**Evaporation**

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1. **Introduction**

A watershed is the area that contributes all the water that passes through a given cross section of a stream on the basis of topography. A watershed is also called drainage basin, river basin, or catchment. The boundary line that delimits a watershed is called a divide. A watershed is treated as a unit for hydrologic investigations as its topographic divide defines hydrologic boundaries that enable water budgets to be computed. The water balance for a given watershed is calculated using the water balance equation for any time period of length t:



Where P is precipitation (liquid and solid), is ground-water inflow (liquid), Q is stream outflow (liquid), ET is evapotranspiration (vapor), is ground-water outflow (liquid), and is the change in all forms of storage (liquid and solid) over the time period.



*Fig. 1 Schematic diagram of a watershed.*

Evaporation is a type of vaporization of a liquid that occurs only on the surface of a liquid. It is an essential part of the water cycle driven by solar energy, which can evaporate water from oceans, lakes, moisture in the soil, and so on. Evaporation of water occurs when the surface of the liquid is exposed, allowing molecules to escape and form water vapor, and then the water vapor can rise up and form clouds.

Related literature:

Dingman, S.L., 2008. Evapotranspiration: Infiltration and Redistribution in Physical Hydrology, pp273~251.

**Question 1**

Evaporation is a common phenomenon in our daily environment. Which factors do influence evaporation, and what is the mechanism? (Hint: keep in mind that the essence of evaporation process is the diffusion of water molecules from high concentration to low concentration).

**Question 2**

Evaporation can be calculated with Fick’s first law, which is shown in the excel file ‘Evaporation’ sheet ‘Fick’s first law. Compare the parameters of the equation with your answers for question 1, are the relationships proportional or inversely proportional?

There are several practices in the excel sheet, you can fill in values and answer the following questions:

*2A*  In sheet ‘Fick’s equation’, we present an equation to calculate KE at a lake surface, which shows that KE is inverse to lake area; why would this be the case?

*2B*  Practice 1 uses a relationship between evaporation and KE. Please calculate E, and plot a graph of E as a function of KE. Make notes on the plot that you made, what is the relationship based on the plot trendline? Will KE greatly influence E? (Hint: check the slope of the trendline)

*2C*  Practice 2 illustrates the relationship between E and wind speed vs, calculate E, and plot a graph of E as a function of vs, what did you get? What is the slope of the trendline?

*2D*  Practice 3 is used to show the relationship between evaporation and vapor pressure. Please calculate E, and plot a graph of E as a function of (es – ea), what did you get? Is pressure difference more important for evaporation than wind speed?

**Question 3**

Evaporation varies for different underlying surfaces. For free water surfaces (for instance, lakes and wetland) evaporation is simplest, we can directly use the equations used in the excel sheet ‘Fick’s first law. Look at the practice in the excel sheet ‘evaporation at water surface’; calculate the value of E with the provided parameters.

**Question 4**

Evaporation for bare soil is quite different than evaporation over a free water surface. Evaporation from a soil surface includes two stages:

1) the atmosphere-controlled stage, in which the evaporation rate is largely determined by the surface condition, which can be determined using the same method as for a free water surface.

2) the soil-controlled stage, in which the evaporation rate is determined by the rate at which water can be conducted to the soil surface in response to potential gradients induced by upward-decreasing soil-water conditions. Generally, the evaporation at this stage is less than the free-water stage. In excel sheet ‘evaporation for bare soil’, we list the equation for bare soil evaporation, please use the equations to answer the questions asked in the worksheet.