SALT AND WATER MOVEMENTS AS AFFECTED BY DIFFERENT SOIL MOISTURE CONTENTS IN SOME EGYPTIAN SOILS

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1. INTRODUCTION.

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One third of the world's land surface has been classified as arid or semi-arid. The world's total population has increased four times in the past 150 years and may double again in the next 30 years. Easily developed land has already been exploited. Attention, therefore, is increasingly turning to the deteriorated areas to relieve population pressures and to provide more food.

The natural resources of arid and semi-arid regions - particularly soil and water - are limited, and are often in a delicate environmental balance. Arid and semi-arid regions are generally characterized by being salt-affected soils. Saline soils usually occur in areas that receive salts from different resources. Water acts as a pioneer source of soluble salts when used for irrigation, especially in arid regions, the same as in the A.R.E.

Water, as reactant, solvent and transporting agent, plays a decisive role in the development of salt-affected soils. Soil irrigation process is directly or indirectly related to soil water, since the soluble salts move with the water and according to the solid-liquid interface phenomena. The chemical characteristics of the soil solutions govern the ion composition of the soil adsorption complex and properties of solid soil constituents. This influences the rate of hydration and dispersion, swelling-shrinkage phenomena, arrangement of primary particle shape, size and stability of soil micro and macro-aggregates, structural elements, consequently, the pore size distribution, factors of soil moisture regime, spatial and time distribution of moisture content, moisture potential and moisture movement.

Water movement can be considered as the only effective agent by which salts move through the soil. The movement of water, however, is relatively complex because of the various directions and strata in which it moves, and these various forces operate to direct its movement. Thus, salts movement and distribution in the soil are affected by all facters affecting water movement. On the other hand, salts move from the layer of high salt concentration to the layers of low concentration, which explains why the direction of salt movement may be opposite to the direction of moisture flow (diffusion movement). So, the simultaneous transport of salt and water is an important phenomenon, which worthes investigation. Sometimes, soil profile has different layers, so the effect of soil stratification on salt and water movement and distribution must be taken into consideration.

Large area in the north part of the Nile Delta suffers from salinization problem besides the north coast zone in A.R.E. Salt accumulation is governed, to a great extent, by soil properties, location and the climate of the zone which is also affected by water movement.

The aim of this investigation is the study of salt and water movement in some Egyptian soils as affected by different initial soil moisture contents, soil textures and stratification.

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2. REVIEW OF LITERATURE.

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2.1. Movement of soil water.

Several aspects of water movement in soils are important. These include the infiltration of water and saturated and unsaturated flow through the soil. Unsaturated flow is particularly important in terms of water supply to roots. Under some conditions, movement in the form of vapor is of importance, Kramer (1983) . Generally, water in the liquid phase moves under potential gradient effect. Water flow takes place in the direction of decreasing potential, Kramer (1983).

2.1.1. Soil water flow concept.

The theory of moisture transport in soil has been the subject of numbers of review and books, (Childs, 1967; 1969; Klute,1969; Bear,1970; Hillel,1970; Philip, 1970;Baver et al.1972,1976;Hillel,1980,1982). The movement of water in a porous medium such as soil may be analyzed utilizing the continuous medium approach in which, the various relevant physical properties (densities, velocities, ...etc.) are considered to be continuous of position and time.

A. <u>Saturated flow.</u>

Saturated flow in soils occurs when all or most of the pores are completely filled with water. The rate of saturated flow can be stated in two equations. The first equation is the equation of Poiseuille which expresses the flow of water in a narrow tube.

$$Q = \frac{P.\ \pi.\ R^4}{8.\ L.\ Z}\text{, where;}$$

Q = volume of flow, Cm^3/Sec.

P = pressure difference, dyne/Cm^2

R = radius of tube, Cm.

L = length of tube, Cm.

Z = viscosity of liquid , dyne-sec/Cm^2.

This equation shows that the pore size is of outstanding importance as its fourth power is proportional to the rate of saturated flow. This indicates that, saturated flow under,otherwise,identical conditions decreases as the pore size decreases. In fact, flow through deflocculated clay is practically zero. The occurrence of viscosity in Poiseuile equation indicates the effect of temperature on saturated flow. Viscosity of water increases more than one percent with each degree centigrade drop in temperature.

The second equation is the equation of Darcy, (1956) which states that the viscosity of liquid flow through a porous medium is proportional to the force causing the flow, the hydraulic conductivity of the medium , and to the pressure gradient as a driving force as follows.

$$Q = \frac{C.\ K.\ A.\ P.}{L} \quad , \quad \text{where;}$$

Q = flow velocity, L^3/T.

C = dimensionless proportionality constant

K = hydraulic conductivity, $L^3.T/M$

A = cross-sectional area of porous media L^2

P = pressure gradient $M/L.T^2$

L = length of porous media, L.

If the hydraulic head gradient is considered as a driving force, the equation will then become;

$$V = K.i. \quad , \quad \text{where;}$$

V = flow rate, L/T

K = hydraulic conductivity, L/T

i = hydraulic-head gradient ratio.

B. <u>Unsaturated flow</u>.

The rate of unsaturated flow depends on the tension with which the soil water is held, while in saturated flow no air-water interface exists, meniscus formation and change has much to do with the rate of unsaturated flow, Kohnke, (1968). The tighter the water is held by the soil, the slower is the ability of water to move under the influence of a tension gradient.

The water flow equation for unsaturated condition can be written according to Klute, (1973) as follow:-

$$\frac{\partial \phi}{\partial t} = \frac{\partial}{\partial Z} \cdot \left[D(\phi) \frac{\partial \phi}{\partial t} \right] + \frac{K(\phi)}{\partial Z}$$

where;

~~Q = moisture content on volume basis, Cm^3/Cm^3.~~

t = time, day

Z = the depth measured positively downwards, Cm.

$K(\phi)$= Unsaturated hydraulic conductivity

$D(\phi)$= the diffusivity, Cm^2/day.