An Agent Based Hydro Informatics Approach for the Engagement of Farmers in Irrigation Water Management in Saudi Arabia

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ABSTRACT

The use of software agent systems and technologies to simulate water resources management scenarios and improve the engagement of stakeholders in policy making is gaining paramount importance. Such importance originates from two main concerns or change agents. Firstly, the context of water management is becoming highly complicated due to the intensity of connections with other systems, the diversity of stakeholders and the multiplicity (and sometime conflicting) objectives of decision partners. Moreover, the domain used for capitalizing on water management issues is becoming planetary (as it is the case of shared basins) rather than being local (watershed, watercourse, scheme, etc.). As a result, the concern is not limited to the optimization of the utility matrix of stakeholders but additional attention is required to incorporate many emerging issues such as the maintenance of financial sustainability, functional mainstreaming and improving engagement to promote reconciliation and change of water use behaviors. Secondly, the recent technological developments have improved the processing capacity of hardware, software functionalities and the accessibility of telecommunication platforms. Such developments have been reflected in the improvement of the capacities of decision makers to address complex problem domains. Software agents’ technologies possess the qualities that make them useful for the provision of decision support in water management domains. As it is the case of irrigated agriculture, software agents’ technology can be used for the design of farm surface irrigation systems, the improvement of irrigation systems management and the enhancement of the involvement of farmers in the processes of integrated water management. This paper is concerned with the use of agent based systems to facilitate the engagement of farmers in Al Ahsaa area in the management of water resources. The government of the Kingdom is adopting a demand management approach for the management of irrigation water by discouraging the cultivation of water-consuming crops such as wheat and dates. Improving the ability of farmers to analyze alternative cropping patterns significantly affects their water use behavior.

Keywords: Agriculture, Decentralization, Integrated Water Management, Software Agents, Water Resources Management

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INTRODUCTION

There has been a growing interest in the improvement of irrigation water management by addressing decision making imperfections resulting from the fluctuation of supplies and the expansion of conflicts due to increase of demand. In addition to the emphasis on demand management, policy makers are becoming highly concerned with the adoption of decentralized decision making and the acquisition and sharing of real time information to facilitate the engagement of stakeholders. Such a concern has been facilitated by the emergence of different technological platforms and infrastructure that improved sensing, acquiring, storage, processing and sharing of irrigation management information. Taken under the umbrella of hydro-informatics, different conventional, intelligent and web based decision support systems and applications are being widely used for irrigation water management. In addition to the integration of information about the dynamics of the physical water system, demand functions and supply indicators, the use of hydro-informatics applications provide effective computational models that can be used for the simulation and optimization of water availability and allocation. Such models can be used at different levels of analysis (watercourse, tributary, river and basin) and under different administrative boundaries (administrative, hydrological or mixed).

Decisions in irrigated agriculture can be taken at three levels (Pereira, 1987). Firstly, at the farm’s level where farmers need to decide on crops, cropping systems, irrigation methods and on-farm irrigation management practices. Such decisions are crucial for the management of irrigation projects. Secondly, at the level of the irrigation project, operation authorities decide on the amount and schedule of deliveries which significantly effects on-farm water management decisions. To enable best irrigation and farming practices such decisions need to be highly integrated. Thirdly, at the basin’s level decisions reflect trans-boundary decisions are related to country or regional water resource policies and influence agriculture through water allocation and water quality criteria. In managing irrigation water resources, decision making is viewed as a multi-phase (i.e., decision making steps) multi-layer (local, regional and state) and multi-duration (short, medium and long terms). However, according to Becu et al (2003), taking these decisions demands the adoption of an integrated framework because of (a) the interactions between natural resources and other resources (such as local goods market, local labor market and land tenure systems) which requires large scale representation of several irrigation schemes and (b) the growing importance of understanding the behavior of farmers and simulating “complex” emerging rules on the basis of simple individual behaviors. Taking effective decisions in irrigated agriculture tends to be challenged with different complexities. The intensity and rigidity of supply-related change agents; the shift of stakeholders’ preferences (mainly of farmers) and the lack and inaccessibility of real time information are, among others, the main decision-related obstacles.

The question of information availability is moving to the front line agenda of irrigation water managers due to its direct and inexorable relation with the prioritization of the optimization of the utility matrix of stakeholders (farmers and water development authorities) over other tasks. Because of the diversity and complexity of the processes involved in irrigation water management systems (ecological, spatial, environmental, social and economic), data should be collected from various sources in a systematic or task-wise fashion. Data sources, usually, differ in location, focus and structures as well as in the methodologies used for organizing, storing and retrieving files. The data making up the physical, environmental, hydrological and spatial aspects of the irrigation water system are a part of a complex cause-effect system that is expected, by introducing unexpected variability, to change the swing of the pendulum of decision-making and control (Elseid, 1999). The changes in the social values, ownership patterns, demography, among others, are unpredictable forces that complicate the decision-making.