AENSI Journals

Advances in Environmental Biology

ISSN-1995-0756 EISSN-1998-1066

Journal home page: http://www.aensiweb.com/AEB/

Applied Computer Models Used in the Designing of Soil Drainage Networks

[1]Kamran Parvanak and [2]Hadi Chamheidar

[1]Department of Soil Science, Yadegar-e- Imam Khomeini(RAH), Shahre-rey Branch, Islamic Azad University, Tehran, Iran.
[2]Department of Soil Science, Shoushtar branch, Islamic Azad University, Shoushtar, Iran

ARTICLE INFO

Article history:
Received 15 June 2014
Received in revised form
8 July 2014
Accepted 4 September 2014
Available online 20 September 2014

Key words:
Computer models, Soil drainage, Hydrus-2D model, Drainmod model

ABSTRACT

Drainage systems are installed typically in semi-arid land which are under irrigation to control soil salinity and water logging. Because of the complexity of the movement of water and solutes in soils, computer models are used to describe the performance and management of soil drainage systems. The purpose of this study is a comprehensive application modeling process and models in predicting soil drainage processes. The result showed, computer models used in the design of soil drainage networks including HEC-1, HEC-HMS, TR-20, DUFLOW, DRAINMOD, SWAP, SGMP, MUDFLOW, Hydrus-1D and Hydrus-2D. In fact, they are a powerful computational tool that allow quantitative and qualitative transformation into a drainage system operation and forecast and evaluate under various conditions and changes in boundary conditions. Using these models widely recommended due to lower costs and shorten the time to achieve results of run a script on a system.

To Cite This Article: Kamran Parvanak and Hadi Chamheidar., Applied computer models used in the designing of soil drainage networks. ***Adv. Environ. Biol., 8(12),*** *876-881, 2014*

INTRODUCTION

The model is described to better understand phenomena that could not be seen them. In other words, a model simulated spatial and temporal properties of a system or parts of it in the physical (real) or mathematics. The concept of model is generalized in recent decades as some have thought, that there are no absolute rules and principles of science and physics and what is the model. In fact, the new science and the new view of science, knowledge is not an absolute phenomenon. But the objective is image to find that the relative simplicity and represents the facts and phenomena [11]. Accurate model of the phenomenon is it phenomenon on itself. But issues such as complexity, cost or time consuming is being caused human to use the model. Models that are commonly used for the study of soil irrigation and drainage systems are three types [10]:

1-Physical model
2-Deductive model
3-Mathematical model

Steps to establish and implement the model generally includes the following [4]:

A. Understanding the issue
B. Understanding the physical behavior of the system
C. Determine the relationship between empirical and mathematical equations governing the physical behavior of the system
D. Solving mathematical formulas and equations
E. Programming for solved mathematical equations
F. Evaluate the model results with the actual results

The operation model began input data and leads to output results. Model input data is a specification of the model specifications subject directly observed and is therefore unknowable. Model will follow from the point of data entry, over time and his path until the provide output results related to input. The model results matched the specifications as its object is inferred and this kind of insight into the performance and behavior obtained of the results of model. In Figure 1 the arrows between subject and model, shows their interaction. Each entry in the "Subject", X, a "model", X and Y, each model outputs a corresponding output Y is thus subject [11].

Corresponding Author: Kamran Parvanak, Assistant Professor, Department of Soil Science, Yadegar-e- Imam Khomeini (RAH), Shahre-rey Branch, Islamic Azad University, Tehran, Iran.
E-mail: kparvanak@iausr.ac.ir, Tel: +982155229200, Fax: +982155229297

Advances in Environmental Biology, 8(12) July 2014, Pages: 876-881

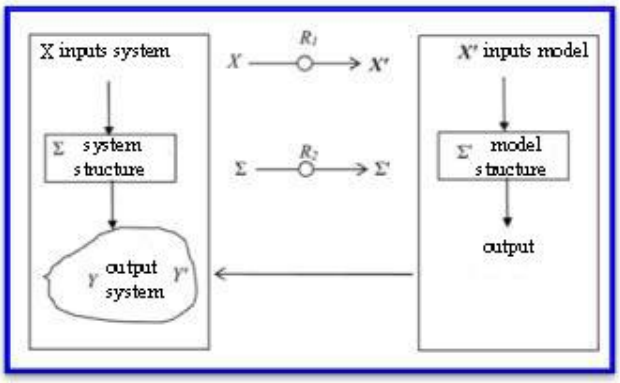

Fig. 1: The relationship between the model and the subject.

In the evaluation of the model can predict natural process with applying various inputs to the model. Whatever the model results is similar to facts show that the model is more accurate [3]. Figure 2 schematically represents the sound of it [11].

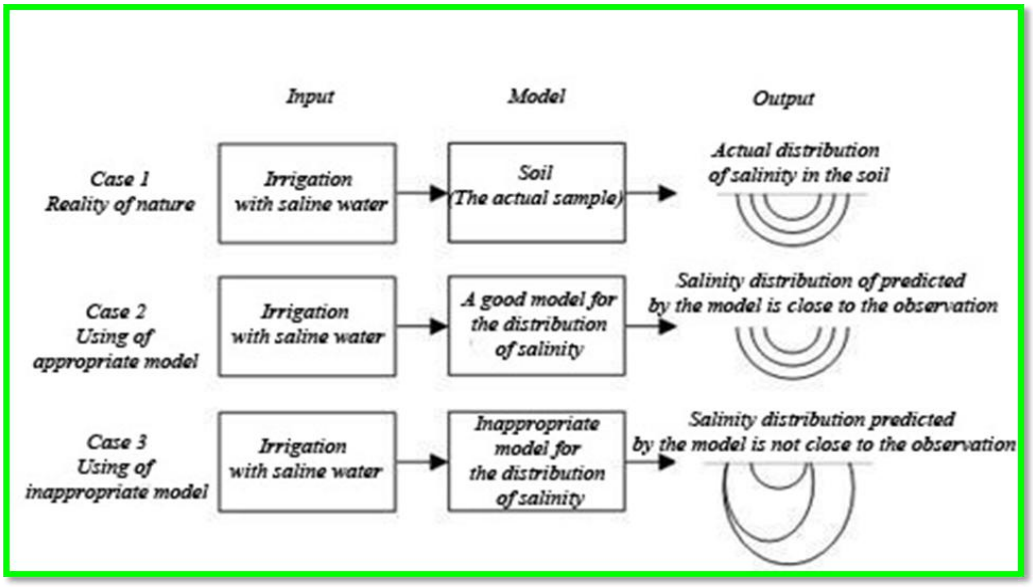

Fig. 2: A comparison of various forecasting models to reality.

Computers are entered in all aspects of irrigation and drainage systems today. Using computers and computer models do not even need laboratory tasks. Usually various computer programs used to analysis of mathematical models. In fact, the computer models are mathematical models but because these kinds of models are analyzed by computer named computer models. The use of this type of models is greatly expanding. The reason is simple and low cost of this type of models [10]. The purpose of this study is a comprehensive computer models investigation to predict the drainage process in soils.

MATERIALS AND METHODS

This study was performed based on library studies from the literature ISI, Science-Research, doctoral dissertations, master's theses, books, and the results of research conducted by the authors in the field of soil and water processes modeling. Then the use of computer models are followed to predict soil drainage procedures.

RESULTS AND DISCUSSION

Types of computer models in the designing of soil drainage networks:

1. Discharge – runoff models:

There are many computer models that can simulate runoff from rainfall. Using this model, it may be acquired drainage demands in large and small watershed or parts of agricultural land. The models Called, HEC-1, HEC-HMS, TR-20 and DUFLOW are handled in these cases.

1.1 HEC-1 and HEC-HMS Model:

HEC-1 model was developed in the 1980s by America's Army Consulting Engineers. This software is capable to produce hydrograph from ununiformed rainfall and trend by rivers direction and reservoirs [15]. HEC-HMS model is an advanced version of HEC-1 model that was produced in 1998 by the United States Army Center of Hydrology. Taheri et al., (2004) used HEC-HMS model to simulate rainfall-runoff processes in three main basins Jaghregh, Dehbar and Mayan of Torghabeh catchment of Mashhad [13]. Information required by the model, including infiltration information, precipitation and stream properties that is estimate by remote sensing and geographic information systems to compile the model. After entering the necessary information to model the flood hydrograph for each basin hydrologic units were calculated (Figure 3).

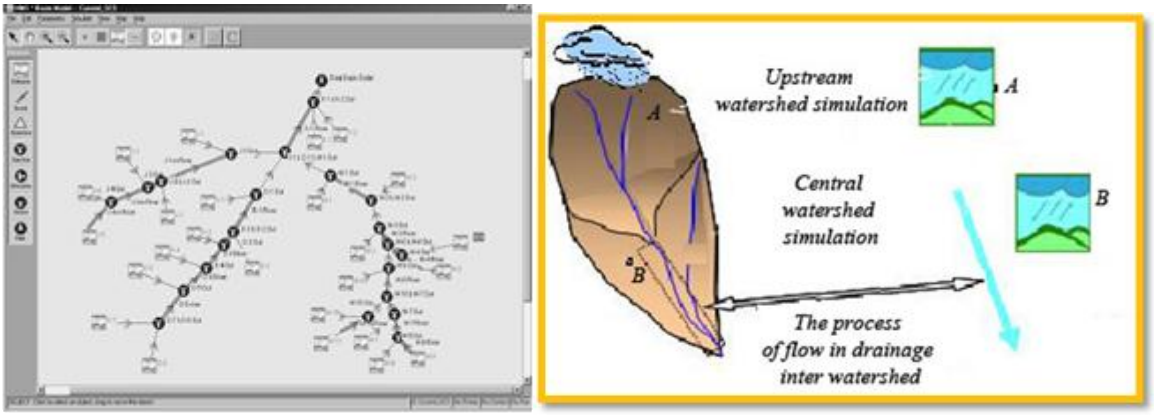

Fig. 3: Flood hydrograph for each hydrologic units of Torghabeh catchment.

1-2 TR-20Model:

Technical Bulletin No. 20 (TR-20) Department of Resource America is about this model and with implementation of it can be achieved flood hydrograph resulting from precipitation types. The model also performed the trend of flooding in a river or reservoirs. With entering the flood of different branches join the main stream, are mixed together, and ultimately computed the final hydrograph [8]

1-3 DUFLOW Model:

DUFLOW model is also one of the rainfall-runoff simulation model. This model is suitable for flat land with subsurface drainage is associated with conditions such as the Netherlands. In this model, the runoff - rainfall is marked with the RAM, so it is also popular called DUFLOW / RAM model. The rate of drainage of agricultural lands or parks also predicted with this model. The trending operation of this model is also done. In 2003 a new version of this model called DUFLOW/DMS were presented that the design of water control structures such as overflow and drains etc. have been added [5].

2- Groundwater flow models:

These models are used for the groundwater model that does not allows analytical solution for them. The way most of these models is to solve the Laplace equation is a method known as network flow (flow net method) or squares method (squares method) or the relaxation method. All these methods are actually numerically by finite element or finite elements [3]. If the previous method based on two-dimensional equations were based on steady-state in non-steady-state model and non-concurrent mode and multi-layered aquifer is considered. Groundwater applied flow models are as follow:

2.1 Spreadsheet model:

These models are versions of the spreadsheet model MODFLOW that quickly replaced other computer models. Spreadsheets are not in need of special software and can be used for designing the drainage and flow separation in two-dimensional steady-state. Hooghoudt formula are often used and adequate in spreadsheets and replaced other equations to calculate the distance of subsurface drainage [9].

2.2 MUDFLOW model:

This model is a three-dimensional model of groundwater flow that was prepared by America Geological Survey (USGS) and the way that used in which was the finite difference method. Since the launch of the first model, a lot of changes and modifications have been done on it [16]. In the new version of the model the GIS and the salinity and water quality and contaminant transport have also been added. The new version can be MODFLOW / GMS and MS-VMS- SURFACE.

2.3 SGMP model:

With the standard model of groundwater that known as SGMP can analyzed human impact of irrigation and drainage schemes, artificial nutrition and water extraction of wells. In this model, the region of interest to a number of the polygon each of them are divided within the region as well as an area outside the boundaries. This model is well used for the design of drainage tube in Pakistan and India [6].

3. Agrohydrologic models:

Agrohydrologic models are models that can be identified soil moisture regime condition, soil and water table and the effects of various management. Some of these models also consider plant growth. To calibrate these models are often used past data or test. Two major Agrohydrologic models are DRAINMOD and SWAP.DRAINMOD model was developed in the 1960s in America at North Carolina State University and SWAP model was developed in the 1970s at the University of Wageningen Netherlands. DRAINMOD model is based on water balance and empirical equations. While in the SWAP model, the water - soil regime is based on water movement in the soil and evapotranspiration rate [15,14,6].

4. Models to predict water movement in the soil:

4-1 Hydrus-1D model:

Hydrus-1D model is an advanced model based on the numerical solution of Richard's equation and transfer and diffusion equations used in order to study the movement of water and soil solutes and heat in soils. This model developed by Simunek, *et al*, and Abbasi *et al* in laboratory and field studies to simulate soil hydraulic properties and solute transport in saturated and unsaturated conditions [12,2]. With the implementation of the model, the page similar to Figure 4 is displayed. As seen on the left of the input data with reference to each section, and enter the required parameters can be introduced into the program. The main results of the program are classified and graphically displayed in the right. The same results as text files placed on the user [2].

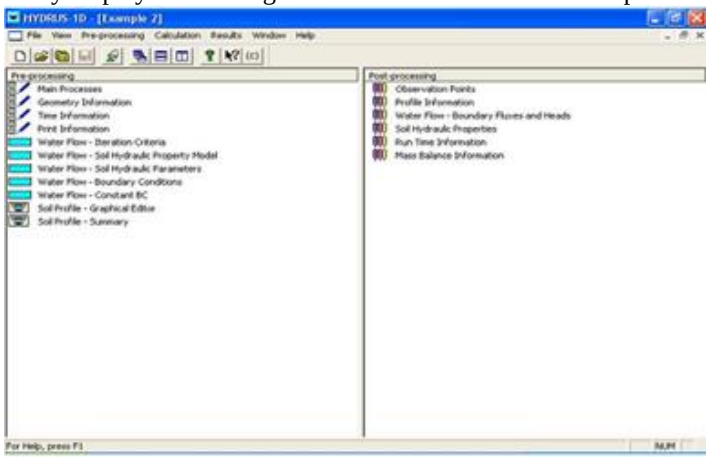

Fig. 4: Schematic General's Hydrus-1D model.

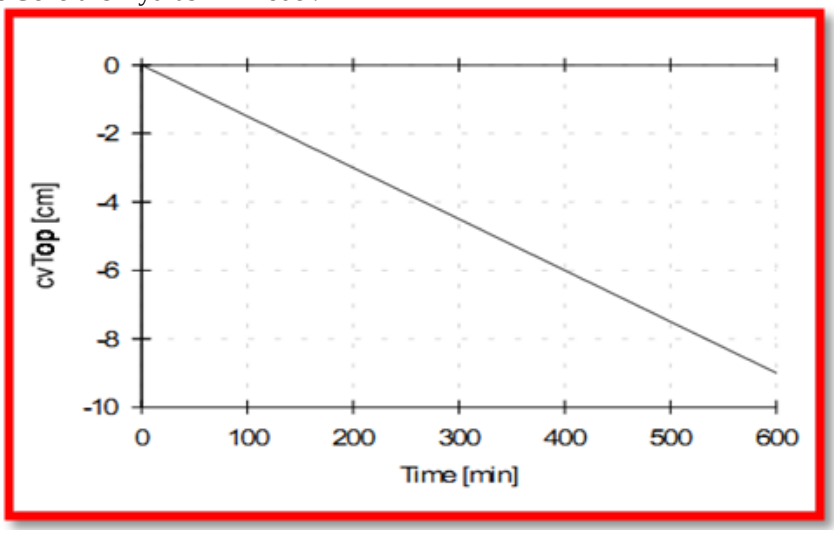

Fig. 5: Cumulative amount of water changes entering from upstream.

Abbasi, used Hydrus-1D model to predict the amount of water penetration, changes in moisture content and soil suction in a loamy soil Under sprinkler irrigation system [2]. Model results graphically are shown in Figures 2 to 7.

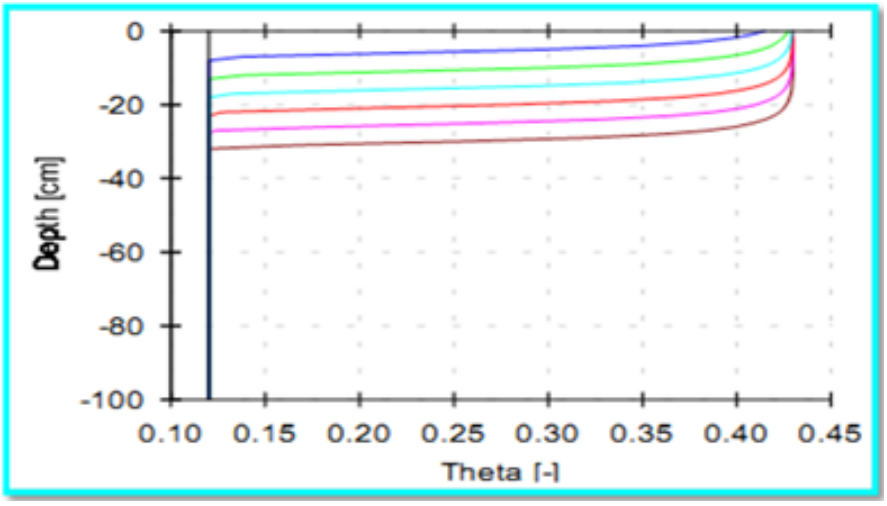

Fig. 6: Changes in soil moisture content at different times.

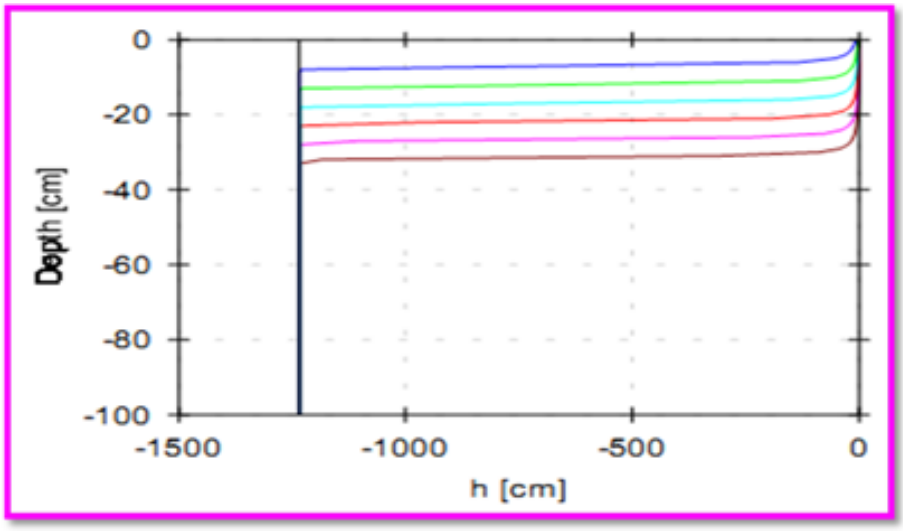

Fig. 7: Suction changes with soil depth at different times.

Conclusion:

Log in to the computer, causing drainage issues that was impossible due to the large volume of computing and the need to repeat the calculations become possible. Using computers and computer models do not even need traditional laboratory experiments. Thus, the use of computer models in order to identifying and studying various phenomena complex engineering and solving complex engineering problems related to the design of soil drainage networks has led to new concepts and methods. Computer models used in the design of soil drainage networks including HEC-1, HEC-HMS, TR-20, DUFLOW, DRAINMOD, SWAP, SGMP, MUDFLOW and Hydrus-1D. In fact, they are a powerful computational tool that allow quantitative and qualitative transformation into a drainage system operation and forecast and evaluate under various conditions and changes in boundary conditions. Using these models widely recommended due to lower costs and shorten the time to achieve results of run a script on a system.

REFERENCES

[1] Abbasi, F., D. Jacques, J. Simunek, J. Feyen and M. Th. van Genuchten, 2003. Inverse estimation of the soil hydraulic and solute transport parameters from transient field experiments: heterogeneous soil. Trans. ASAE, 46(4): 1097-1111.

[2] Abbasi, F., 2005. Simulates of movement of water in soil by Hydrus-1D model. Workshop on Modeling in Irrigation and Drainage, Tehran, Iran.
[3] Burden, R.L. and J.D. Faires, 2001. Numerical Analysis, 7th Edition, Brooks Cole, London.
[4] Banaeyan, M., 2013. Development and application of simulation models in agriculture. Press University of Mashhad, Iran.
[5] Davidson, L., 2003. An Introduction to Turbulence Models. Publication 97/2, department of thermo and fluid mechanics, Uni. Of Chalmers, Sweden.
[6] Ebrahimian H., A. Liaghat, 2011. Field evaluation of various mathematical models for furrow and border irrigation systems. Soil and Water Research, 6(2): 91-101.
[7] Thornley, 2004. Mathematical model in agriculture, the quantities approach to problems in agriculture and related science, Butterworth, London.
[8] http://www.google.com/Modflow, 13 Agustus 2012.
[9] Jellali, S., E. Diamantopoulos, H. Kallali, S. Bennaceur, M. Anane and N. Jedidi, 2010. Dynamic sorption of ammonium by sandy soil in fixed bed columns: Evaluation of equilibrium and non-equilibrium transport processes. Journal of Environmental Management, 91: 897-905.
[10] Khaledei, H. and H. Tabatabaei, 2005. Introduction to Models and application its. Workshop on Modeling in Irrigation and Drainage, Tehran, Iran.
[11] Mirzadeh, M. and M. Ghobadeniya, 2005. The structure of mathematical modeling and its application in ground-water systems. Workshop on Modeling in Irrigation and Drainage, Tehran, Iran.
[12] Simunek, J., R. Kodesova, M.M. Gribb and M. Th. van Genuchten, 1999. Estimating hysteresis in the soil water retention function from cone permeameter experiments. Water Resour. Res., 35(5): 1329-1345.
[13] Taherei, A., A. Adib and A. Ershadei, 2007. Simulation and Flood control by using mathematical models in GIS. Regional Water Company, Khorasan, Iran.
[14] Ventrella, D., B.P. Mohanty, J. Simunek, N. Losavio and M. Th. van Genuchten, 2000. Water and chloride transport in a fine-textured soil: Field experiments and modeling. Soil Sci., 165(8): 624-631.
[15] Wang, D., S.R. Yates, J. Simunek and M. Th. van Genuchten, 1997. Solute transport in simulated conductivity fields under different irrigations. J. Irrig. Drain. Eng., 123(5): 336-343.
[16] Zheng, Ch., G.D. Bennett, 2002. "Applied Contaminant Transport Modeling", 2ndEdition". Wiley Pub.