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ENORASIS

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Abstract

Under the influence of the Water Framework Directive and the EU Common Agricultural Policy, and considering the fact that agriculture is globally the largest consumer of water, the efficient and sustainable management of irrigation water has become an issue of foremost priority in the EU environmental agenda. In this context this study presents the ENORASIS Platform, which offers an intelligent Decision Support System (ENORASIS Service Platform and Components) for sustainable irrigation and water management based upon advanced, state of the art technologies, methodologies and models from various scientific fields. Real life pilot cases were deployed in different climate regimes and with different crop types in order to prove and demonstrate the effectiveness and the benefits of the proposed platform.

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Keywords: ENORASIS Platform; irrigation management; ICT

1. Introduction

Agriculture consumes the largest amount of water globally, accounting for the 70% of the total water consumption [1], while in most European Countries the respective figures range between 30% and 60%. Irrigation is broadly recognized as a significant environmental challenge, especially in South European countries. It is addressed in the EU Common Agricultural Policy (CAP), which puts the environment among the top priorities of farming policy. By linking subsidies with strict environmental standards in the so-called Cross Compliance Scheme (CCS), farmers face cuts in their subsidy levels unless they meet these requirements. In addition, the combined application

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of the Water Framework Directive (WFD) [2] along with the CCS of CAP brings in dramatic changes in irrigation practices, as they aim at the rationalization of water consumption. The foreseen solution is based upon the principle that "the user pays" while inefficient or inappropriate use of water is penalized with subsidy cuts.

In this context, ENORASIS Platform perceives the above conditions as a challenge for environmental optimization of irrigation management systems and relevant agricultural practices, in line with the EU legislation and the needs and incentives of the involved stakeholders. This challenge can be addressed by integrating various innovative e-agriculture technologies into coherent business and operational models that incorporate personalized value-added services while empowering all stakeholders with decision making rights.

This study presents the ENORASIS Platform as an intelligent, integrated Decision Support System for environmentally optimized and sustainable irrigation management by farmers and water management organizations.

2. ENORASIS Platform

2.1. Description of the ENORASIS Platform

ENORASIS Platform targets to motivate irrigation farmers to optimize the use of water, whereas it also provides to (irrigation) water management organizations intelligent tools and services to effectively forecast and manage irrigation water resources, to cover irrigation demand and to charge customers (farmers) on the basis of an intelligent system of motives and incentives that exploits irrigation demand side fluctuations.

The ENORASIS System is designed and developed as one integrated Service Platform with two major components:

1. The ENORASIS Decision Support System (DSS) based on GIS technologies and acting as the information backbone of the ENORASIS solution. The DSS receives information from multiple sources (meteorological and hydrological analysis tools, sensors in the field, users, Irrigation Plan System), and then processes and diffuses them back to users (farmers and water management authorities) via multiple channels (web, mobile, smart card readers).
2. The ENORASIS Irrigation Management System, performing the assessment of irrigation water needs and controlling the irrigation management and optimization rules. It uses the FAO56 model [3] and "irrigation optimization rules" derived from the Irrigation Knowledge Base. Variables such as daily precipitation, minimal and maximal temperatures, factor of cloudiness measured as relative sunshine duration, wind speed, relative humidity and hydrological variables (river discharge and evapotranspiration) are the required input data.

The subsystems that consists the ENORASIS platform are:

- The Land Management Subsystem. The purpose of the subsystem is the administering of the field data by the farmer. The irrigation knowledge base is a set of properties defined for each crop and soil type along with evaporation factors specific to temperature and time, which influence the decisions that the ENORASIS Decision Support Subsystem will take for each Plot.
- The Remote Data Subsystem. ENORASIS collects raw data via the sensors (covering existing meteorological conditions or ground conditions), the water valves (covering water consumption) deployed in the fields and also data deriving from the meteorological analysis tools. All those data are inserted to the database through the ENORASIS web services, which checks for the validity of the sender, performs a quality control on the data and stores it on the system's database. For fields that are not equipped with on-line sensors or water valves, the farmers (or any potential user of the system) will be able to enter the data manually in the system, by using off-line sensors or centrally installed measurement systems.
- The Decision Support Subsystem. This subsystem calculates current plant water deficit (water stress) for particular plant phonological stage for each Plot (based upon measured soil moisture data), while expected water deficit for the following days is calculated based upon the weather forecast. The deficit is necessary in order to calculate the plant water demand needed to cover the current deficit in following day's irrigation. The deficit is the physical information about the soil-plant-water conditions. To calculate the amount of water necessary to cover the demand using particular irrigation system a system-specific watering ratio is used within the DSS.
- The Administration Subsystem. The subsystem provides the ability to administrators to determine roles and rights of use to the system. Furthermore the subsystem provides the ability to retrieve reports on usage and

irrigation actions and sets the irrigation knowledge base parameters that influence the way the DSS decides on specific crop and soil types.

- The GIS Dashboard Subsystem. The subsystem provides GIS functionality and spatial data to be deployed from a central environment. The ENORASIS Platform uses the ESRI's ArcGIS Server for spatial data management and for creating and managing GIS Web services, applications and data.

2.2. ENORASIS Platform pilot implementation

The two core aims of ENORASIS pilots are to cover an adequate spectrum of different real-life cases and to effectively incorporate the main needs and requirements of ENORASIS target groups (farmers, water management organizations), thus, be able to properly validate and assess ENORASIS system.

More specifically, ENORASIS Pilots will involve 7 crop types in four different climate regimes (North Central Europe-Poland, South Central Europe-Serbia, continental Mediterranean-Turkey, island Mediterranean-Cyprus) (Table 1).

Table 1. ENORASIS pilots implementations

	Country	Plots	Crop Type	Farm name	Type of experiment
Pilot 1	Poland	1	Potato	Glabow ES	Research Farm
		2	Maize		
Pilot 2		3	Potato	Farm Frites 2	Production Farm
Pilot 3	Serbia	1	Apple	Delta Agrar	Production Farm
		2	Sweet Cherry		
Pilot 4	Turkey	1	Sugar beet	TZARI	Production Farm
		2	Tomato		
Pilot 5	Cyprus	1	Grapefruit	Fassouri Plantations	Production Farm

The pilots will fulfill the requirements of wide geographical coverage, minimal spectrum of different crops and operational approaches and economic analysis of the irrigation effect on crop production. The schemes will assure homogeneity (where possible) of the pilot applications to allow later comparisons and to assure interoperability at system level. The effectiveness of the ENORASIS irrigation control will be assessed during two season-long experiments on pilot areas / fields.

The ENORASIS system will be refined based upon the real-life experiences gained from pilot applications. Finally, apart from the demonstration of the ENORASIS prototype for validation, assessment and potential improvement purposes, pilots will also prove the feasibility of the uptakes scenarios of the whole ENORASIS solution at different operational settings and contexts. Summarizing, the objective of the ENORASIS pilots are:

- To define the pilots' context as well as the concrete validation criteria & success measures (Key Performance Indicators - KPIs).
- To involve end users (farmers, water management organizations) in pilot preparation and execution.
- To setup the ENORASIS test-bed environment in real life conditions.
- To validate & assess ENORASIS solution against specified Key Performance Indicators (KPIs).

3. Conclusion - Discussion

The ENORASIS platform is expected to have positive environmental, social, economic, as well as scientific and technological impact. Regarding the environmental impact, rational and sustainable use of irrigation water is expected to bring substantial environmental benefits in terms of reduction of water consumption. To this extent, the

ENORASIS system will help water management organizations and farmers to better plan the water consumption of agricultural processes, so as to ensure that irrigation needs will not exceed the capacity of water resources beyond safety levels.

As far as social impact concerned ENORASIS will improve transparency on irrigation water usage and allow actors to achieve enhanced compliance with existing and upcoming regulation and legislation at EU and national level. Meanwhile, the limited digital literacy of farmers is one of the major obstacles toward the achievement of digital convergence in Europe [4]. The multichannel (web, mobile, smart cards) approach adopted by ENORASIS, allows end users to benefit from digital services according to their real needs, regardless of their ICT competencies.

In an economic level ENORASIS foresees a strategic business plan for innovative SMEs operating both as technology/service providers and as users in the agricultural and water management sectors. The business and operational models proposed by ENORASIS will challenge the conflicting interests of farmers and water authorities by suggesting and promoting win-win collaboration alternatives, and will open a new market for respective technology and service providers.

The ENORASIS Platform, when fully operational, is expected to bring scientific and technological advantages in Prediction/Planning Intelligence. The data regarding water consumption patterns and trends will be archived and form the historic database, part of the ENORASIS data platform, which will be used to predict short- and long-term pressures in water reservoirs and also to assist water management organizations in imposing proper measures (from awareness raising and incentives-based irrigation water pricing schemes to investment decisions regarding required irrigation infrastructures). From a technological point of view ENORASIS innovates in relying on real (regional) irrigation water consumption data (rather than results of theoretical models) that are updated in real-time and which are used to support the decision making process of water management organizations. Moreover, apart from utilizing the state-of-the-art model FAO56 to assess water needs for irrigation, ENORASIS further empowers the model's performance in terms of credibility, trustworthiness and accuracy, by using soil moisture sensors, weather forecasting data and information collected from the end users themselves.

In conclusion, under the light of stricter legislation and regulation on water management and enhanced policy support on sustainable agriculture, the ENORASIS eco-innovative solution is expected to substantially improve the environmental performance of irrigation management systems and prevent the misuse of water in agricultural practices, while ensure mutual benefits for both water management organizations and farmers

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