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Improving irrigation Schedules and Identify Standards By Using KATENA Model

Mahmoued M. Ali
Department of Soils and Water Science, Faculty of Agriculture, Fayoum University, Fayoum, Egypt

ABSTRACT

Models can be used for such a purposes to enable rapid and extensive condition testing. The current study is carried out to adaption mathematical model called KATENA to calculate the irrigation requirements under Egyptian conditions. Model use input data about climate, soil and plant parameters. Our study specified in metrological information for five stations in Egypt for 10 years and five kinds of fruit trees. By calculating the irrigation rate using different values of soil moisture content in the period of vegetation and non-vegetation show that the best value of pre-irrigation humidity are 0.65 and 0.75 and the optimum is 0.82%.

Key words: Irrigation management, Irrigation schedule, Katina model.

INTRODUCTION

Farmers who use a large amount of the available water to irrigate their crops are criticized by environmentalists and politicians for using too much water and creating nitrate problems in the Groundwater tables. In some areas where water resources are limited, farmers who irrigate may receive a fixed amount of water for the growing season or may have to restrict their irrigation flow rates at certain times. On the other hand, the profitability of irrigated crops can be improved by reducing the amount of water used and optimizing the timing of application (Stockle and James, 1989).

New irrigation scheduling approaches, not necessarily based on satisfying the full crop water requirement, but aimed to increase efficient use of the allocated irrigation water so as to give the highest crop production with the least water use, must be developed (Kirda and Kanber, 1999; Pereira, 1999). Profit maximizing strategies call for significantly less water than maximum yield strategies. The philosophy behind limited irrigation strategies is that marginal stress, except during critical reproductive stages, may not affect yield enough to justify the cost of irrigation until the soil water deficit becomes quite large (Boggess and Ritchie, 1988). Quantitative management of available water in France is a key aspect of the relationship between agriculture and the other components of society (Me´rillon and Evain-Bousquet, 1996).

Therefore, there is a need to estimate precisely how to use the water for irrigation and how to calculate the consequences of a restricted amount of water on farmers' incomes. Maize irrigation, the largest as regards both land area and water volume in France, is particularly affected by this problem, to solve the problem; models can be used as they enable rapid and extensive condition testing (Whisler *et al.*, 1986). The main points regarding irrigation are strategic, i.e. they must be decided before the irrigation season has begun (Anderson *et al*., 1996). Some tools are already available to virtually test irrigation decisions.

They can be developed at a reservoir or basin level and used more specifically by advisors or to develop general policy (Evers *et al*., 1998) at a farm level for strategic planning (Leroy and Jacquin, 1994; Leroy *et al*., 1997) or at a plot level, quite often as a secondary use of complex biophysical models which may not contain decisional aspects (Howell *et al*., 1989; Epperson *et al*., 1993; Hooks, 1994; Cabelguenne *et al*., 1997; Stockle, 1997).

The farm level model is difficult to work with, as it requires a large amount of data to describe the farm enterprise and quite often does not use a dynamic model and the crop model is quite often based on empirical relationships between yield water stresses. The latter does not allow the decision to irrigate to be properly described, and is often based on a simulated irrigation calendar where irrigation constraints are not necessarily taken into account in the decision process. Irrigation is a more complex technical operation than fertilization for instance.

It is of course a 2-fold decision process of when and how much, but it requires much more information as irrigation is repeated several times throughout the growing season. Different constraints have to be considered. It is thus worth developing irrigation strategies based on decision rules rather than on prescriptive schedules (Aubry *et al*., 1998; Shaffer and Brodahl, 1998). A decision rule may be seen as a function of the state of the system, which asks every day is it time to irrigate? (Yes, no) what quantity of irrigation water should be applied?. Therefore, developing a dynamic model of the biophysical functioning of the system linked with a decisional model could be a significant improvement for irrigation scheduling.

The main enquiries from advisors regarding the decision rules for irrigation are: When to start the main irrigation period? (Mircovich, 1999). If irrigation starts too early there is a risk of drainage and furthermore, if there is a limited amount of available water for irrigation then there is a risk of a shortage at a critical period.

* *Corresponding Author: mma12@fayoum.edu.eg*

MATERIALS AND METHODS

The model working for five governments in Egypt and three kinds of soil and five kinds of fruits. The study area was in five location in Egypt (hegazi farms in Giza 30:03:54:20 N, 30:49:22:93E), (Salhia farms in Ismailia 30:35:47:48 N, 32:14:34:19E), (Sedmant algabl farms in Fayoum 29:13:50:59 N, 30:47:00:30E), and farms in (El-wadi algaded 24:24:24:69 N, 27:01:50:64E) and Bohera government (30:42:27:13 N, 29:47:52:48E) were selected.

All data about study area, the yield and climatic data about temperature, humidity and rain for 10 years were collected. Use five kind of fruits (Peach, Apple, Citrus, Grapes and Mango) the data selected (biological factor shadow factor - the area of tree -the area for vegetation - period of vegetation).

Three kinds of soil types (Loam Sandy, loamy and Sandy) at three horizontal layers and the characters of soil are (Porosity- maximum hygroscopic- capillary rice - filtration factor).

The method of calculating is model «KATENA» author Golovanoov A. E (2005). This model issued for calculating the irrigation rate for drip irrigation consisting of trench (Fig. 1) for the different kinds of culture. Interface model KATENA (Fig. 2).

The language of program are Visual Basic (6), the modelling show high relation between irrigation rate and relative yield of plants with values of soil water content.

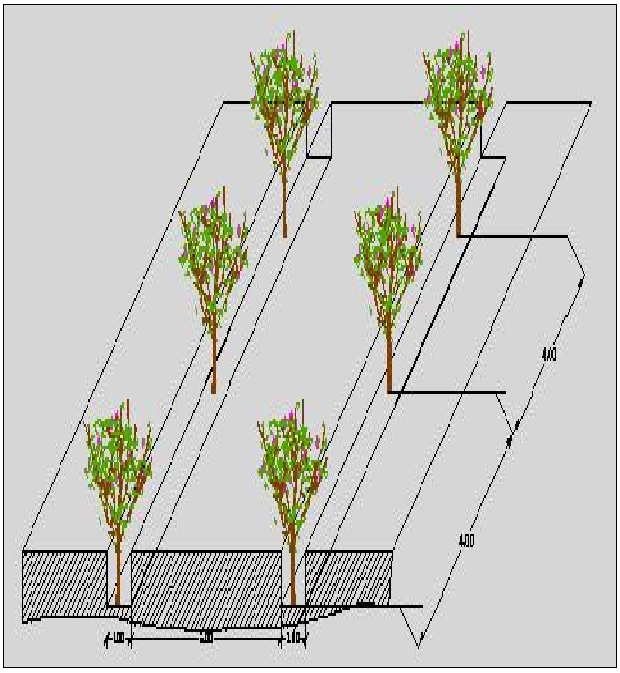
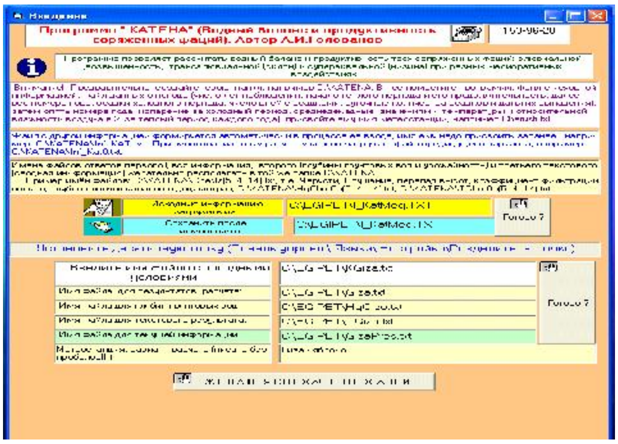
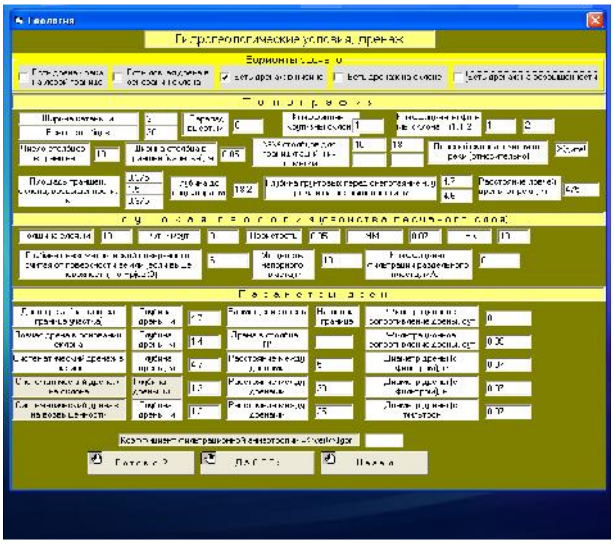
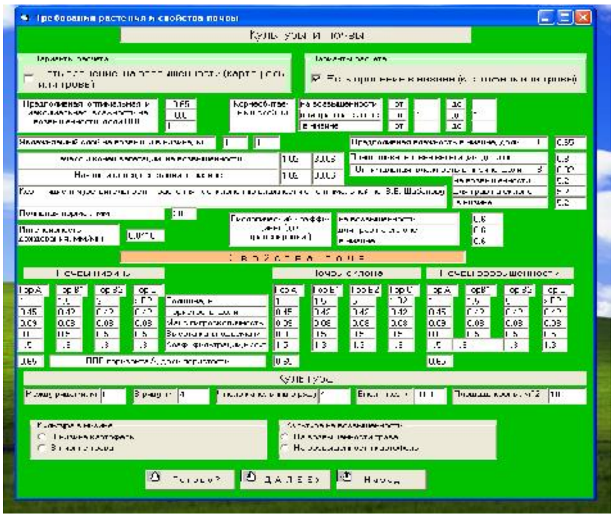
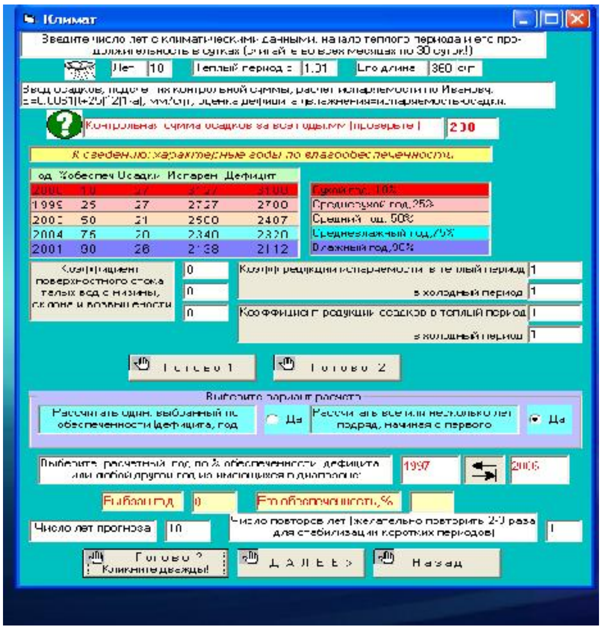


Figure (1): Schema for trench and distance between the trees.









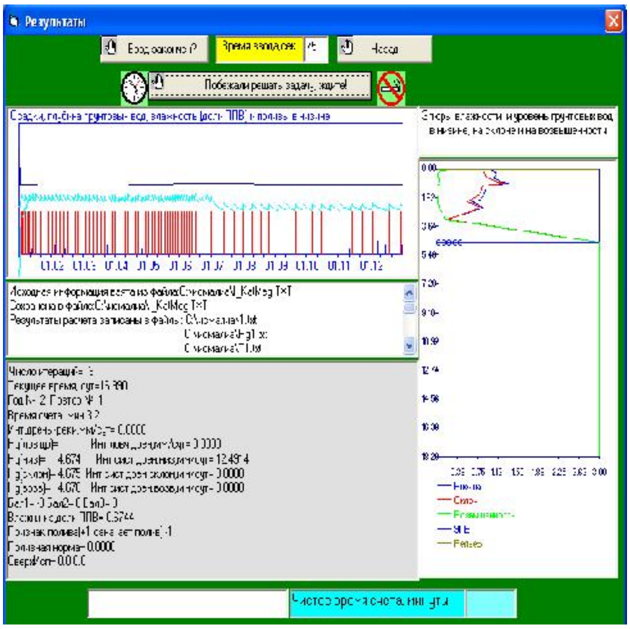


Figure (2): Interface model KATENA.

The definition of moisture conductivity $K(\mu)$ depending on humidity of soil use modified Averjanov S. F. (1949), formula:

$$K(\mu) = K_{\phi}\left(\frac{\mu - \mu^{*}}{m - \mu^{*}}\right)^{5} \quad (1)$$

The model use Ivanovo N.N. (1959) Formula for calculating potential evapotranspiration:

$$E_{pot} = 0{,}0061 K_{6}(25 + T)^{2}(1 - 0{,}01a), \text{mm/day} \quad (2)$$

Potential evapotranspiration divided into potential evaporation from a surface of soil E^{S}_{pot} and potential transpiration E^{t}_{pot} of plant and it is proportional factor the shadow of soil.

$$E^{S}_{pot} = (1\text{-Kshad}) E_{pot}, \quad E^{t}_{pot} = K_{shad} * E_{pot} \quad (3)$$

Actual productivity of plants (yield) developed by Shabanov V.V. (1981) formula

$$U_{a} = U_{P} K_{\omega} K_{\theta} K_{\pi} K_{S} K_{Z} \quad (4)$$

U_{a} – actual productivity; U_{P} - potential productivity of the given culture under all optimum conditions and the agricultural technician; $K_{\omega} K_{\theta} K_{\pi} K_{S} K_{Z}$ - the factors considering not optimum humidifying of soil, heat supply, nutrients, salinity, pollution,…..etc.

Table (1): Values of pre-irrigation and optimum soil moisture content.

Optimum of The soil moisture	Pre-irrigation in Non-vegetation	Pre-irrigation in The vegetation
0.82	0.80	0.70
0.82	0.80	0.65
0.82	0.80	0.62
0.82	0.80	0.60
0.82	0.75	0.65
0.82	0.75	0.62
0.82	0.68	0.62
0.82	0.65	0.62
0.82	0.65	0.60
0.82	0.62	0.60
0.82	0.60	0.60
0.82	0.58	0.58

RESULTS AND DISCUSSION

Figures 2 and 3 show that for all the kinds of fruits with all farms the best value of water content are variant number five because this variant make standard yield with minimum amount of irrigation.

The study confirmed the validity of the method of calculation to work in Egyptian conditions and show high significant with the amount of irrigation and the yield.

The best value of soil moisture content in the period of vegetation and non-vegetation show that the best value using are 0, 65 and 0, 75 and optimum is 0.82. by using this values and make comparing between results by model with real data from farms in Egypt we find that the relative yield will increase and the amount of irrigation will not change.

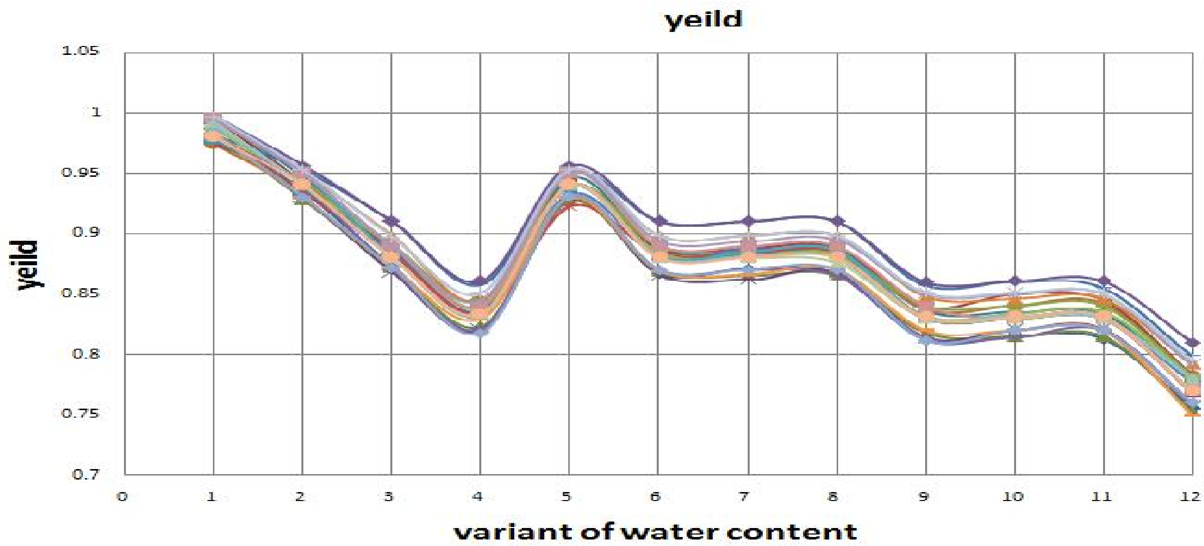


Fig (2): Relation between the relative yields with the variant of water content.

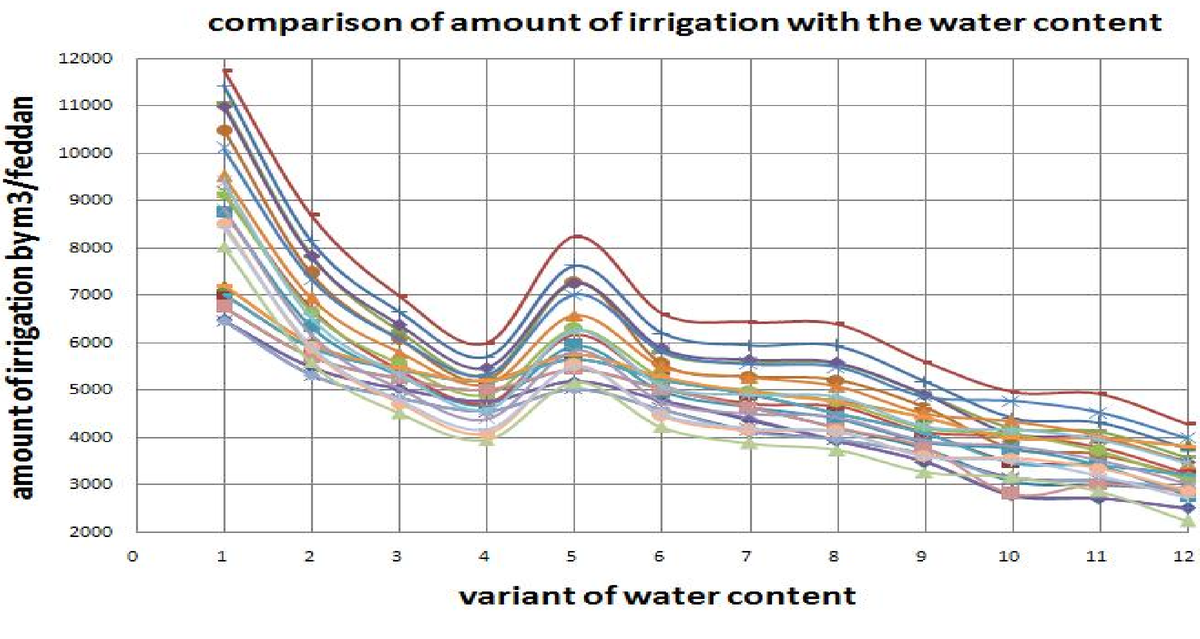


Fig (3): Relation between the amounts of irrigation with the variant of water content.

REFERENCES

ANDERSON, C. A., D. S. KRULL AND B. WEINER. 1996. Ex- planations: processes and consequences. SeeHiggins & Kruglanski 1996, pp. 271–96.

AUBRY, C., F. PAPY, A. CAPILLON. 1998. Modelling decision-making processes for annual crop management. Agric. Syst. **56**: 45 - 65.

AVERJANOV, S. F. 1949. Dependence of water permeability of soil - Reports of USSR Academy of Sciences, vol. **69**, No 2.

BOGGESS, W. G. AND J. T. RITCHIE. 1988. Economic and risk analysis of irrigation decisions in humid regions. J. Prod. Agric. **1**:116 – 122.

CABELGUENNE, M., J. PUECH, PH. DEBAEKE AND N. BOSC. 1997. Real time irrigation management using the EPIC-PHASE model and weather forecasts. Agricultural Water Management, **32**: 227- 238.

EPPERSON, W. B., K. H. HOBLET AND K. L. SMITH. 1993. Association of abnormal uterine discharge with new intramammary infection in the early. postpartum period in multiparous dairy cows. Am.Vet. Med. Assoc. **202**: 1461-1464.

EVERS, A. J. M., R. L. ELLIOTT AND E. W. STEVENS. 1998. Integrated decision making for reservoir, irrigation, and crop management. Agric. Syst. **58**: 529 - 554.

FOGEL M. M., L. DUCKSTEIN C. C. KISIEL. 1976. Optimum control for irrigation water application. J. Hydrol. **28**: 343 - 358.

GOLOVANOOV, A. E. 2005. Mathematical landscape model « KATENA » scientific proceeding collection of nature management in Russia. Part 2 MSUEE.

HOOKS, B. (1994). Teaching to Transgress. Education as the practice of freedom, London: Routledge. 216 + x pages. Draws on Freire but looks to developing a feminist, engaged pedagogy relevant to multicultural contexts.

HOWELL, T. A., K. S. COPLAND, A. D. SCHNEIDER AND D. A. DUSEK. 1989. Sprinkler irrigation management for corn-southern great plains. Trans. ASAE **32**: 147 - 160.

KIRDA, C. AND R. KANBER. 1999. Water, no longer a plentiful resource, should be used sparingly in irrigated agriculture. In: Kirda, C., Moutonnet, P., Hera, C., Nielsen, D.R., [Eds.]. Crop Yield Responses to Deficit Irrigation, Kluwer Academic, Dordrecht, pp. 1 - 20.

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