Principles of Irrigation and Drainage

Definitions of Some Parameters of Hydrological Cycle

Evaporation:

Water is transferred from the surface to the atmosphere through evaporation, the process by which water changes from a liquid to a gas.

Dr. Marwa Abdel Fattah

Condensation:

Condensation is the change of water from its gaseous form (water vapor) into liquid water. Condensation generally occurs in the atmosphere when warm air raises, cools and loses its capacity to hold water vapor. As a result, excess water vapor condenses to form cloud droplets.

The upward motions that generate clouds can be produced by convection in unstable air, convergence associated with cyclones, lifting of air by fronts and lifting over elevated topography such as mountains.

Transportation:

In the hydrologic cycle, transport is *the movement of water through the atmosphere, specifically from over the oceans to over land.*

Some of the earth's moisture transport is visible as clouds, which themselves consist of ice crystals and/or tiny water droplets. Clouds are propelled from one place to another by the jet stream, surface-based circulations like land and sea breezes, or other mechanisms. However, a typical 1 kilometer thick cloud contains only enough water for a millimeter of rainfall, whereas the amount of moisture in the atmosphere is usually 10-50 times greater.

Ground water

Groundwater is all the water that has penetrated the earth's surface and is found in one of two soil layers. The one nearest the surface is the "zone of aeration", where gaps between soil are filled with both air and water. Below this layer is the "zone of saturation", where the gaps are filled with water. The water table is the boundary between these two layers. As the amount

of groundwater water increases or decreases, the water table rises or falls accordingly. When the entire area below the ground is saturated, flooding occurs because all subsequent precipitation is forced to remain on the surface

Transpiration:

Transpiration is the evaporation of water into the atmosphere from the leaves and stems of plants. Plants

Dr. Marwa Abdel Fattah

absorb soil water through their roots and this water can originate from deep in the soil. (For example, corn plants have roots that are 2.5 meters deep, while some desert plants have roots that extend 20 meters into the ground). Plants pump the water up from the soil to deliver nutrients to their leaves. This pumping is driven by the evaporation of water through small pores called "stomata", which are found on the undersides of leaves.

Dr. Marwa Abdel Fattah

Transpiration accounts for approximately 10% of all evaporating water.

Runoff:

Runoff is the movement of surface water to the oceans, chiefly in the form of rivers, lakes, and streams. Runoff consists of precipitation that neither evaporates, transpires nor penetrates the surface to become groundwater. Even the smallest streams are connected to larger rivers that carry billions of gallons of water into oceans worldwide.

Dr. Marwa Abdel Fattah

MATHEMATICAL REPRESENTATION FOR THE HYDROLOGIC CYCLE

The hydrological cycle in a particular area can be studied by dividing this area into sections by watershed divide; each one represents a *Basin*.

The basin is water-independent from the surrounding basins, (no surface or subsurface flow from neighboring basins or vice versa), i.e.; when a fall occurs on a basin area, all the precipitation that occurs

on the basin area takes place in the surface or groundwater flow of the basin or evaporates again.

The area within the basin is called *Basin area*, *Catchment area*, or *Drainage area* and the boundaries of this area are called *Basin border*.

Water cycle can be represented during a certain period of time by using water balance equation (water budget equation) for the basin as following:

$$P - R - G - E - T = \Delta s$$

Where:

P= precipitation.

R= surface runoff.

G= net groundwater flow out of the catchment.

E= evaporation.

T= transpiration.

ΔS= change in storage.

The storage S consists of three components as:

$$S = S_s + S_{sm} + S_g$$

Where:

S_s = surface water storage.

S_{sm} = water in storage as soil moisture.

S_g = water in storage as groundwater.

All terms in this equation have dimensions of volume.

Dr. Marwa Abdel Fattah

For rainfall-runoff relationship this equation can be expressed as:

$$R = P - L$$

Where:

L = losses or water not available to runoff due to infiltration, evaporation, transpiration and surface storage.

The period of time used for water balance equation is called water year (or hydrological year). It is differentiated in counties according to the local water conditions of each country.