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How Earth Observation, Crop Modeling and ICT tools can help rice cultivation: the ERMES project

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Abstract

Due to pressure of food demand, increased price competition and demand for sustainable farming practices, it's increasingly important to optimize agricultural practices. The European FP7 project ERMES focuses specifically on rice cultivation, and aims to combine earth observation, crop modelling and ICT techniques and tools to optimize agro-practices and ultimately, support environmentally and economically sustainable farming systems. ERMES combines partners from Europe's three main rice-producing countries: Italy (51,3%), Spain (25,4%) and Greece (7%)[1]. With end-users and case studies in these three countries, the ERMES project is perfectly positioned to chart current practices and innovation potential in the European rice cultivation market. In this work, we focus on how ERMES plans to develop and exploit modern ICT tools and techniques to assist rice farmers to streamline the rice cultivation process on one hand, and local authorities to better regulate, control and oversee rice cultivation on the other hand.

Keywords: crop modelling, rice cultivation, smart app, geo-portal

1 Introduction

In times of continuous worldwide population growth and the progressing climate change, an efficient and sustainable food production process is more important than ever. In research areas such as agricultural engineering and agronomy, scientists dedicate their knowledge to meet these challenges. Crop modelling [1] is a primary tool developed to model, analyse and make predictions about crops (e.g., crop evolution, yield, nutrition requirements, risks, etc.), based on meteorological, environmental and crop-specific parameters. Over the years, these models were refined and complemented with satellite [2] and remote sensing data [3], whereby advances in analysis techniques play an important role [4, 5].

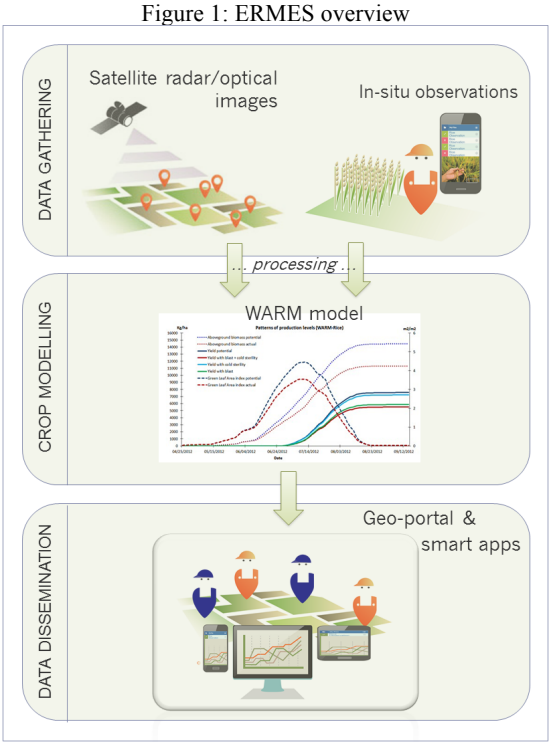
The European-funded FP7 project ERMES aims to apply and refine the aforementioned crop modelling techniques for rice cultivation in a European context, and combine them with modern, state-of-the-art technical solutions. According to the Food and Agricultural Organization (FAO), rice paddies are the world's second most important food commodity in terms of monetary value, and world's third in terms of quantity produced[1]. Although rice cultivation is mainly performed in Asia, European research in this area benefits from excellent available infrastructure, available technical resources and highly skilled human resources. In the ERMES project, recently available technologies, such as Sentinel-1 and -2 satellite images, technical expertise in crop modelling and remotely sensed imagery analysis, and modern ICT technologies (e.g., geo-spatial and mobile technologies), will be combined to realize improvements to current crop modelling research, and create a state-of-the-art solutions to assist farmers and local regulatory authorities in the rice cultivation process.
In this short paper, we give a general overview of the project, and focus on the role of modern ICT technologies within the project.

[1] http://faostat.fao.org/ ; accessed 1st of June 2014

2 ERMES in a Nutshell

Figure 1 shows a schematic overview of the ERMES project. It largely consists of three components: data gathering, crop modelling, and dissemination.

Figure 1: ERMES overview



2.1 Data gathering

The ERMES project foresees the use of three different types of data sources: 1/ traditional in-field meteorological sensor data (e.g. to measure temperature, humidity, wind speed, etc) 2/ medium and high-resolution satellite data and 3/ in-situ expert-gathered data. The advancement in our approach lies in the exploitation of modern ICT solutions to gather and analyse data, and to distribute value added information derived from the analysis to the agri-business sector. On one hand, in the European context, the availability of high resolution Sentinel-1 SAR and foreseen Sentinel-2 Optical data provides a unique opportunity to gather more precise data. On the other hand, with the proliferation of modern, cheap smart phones, packed with built-in sensors and featuring user-friendly input capabilities and continuous Internet connectivity, unique opportunities arise to gather in-situ data. In the context of the ERMES project, smart apps specifically geared towards this aim are foreseen. Finally, recent availability of low-cost multi-functional sensors may provide yet another way to further enrich data gathering.

2.2 Crop modeling

After a data processing step (i.e., quality screening, derivation of added value Earth Observation products and integration), the data resulting from the data gathering phase are used as input for a crop modeling component. The ERMES project uses the WARM rice model [6] for crop modeling and forecasting. Although this model is capable of working with incomplete input, the model accuracy and forecasting capabilities significantly improve with a more complete, and wider range of data input. By using multiple data gathering techniques, and integrating and combining the available data, we aim to provide the WARM rice model with such more complete data, and/or use complementary/overlapping data (e.g., user-provided data) to adjust and better calibrate the WARM model. Ultimately, this yields more accurate forecasting results.

2.3 Dissemination

The ERMES project targets three distinct user groups, corresponding with three distinct goals: supporting *rice farmers* for more efficient and sustainable rice cultivation, supporting *regional authorities* in controlling and overseeing rice farming practices and implementing agro-environmental policies, and providing the *agri-business* sector with relevant information.

To this aim, the ERMES project foresees two services: a regional rice service, targeted at public authorities, and a local rice service, targeted at local farmers and private companies. Based on a common Spatial Data Infrastructure (SDI), these services come in two forms:

- A Web-based geo-portal to visualize relevant geographic areas and features, overlaid with model simulations and forecasts (i.e., yield estimation, grain quality), eventual alerts related to biotic and abiotic risks (e.g., cold spells, pests), customizable information on crop development and meteorological data useful for reporting and bulletin generation, and (limited) social interactions.
- Smart apps to allow in-situ observations gathering and reporting (i.e., expert feedback), location-based information provisioning, local navigation and instant notifications (i.e., risk alerts).

The long-term goal is to transfer the solutions developed within the ERMES project, using European expertise and technical artefacts, to the global rice sector.

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References

[1] T. R. Sinclair and N. G. Seligman. Crop Modeling: From Infancy to Maturity. *Agronomy Journal*, 88(5):698-704, 1996.

[2] G. E. Battesea, R. M. Harterb and W. A. Fullerc. An Error-Components Model for Prediction of County Crop Areas Using Survey and Satellite Data. *Journal of the*

American Statistical Association, 83(401): pages 28-36. 1988.

[3] P.J. Pinter Jr., J.L. Hatfield, J.S. Schepers, E.M. Barnes, M.S. Moran, C.S.T. Daughtry, D.R. Upchurch. *Remote Sensing for Crop Modeling*. *Photogrammetric Engineering & Remote Sensing,* 69(6):647–664, 2003

[4] J.A. Richards. *Remote Sensing Digital Image Analysis*. Springer, 1999

[5] R.A. Schowengerdt. *Remote Sensing: Models and Methods for Image Processing*. Elsevier Inc., 2007

[6] R. Confalonieri, G. Bellocchi, S. Bregaglio, M. Donatelli, M. Acutis. Comparison of sensitivity analysis techniques: A case study with the rice model WARM, *Journal of Ecological Modelling*, 221(16):1897-1906, 2011