# The TELERIEG Project

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**The use of remote sensing and geographic information systems for irrigation management in Southwest Europe**

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# The TELERIEG Project

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**Abstract.** The TELERIEG (The use of remote sensing for irrigation practice, recommendation and monitoring in the SUDOE space, www.telerieg.net), co-financed by the Interreg IVB SUDOE Programme of the European Union, has spent three years of activity with the objective of developing knowledge and tools on the application of remote sensing and geographic information systems for the improvement of irrigation water management and the response to natural risks affecting agriculture in the Southwest of Europe. The main results include an automated image processing that generates daily maps with useful parameters for irrigation management, and a geoportal adapted to the INSPIRE Directive, made up of large databases of agroclimatic and cartographic information, as well as utilities and tools based on geographic information systems and remote sensing allowing users to calculate irrigation requirements at plot scale. A collaboration network has been created of institutions working in the field of remote sensing and irrigation water management, using the most advanced techniques of high resolution images processing for estimation of agronomic parameters at field scales. All these results have been disseminated at local and international scale, covering mainly the project areas of Southwestern Europe but also other Mediterranean countries. The technologies developed by TELERIEG can contribute to improvements in optimization of the agricultural production factors mainly water.

**Keywords.** Irrigation – Remote sensing – Decisión support system – Southwest Europe – Interreg.

***Le projet TELERIEG***

***Résumé.*** *Le projet TELERIEG (Utilisation de la télédétection pour la recommandation et le suivi des pratiques d'irrigation dans l'espace SUDOE), cofinancé par le Programme SUDOE-Interreg IV-B de l'Union européenne, compte déjà trois années d'activité dans l'objectif de développer les connaissances et les outils pour l'application de la télédétection et des systèmes d'information géographique à l'amélioration de la gestion de l'eau d'irrigation et à la réponse aux risques naturels que subit l'agriculture dans le Sud-Ouest de l'Europe. Les principaux résultats comprennent le traitement automatisé des images, permettant la création de cartes journalières où figurent des paramètres utiles pour la gestion de l'irrigation, et un géoportail adapté à la Directive INSPIRE qui héberge de vastes bases de données d'information agroclimatique et cartographique, ainsi que des utilités et outils basés sur les systèmes d'information géographique et la télédétection, permettant aux usagers de calculer les besoins en irrigation à l'échelle de la parcelle. Un réseau de collaboration a été créé pour les institutions travaillant dans le domaine de la télédétection et de la gestion de l'eau d'irrigation, utilisant les techniques les plus avancées de traitement d'images à haute performance pour l'estimation de paramètres agronomiques à l'échelle du terrain. Tous ces résultats ont été diffusés au niveau local et international, couvrant les zones du projet dans le Sud-Ouest de l'Europe et d'autres zones de pays méditerranéens. Les technologies développées par TELERIEG peuvent contribuer à l'optimisation des facteurs de production agricole, l'eau notamment.*

***Mots-clés.*** *Irrigation – Télédétection – Système d'aide à la décision –Sud-ouest de l'Europe – Interreg.*

## I – Background

TELERIEG (The use of remote sensing for irrigation practice, recommendation and monitoring in the SUDOE space, contract no. SOE1/P2/E082) was a 33 months (2009-2011) transnational project cofinanced by the beneficiary institutions and the Interreg IV B SUDOE Programme

(Southwest European Space Territorial Cooperation Programme) through the European Regional Development Fund (ERDF), within the framework of the European Territorial Cooperation Objective for 2007-2013).

The objective of the SUDOE Cooperation Programme is to consolidate the territorial cooperation of the Southwest European regions in the fields of competitiveness, innovation, environmental protection, and the sustainable planning and development of the area, contributing to the harmonious and balanced integration of the SUDOE regions and their social and economic cohesion within the European Union. The Southwest European Space (SUDOE), consists of 30 regions and autonomous cities (Fig. 1), covering 770,120 km$^2$ and populated by 61.3 millions inhabitants.

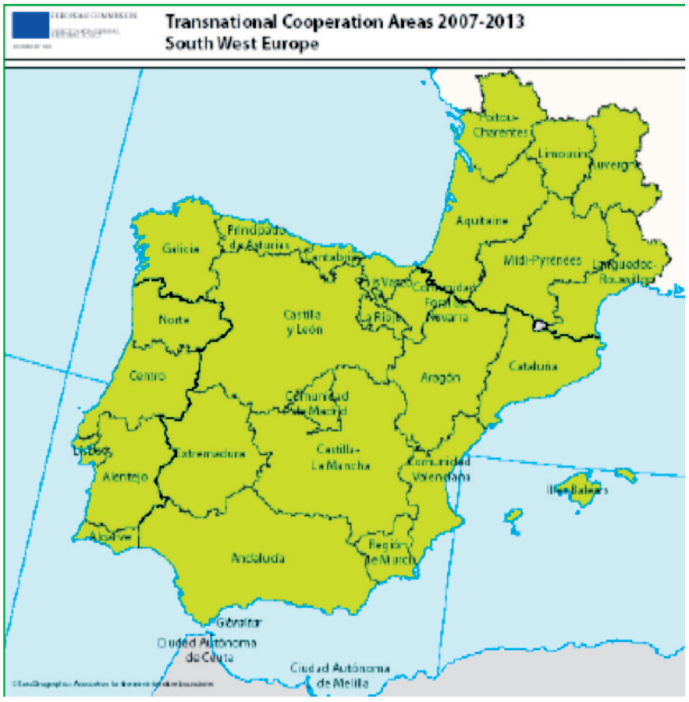


**Fig. 1. The SUDOE Space.**

TELERIEG (www.telerieg.net) was one of the Programme projects included in its Priority number 2, which addressed the "Improvement of sustainability for the protection and conservation of the environment and natural surroundings ofd the SUDOE Space", involving activities of risk prevention and conservation of natural resources.

This project is framed in a context of uncertainty in the rural areas of the SUDOE Space (Fig. 1), especially in the agricultural sector specially. This uncertainty is caused by the loss of competitiveness loss and abandonment of the agricultural activity in many areas because of problems related with the water shortage and the rise in natural risks (as droughts), whose negative effects exceed the scope of the agricultural sector and extend to drinking water availability, rural population maintenance, environmental damages and social conflicts between water resource users. On the other sidehand, the presence of research and development in the agricultural sector is still scarce and very fragmented, and this represents a threat to the survival of the sector survival.

All these problems may be tackled overall through actions in which all the involved stakeholders involved take part, from the Administration to producers and the research sector.

TELERIEG partners have been cooperating in projects related with this issue since for a long time, being the PRECIRIEG Project (SUDOE) being a recent example. The TELERIEG project emanated from this last project activities and results, and has intended to face up the necessity of improving the efficiency of the natural resources management, adapting the economical activities to a more rational resources management (thus improving the competitiveness) and also improving the management capacity of the economical and social agents and the Administration for data collection and analysis and decision-making.

## II – Project objectives

The final objective of the project has been a better environmental protection through a more efficient and rational management of water resources in agriculture and a more effective capacity of prevention and response to natural risks.

For achieving this objective the project is targeted to generating a surveillance and recommendations system for vast areas. More specifically, collection of information, analysis and decision-making services have been developed, allowing a more efficient management of the resource and optimization of the response capacity ahead of the natural risk, such as drought. These services are based on Geographical Information Systems (GIS) and on Remote Sensing, and include adaptionsadaptations to the management of drought and the reduction of climate change impacts. They make on-time information and decision-making utilities available to water users and managers.. Besides, the system is an opportunity for a regional development based on the creation of new services for the irrigation water user's communities and companies, optimizing the productions and the resource uses, besides contributing to develop the information society. Finally, the availability of information about the SUDOE area has the potential to create an important opportunity for the transmission of results and their application throughout the whole SUDOE area. It is to be highlighted that the project has been working with the standards set up by the INSPIRE Directive (Infrastructure for Spatial Information in the European Community), which had not yet been put into practice by any initiative in the SUDOE space. This fact supposes an important innovation and an element of territorial cohesion, because it will allow the SUDOE area to work with the same data set, which will generate important benefits for working together in the future.

## III – Project partenariat partnership and involved territories involved

The Telerieg project involved nine partners from 8 regions of the SUDOE Space (Fig. 2):

1. IMIDA: Instituto Murciano de Investigación y Desarrollo Agrario y Alimentario de la Consejería de Agricultura y Agua - Región de Murcia (Spain). Project leader beneficiary.
2. ACMG: Association climatologique de la moyenne Garonne (France).
3. IVIA: Instituto Valenciano de Investigaciónes Investigaciones Agrariasde la Consejería de Agricultura - Generalitat Valenciana (Spain).
4. ISA: Instituto Superior de Agronomia de la Universidade Técnica de Lisboa (Portugal).
5. ANPN: Association nationale des producteurs de noisettes (France).
6. IRTA: Institut de Recerca i Tecnologia Agroalimentàries - Generalitat de Catalunya (Spain).
7. CEMAGREF: Centre national du machinisme agricole, du génie rural, des eaux et des forêts de Montpellier, actually currently IRSTEA (France).

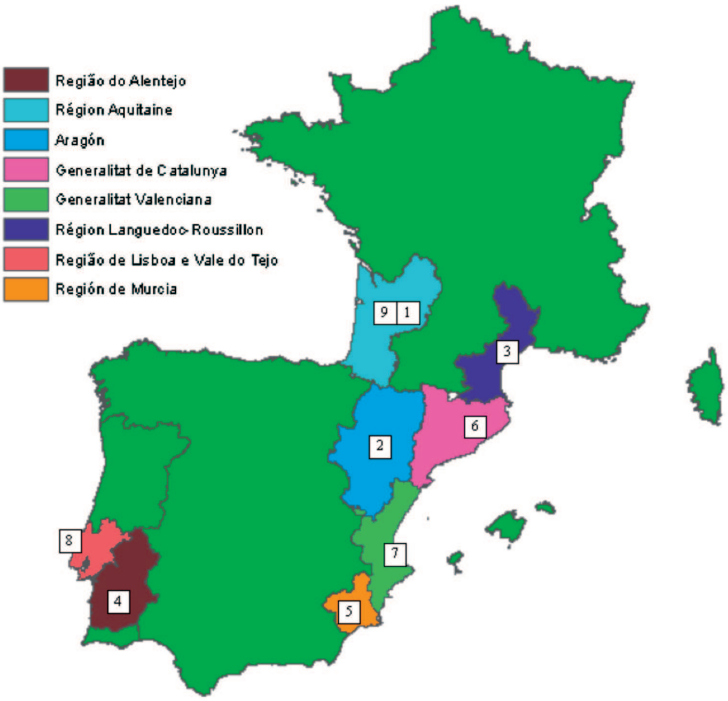


**Fig. 2. Regions participating in the Telerieg Project. In each region, partners are identified by their number in the list above.**

8. COTR: Centro Operativo e de Tecnologia de Regadio (Portugal).
9. IAMZ-CCIHEHAM: Mediterranean Agronomic Institute of Zaragoza (Spain).

Telerieg also involved a number of collaborators that have contributed to the project activities through different inputs: technical and sicientificscientific expertise, field experiments, practical applications, data and information, etc. These collaborators were the following:

1. A.S.A de la Baysole: Association Syndicale Autorisée pour l'irrigation des coteaux de la Baysole (France).
2. AEMET Murcia: Agencia Estatal de Meteorología (Spain).
3. IGN: Instituto Geográfico Nacional. Plan Nacional de Teledetección (Spain).
4. DARTCOM: Weather Satellite and Remote Sensing Ground Stations (UK).
5. AQUITANE: Fruits et légumes d'Aquitaine (France).
6. AREFLH: Assemblée des Régions Européennes Fruitières, Légumières et Horticoles (France).
7. C.R.D.O. Jumilla: Consejo Regulador de la Denominación de Origen Jumilla (Spain).
8. CEBAS-CSIC: Centro de Edafología y Biología Aplicada del Segura (Spain).
9. CGAT: Grupo de Investigación de Cartografía GeoAmbiental Geoambiental y Teledetección, Universidad Politécnica de Valencia (Spain).

10. CRCC: Comunidad de Regantes del Campo de Cartagena (Spain).
11. GEOSYS, S.L.: Sistemas Sistemas de Información de la Tierra (Spain).
12. IDR: Instituto de Desarrollo Regional. Universidad de Castilla la Mancha (Spain).
13. INDRA S.A.: Indra Espacio (Spain).
14. DEIMOS S.A.: Deimos Space (Spain).
15. SCRATS: Sindicato Central de Regantes del Acueducto Tajo-Segura (Spain).
16. SYNGENTA: Syngenta seeds.
17. UNICOQUE: Coopérative Unicoque (France).
18. UPCT: Universidad Politécnica de Cartagena (Spain).
19. ADOUR-GARONE: L'Agence de l'eau Adour-Garonne (France).

## IV – Project actions and main results

To achieve the aims of the project, a net of transnational cooperation has been created to develop assessment services based on remote sensing and geographic information systems. The net permitted the knowledge transfer and technical innovation in water resources management issues and the fight against drought.

The Project activities were articulated into several groups of tasks:

- GT.1 Coordination and management of the project.
- GT.2 Development of the automatic processing of the remote sensing data.
- GT.3 Vegetation monitoring system.
- GT.4 Network of demonstrative pilot plots.
- GT.5 Extensive areas irrigation assessment system.
- GT.6 Monitoring and evaluation of the project.
- GT.7 Publicity, information and capitalization of the project.

The TELERIEG tools in the pilot zone permit the integration and management of georeferenced agroclimatic data, soil maps, quantity and quality of waters, crop information and other technical parameters of a farm or an irrigated area. The final product is a decision support system to facilitate decision-taking processes in a comfortable and generic access through internet, incorporating different techniques and access into GIS and remote sensing data.

The information technologies and in a more precisely way, the new technologies, applied in different agriculture environments, can introduce important improvements in optimization of the agricultural production factors. The main beneficiaries of the information and decision taking systems are, in one sideon the one hand, the irrigators communities, which would improve the efficiency and the productivity of the available water, fulfilling environmental guidelines and including the water management in deficitary irrigation conditions; in on the other sidehand, the authorities in water and in natural risks management, which can relay on an information system for water management, drought prevention and improving the adaptation to climate change.

Amongst the different outcomes of the Project the following can be highlighted: in the first phase an automated image processing system has been developed using NOAA's images, which are

of low resolution but are taken at high frequency and cover the SUDOE area. This tool generates daily soil temperature, vegetation and irrigated surface area maps for the different zones of the SUDOE area, mainly for the Segura Basin (Spain), where additional parameters have been estimated, such as air temperature and crop evaporative demand.

In the second phase, and with the objective of calibrating the results obtained from remote sensing, partnerships have been established among institutions that have experimental plots such as IRTA, ACMG, ANPN, IRSTEA, ISA, COTR, CEBAS, UPCT, UPV and IVIA, among others, with the idea of implementing a collaboration network in the field of remote sensing and irrigation water management. On the other hand, a geoportal has been developed and adapted to the European directive on Spatial Data Infrastructures –INSPIRE–, made up of large databases of agroclimatic and cartographic information, as well as utilities and tools based on geographic information systems and remote sensing "allowing users to calculate and customize irrigation requirements for a given plot and taking into account maximal environmentally and technically efficient parameters". Finally, this portal also offers a monitoring and advisory service for farmers, who can have access to a large amount of agriculture- and environment-related information about large areas so that they can be more efficient and effective in managing irrigation water.

It should also be pointed out that the most advanced technologies have been used for estimating agronomic data on the crops at the pilot zones, since very high resolution imagery has been used, 25 cm pixels, obtained through satellite- or airplane-borne cameras or with unmanned vehicles.

In closing, we could not ignore the big contribution of cartographic information, as well as satellite images provided by the Plan Nacional de Teledetección de España [Spain's Remote Sensing National Plan] developed by the Instituto Geográfico Nacional [National Geographic Institute], which have endowed the project geoportal with many contents.

The involvement of final users, such as farmers unions and irrigators associations, in the project development and dissemination activities has meant that the products developed within the project can be used by water users when managing their farms or irrigation districts. Moreover, the latest TELERIEG activity was an advanced international course on "The use of remote sensing for irrigation management ", organized by the IAMZ in Zaragoza (Spain), from 21 to 26 November 2011. The course included the participation of 30 attendees from 11 Mediterranean countries and 16 lecturers from TELERIEG partner institutions and other organizations, guaranteeing the dissemination of the project among professionals involved in irrigation in the above-mentioned countries. This course combined new image-processing techniques used in remote sensing with field-sensor approaches, and offered an overview of the state-of-the-art and future possibilities to improve irrigation management; the project results were also presented and discussed, both at the level of plot experimentation as well as concerning management and decision-support products. The contents of the present book, which is a last dissemination product of TELERIEG, were used as supporting material in the course.

De los diversos resultados del proyecto se pueden resaltar, que en una primera fase se conseguido desarrollar un sistema de procesado automático de imágenes del satélite meteorológico NOAAA, de baja resolución pero de alta frecuencia que cubre el área SUDOE, esta herramienta permite generar mapas diarios de la temperatura del suelo, del estado de la vegetación y de la superficie regada en las diferentes zonas del área SUDOE, y especialmente en la Cuenca del Segura, donde han estimado además de los anteriores parámetros, la temperatura del aire y la demanda evaporativa de los cultivos.

En una segunda fase, y con el propósito de calibrar los resultados obtenidos por teledetección, se ha colaborado con otras instituciones que tienen parcelas de experimentación como son el IRTA, ACMG, ANPN, IRSTEA, ISA, COTR, CEBAS, UPCT, UPV y IVIA, entre otras, con la idea de crear una red de colaboración en el ámbito de la teledetección y la gestión del agua para riego. Por otro

lado, se ha desarrollado un geoportal adaptado a la directiva europea sobre Infraestructuras de Datos Espaciales -INSPIRE constituido por amplias bases de datos agroclimáticas y cartográficas, así como utilidades y herramientas basadas en los sistemas de información geográfica y la teledetección "que permiten a los usuarios calcular las necesidades de riego de una parcela de forma personalizada y bajo los parámetros de máxima eficiencia técnica y medioambiental". Por último, mediante este portal se ha desarrollado un sistema de vigilancia y recomendaciones en áreas extensas que permite a los agricultores acceder a gran cantidad información agraria y medio ambiental para que realicen una gestión más eficaz y eficiente del agua de riego.

También se puede resaltar que se han utilizado las metodologías mas avanzadas para la estimación de los datos agronómicos de los cultivos en las zonas piloto, ya que se han utilizado imágenes de muy alta resolución, 25 cm de pixel, que se han obtenido mediante el uso de cámaras aerotransportadas en satélites, aviones ó mediante vehículos no tripulados.

Para terminar no podíamos olvidar la gran aportación de información cartográfica, así como las imágenes procedentes de satélite facilitadas por el Plan Nacional de Teledetección de España desarrollado por el Instituto Geográfico Nacional y que han servido para dotar de gran cantidad de contenidos al geoportal del proyecto.

## IV – Conclusions

The TELERIEG tools in the pilot zone permit the integration and management of georeferenced agroclimatic data, soil maps, quantity and quality of waters, crop information and other technical parameters of a farm or an irrigated area. The final product is a decision support system to facilitate decision-taking processes in a comfortable and generic access through internet, incorporating different techniques and access into GIS and remote sensing data.

The information technologies and more precisely, the new technologies, applied in different agriculture environments, can introduce important improvements in optimization of the agricultural production factors. The main beneficiaries of the information and decision taking systems are, on the one hand, the irrigators communities, which would improve the efficiency and the productivity of the available water, fulfilling environmental guidelines and including water management in deficitary irrigation conditions; on the other hand, the authorities in water and in natural risk management, which can rely on an information system for water management, drought prevention and improving adaptation to climate change.