Decision Support System for Water Demand Management in Egypt

by

MOHAMED MOHAMED MOSTAFA

A Thesis submitted to the

Faculty of Engineering - Ain Shams University

in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

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IRRIGATION & HYDRAULICS

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Under the Supervision of

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Firstly, and always, all thanks and praise to ALLAH,
the most merciful GOD.

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To My Late Father and Mother … GOD bless them

To My Beloved Son …

I dedicate this piece of work …

ABSTRACT

Management of water resources was caught between the dilemma of supply management (working with physical laws of hydrology and engineering principles) and demand management (which depends on variables linked to human needs, priorities and behavior, and which change over time and space), until it was undertaken in an integrated water resource management (IWRM) framework. Managing water demands (WD) and water resources (WR) is a broad topic and need to be studied from a multi-disciplinary and integrated perspective, this research will study these topics and its related fields, with more emphasis on monitoring the fluctuation of the available WR and on estimation the agriculture WD. This research is a sincere trial to understand and identify most of the related factors influencing water demands, with more focus on Nasser lake reservoir and the agriculture water demand, the research objective is to develop a model (DSS) suitable for the Egyptian situation and circumstances.

In the light of the previous DSS experiments in Egypt, the National Water Resource Plan – Decision Support System (NWRP-DSS) and its sub models, like the Agricultural Sector Model for Egypt (ASME) Model, learning from its advancements and drawbacks, this research work is focusing on developing a free and open-source DSS tools and modules to facilitate the participation of all water users through a public domain DSS, believing this will enhance the commitment and the involvement of the different partners in management, and increase the awareness of the community. Also, it will have many positive impacts on employment opportunities and strengthen the information and communication technology (ICT) dissemination, while ICT infrastructure became an essential component for any successful management.

In Egypt, due to the population growth and the limitation, rather than fluctuation, of water resources, there is an increasing necessity to enhance the decision making processes by monitoring and analyzing water use patterns continuously, encouraging collaboration of all water users, to prioritize and optimize water demand and water consumption in the future.

The main objective of this research is to develop a web-based DSS application, using open-source software, realizing its technical, social and economical capabilities to be utilized and diffused among the different levels of water users, and believing this will exchange the information, facilitate the involvement of local communities of water users and provide adequate management capabilities for the agriculture water demands sector (the major water consumer) in Egypt. Alternatives of Open-source technologies were used and evaluated; it showed positive results to encourage and facilitate the dissemination of the GIS technology at different national, local communities and individuals. This will save financial resources that are wasted in buying the costly commercial systems, and provide more opportunities for participation and employment. Moreover than its low cost, the open standard software and open format are more transparent and it permits users to transfer the knowledge, improve the software and to redistribute it freely in modified or unmodified forms.

The study concluded that the developed Open-source GIS and DSS tools are effective for modeling, monitoring the available water resources in Nasser Lake, and for estimating the agriculture water demands. The developed DSS allows the exchanging of information among different involved water partners. Also, it allows generating different scenarios for cropping pattern (based on different objectives and with reference to the fluctuation in water resource). The resulted maps of the water demand for each crop indicates a variance about 30% in water consumption was optimized by re-allocating crops at the least water consumption location over all the arable land in Egypt, without changing the cropping pattern, saving amounts of 2% to 5% of the total crop water requirements. It is believed that the developed DSS, 100% price free, available and feasible, will facilitate the coordination between institutions and individuals, and is highly needed to overcome the fragmented responsibilities in the field of integrated water resources management in Egypt.

Key words

Water Resources Management, Water Demands Management, Nasser Lake, Cropping Pattern, Evapotranspiration, Modeling, Monitoring, Estimation, DSS, GIS, Remote Sensing, Open-Source, Egypt.

Acronyms and Abbreviations:

ARC	Agricultural Research Center (MALR)
ASME	Agricultural Sector Model for Egypt
CAPMAS	Central Agency for Public Mobilization and Statistics
CWR	Crop Water Requirement
DELWAQ	Water Quality Model
DIP	Digital Image Processing
DM	Decision Making
DSS	Decision Support System
ETC	Crop Evapotranspiration
ETO	Reference Evapotranspiration
GDP	Gross Domestic Production
GIS	Geographic Information System
ICT	Information and Communication Technology
IWRM	Integrated Water Resource Management
MALR	Ministry of Agriculture and Land Reclamation
MCIT	Ministry of Communication and Information Technology
MHUUD	Ministry of Housing Utilities and Urban Communities
MWRI	Ministry of Water Resources and Irrigation
NAICS	North American Industry Classification System
NWRP	National Water Resource Plan
RDBMS	Relational Data Base Management Systems
RIBASIM	River Basin Simulation Model
RS	Remote Sensing
SIWARE	Simulation of Water management of Arab Republic of Egypt
SW	Software
WD	Water Demands
WDM	Water Demand Management
WLM	Waste Load Model
WR	Water Resources
WRM	Water Resources Management

UNITS and Conversions

1 km^2	= 1 x 10^6 m^2 = 100 hectare (ha)
1 feddan	= 0.42 hectare
1 feddan	= 1.038 acre
1 acre	= 0.4046 hectare

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