CE 3354 Engineering Hydrology
Exercise Set 1

Exercises

1. Using the internet, textbook(s), and the on-line reading collection define the following (in a sentance or two); please cite your references (URL is sufficient):

   (a) Alluvium

   (b) Bankfull Discharge

   (c) Best Management Practice

   (d) Drainage Divide

   (e) Evaporation

   (f) Evapotranspiration

   (g) Precipitation

   (h) Flow Duration Curve

   (i) Flood Frequency Curve

   (j) Watershed

   (k) Catchment

   Solution(s)

   (a) **Alluvium** (from Latin alluvius, from alluere 'to wash against') is loose clay, silt, sand, or gravel that has been deposited by running water in a stream bed, on a floodplain, in an alluvial fan or beach, or in similar settings `https://en.wikipedia.org/wiki/Alluvium`

   (b) **Bankfull Discharge** is the maximum discharge that the channel can convey without overflowing onto the floodplain. `http://www.extranet.vdot.state.va.us/locdes/hydraulic_design/nchrp_rpt544/content/html/WorksCited/Copeland_2001.pdf`

   (c) **Stormwater Best Management Practices** are devices, practices, or methods that are used to manage stormwater runoff by controlling peak runoff rate, improving water quality, and managing runoff volume. `https://spcwater.org/topics/stormwater-management/stormwater-best-management-practices-2/`

   (d) **Drainage Divide**, water divide, ridgeline, watershed boundary, water parting

or height of land is elevated terrain that separates neighboring drainage basins. https://en.wikipedia.org/wiki/Drainage_divide

(e) **Evaporation** is the process that changes liquid water to gaseous water (water vapor). Water moves from the Earth's surface to the atmosphere via evaporation. https://www.usgs.gov/special-topics/water-science-school/science/evaporation-ar

(f) **Evapotranspiration** is the sum of all processes by which water moves from the land surface to the atmosphere via evaporation and transpiration. https://www.usgs.gov/special-topics/water-science-school/science/evapotranspiration-and-wat

(g) **Precipitation** is water released from clouds in the form of rain, freezing rain, sleet, snow, or hail. Precipitation is the main way atmospheric water returns to the surface of the Earth. Most precipitation falls as rain. https://www.usgs.gov/special-topics/water-science-school/science/precipitation-and-water-cycle

(h) **Flow Duration Curve** is a cumulative frequency curve that shows the percent of time specified discharges were equaled or exceeded during a given period. It combines in one curve the flow characteristics of a stream throughout the range of discharge, without regard to the sequence of occurrence. https://pubs.er.usgs.gov/publication/wsp1542A

(i) **Flood Frequency Curve** is used to relate flood discharge values to return periods to provide an estimate of the intensity of a flood event. The discharges are plotted against return periods using either a linear or a logarithmic scale. In order to provide an estimate of return period for a given discharge or vice versa, the observed data is fitted with a theoretical distribution using a cumulative density function (CDF). https://serc.carleton.edu/hydromodules/steps/168500.html

(j) **Watershed** is the land area that channels rainfall and snowmelt to creeks, streams, and rivers, and eventually to outflow points such as reservoirs, bays, and the ocean. https://oceanservice.noaa.gov/facts/watershed.html

(k) **Catchment** is an area where water is collected by the natural landscape. https://www.waternsw.com.au/water-quality/education/learn/catchment

2. Assuming that all water in the oceans is involved in the hydrologic cycle, estimate the average residence time of ocean water. [Problem 1.1.1 in Chow, Maidment, and Mays]

3. Assuming that all surface runoff to the oceans comes from rivers, estimate the average residence time of water in rivers. [Problem 1.1.2 in Chow, Maidment, and Mays]

4. The equation $k\frac{dQ}{dt} + Q(t) = I(t)$ has been used to describe the response of streamflow to a constant rate of precipitation continuing indefinitely on a watershed. For this

problem, let $I(t) = 1$ for $t > 0$ and $Q(t) = 0$ for $t = 0$. Plot values of $I(t)$ and $Q(t)$ over a 10-hour period if $k = 2$. [Problem 1.3.2 in in Chow, Maidment, and Mays][1]

[1] You will need to solve the differential equation

5. Figure **??** is a schematic of a 600-hectare farm; the land receives annual rainfall of 2500 mm. There is a river flowing through the farm land with inflow rate of 5 m^3/s and outflow rate of $4m^3/s$. The annual water storage in the farm land increases by $2.5\times10^6 m^3$. Using the water budget concept, estimate the annual evaporation amount in millimeters.[2]

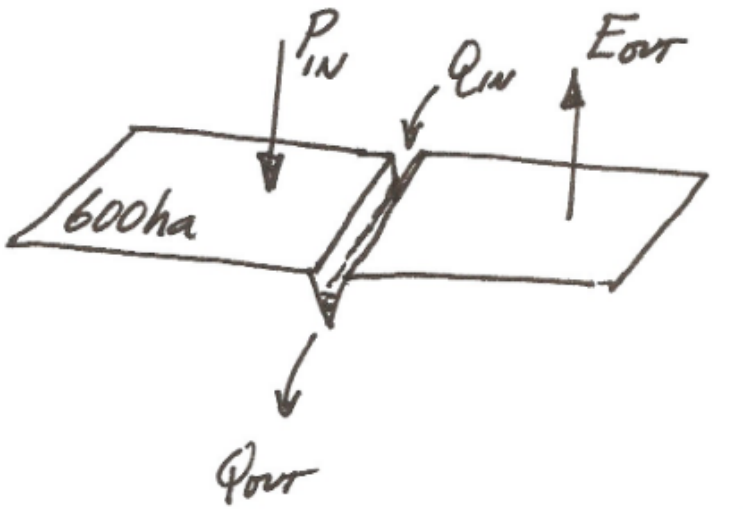

Figure 1: Schematic of Farmland

6. A reservoir has a surface area of 690 acres. Figure **??** shows the monthly inflow of surface water, outflows as releases from the reservoir via the spillway, direct precipitation into the reservoir, and evaporation from the reservoir. The reservoir water surface elevation was 701.0 feet on January 1. Determine the reservoir water surface elevation at the end of each month (i.e. complete the table)

[2] 1 hectare = 10,000 m^2

Lake Woodlands
Average Surface Area = 690 acres

Month	Inflow (acre-feet)	Outflow (acre-feet)	Precipitation (inches)	Precipitation (acre-feet)	Evaporation (inches)	Evaporation (acre-feet)	Storage Net Change (acre-feet)	Elevation Change (feet)	Water Surface Elevation (feet)
December									701.00
January	1732	175	2.75	158.13	1.05	60.38	1654.75	2.40	703.40
February	1755	190	3.05		1.55				
March	872	232	3.76		2.05				
April	955	375	4.11		2.80				
May	708	525	2.70		3.75				
June	312	955	1.05		4.25				
July	102	1720	0.75		5.15				
August	37	2250	1.25		5.76				
September	175	1575	1.55		4.92				
October	575	550	3.79		3.02				
November	1250	175	4.53		1.75				
December	1875	125	5.01		0.60				

Figure 2: Tabular Water Budget Values