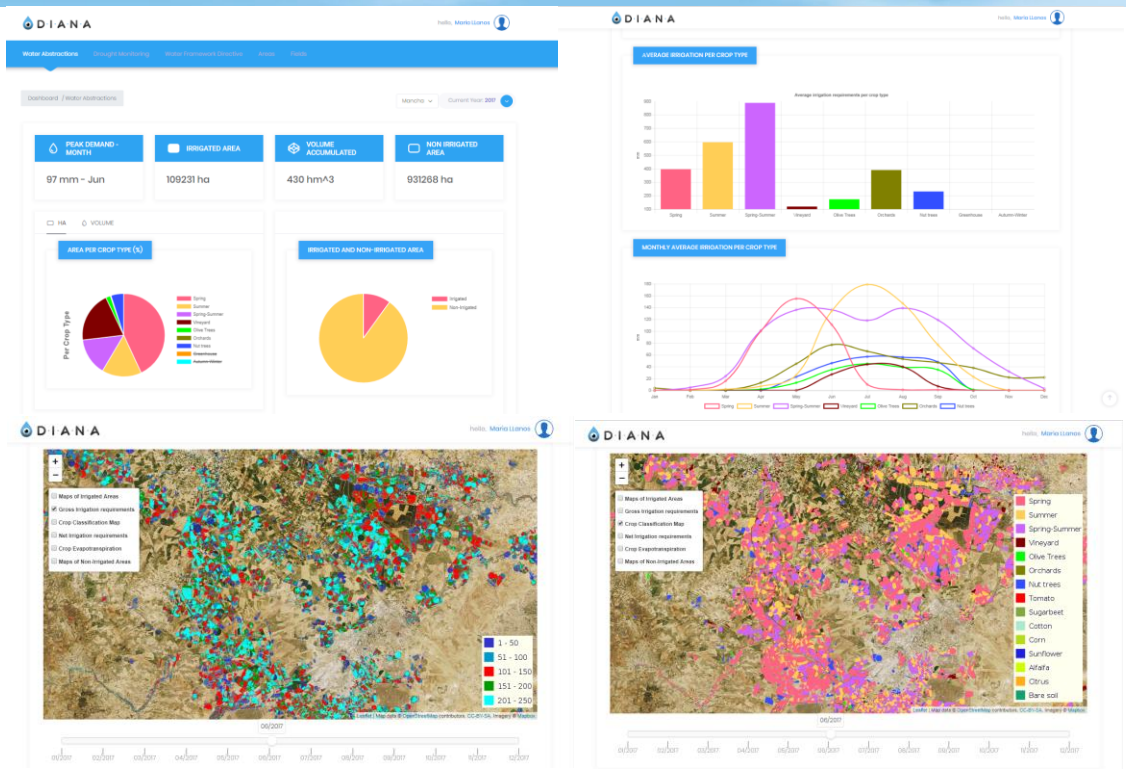

Figure 2. Screenshot of DIANA platform viewer for Mancha-Oriental Pilot Area.

Steps 2 and 3 have been executed by technicians from Ariespace, AgriSat and AgroApps, who dedicated important efforts to adapt pre-existing DIANA products to the technical requirements of the DIANA platform and users.

This work covered mainly:

-An adequate product format was defined, thus standardizing the characteristics needed for upload.

-The data volume of the products has been reduced. Due to the high spatial resolution (10mx10m) of the products and the large surface covered by the DIANA pilots, the data volume of products provided by the supporting groups (e.g. UCLM) is not fit for operational handling. A monthly net irrigation water requirements product e.g. is 1 GB and it has been transformed in to 0.3MB. This turns any data product transfer into a cumbersome process, taking 1 hour for the net irrigation water requirement example, being 39 products per pilot area.

-Format transformations were developed in order to make DIANA products more appealing for the user.

3. The DIANA co-evaluation and validation process

At the end of the pilot campaign the Core Users started evaluating the performance, usefulness, and benefits of DIANA tools, as compared to their routine operations and decision-making.

As described in D4.1, we distinguish three steps of the co-evaluation and validation process:

1) *Verification* (technical checks of conformity with specification);

2) *Participatory assessment with users and evaluation* (based on evaluation protocol & criteria for "fit for purpose"); this step gives indications on efficiency & "usefulness" of DIANA tools; The evaluation criteria include accuracy ("at least as good as field data"), information content (spatial resolution and coverage of large areas), reliability, economic viability, social benefits, and cultural acceptance.

3) *Validation* (confirmation from users that DIANA services are exactly what they want, based on a validation protocol and criteria); this step gives conclusions on effectiveness and cost-benefit, as well as further impact, it demonstrates if/that DIANA services "make a difference" for the users and their environment.

As of M24, the first two steps have been partly completed, with evaluation of the 2017 growing season data in the viewer (available from M19) still ongoing. With evaluation of all DIANA services still ongoing, the current document covers only the DIANA Water Abstractions Service.

The process of co-evaluation and validation is being supported by and closely coordinated with the series of co-creation meetings (see WP1, Kensing and Madsen, 1991).

3.1. Verification

The technical aspects of the platform have been evaluated mainly by AgriSat and Ariespace technicians, who are experts in the use of EO agriculture platforms. They have been continuously working hand-in-hand with DIANA platform developers AgroApps, helping to improve the technical aspects of the platform, such as appearance, accessibility, usability, functionality, and adaptability.

For this purpose, the main products of DIANA water abstraction service have been generated and uploaded to the alpha version of the platform for all pilot areas (as detailed in the previous section). The procedure for products verification was following two main objectives:

1) The accuracy and reliability of the products.
2) The proper functioning of the DIANA platform alpha version (product approach). Correct visualization of the products and correct statistical information derived, correct matching with the requirements from users of different areas collected from WP1.

The products generated in DIANA, as described above (Table 4), have been provided by 3 different partners of the project, UCLM (subcontractor to AgriSat), Ariespace and Feragua. The University

of Castilla La Mancha (UCLM) has supported four pilot areas: Bajo Jalón, Tierra del Vino, Mancha Oriental and Banat. Ariespace has provided the products related to Sannio Alifano. Feragua has provided products for the Bémbezar pilot area. After a pre-processing of the information to adapt the products to the requirements of the DIANA platform developers, all the products have been uploaded and have been verified by their corresponding pilot area teams.

Each pilot has verified the products and statistics shown in DIANA platform are correct Figure 3 shows an example of the Bajo Jalón pilot area in the DIANA platform viewer (see Annex B for examples of all other pilot areas).

Figure 3. Bajo Jalón product verification on DIANA platform showing No-Stress Crop Water requirement product.

For the pilot deployment, implementation, and verification in the Romanian pilot area Banat, AgriSat technicians, supported by UCLM, have generated the 2017 DIANA products, always in close collaboration with ROSA and NARW.

The procedure was implemented as follows:

1.- ROSA provided the crop classification maps to AgriSat.

2.- AgriSat Technicians, working hand in hand with UCLM, generated the main products of DIANA, according to the definitions in Box 1: annual Crop Evapotranspiration (ETc), annual Net Irrigation Water Requirements (NIWR) and annual Gross Irrigation Water Requirements (GIWR).

3.- AgriSat provided the products and a report (Annex C) to the Romanian team in order to check them and confirm the accuracy and reliability of the products.

4.-Products were uploaded to the platform.

In the case of la Mancha Oriental, Tierra del Vino, and Bajo Jalón pilots, additional efforts have been devoted to the verification of the precision, usefulness and reliability of the products. Different reports have been generated summarizing the information provided by DIANA products using GIS software by UCLM-AgriSat. Annex B shows examples of these reports.

On the other hand, in order to quantify the accuracy of the methodological approach in the Italian pilot, a comparison of the water volume applied and GIWR estimated from EO data was performed considering a sample of farms. The information was provided by the Consorzio di Bonifica Sannio Alifano, in terms of cadastral coordinates (municipality, sheet and parcel) and identity of land owners. In this phase, considering also the classification results, it was possible to compare the irrigated area declared by the farmers and those estimated from EO data. Figure 4 shows an example, more details can be found in D2.3.

3.2. Participatory service evaluation

This section reports on steps 4-6 of the scheme defined in section 1.3.

(Step 4) The User's Guide of the DIANA platform viewer has been elaborated in an iterative way (as soon as the DIANA platform viewer allowed to produce the corresponding screenshots). The "DIANA User's Guide" (D4.2) is a well-tailored tutorial, consisting of ready to use training material on how to use the platform viewer and explore the information services provided.

(Step 5) The technical teams provided training of the platform viewer to users, both in person and via skype. These training meetings were found to be more effective than webinars. In addition, several meetings between the partners and with further target groups were carried out during the second year (see WP6) to explain the services provided by DIANA platform and how it can be useful for their work in the future.

(Step 6) As soon as pilot campaign data products were available for viewing on the DIANA platform, the Core Users have started to evaluate the performance, usefulness and benefits of DIANA tools, as compared to their routine operations and decision-making. This part of the evaluation has been supported by members of pilot area teams. It will continue in the third year. Feedback has been collected from Core Users through questionnaires and interviews, as described below.

The co-evaluation has been carried out following different approaches (questionnaires and in-person interviews) and directed to two different categories of platform viewer users:

1. From the point of view of the end-user (water manager Core Users).
2. From the point of view of technicians (beyond the technical verification described above).

3.2.1. Conclusions from co-evaluation meetings with end-users

Different meetings and interviews have been carried out with the final users which are partners of the project (Core Users), who have also been asked to fill out the evaluation questionnaire (see Annex A). Training has been provided to them through in-person evaluation sessions and training material (Users' Guide D4.2).

The conclusions extracted from the various meetings are summarized below and in Table 5:

Mancha Oriental:

- The DIANA products/platform seem very interesting and the information of high value for the tasks routinely executed by the JCRMO.
- Currently, 7 technicians work and constantly check around 70,000 polygons in other to follow the irregularities of the whole territory. DIANA can help saving time of the technicians for their field inspections.
- Statistical information and different GUIs provided in DIANA platform are helpful for them to establish the volume of water per crop and year.
- The possibility to change between products ET_C, NIWR and GIWR and GUIs are important in order to give high usefulness to the platform. Ongoing development for the second release.
- Integrate the function of spatial and temporal analysis is considered as high added value to the platform. Ongoing development for the second release.

Bajo Jalón:

Points out the practical application of DIANA services for detecting conflicting areas and for establishing volumes per crop type. These requirements have been achieved during the 2018 season of generation products and deployment of the platform.

Tierra del Vino:

Points out the requirement to create the products referred to the cadastral polygon layer. These requirements have been achieved during the 2018 season of generation products.

Bembézar:

Stresses the requirement to detect over-irrigation during the years of restrictions. The research project partners Feragua, Ariespace, UCLM, ROSA are working on the three different methodological approaches in order to fulfill these requirements. Ongoing.

Banat

Pilot area has stressed the requirement of using radar satellite data in order to detect humidity in the surface of the fields. ROSA has been working on this.

Sannio Alifano:

The main idea extracted from Sannio Alifano is implementing "traffic light" alarm (Figure 4, see also Figure 10and Figure 11) where the Water Rights information is crossed with Irrigated area products or with the DIANA crop classification layer. Some work in that direction have been developed by the Italian team working hand to hand Ariespace and Sannio Alifano Pilot area.

More in general, DIANA products/platform are considered valuable, being physically based -for instance regarding crops- and available both in time and space, moreover scalable on the territory from large areas to single cadastral parcel. So, they are essential to WUAs -and not only for them- to improve knowledge of irrigated agriculture managements itself, especially in terms of:

- Detection of irrigated areas, both with and without water rights;
- Classification of crops;
- Evaluation of irrigation water volumes used by farmers, wherever flowmeters are missing or not working. This, particularly, is possible -with satisfying accuracy- by

processing on statistical basis the data obtained from cross-checks among GIWR and the corresponding measured water volumes, where they are available.

Table 5. Ideas from the first steps in the co-evaluation and the status of the improvements.

	Pilot area	Conclusions	Status
ES	Mancha Oriental	DIANA products/platform as provided can save time for the technicians in charge of field inspections.	Implemented
		DIANA products/platform help them to have more information about the real volumes of consumption and can help to establish the volumes per crop in the year.	Implemented
		Integrate the function of spatial and temporal analysis is considered a high added value to the platform.	Ongoing
ES	Bembézar	Stresses the requirement to detect over-irrigation during the years of restrictions.	Ongoing
ES	Tierra del Vino	Points out the need to create the products referred to the cadastral polygon layer.	Implemented
ES	Bajo Jalón, Mancha	Practical application of DIANA services for detecting conflicting areas and for establishing volumes per crop type.	Implemented
IT	Sannio Alifano	DIANA can help WUA and other organizations to detect irrigated areas, both with or without water rights, classification of crops and evaluation of water irrigation volumes used by farmers. See also Traffic light" alarm described above.	Ongoing
RO	Banat Area	Pilot area has stressed the need for using radar satellite data in order to detect humidity in the surface of the fields.	Ongoing

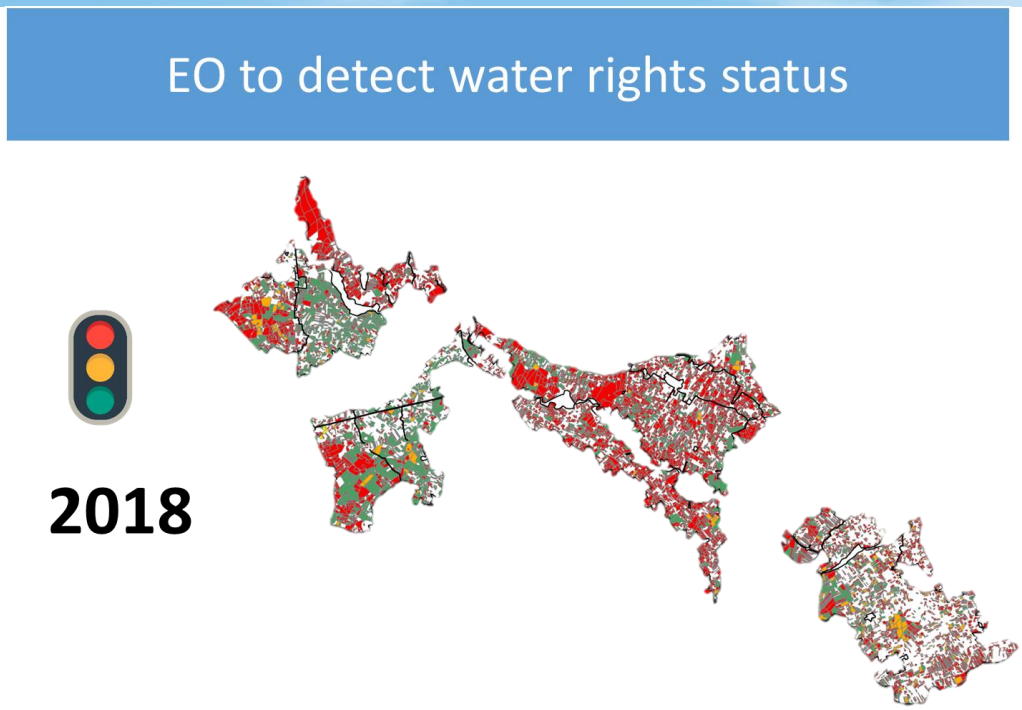

Figure 4. Traffic light example of Sannio Alifano where RED are areas are irrigated parcels without necessary water rights. YELLOW corresponds to irrigated areas exceeding the declared irrigated areas GREEN are areas with necessary water rights that are similar to the declared irrigated areas.

3.2.2. Conclusions from co-evaluation meetings with technicians

Mainly AgriSat and Ariespace technicians, who are experts in the use of EO agriculture platforms, have been constantly working hand-in-hand with DIANA platform developers AgroApps, to improve the technical aspects of the platform, appearance, accessibility, usability and functionality and adaptability. This was complementary to the technical verification reported above in section 3.1.

Specifically, the main suggested improvements extracted from different meetings among technicians are:

- The name “Time line” it should be above the slider bar.
- The layers name in the map should be hidden under any icon remembering layers. It would be convenient to have the possibility of creating GUIs from any temporal layers (Monthly products ET_C, NIWR, GIWR). It could be in a drop-down list once the user has displayed the product by clicking a button.
- The name of the Pilot Area should be shown in the initial page of the map.
- The development of drawing and edition function (vector layers) would be very attractive.
- The initial screen should be more dynamic.
- The possibility of creating reports from a user’s own layers is important.
- Coordinates should be shown in the navigation.
- Search of cities, town, should be implemented on the platform.

All these improvements have been suggested for implementation in the beta release of the DIANA platform viewer.

3.2.3. Analysis of questionnaires from Core Users and technician

A questionnaire (see Annex A) was developed to evaluate the alpha-version of the DIANA platform and to compile the first opinions of the technicians and users of the DIANA platform. The Table 6 summarizes the participants in the first round of questionnaires about the DIANA platform viewer. The rest of this section provides an overview of the responses received.

Table 6.Participants in the 1st round of questionnaires about the DIANA platform.

ID	Country	Pilot Area	Organization
ID1	Italy	Sannio Alifano	ARIESPACE s.r.l.
ID2	Italy	Sannio Alifano	ARIESPACE s.r.l.
ID3	Italy	Sannio Alifano	Consorzio di Bonifica Sannio Alifano
ID4	Italy	Sannio Alifano	ARIESPACE s.r.l.
ID5	Italy	Sannio Alifano	ARIESPACE s.r.l.
ID6	Spain	Mancha Orienta	Junta Central de Regantes Mancha Oriental
ID7	Romania	Banat	NARW/ Banat Water Basin Administration
ID8	Spain	Bembézar MD	Feragua

Table 7 summarizes the main challenges that end-users face and how DIANA can improve the routine tasks of these end users.

Table 7. Main challenges and how DIANA can contribute from the user's questionnaires

Main challenges faced by users	How DIANA can contribute
Improving the management of the water resources.	Cross-check between irrigated volumes applied by farmers and estimated by DIANA.
Detecting illegal use of water in agriculture: • Preserving water resources • Avoiding water waste	Cross-check between irrigated volumes applied by farmers and estimated by DIANA.
System to detect the water over abstractions.	Providing a useful tool to help the end users to improve the management of water resources.

Table 8. Demographics and Personal Data of participants of the questionnaires.

Demographics and Personal Data	Nº
Male	6
Female	2
Graduate	3
Post-Graduate	5

In the first version of the platform, the evaluation of their functionalities showed that it has a good manageability, it is intuitive, and the results are easily understood. But the layers terminology needs to be reviewed for its better understanding, and the translation into other languages will be of key importance to reach more potential users.

Regarding the user's guide, it is useful to start to use the platform, and the next steps could be the new version translated in different languages, and maybe including some technical descriptions about the products displayed in the platform viewer.

Table 9.Summary of the opinions about the platform functionalities.

DIANA Platform Functionalities				
	Very Good	Good	Poor	
Manageable	3	5		
Intuitive	4	4		
Visualization	5	3		
Layers Terminology	4	3	1	
Understanding results	3	5		
	Very Useful	Useful	I don't know	
Advantages of the platform	3	4	1	
	Daily	Weekly	Once a month	2-3 times a year
How often do you use it	1	5	1	1
	Very Useful	Useful		
User's Guide	1	7		
Comments				
ID7. The User Guide looks fine, I think what it contains now should get the job done. ID8. Spanish language will be appreciated. ID8. More technical information of DIANA's products in the user's guide.				

The Water Abstraction Service is the main service offered by the DIANA platform. In general, the products present in this service contain a very useful information for the users, but not all the information that they need such as the over abstractions (Table 10).

Table 10. Water Abstraction Service evaluation by the users.

Water Abstractions		
	Yes	No
Give you all the information that you need	6	2
Presentation of the information helpful	7	1
Data in graphics well understood	8	-
Maps well understood	8	-
Comments		
ID8. In its present state, the platform does not meet the expectation of detecting irrigation over abstractions in years of limited allocation. We think we still will need to read the water counters frequently. ID8. I'd like to see expected values and over abstractions. ID8. Need to find a description of the indexes and how to relate them with drought.		

In the case of the Drought Monitoring Service, the users are missing more information about the products provided by the platform to check if they can incorporate them into their work (Table 11).

Table 11. Drought Monitoring Service evaluation by the users.

Drought Monitoring		
	Yes	No
Give you useful information	6	1
Maps well understood	6	2
Drought Monitoring		
ID8. Need to find a description of the indexes and how to relate them with drought.		

In general, the responses to the questionnaires show the same ideas and suggestions as discussed during the meetings, as described in the previous sections.

With these results, the next step is the feedback loop with the developers to send them the opinions and suggestions of the users, and in this way, to improve the platform globally.

Table 12.General comments and suggestions by the users.

General Comments & Suggestions
ID.3. If possible, I would prefer to use the platform for a longer time, together with Ariespace, to express more conscious opinions. ID7.1. Map legends should have measurements units for each layer. ID7.2. Layer transparency should be adjustable by user, because a 50% transparency, for example, will change the color compared to it being 0% transparent. ID7.3. Is there, or is it possible, to make a download or export button, to use the layers (vector or raster format) in other GIS software for further analysis?

4. Conclusions and next steps

The first release of the platform (alpha version) has taken place successfully in a good state of usability and the evaluation in an operational environment have provided the first ideas of improvements from different user perspectives for the second release of the platform. The feedback collected from user stresses that the information provided by DIANA products has a high level of interest and is very useful for them.
Additionally, the interest raised has led to more water user associations joining the co-evaluation process. In particular, the Spanish Ministry of Ecological Transition, in collaboration with the Ministry of Agriculture, has started to play a more active role in implementing and co-evaluating DIANA services in more river basins.

The objective and purpose of the first two campaigns have been achieved:

(1) to provide the required datasets and products generation for stakeholder pilot areas;
(2) to provide the frame of reference with alpha version of DIANA platform to show the products and first graphics derived from the products representing interest information, training, and guidance for the stakeholder evaluation process.
(3) First feedback and evaluation of the products and platform.

With these results, the next step is the feedback loop with the developers to send them the opinions and suggestions of the users, and in this way, to improve the platform globally

During the 3rd year of the project (phase 3) a “second round” of questionnaires will be launched to evaluate the updates in the platform along with co-evaluation meetings with the Core Users and further stakeholders.

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Annexes

Annex A. Questionnaire DIANA platform

Demographics and Personal Data				
	Pilot Area and Country:			
	Place and Date:			
	Profession:			
	Organization:			
	Tel	Mobile	E-mail	
	What is your gender? ☐ Male ☐ Female			
	What is your education level?			
	Primary ☐	Secondary ☐	Graduate ☐	Post-Graduate ☐

Expectations on the use of DIANA platform		
	What are the main challenges in your pilot area and how do you think DIANA can contribute?	
	Main challenges (in order to priority)	*How DIANA can contribute*

DIANA platform functionalities						
	Have you used DIANA platform by yourself? ☐ Yes ☐ No					
	If yes, how would you rate the following aspects?					
		Very Good	Good	Poor	Very Poor	I don't know
	Manageable	☐	☐	☐	☐	☐

	Intuitive	☐	☐	☐	☐	☐
	Visualization	☐	☐	☐	☐	☐
	Layers Terminology	☐	☐	☐	☐	☐
	Understanding results	☒	☐	☐	☐	☐

Comments:

Would you see advantages of using DIANA platform?

Very useful	Useful	Not useful	I don't know
☐	☐	☐	☐

How often do you typically use the DIANA platform? Or will you use the platform?

Daily	Weekly	Once a month	Every 2.3 months	2-3 times a year	Once a year	Do not use
☐	☐	☐	☐	☐	☐	☐

How have you found DIANA User's Guide?

Very useful	Useful	Not useful	I don't know
☐	☐	☐	☐

In your opinion, what should be included in the User's Guide?

Water Abstractions

Does the platform give you all the information you need to get an overview of the status of abstractions?

☐ Yes ☐ No

If not, what is missing?

(Please note that the purpose of DIANA platform is rather to give you a quick overview at a glance, it is not designed to provide detailed geo-spatial information, which can be accessed from SPIDERwebGIS or Irrisat)

Is the presentation of the information helpful for your routine tasks?

☐ Yes ☐ No

	If not, what would you like to change?
	Are the data in the graphics well understood? ☐ Yes ☐ No
	If not, which graphic/data? Why?
	Are the maps of Water Abstraction service well understood? ☐ Yes ☐ No
	If not, which map? Why?
Drought Monitoring	
	Does the platform give you useful information about Drought Monitoring? ☐ Yes ☐ No
	If not, which information will be useful to include it?
	In the Drought Monitoring map, is the information well understood? ☐ Yes ☐ No
	If not, which information? Why?
Comments and Suggestions	

Annex B. Products of Pilot Areas on DIANA platform & Reports

In this section, examples of DIANA platform of Pilot Areas are showed.

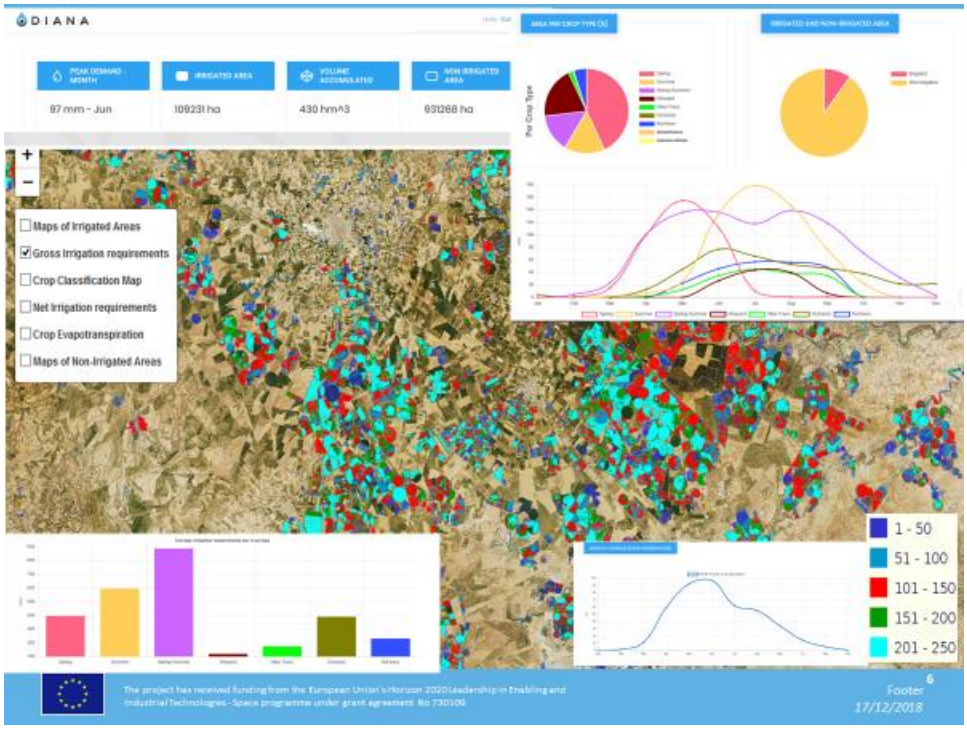


Figure 5. Mancha Oriental product verification on DIANA platform showing gross irrigation water requirement product.

Figure 6. Tierra del vino product verification on DIANA platform showing Crop Classification product.

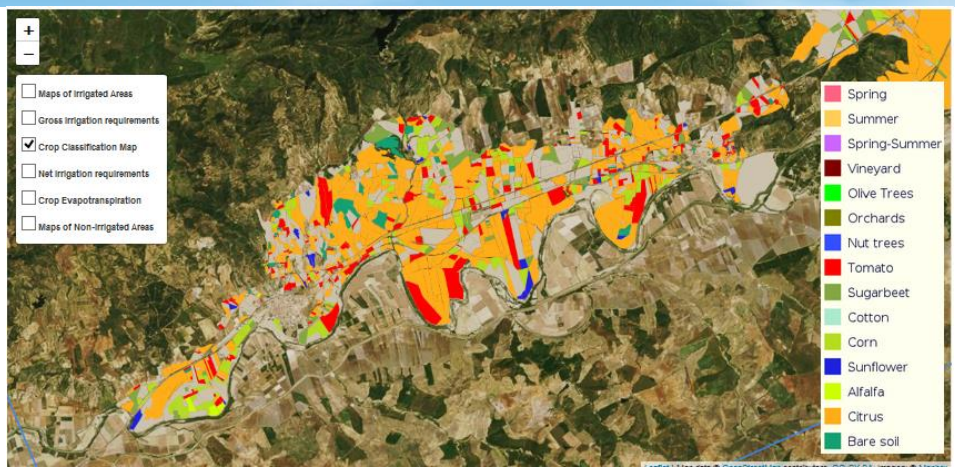


Figure 7. Bembézar product verification on DIANA platform showing crop classification.

Figure 8. Sannio Alifano product verification on DIANA platform showing map of irrigated areas product.

Figure 9. Banat product verification on DIANA platform showing map of Gross Irrigation Water Requirements.

Furthermore, in the case of la Mancha Oriental, Tierra del Vino y Bajo Jalón additional efforts have been devoted to the verification of the precision, usefulness and reliability of the products. Different reports have been generated summarizing the information provided by DIANA products using GIS software by UCLM-AgriSat (http://maps.spiderwebgis.org/ & https://www.agrisatwebgis.com/).

In case of Consortium Sannio Alifano, a test was carried out in Telesina Valley during growing season of 2017. The results of the "traffic light alarm" method are showed in Figure 10 and Figure 11.

Non–compliance – First type

Definition: Irrigated areas without necessary water rights

Rule sets:
- Parcels over ½ ha
- Irrigated parcels with a surface upper to 20% than cadastral surface.

Results:
- **Cadastral parcels with *Non-compliance of First type (nr.)*** 1084
  - Total cadastral area = 1007 ha
  - **Total irrigated area = 783 ha**
    - Herbaceous crop = 323 ha
    - Permanent crop = 460 ha

Non–compliance – Second type

Definition: The irrigated areas exceeds the declared irrigated areas

Rule sets:
- Parcels over ½ ha
- Difference between classified irrigated area (a) and declared irrigated area (b) upper to 20%
  [(a-b) > 20%(b)]

Results:
- **Cadastral parcels with *Non-compliance – Second type (nr)*:** 282
- Total declared irrigated area = 160 ha
  - Total irrigated area = 376 ha
    - Herbaceous crop = 217 ha
    - Permanent crop = 159 ha
  - **Difference = 216 ha**

Compliance

Definition: Irrigated areas - with necessary water rights - are similar to the declared irrigated areas

Rule sets:
- Parcels over ½ ha

Results:
Cadastral parcels with *water rights (nr.)*: 2549
- Checked cadastral parcels: 472

- Total declared irrigated area = 472 ha
- Total irrigated area = 454 ha
  - Herbaceous crop = 353 ha
  - Permanent crop = 101 ha

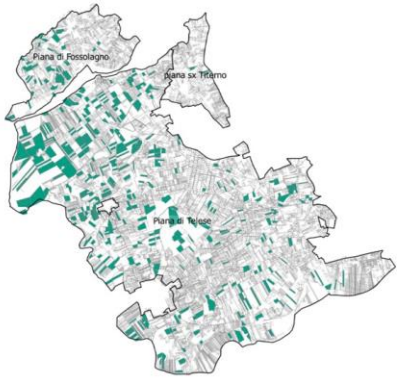


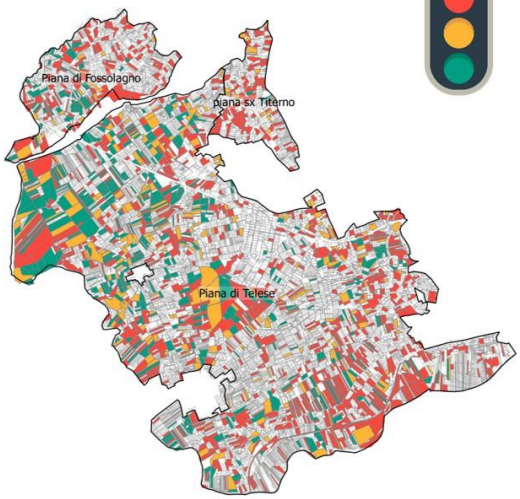
Figure 10. Description of the "Traffic light alarm" method used in Telesina Valley for the season 2017.

EO to detect irrigated areas - Telesina Valley - 2017

Test Case
Telesina Valley

Districts:
- Piana di Telese
- Piana sx Tirreno
- Pian di Fossolagno

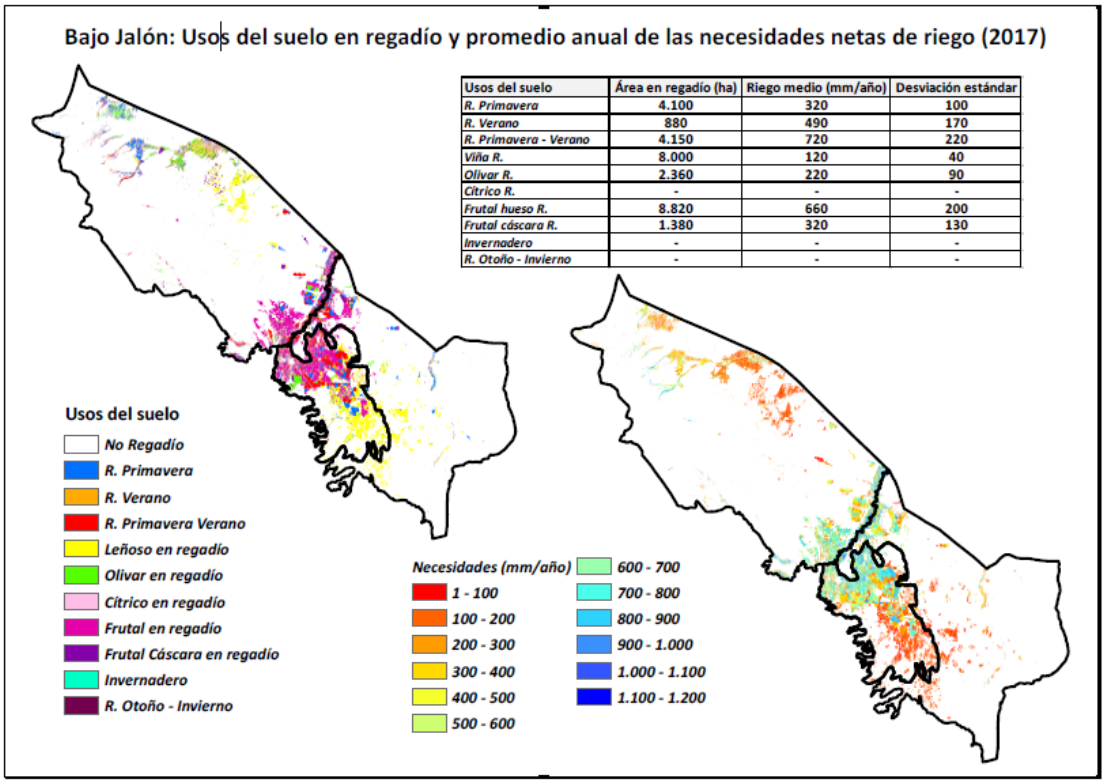
Cadastral parcels with *water rights (nr.)*: 2831 (1404 ha)



SUMMARY

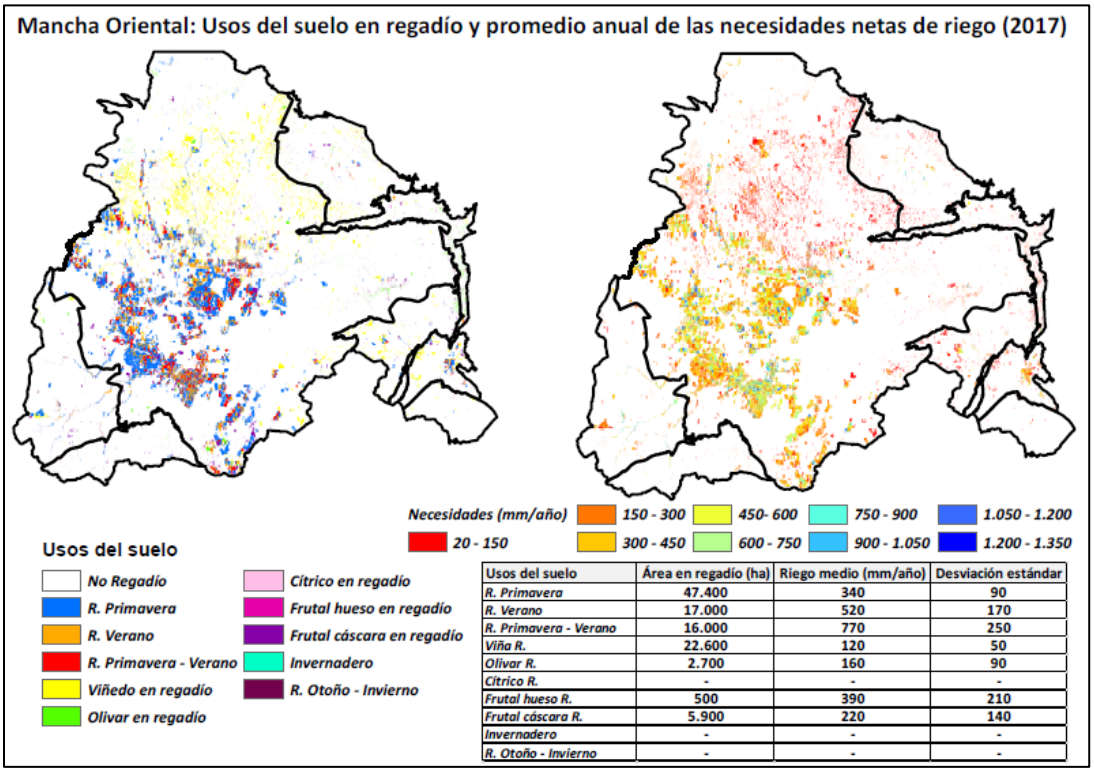
	Not-compliance First type	Not-compliance Second type	Compliance	Total	Water rights
Number of parcels	1084	282	2549	3915	2831

Figure 11. Final results of the detection of irrigated areas by "Traffic light alarm" based in EO methods in Telesina Valley (Italy) in season 2017.



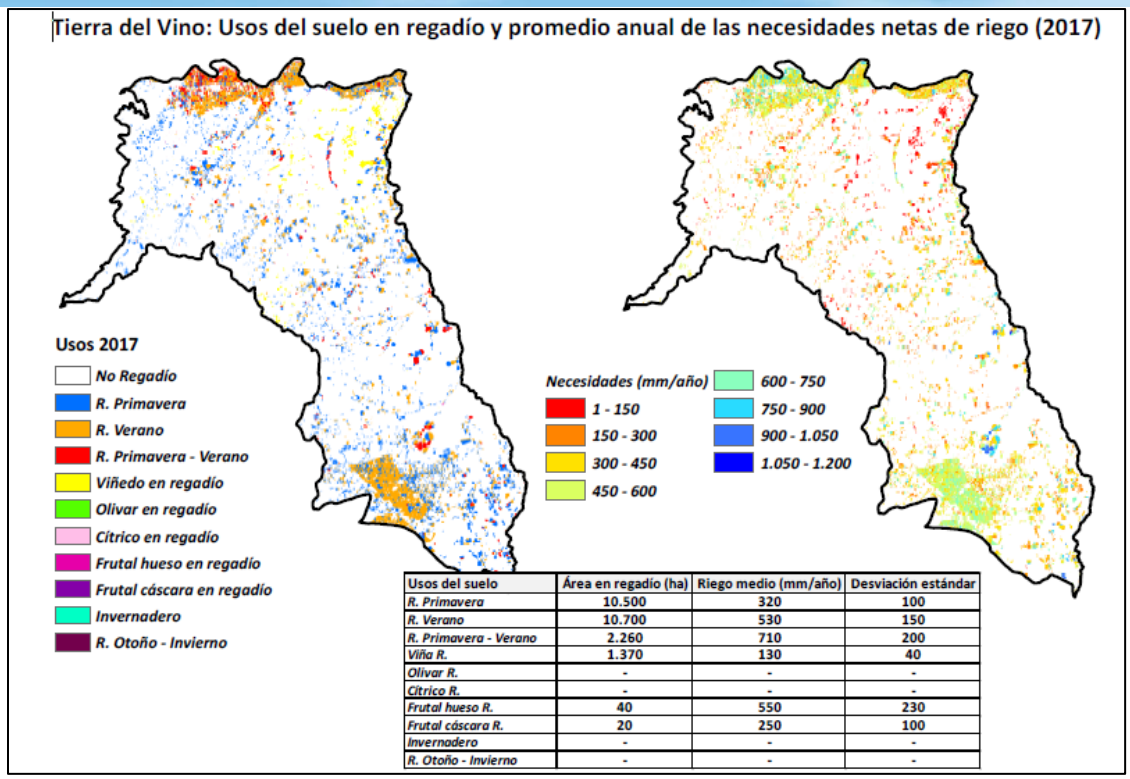
Usos del suelo	Área en regadío (ha)	Riego medio (mm/año)	Desviación estándar
R. Primavera	4.100	320	100
R. Verano	880	490	170
R. Primavera - Verano	4.150	720	220
Viña R.	8.000	120	40
Olivar R.	2.360	220	90
Cítrico R.	-	-	-
Frutal hueso R.	8.820	660	200
Frutal cáscara R.	1.380	320	130
Invernadero	-	-	-
R. Otoño - Invierno	-	-	-

Figure 12. Bajo Jalón report summarizing DIANA products.



Usos del suelo	Área en regadío (ha)	Riego medio (mm/año)	Desviación estándar
R. Primavera	47.400	340	90
R. Verano	17.000	520	170
R. Primavera - Verano	16.000	770	250
Viña R.	22.600	120	50
Olivar R.	2.700	160	90
Cítrico R.	-	-	-
Frutal hueso R.	500	390	210
Frutal cáscara R.	5.900	220	140
Invernadero	-	-	-
R. Otoño - Invierno	-	-	-

Figure 13. Mancha Oriental report summarizing DIANA products.



Usos del suelo	Área en regadío (ha)	Riego medio (mm/año)	Desviación estándar
R. Primavera	10.500	320	100
R. Verano	10.700	530	150
R. Primavera - Verano	2.260	710	200
Viña R.	1.370	130	40
Olivar R.	-	-	-
Cítrico R.	-	-	-
Frutal hueso R.	40	550	230
Frutal cáscara R.	20	250	100
Invernadero	-	-	-
R. Otoño - Invierno	-	-	-

Figure 14. Tierra del vino report summarizing DIANA products.

Irrigated area (declared by farmer) [ha]	Irrigated area (deduced from Satellite) [ha]	Irrigation water volume distributed m^3	NIWR m^3 for season	GIWR m^3 for season (CU = 0.9)
5.5	4.8	33,000	27,000	30,000

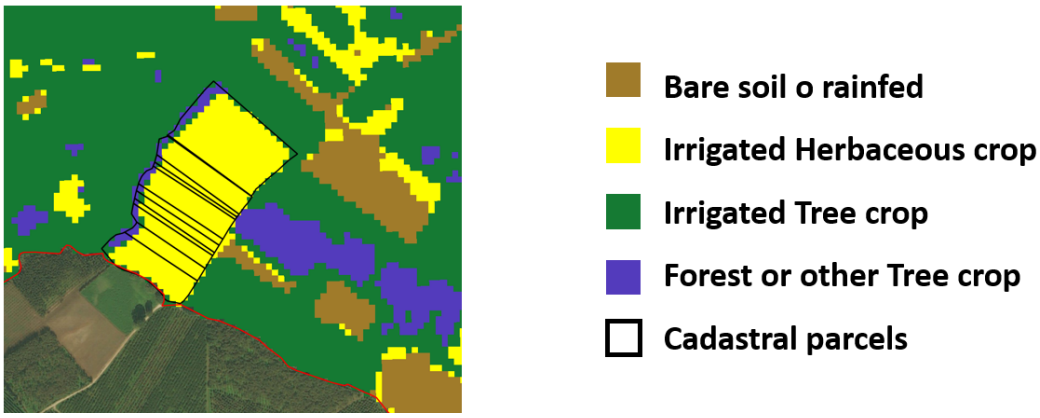


Figure 15. An example of cross-check comparison performed to validate the GIWR data product.

Annex C. Banat pilot area generation product report

DIANA products

The products provided in order to be uploaded in DIANA platform are:

- Crop water requirements or Crop evapotranspiration (ET_C) (raster; vector for irrigated plots). This will be the annual product. The calculation considers just the crop growing cycle. The monthly CWR can be generated on demand.
- Net Irrigation Water Requirements (NIWR) (vector).
- Gross Irrigation Water Requirements (GIWR) (vector).

ETc calculation

EO-derived crop evapotranspiration (maximum) (ET_C) is the value of evapotranspiration under standard conditions, as defined by FAO56: disease-free, well-fertilized crops, under optimum soil water conditions. It can be derived by using a coefficient-based approach (K_C* x ET_0; K_C*: reflectance-based crop coefficient; several approaches can be used for estimating kc* from Vegetation Indices, by using basal crop coefficient relationships).

To calculate ET_C, the Crop coefficient-Reference evapotranspiration methodology described in the FAO56 manual (Allen et al.1998) was used. More concretely a "single" crop coefficient model where the estimation of ET_C, in absence of water stress, is calculated as:

$$ET_C = K_C \cdot ET_0$$

Where ET_0 is the reference evapotranspiration and K_C is the crop coefficient. ET_0 is calculated from different climatic variables, while K_C can be calculated through its linear relationship with the NDVI. In this case, the equation used has been the next:

$$K_C = 1.25 \cdot NDVI + 0.1$$

Thus, from NDVI data, the ET_C can be calculated via K_C relationship.

The NIWR and GIWR products are related as follows:

$$NIWR = ET_C - PP$$

$$GIWR = NIRW/Ɛ$$

Where PP is the precipitation and Ɛ is the irrigation efficiency. So, from the ET_C we can obtain the other products.

Accumulated ET_C calculation in Banat area

The software used to calculate the accumulated ET_C is *Tonipbp*, developed in UCLM. The program allows to accumulate values of ET_C pixel by pixel from temporal series of NDVI and reference ET (ET_0) data during the growing crop as follow:

$K_C = 1.25 \cdot NDVI + 0.1 \rightarrow ET_C = K_C \cdot ET_0$

It is necessary to describe the growing crop cycle to define the period to accumulate the ET_C per pixel. For Banat area, the growing cycle was defined for the irrigated crops in 2017: soybeans, sunflowers, maize and sorghum.

The inputs of TONIpbp are: selected time series NDVI (cloud free), daily ET_0, the range of NDVI values and the shape (layer) of the area of interest. The software creates daily NDVI values interpolating between the dates of NDVI images, applies the correlation NDVI-Kc defined above and multiplies by the daily ET_0 values. In order to capture the growing cycle, it is necessary to define the values of NDVI representing the beginning and the end of the crop cycle. In this case it has been stablished 0.3 NDVI as the green up, the moment when the crop starts the vegetative development and 0.45 NDVI as the maturity physiological is reached. So, when one-pixel reaches 0.3 of NDVI, TONI will use this date to start to accumulate the ET_C. And it will stop in the date when the value of NDVI decrease under 0.45. The daily ET_0 and precipitation was obtained from the weather station of Sannicolau Mare (data provided by ROSA group).

The images used were NDVI Sentinel 2A, Sentinel 2B and Landsat 8 for 2017 cloud free. The dates used are summarized in the next list.

- ndvi3_20170102_S2A_32634_136000T34TDS_02.img
- ndvi3_20170303_S2A_32634_136000T34TDS_00.img
- ndvi3_20170402_S2A_32634_136000T34TDS_00.img
- ndvi3_20170516_landsat8_32634_186028_cc_26_rec.img
- ndvi3_20170704_S2A_32634_036000T34TDS_00.img
- ndvi3_20170719_S2B_32634_036000T34TDS_01.img
- ndvi3_20170808_S2B_32634_036000T34TDS_02.img
- ndvi3_20170815_S2B_32634_136000T34TDS_00.img
- ndvi3_20170914_S2B_32634_136000T34TDS_00.img
- ndvi3_20171002_S2A_32634_036000T34TDS_00.img

The *Figure 16* is an example of the curve described by the evolution of NDVI images values for one pixel (red point in the map) in a soybean plot in an irrigated plot of Bannat area.

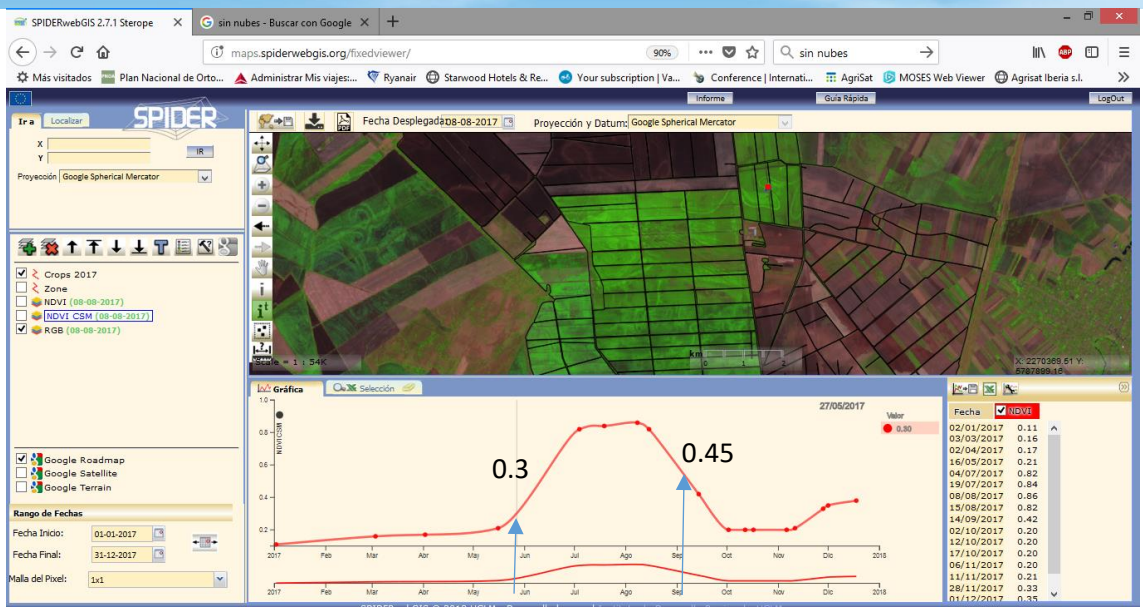


Figure 16.NDVI evolution for a pixel in a Soybean plot in Banat area in 2017.

For this pixel the software starts to accumulate in the 26/05/2017 (0.3 NDVI) and stops in 11/09/2017.

The final product is the accumulated ET_C (mm) during the growing cycle pixel by pixel. This product is represented in the next figure (provided in *.img* format, *Figure 17*).

Notice the south plots are incomplete due to the extension of the satellite Image doesn't cover the whole plot.

Every pixel value of the ET_C map shows the crop evapotranspiration in millimeters, mm (l/m^2), usually understood as the crop water requirements (CWR). This ET_C is the accumulated over the growing season Units are mm for the total CWR growing cycle (mm(year)).

Figure 17. Evapotranspiration accumulated at the end of the crop growing cycle

ETc average, Net Irrigation Water Requirements and Gross Irrigation Water Requirements Calculation

ETc average (mm): Once we have the ET_C value pixel by pixel for the whole growing cycle in a raster format, zonal statistic has been run in QGIS program. Previously, it has been applied a buffer of minus 30 meters to the original vector layer where the boundaries of the plots are defined in order to avoid the boundary effects of the images. Finally, it has been obtained the ET_C average per plot.

The value it has been provided for every polygon in the attribute table of the original vector layer (column called *ETc_lbl*).

The *Figure 18* shows the map with assigned values of ETc.

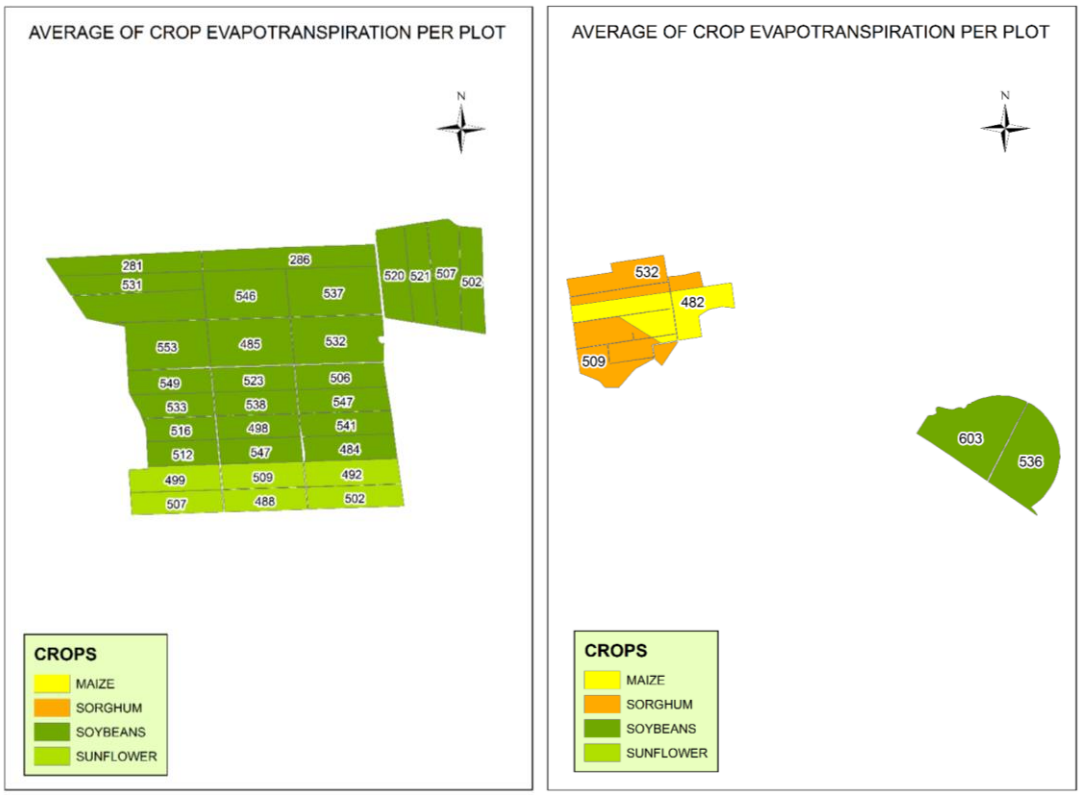


Figure 18. Average of Accumulated Evapotranspiration per plot (1)

Net Irrigation Water Requirements (mm) NIWR = ETc-PP: PP is the precipitation during the growing cycle. In order to accumulate the precipitation during the growing cycle, the dates of the beginning of the cycle (0.3 NDVI) and the end (0.45 NDVI) have been stablished studying groups of plots and crops which have similar cycles. Finally, seven groups were defined.

Table 13.Groups of crops and plots associated by their similarity of the length of their growing cycles

Group	Precipitation mm	Start. Date	Finish. Date
Sorghum	84.4	21/05/2017	16/08/2017
Corn	89.6	16/05/2017	24/08/2017
Soybeans1	86.3	15/03/2017	19/03/2017
Soybeans2	125.3	04/05/2017	03/09/2017
Soybeans3	125.3	26/04/2017	03/09/2017
Soybean4	89.6	16/05/2017	26/08/2017
Sunflowers	82	23/05/2017	19/08/2017

The *Figure 19* shows the map with the crops aggregated by their growing cycles.

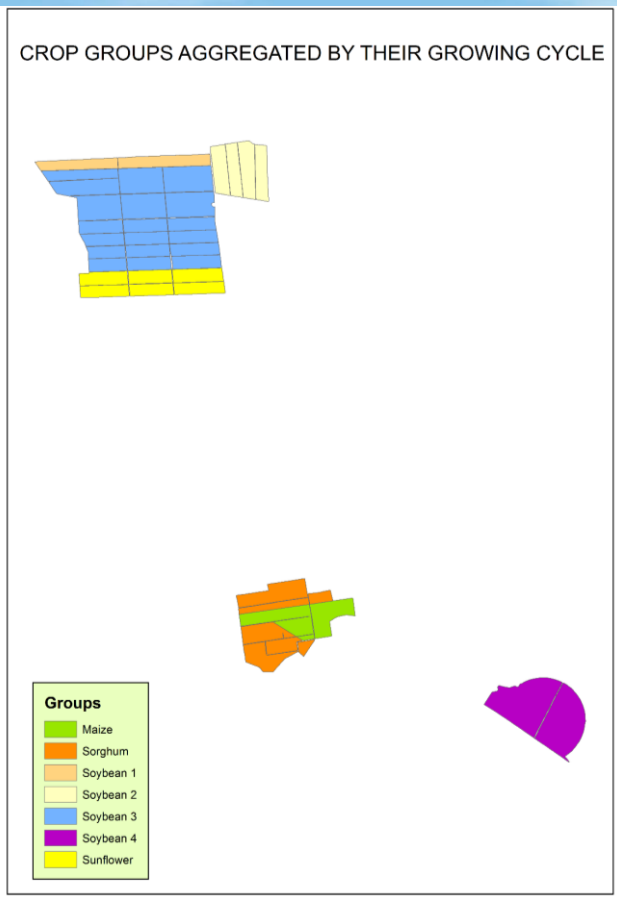


Figure 19. Groups of crops and plots associated by their similarity of the length of their growing cycles.

The value it has been provided for every polygon in the attribute table of the original vector layer (column called *NIWR_Ibl*) and it is shown in the next figure:

The *Figure 20* shows the map with assigned values of NIWR.

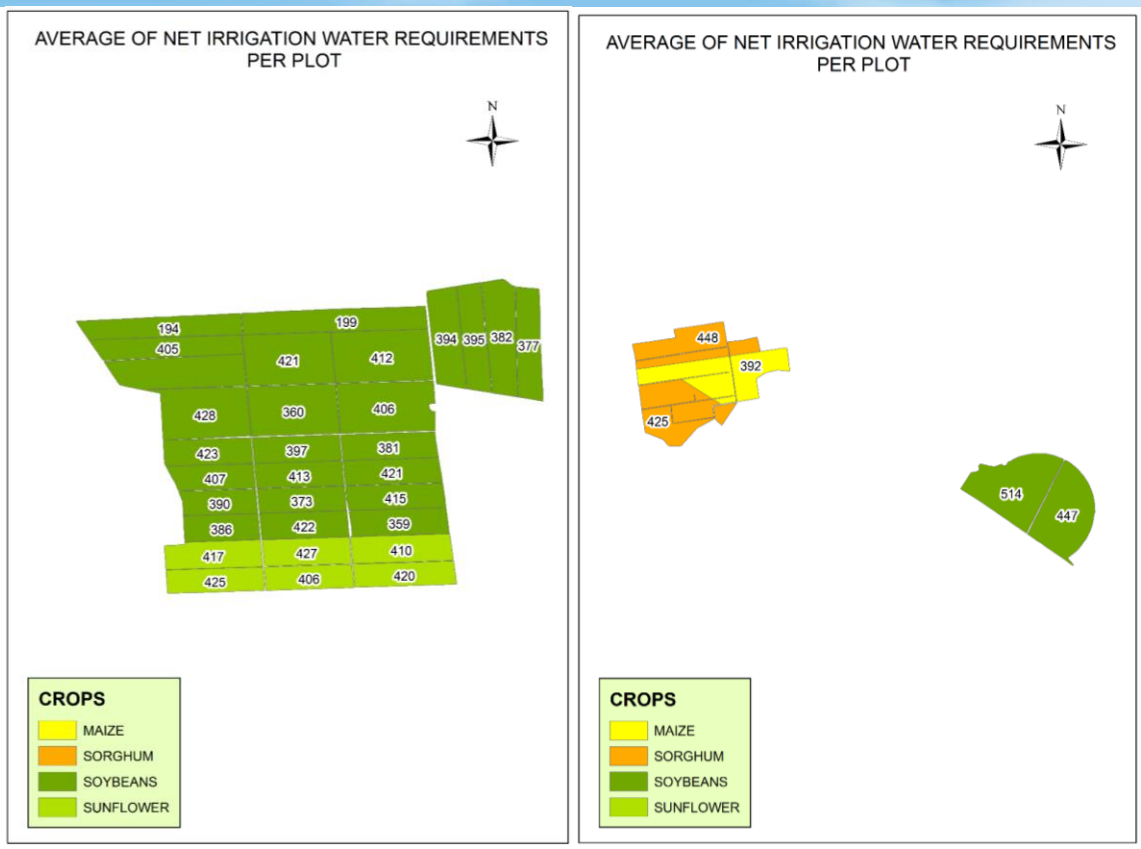


Figure 20. Net Irrigation Water Requirement Average per plot.

Gross Irrigation Water Requirements (mm) (NIWR/ Ɛ): Derived from applying an efficiency irrigation coefficient to the net irrigation water requirements NIWR. In this case it has been used 0.85 as a regular value but we need to keep in mind that these coefficients are very specific parameters depending mainly on the type of irrigation system and on the effectiveness of the application of the water (open channels, pumping, sprinkling, dripping, irrigating climate conditions, etc.). It would be interesting to be flexible with the spatial scale of this product because, maybe different areas within the Pilot area have different coefficients which means different products that could be aggregated if needed. If this coefficient is known for Banat area or any of the sub-areas please, correct it.

The value it has been provided for every polygon in the attribute table of the original vector layer (column called *GIWR_Ibl*).

The *Figure 21* shows the map with assigned values of Gross Irrigation Water Requirements averaged per plot.

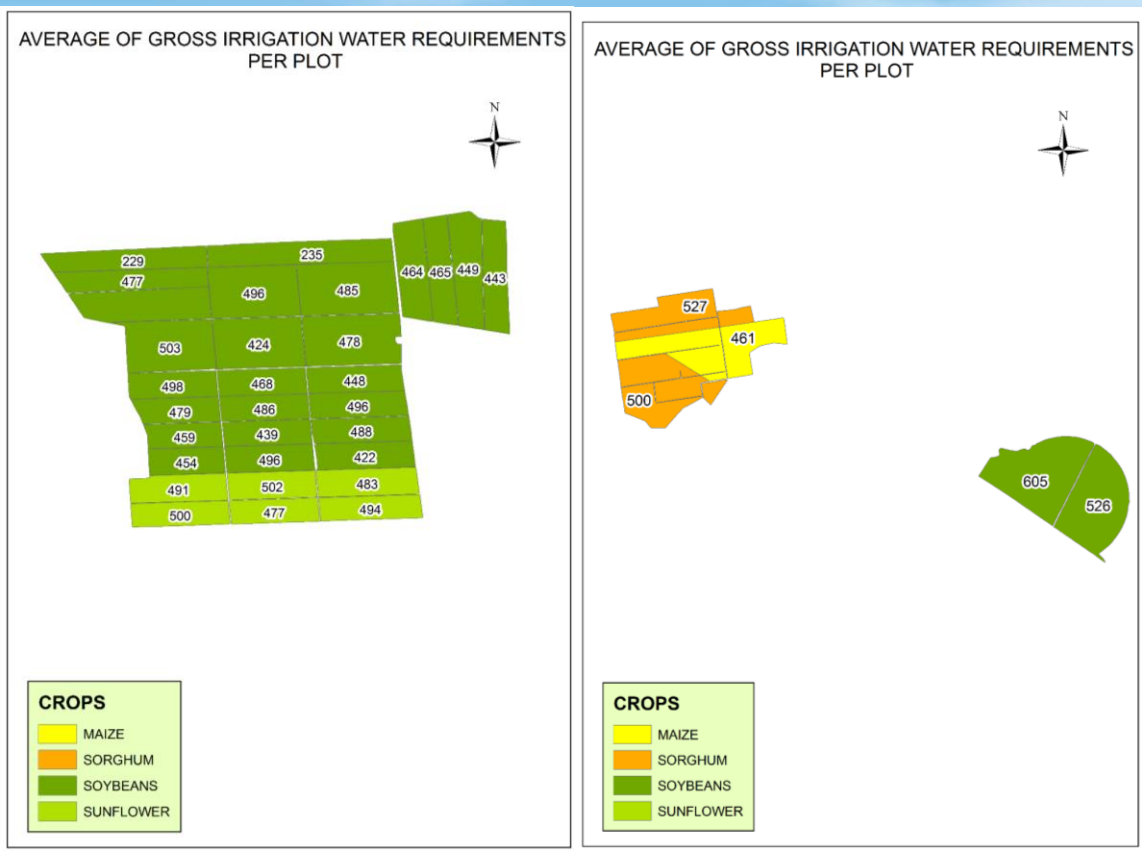


Figure 21. Gross Irrigation Water Requirement Average per plot.

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