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On-line satellite-assisted tools for participatory irrigation water management

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Abstract. We briefly present the concept and some applications of irrigation water management assisted by Earth observation satellites and Information and Communication Technologies. Jointly, these tools provide easy-to-use access to information on key parameters for monitoring and management of irrigation schemes, farms, and river basins.

Keywords. Irrigation water management – Irrigation advisory service – Earth observation satellites – Information – Communication Technologies – Participatory Geographical Information Systems.

Outils satellites en ligne pour la gestion participative de l'eau d'irrigation

***Résumé**. Dans cette contribution, nous allons donner un bref aperçu du concept de gestion de l'eau d'irrigation et de certaines applications, en utilisant les satellites d'observation de la Terre et les Technologies de l'Information et de la Communication. La combinaison des ces outils peut faciliter l'accès aux informations sur les paramètres clés pour le suivi et la gestion des périmètres irrigués, des exploitations et des bassins versants.*

***Mots-clés.** Eau d'irrigation – Assistance technique pour l'irrigation – Satellites d'observation de la Terre – Technologies de l'Information et de la Communication – Systèmes d'Information Géographique participatifs*

I – Introduction

Saving water in irrigated agriculture can be achieved through the use of Earth observation (EO)-derived information in operational irrigation scheduling at farm and field scale. End-users of the information are the farmers, who experience benefits in the form of "more crops per drop" (enhanced water productivity) and "more jobs per drop" (boost of rural development). Space-assisted Irrigation Advisory Services (IAS) at community level provide the EO-derived irrigation scheduling information to them, interacting with water management decision makers at river basin level, and serving as a potential policy instrument at national and European scale.

The concept of irrigation modernization has evolved over the years from the mere introduction of new technical infrastructure and equipment towards a more holistic concept including measures to optimize water application. Such a system now includes also tools to generate information on most efficient water use and mechanisms to transmit this information to farmers. Irrigation Advisory Services (IAS) are ideal management instruments for this purpose and they are gradually adopting this extended role.

New tools are needed to support this process. Current IAS are normally not able to cover each agricultural holding in extended areas at regular short time intervals. Earth observation (EO), in combination with Geographical Information Systems (GIS), is naturally destined to fill such a gap. In parallel, last-generation Information and Communication Technologies (ICT) open vast possibilities to transmit spatialized information to users in a personalized way using internet and mobile phones.

II – Online space-assisted irrigation advisory service

The project DEMETER (Demonstration of Earth observation Technologies for routine irrigation advisory services) was designed to assess and demonstrate in an operational perspective how the integration of New Technologies can improve the efficiency in the use of water for irrigation (Calera et al., 2005; Osann Jochum *et al.*, 2006). The DEMETER prototype e-SARAS® (e-Servicio de Asesoramiento de Riego Asistido por Satélite) or e-SAIAS® (online Space-Assisted Irrigation Advisory Service) is the central outcome of the project. Its key feature is the operational generation of irrigation scheduling information products from a virtual constellation of high-resolution EO satellites and their delivery to farmers in near-real-time using leading-edge on-line analysis and visualization tools. It is supported by a methodology package to derive crop coefficients and further advanced parameters from EO satellite images in an operational processing chain on one hand and a software package for spatial data handling, visualization, and on-line analysis on the other hand. Jointly, these two packages provide a tool for upgrading conventional IAS or for implementing similar new services. Figures 1 and 2 show schematically the functioning of the new service. Figure 3 shows a screen example.

The IAS of the Instituto Técnico Agronómico Provincial (ITAP, Spain) has served as the perfect testbed for demonstrating the water-saving potential of space-assisted IAS. It is a highly sophisticated IAS, which over 18 years of operation has built a strong confidence link with the farmers (Montoro et al., 2002). Initially based on traditional IAS methodology and a personalized service to one third of the area (100.000 hectares of irrigated land), the e-SAIAS allows them now to extend this personalized service to the whole area and reach more farmers. Estimates of water saving (depending on annually varying cropping patterns) have been shown to be on average 10-20%.

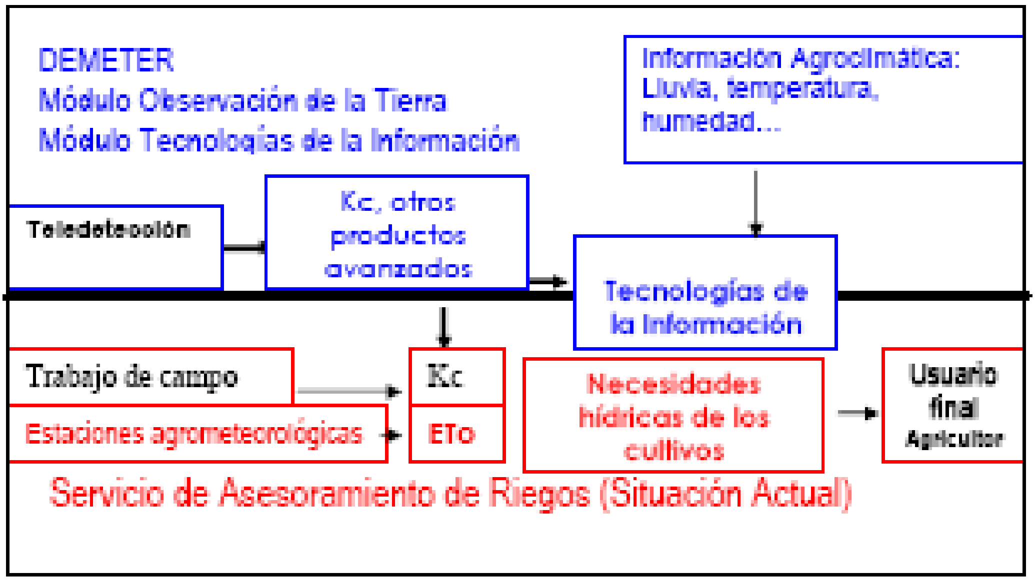

Figure 1. Concept and functioning of current IAS (lower part) and new IT-and-Space-assisted Irrigation Advisory Service (e-SaIAS, upper part).

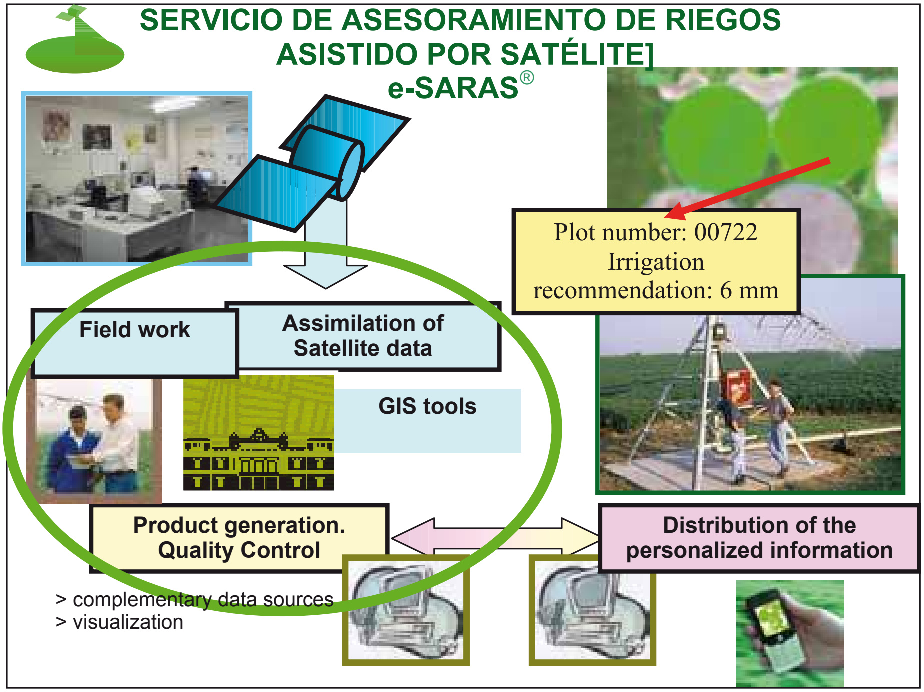

Figure 2. Schematic overview of e-SAIAS®.

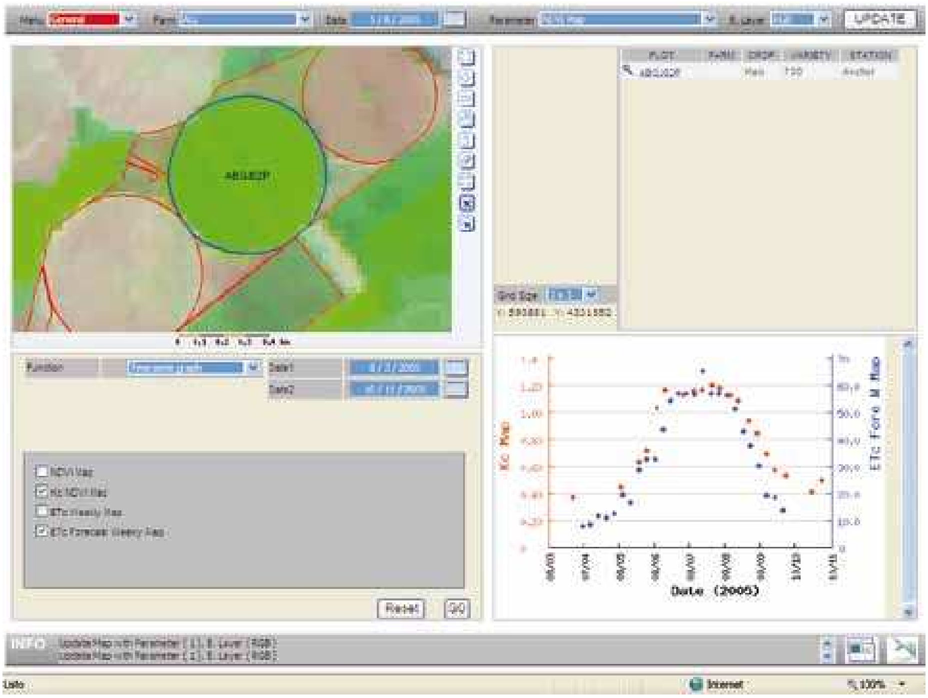

Figure 3. Example of irrigation scheduling information provided to farmers by online system e-SAIAS®.

III – Space-assisted integrated water resources management

The concept of online space-assisted IAS has been extended to include all dimensions of water resources management in an integrated way. We consider the economic, environmental, technical, social, and political dimensions through a synergy of leading-edge technologies and participatory approaches. These technologies provide easy access to information for all stakeholders while active participation will be effected by spatial information and innovative networking tools.

The project PLEIADeS (Participatory multi-Level EO-assisted tools for Irrigation water management and Agricultural Decision Support) aims at improving the performance of irrigation schemes by means of a range of measures. Major technical innovation is made possible by the comprehensive space-time coverage of Earth observation (EO) data and the interactive networking/connecting capabilities of Information and Communication Technologies (ICT).

Figure 4 shows an example of a multi-scale online interface for water managers.

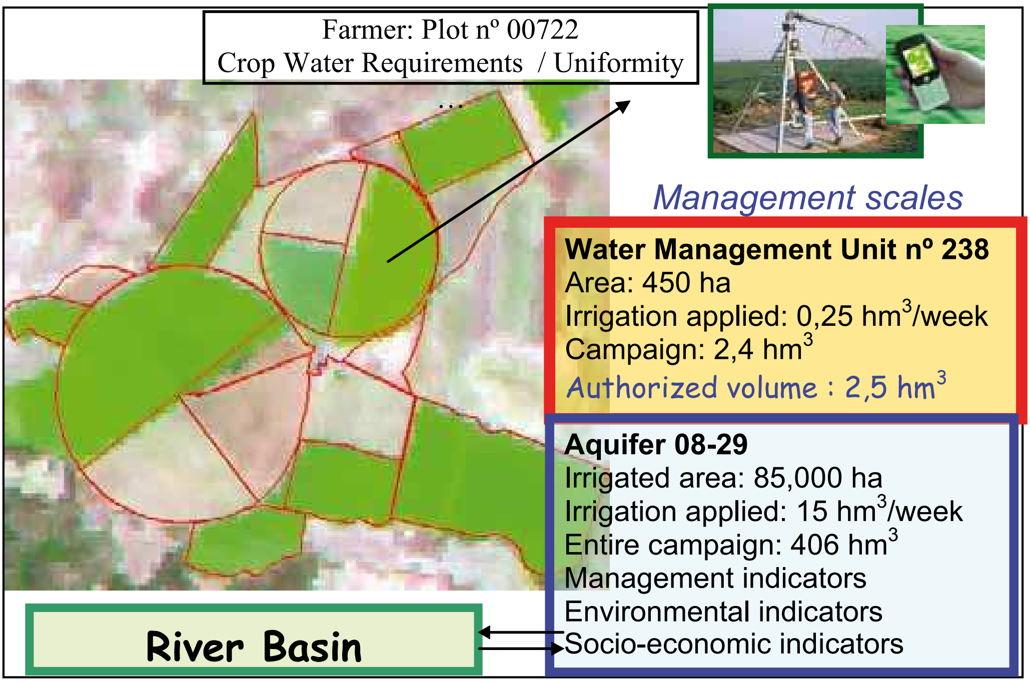

Figure 4. Example of online interface for water managers of a water management unit within an aquifer, with downlink to individual farms and uplink to aquifer and river basin.

IV – The PLEIADeS approach

PLEIADeS is being developed in a set of nine pilot Case Studies that represent a sample of the wide range of conditions found in the Mediterranean and in the Americas, covering Portugal, Spain, Italy, Greece, Turkey, Morocco, Mexico, Peru, and Brazil.

The project revolves around users (irrigation water managers and farmers) and other stakeholders. The first project phase was dedicated to assessing and analyzing their situation in each pilot area, covering technical data as well as the stakeholders' perceptions on current needs and future perspectives. Along with reports on stakeholder analysis and baseline descriptions of pilot areas, a set of video Pilot Stories was created. The first of these Pilot Stories have been made available on www.youTube.es/pleiades8stories.

The technical development is based on a joint vision of stakeholders (articulating their requirements) and system developers (proposing tailor-made technical solutions) and a continuous dialogue between them. The common goal is to offer the information to a wide range of stakeholders at their required space-time resolution in non-academic, non-technical, easy-to-use and intuitive form that encourages participation. Working directly with key users and the relevant government organisations, including active stakeholder participation and gender mainstreaming, increases the chances for successful implementation in policy and practice.

V – Technological innovation to support monitoring, management, and participative decision making

The technical innovation is based on the complementary use of mature EO methodology in GIS-based web services with online analysis capability. The design of the System of Participatory Information, Decision support, and Expert knowledge for irrigation and River basin water management (SPIDER) was oriented towards its global application, including the capability to be configured and installed by the responsible partner in each pilot area.

For farmers and irrigation scheme water managers, SPIDER generates weekly or bi-weekly irrigation scheduling information products from a virtual constellation of high-resolution EO satellites and delivers them to farmers in near-real-time using leading-edge on-line analysis and visualization tools. It is supported by a methodology package to derive crop coefficients and further advanced parameters from EO satellite images in an operational processing chain. The satellite can “see” for example the actual crop vigor and water requirements (in combination with agrometeorological data) over extended areas and can detect non-homogeneities within individual fields.

For water managers at irrigation district and river-basin scale, SPIDER provides monitoring products, like maps of consumptive water use, with options to derive values aggregated over an irrigation season and/or over spatial water management units and/or crop types.

In support of participatory processes, be they incipient or ongoing, SPIDER can first collect all available information and then provide this information from local to river-basin scale to all stakeholders involved and thus facilitate discussion, enhance transparency, and enable informed and shared decisions.

The development of SPIDER in each pilot area is being driven by the needs and perceptions of the users. At all project stages, it is a joint venture of the project team composed of selected key stakeholders, information service providers, and research groups. The general philosophy is that of an open-source system that is made available to users on a non-commercial licence basis. The clear intention is to implement an operational version in some pilot areas by the end of the project time. The details of this implementation will depend on the local situation and will be worked out jointly on a case-to-case basis.

VI – Participatory evaluation with stakeholders

The central hypothesis of PLEIADeS is that a tool like SPIDER can make an essential contribution to changing irrigation water management at several levels. Social and technical learning are an important part of this process. We intend to initiate this process by means of pilot campaigns which are conducted in each pilot area. There, the core users (irrigation scheme managers, farmers, and river-basin authorities) are provided with SPIDER and its products and services during several months. The local project teams provide technical training at the beginning and support during the whole campaign. Group meetings are held to discuss their experiences, comparing the situation with or without SPIDER.

Furthermore, a set of frameworks for performance and impact assessment has been developed, each of which is being thoroughly tested in one pilot area. The set includes frameworks for irrigation performance assessment, environmental performance assessment, socio-economic assessment and cost-benefit analysis, for the assessment of impacts of climate- and policy-related external drivers, and for social multi-criteria evaluation. Stakeholder group meetings serve to jointly evaluate the findings from these assessments and to develop visions of a sustainable future in each pilot area.

VII – Conclusions and recommendations

Online geospatial information and communication systems provide powerful tools to enhance the participation and transparency needed in the social and political process to achieve a rational use of water resources. The use of technological tools has always to be integrated in the social and political context. Otherwise they can contribute to reinforcing existing inequalities or even bring about a result that is opposite to the initial objective.

VIII – Acknowledgement

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