IMPLEMANTATION PROJECT INVOLVED IN ICCAP
ON
Simulation of Soil-Water-Climate and Plant Relationships in Seyhan Plain under Changing Global Climate

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Introduction

For proper irrigation management, two major decisions are required: when to irrigate and how much water to apply. This requires a precise knowledge of crop water use or water losses by evapotranspiration of crops under field conditions. Evapotranspiration, which is described as the sum of the water evaporated from land and water surfaces and transpirated by vegetation, is one of the most basic components of the hydrological balance. It is expressed by equation as follow.

$I+P-(D_p+R_f+ET)=\pm \Delta SW$ ....(1)

Where, I, irrigation; P, precipitation; D_p, drainage; R_f, runoff; ET, evapotranspiration; ΔSW, change of soil water storage in plant root zone.

Evapotranspiration measurements are also required for estimating crop coefficient (Kc), which is used with reference and actual ET determinations to calculate crop water requirements. ET values are used to study the physiological aspects of water use efficiency, estimation of crop water stress indexes, and reliable crop modeling results.

Therefore, many techniques and models for directly or indirectly measure crop evapotranspiration were developed (Tanner, 1967; Doorenbos and Pruitt, 1975; Reicosky and Peters, 1977; Jensen et al., 1990; Burman and Pochop, 1994; Steduto et al., 2002). Table 1 (Cetinkökü, 1998 from Sharma, 1984) shows the some of most important of ET determination methods. ET determinations are summarized by subdividing them into three categories: Water balance, micrometeorological and plant physiological methods. Different approaches are also ranked according to their spatial and temporal scale, equipment sophistication, required skills to operate them, mobility from one location to another, and costs.

As it can be seen from Table 1, to choose among different methods should be devoted according to the study purposes and the boundary conditions in which the study is carried out. For direct determinations of ET under different soil and water management practices, it is however necessary to develop reliable, inexpensive and portable equipment.

Table 1. Summary of applicability of different ET determination methods according to their spatial and technical scale, equipment sophystication, required skills, mobility and costs (Cetinkökü, 1998, redrawn and modifid from Sharma, 1984

Methods	Time Scale*						Space scale**						Equipment Sophyst.	Requir. skills	Mobility	Costs
	m	h	d	w	M	y	L	P	pl	F	C	R				
Water Balance																
Lysimeter-W		*	*	*	*	*		*	*				high	medium	none	high
Lysimeter-nW				*	*	*		*	*				medium	medium	none	medium
Soil-Water Bal.				*	*				*	*			medium	medium	high	medium
Micrometeorolog.																
Aerodynamic		*	*	*						*	*		high	medium	low	low
Bowen-ratio		*	*	*						*	*		high	medium	medium	medium
Eddy covariance		*	*	*						*	*		high	high	medium	high
Plant Physiological																
Chamber	*	*	*	*				*	*				medium	medium	high	low
Heat pulse/balance	*	*	*	*				*	*				high	high	low	high

* m: min; h: hour; d: day; w: week; m: month, y: year
** L: leaf, P: plant, pl: plot, F: field, C: catchment, R: region

In fact, weighing lysimeter, which is a tank used to isolate a soil mass containing growing plants from surrounding soil, is the most accurate and direct method (Reicosky et al., 1983, Kanber et al., 1999), but they are costly and immobile. The methods based on soil-water balance are mobile too, but expensive, time consuming and variable in accuracy depending on soil types and conditions. Soil-water balance methods are used to measure soil water content directly into the soil to determine evapotranspiration. Gravimetric, Neutron probe and Time Domain Reflectometry (TDR) are limited in their use due to their disadvantages (e.g. radioactivity; labor intensive, time consuming, costs, etc.). Furthermore, the additional use of tensiometers for all of them might be required. However, this method is still very relevant for many agronomic studies, particularly for variety testing, irrigation, nitrogen and salinity treatments, etc. Canopy chamber methods can be considered relatively inexpensive, simple, portable and accurate (Reicosky and Peters, 1977; Reicosky, 1985; Steduto et al., 2002). Consequently, only the soil-water balance and the canopy chamber methods are seem to be properly suited and economically applicable for agronomic studies. Micrometeorological methods, which are widely used to determine gas exchanges over crops covering a surface of some hectares, are mobile, but expensive and requiring large fetch.

Objectives

There is a recent consensus among scientists that earth's energy balance will be altered and global temperatures will increase due to greenhouse emissions. It is expected that precipitation will decrease and plant water use will increase due to this change. Naturally, Çukurova Region, which is one of the most important agricultural regions of Turkey, will most likely be affected by these changes. Some of the Mediterranean Region's basins such as Seyhan basin, which has a semi-arid character, may have an arid character in the plain region, and upper basins, which currently have sub-humid character, could have semi-arid character. This possibility can cause important changes in the soil and water resources management and agricultural production. Soil-water-climate and plant simulation models can estimate the impact of climate changes on agricultural production and yields. Besides, recent and upcoming technology that has made many climate components readily available has allowed the measurement of plant water use with sensitive and reliable meteorological methods.

The objective of this study is to determine effect of soil properties (soil hydraulic properties, salinity and heat balance), water regime (precipitation and plant water use) and climate parameters on the plant growth and yield using simulation models in studies that will be carried out in Seyhan Plain in existing and global (or local) conditions. This study is expected to provide important information for scientists, institutions and producers that work on soil and water management.

Material and Method

Application of Project

The experiment will be carried out at the farmer fields in the Seyhan Plain. The fields where wheat and maize are planted will be chosen for these purposes. The data needed for running of the simulation model will be collected and analyzed. This project will be important work to determine soil water atmosphere and plant relationships to take into consideration of climatic variables. The simulation model to be supported with remote sensing techniques could be applied not only to working area and also to agricultural studies.

It is possible to summarize the main part of the project as follow:

1. to compile some meteorological observations for last 40 to 50 years.
2. to determine of the some micro-meteorological measurements on the field conditions; and also to establish some plant and soil parameters.
3. to pick up some daily meteorological data belong to extreme two period with investigating monthly meteorological data.
4. to constitute basic databases for project area and to supply input data for simulation model.
5. to get numerous of soil heat flux, soluble matter transport and water budget components for the project area wit simulation model.
6. to determine of the micro-meteorological and plant growth parameters under present and different meteorological conditions. to collect satellite spectre, for LANDSAT-5 TM and/or 7 ETM including two time period recorded for a long time at least two time period for the project area.
7. to determine NDVI (normalised differences vegetation index) data and to calculate plant productivity in the project area.
8. to investigate results obtained on plant productivity and soil hydrology with possible climatic variables.

ET Measurements

Micrometeorological methods, which are Bowen Ratio-Energy Balance (BREB) and Eddy-Correlation (EC), will be used to measure gas exchanges over crops surface in this experiment. These methods provide the simple, precise and unattended continuous measurement with minimum error due to use the automatic equipments.

In BREB method, temperature and vapor pressure of air are measured at same two hight. In 1926, Bowen suggested to take the ratio between sensible and laten heat fluxes for determination evapotarion from lake. Since 1926, Bowen' sugestion has received widespread acceptance and has became the atarting po,nt for instrumentation development. The method has been thoroughly tested in the past and its validity well establishe (Steduto a nd Ç etinkökü, 1 999). F urthermore, t he r esults o btained f rom t he studies done on BREB methos showed that this methos is less sensitive than other micrometeorological methos to unsuitable fetch conditions.

Eddy-Correlation method is based on turbulent transfer theory. In this method, the deviations of mean values of wind velocity and water vapor flux at vertical (one-dimensional) direction are measured (Rosenberg el al., 1983). Some times, sensible heat is obtained instead of wind, and sensible heat is used in energy budget method for estimating crop evapotranspiration (Tanner et al., 1985; Dugas et al., 1991; Kanber et al., 1998a, b).

Simulation of Model

Monthly meteorological data for a long time period (40-50 years) and daily data for some extreme years will be obtained from General Meteorological Directorate. Besides, images for the plain, which have been recorded during the long time period, cowered at least two time segments are going to be buy. The values of NDVI required for creating the crop productivity of the plain, the results to be taken from a study to be done by Dr Evrendilek and his friends who are the staff of MK University will be used.

The SWAP-2.0 version will be used as simulation model in this experiment. To get model easily applicable to the region, the some important parameters will be determined with measurements done on land/field conditions and some data as towards of back will be obtained by remote sensing techniques. The model will be operated with daily basis and all sub modules (water flow, solute transport and crop growth and heat flow, soil heterogeneity) which are influenced each other will be tested. The model will be changed in numerical form as a function of four different parameters of soil, water, plant and irrigation applications.

To simulate model required variables and parameters as follow:

Climate Data (Daly):

Radiation (kJ/m^2) or sunshine (h)

Temperature (maximum and minimum ^{o}C)

Precipitation (mm/day)

Potential evapotranspiration (m/day)

Relative humidity (%) or vapor pressure

Wind speed (m/s)

Soil Properties:

Texture,

Soil moisture characteristic curve

Hydraulic conductivity (cm/day)

Electrical conductivity EC (dS/m)

Albedo

Initial soil moisture conditions or water ponded on soil surface

Crack flow conditions

Effective soil depth,

Soil heat properties

Irrigation Applications (existing):

Irrigation method,

Irrigation dates,

Irrigation water quality analysis (mg/cm^3).

Plant Parameters:

Sowing and germination date, germination ratio

Plant height

Harvesting date

Biomass changes (kg/day)

LAI changes

Potential crop growth degree-day

Photosynthesis and respiration rate (or water use functions)

Crop salinity tolerance coefficient

Root distribution parameters

Main variables to be simulated in this SWAP-2.0 Model as follow:

Components of water budget (including flows through soil profile)

Salinity distribution

Soil heat profiles

Water uptake of roots

Potential and actual transpiration

Potential and actual evaporation

Plant growth situation and yield

Furthermore, using some meteorological observations obtained from chosen various years will be used to estimate the effects of possible climatic changes on plant growth.

After calibration and verification of model, its validation will be done using databases, which are independence from those, used during calibration and verification of model. The beginning values of state variables in the model will be determined as close to approximating values using steady state simulation levels, statistics, statistical methods, literatures, and opinion of specialists when direct measurements can not be done. The modification studies to be done in future will be illuminated by comparing some simulated values with measured values

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