205 2: مختبر
"3"

College of Science
Dept.Of Geology
Hydrology Lab.No.3

The Water Balanc and Catchment Manipulation

Background/Data

The data (below) derive from the Wagonwheel Gap Expriment, a classic paired basin study of 75 years ago. These data come from the experimental basin only. The catchment is in the upper Rio Grande vally (between South Fork and Greede) at about 10,000 ft elevation. It has an area of about 200 acres and was studied in the period 1910-1926. In 1910, 25% of it was covered by uncut spruce-fir forest, 61% by aspen, and 14% by grass meadows. In 1919-1920, the forest was cut, all large timber removed and the slash burnt (Sept 1920 for the last). By 1926, aspen regrowth over the catchment had reached 3 ft to 6 ft in height.

Years	Precip(p)	Runoff(Ru)	Years	Precip(p)	Runoff(Ru)
1911	21.5	8.4	1919	21.8	8.6
1912	19.7	5.3	1920	22.5	8.3
1913	21.9	5.6	1921	20.5	8.7
1914	19.8	5.4	1922	23.8	7.2
1915	21.1	4.5	1923	16.8	8.0
1916	22.8	9.9	1924	22.4	5.0
1917	18.8	3.5	1925	18.1	5.1
1918	21.2	6.0			

Years are water years,i.e.October 1-September 30. Precipitation and runoff values for each water year are in inches.

Problems

1) Estimate evapotranspiration (Et) for each year. Assuming there is not change in storage ($\Delta s = 0.0$)., you can estimate Et as the residual difference between precipitation and runoff (i.e. using a water balance model).

We start with the water-balance equation(Dingman Section 2.5.1)

$$P + G_{in} - (Ru + Et + G_{out}) = \Delta s$$

where p is precipitation, G_{in} is groundwater inflow, Ru is stream outflow, Et is evapotranspiration, G_{out} is groundwater outflow, and Δs is the change in storage. Rearranging the math gives us an equation for the evapotranspiration

$$Et = -\Delta s + p + G_{in} - G_{out} - Ru$$

Assuming that the groundwater inflow and outflow are negligible, and there is no change in storage

$$Et = p - Ru$$

Using the preceding equation, evapotranspiration is calculated for each year .

Years	Precip(p) (inches)	Runoff(Ru) (inches)	Evapotranspiration (Et)(inches)
1911	21.5	8.4	
1912	19.7	5.3	
1913	21.9	5.6	
1914	19.8	5.4	
1915	21.1	4.5	
1916	22.8	9.9	
1917	18.8	3.5	
1918	21.2	6	
1919	21.8	8.6	
1920	22.5	8.3	
1921	20.5	8.7	
1922	23.8	7.2	
1923	16.8	8	
1924	22.4	5	
1925	18.1	5.1	

2) Estimate the catchment efficiency for each year (%). In terms of water as a resource available for use, efficiency can be defined as the percentage of precipitation that was converted to runoff.

From the problem statement

$$\text{Eff} = \frac{Ru}{P} \times 100$$

Were Eff is the catchment efficiency. The efficiency for each year is shown in the following table

Years	Precip(p) (inches)	Runoff(Ru) (inches)	Efficiency (%)
1911	21.5	8.4	
1912	19.7	5.3	
1913	21.9	5.6	
1914	19.8	5.4	
1915	21.1	4.5	
1916	22.8	9.9	
1917	18.8	3.5	
1918	21.2	6	
1919	21.8	8.6	
1920	22.5	8.3	
1921	20.5	8.7	
1922	23.8	7.2	
1923	16.8	8	
1924	22.4	5	
1925	18.1	5.1	

3) Graph the changes in precipitation(p), runoff (Ru), evapotranspiration (Et), and efficiency through time. Mark on your graphs the 1919-1920 period when conditions in the basin changed.