MODELING OF INTEGRATED WATER MANAGEMENT FOR LANDSCAPE IRRIGATION

By

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B.Sc. Agric. Sc. (Agric. Mechanization), Ain Shams University, 1993

M.Sc. Agric. Sc. (Agric. Mechanization), Ain Shams University, 2009

A thesis submitted in partial fulfillment

of

the requirements for the degree of

DOCTOR OF PHILOSOPHY
in
Agricultural Engineering Sciences
(On Farm Irrigation and Drainage Engineering)

Department of Agricultural Engineering
Faculty of Agriculture
Ain Shams University

2012

Approval Sheet

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ABSTRACT

Medhat Mahmoud Omar El-Zakaziky : Modeling of Integrated Water Management for Landscape Irrigation. Unpublished Ph.D. Thesis, Department of Agriculture Engineering, Faculty of Agriculture, Ain Shams University, 2012.

Watering commercial and residential landscapes is the greatest household use of water in Egypt. So improvements in management and efficiency of landscape irrigation systems could potentially yield significant water savings. Irrigation scheduling is the process of defining when irrigation is to occur to various zones of the landscape and how much water to apply. The objective is to maintain the health of the landscape without overwatering and without dry spots in the landscape.

Management of turf irrigation systems requires a highly-qualitative database of the available resources and corresponding landscaping status and conditions. For solving the abovementioned problems, management information systems (MIS) can be used efficiently. One of these tools is that Expert Systems (ES) that presents an approach of complex problem solving behavior of a domain expert in narrow discipline.

Hereby, the aim of this investigation was to build, verify and validate a proto type-rule based expert system for managing turf irrigation systems under arid and semi-arid ecosystem conditions of Egypt.

Fuzzy set theory is used to the TIM-ES model problem domain characterized by inherent uncertainty; in order to encode probability of turf irrigation relationships among variables and factors in the domain. These variables and key factors of the turf irrigation management process can be cataloged as: i)soils and its attributed characteristics; ii) plant types; iii) irrigation systems and its performance analysis characteristics;

iv) metrological data, and (v) technical operating system. Results indicated that outputs (estimated) that designer's judgment was higher than the TIM-ES output with 4.32%, 44.55% for rotors and spray head respectively and less than the TIM-ES outputs with 8.6% for multi streams sprinklers. On the other hand, Outputs (estimated) that contractors judgment was higher than the TIM-ES output with 45.57% , 84.13% and 7.59% for rotors, spray head and multi streams sprinklers respectively. Moreover outputs (estimated) that operator's judgment was higher than the TIM-ES output with 83.13% for spray head and less than the TIM-ES outputs with 12.13% and 5.61% for rotors and multi streams sprinklers respectively.

Key Words:

Irrigation systems, Landscape Irrigation, Modeling, Integrated Water Management.

ACKNOWLEDGEMENT

All Praise and thanks be to **ALLAH**, the most merciful for directing me to the right way and provides me all I have.

I would like to express my deep appreciation and gratitude to **Dr. Abdel-Ghany Mohamed El-Gindy,** Professor Emeritus of Agricultural Engineering, Faculty of Agriculture, Ain Shams University, for suggesting the problem of study and for his kindl supervision throughout this work. The author is grateful for his valuable discussions, suggestions and helpful criticism, which helped him to finalize this work.

The author wishes to express his sincere gratitude and appreciation to **Prof. Dr. Essam Ahmed El-Sahar,** Professor of Agricultural Engineering and Head of Agricultural Engineering Department, Faculty of Agriculture, Ain Shams University, for his kind supervision, continuous encouragement and valuable advices throughout this work.

The author wishes to express his sincere gratitude and appreciation to **Dr. Yasser Ezzat Arafa,** Assistance Professor of Agriculture Engineering, Faculty of Agriculture, Ain Shams University, for supervision, problem suggestion, continuous encouragement and valuable advices throughout this work, kind help and for reviewing the manuscript.

Special thanks to all staff members of Agricultural Engineering Department, Faculty of Agriculture, Ain Shams University, for their kind help.

Finally, deepest appreciations are going towards my family for their understanding, patience and loving encouragement.

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1- INTRODUCTION

In Egypt there are a lot of residential compounds, touristic villages and municipalities' landscape and all of these require a big amount of irrigation water per day. The majority of these turfs are grown on highly permeable sandy soils. Careful management is therefore required to achieve an acceptable balance between maintaining turf quality, reducing water use and minimizing water and nutrient loss beyond the root zone **Del Marco 1990.** Water shortages from intermittent public supplies are a major and expanding global problem. Yet individual users, utility managers, and government officials can improve access or cope with shortages in numerous ways. These ways may include the following: New supplies, more efficient use of existing resources and long-term investments to expand infrastructure and reduce leakage. Integrated systems analysis identifies management actions that minimize costs or maximize benefits across a variety of water shortage conditions.

This study is committed to help industrial, commercial, and institutional customers improve their water use efficiency. It was developed to provide guidance to customers wishing to design their own water management programs and provides specific step-by step instructions and suggestions on how best to develop and implement a program for landscape irrigation management.

The rising costs of water, wastewater treatment, and the energy used in turf irrigation all play major roles in our continuing use of this precious resource. More importantly, an endless supply of water is never a guarantee, especially in the arid areas. In an age where business may be seen as an excessive user of water supplies, a successful water conservation program can demonstrate to the public your willingness to become an active community partner in environmental responsibility.

The problem was the mismanagement which rise to irrigation water losses and irrigation cost. Therefor this study amid to build an expert system, which can give users a complete advice about the scheduling process based on the project soil characteristics, turf irrigation system, plant type and weather conditions.

Expert Systems (ES) is one of the important application oriented branches of Artificial Intelligence that can help in that. In the past three decades, a great deal of expert systems had been developed and applied to many fields such as office automation, science, medicine and agriculture. Expert Systems are Computer Programs that different from conventional computer programs as they solve problems by mimicking human reasoning processes, relying on logic, belief, rules of thumb opinion and experience. An ES is a computer program that emulates the behavior of a human expert in a well-specified, narrowly defined domain of knowledge. It captures the knowledge and heuristics that an expert employs in a specific task.

Nowadays most of developed applications following what called the second generation expert system approach. There are two main methodologies, the Common KADS methodology and the generic task methodology. In the second generation expert systems methodology, there generic models for different types of tasks such as diagnosis, planning, design, and others. In the agriculture domain, we find out that two main generic models are used namely: the diagnosis or more broadly the classification, and the scheduling tasks.

In Common KADS methodology there is a library of expertise model for each one of these two tasks **Rafea et al., 1996** said in the generic task methodology, the hierarchical classification model is found suitable for the diagnosis applications and the routine design model is found suitable for the scheduling application.

Wielinga et al., 1992 mentioned that common KADS, covers project management, organizational analysis, knowledge engineering, and software engineering aspects of a knowledge based systems project. It has become a common point of reference in Europe and is well known a publicized throughout the world. Moreover **Schreiber et al., 1993** illustrate that the tools that support the methodology have been developed and some are commercially available. One of the major advantages of Common KADS over the other approaches is that a lot of efforts are done to provide a library for expertise modeling, which covers some generic tasks. The Common KADS modeling framework consists of two major components application knowledge model and problem solving knowledge model.

2. REVIEW OF LITERATURE

The science and technology to improve management practices for landscape irrigation are recently available. Integrated water management means how much water should be applied to have functional, healthy plants without exceeding the water requirement of the landscape? When and how should the irrigation water be applied? The answer to these questions requires an understanding of water need of particular plants in the landscape, as influenced by the environment and other site-specific factors such as soil, root zone depth and local weather conditions. **Irrigation Association, 2005.**

Miller, 1995. Reported that soil-water-plant relationship define a model of how water enters and moves within the effective root zone, into the plant root system and back to the atmosphere.

Burt et al., 1997 reported that irrigation efficiency defines how effectively an irrigation system supplies water to a given crop or turf area. Efficiency can be computed as the ratio between water used beneficially and water applied and is expressed as a percentage. Irrigation efficiency is difficult to quantify; therefore, distribution uniformity is often measured as an indicator of potential efficiency for sprinkler irrigated areas. Irrigation can be uniform and inefficient due to mismanagement (i.e., over irrigation); however, irrigation cannot be non uniform and efficient. As a result, irrigation uniformity can be a good indication of potential irrigation efficiency. Moreover **Merriam and Keller 1978** stated that uniformity of water distribution is a measure of the variability in application depth over a given area. Two methods have been developed to quantify uniformity, distribution uniformity DU and the coefficient of uniformity CU.

2-1- Modeling of turf irrigation management:

There are several approaches available for modeling a dynamic agricultural system. They vary from those using process or mechanistic