Web decision support system for surface irrigation design

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ABSTRACT: This paper presents the Web decision support system for surface irrigation design, an Internet application to assist designers and managers in the process of design and planning improvements in farm surface irrigation systems – furrow, basin and border irrigation. It includes a database, simulation models, user-friendly interfaces and multicriteria analysis models. The system was developed from a stand-alone application and includes two modular components: a Web application and the simulation engine. The development applies the Framework .Net of Microsoft, with the reuse of stand-alone version source-code. The operational and simulation databases apply the SQLServer allowing a simultaneously connection of several users. This approach results on a better service quality, avoiding package installation and is more versatile to upgrade and to integrate other data and models, particularly in world water scarcity areas less developed and with major water scarcity. It is presented the application design, the logical dynamic structure and interface details.

KEYWORDS: surface irrigation design; decision support system (DSS); Web DSS

INTRODUCTION: A decision support system was developed to assist designers and managers in the process of design and planning improvements in farm surface irrigation systems – furrow, basin and border irrigation, entitled SADREG. It allows creating a large set of alternative solutions, their impact evaluation and multicriteria selection analysis through an integrated framework of user knowledge, database and simulation models. This DSS was applied to several agricultural, economical and environmental conditions, considering several irrigation methods, equipments and practices: to optimize irrigation performance on the Lower Mondego Valley, Portugal (GONÇALVES & PEREIRA, 1999), to improve basin irrigation for water savings and salinization control, in the Upper Yellow River Basin, China (GONÇALVES et al. 2003), to improved furrow irrigation in Fergana Valley, Aral Sea Basin, Uzbekistan (GONÇALVES et al., 2005), and to modernize furrows and border irrigation in Euphrates Basin, Syria (DAROUICH et al. 2007; GONÇALVES et al. 2008).

This development of DSS for Web allows better application flexibility, improving the user support to database access and enlarging the number of users, particularly in the world areas where the water scarcity demand a better use of irrigation water. The application version here presented comprises a Web and a simulation engine module, which includes the models integrated in SADREG. This development was based on the Microsoft Framework .Net and the SQLServer to manage databases, allowing a simultaneously connection of several users.

An Internet application has a larger flexibility, with more users worldwide, including areas where the surface irrigation requires improvements and the expert technical support is more incipient. The Web access of DSS allows an easier way to transfer knowledge and tools to improve the procedures to evaluate and design the field irrigation problems. The DSS location on a server allows sharing data and comparison of results of different users. Some examples of Web applications in the irrigation subject demonstrate its usefulness (BRANCO et al., 2005; THYSEN & DETLEFSEN, 2006).
The objective of this paper is to present the Internet application of SADREG, describing the software strategy and its procedures to design, maintain and users support.

**METHODOLOGY:** This Web DSS application comprises a Web module and a simulation engine, which includes the simulation models of SADREG. The Web module, being the interface with the simulation engine, creates the user interface, importing and showing, numerical and graphical data. It includes the simulation models and the knowledge base of stand-alone version of SADREG, with the modifications required to run on the server (Figure 1).

![Figure 1. Abstract system architecture](image)

The user does not interact directly with the simulation engine, because this would spend a lot of time to complete the required tasks. The user makes a request of simulation that remains recorded in a waiting list. When the simulation engine is available, takes the request from the waiting list, processes it, and the results are recorded in the simulation data base, the user is assigned and the results become available on the Web application. The software development applies the Framework .Net from Microsoft, with a very good reuse of source-code (THUAN & HOANG, 2003). The SQLServer is applied for database management, allowing a simultaneously connection of several users. The system has available an interface WebService to integrate with other systems and a short Web version to use with portable and limited equipments, such as PDA for field use.

The server is established by four component modules (JIA & ZHOU, 2005): 1) Communication – is the responsible by the interface with the Web applications using TCP/IP like transport way; 2) Logic – is the responsible by the control of execution and respective data flux; 3) Simulation – is the responsible by the computation of simulation models; and 4) Data abstraction – is responsible for the isolation and optimization data model and data modifications. Each server module is created by reflection, a functionality of Framework .Net, which allows inserts and updates of simulation models without the requirement of change and compilation of other source-code (GAMMA et al., 1995).

One of the problems raised when moving from a standalone service to a multiuser application is the requirement to warrant data protection among the several users. This change requires a modification on data relationship, which has user identification in all records. Therefore, the database tables have been modified for this purpose, with impact on application performance and consistence. The simulation engine was also adjusted from standalone version, in a multitask environment (Figure 2).

The software developed is based on resources file philosophy programming which uses a resources list that is being used and free up to the end of the simulation. The communications with the server are performed in a first step of software development with TPC sockets, to avoid entropy. For normal system operation, it will be added a protection layer based on SSL protocol for a better guarantee of communications security. The some procedure is adopted with the Web application that will use HTTPS links. The protocol used in the communication with the server, without state and atomic operations, will be published to permit creating other applications based in this service.
With the standard of HTML language for more popular browsers, it is created a simple Web user friendly interface (Figure 3). The user would select the language of interface: English and Portuguese are now available, but other languages would be implemented subsequently.

RESULTS AND DISCUSSION: The software developed to implement the Web DSS is being deeply tested and the results prove the feasibility of the methodology applied. One of great advantages of the architecture chose, the Pattern MVC in the client, is to allow in a simple way the reuse of several functionalities. One example is the printing functionality, e.g. exporting data to Excel files, to explore later the graphical mode or the inclusion of results on other documents.

During the simulation process, if the time duration to run the models is high, the user is informed about the progress, through a message.

A interface web é desprovida de scripting e o layout foi mantido simples para uma melhor desempenho ao nível da rede evitando desperdícios desnecessários ao nível da rede de comunicação. A interface com o cliente realiza algumas validações básicas como evitar campos em falta, mas o servidor é responsável pela validação dos dados tanto ao nível da sintaxe, verificação de tipo e gamas de valores, como ao nível da semântica, validação do contexto e falta de atributos para o bom funcionamento do algoritmo de simulação. Esta abordagem permite uma simplificação das interfaces com o utilizador, permitindo uma maior flexibilidade em manutenção no futuro pelos vários tipos de aplicações clientes.

An online help supports the user during all phases of DSS application. It is a determinant tool, as the user needs to understand the irrigation design process, the input parameters and the output results.
CONCLUSION: The Web SADREG is an Internet application that allows a simple way to support surface irrigation designers to improve the project procedures, particularly in the world water scarcity areas where the surface irrigation requires improvements and the expert technical support is more incipient. This development was based on the Microsoft Framework.Net and the SQL Server to manage databases, allowing a simultaneously connection of several users. With a simple Web user friendly interface, with several optional languages and a online help, this tool would contribute to an effective support to enlarge the knowledge of surface irrigation, its design procedures and field practices.

REFERENCES:
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