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ENVS 691 Laboratory Exercise No. 1

River Discharge and Watershed Characteristics

The relationships among discharge, water yield, drainage basin characteristics and climate was examined for 10 locations in the Western United States. Discharge data was obtained from the National Water Information System (U.S. Geological Survey, 2012). The sites selected spanned a range of latitude from 46°25'18" N on the Yellowstone River at Miles City, MT, to 31°53'40" on Bayou Pierre near Lake End, LA. Most of the sites were located on tributaries of the Mississippi River; one was on a tributary of the Rio Grande/Rio Bravo and one was on a tributary of the Colorado. A summary of the hydrological and climatological characteristics of the 10 locations is given in Table 1.

Climate normals for the 1981-2010 period were obtained from the National Climatic Data Center (2011). Data were obtained from selected weather stations in, or in one case near, the watersheds being examined. Comparisons were made between annual discharge and drainage area, water yield and annual precipitation, and water yield percentage and water deficit (defined as the difference between annual potential evapotranspiration and annual precipitation). Annual potential evapotranspiration was estimated using the procedure of Thornthwaite (1948). The annual precipitation, annual potential evapotranspiration, and percentage water yield data are presented in Table 2.

Figure 1 shows the relationship between drainage area and discharge is logarithmic, i.e. a plot of the logarithm of discharge against the logarithm of drainage results in a straight line. As Galster (2007) points out, this type of relationship is consistent with decades of hydrological theory.

The data presented in Figure 2. support the hypothesis that water yield (m y^{-1}) is positively correlated with annual precipitation (Bukaveckas, 2009). One site is anomalous, however. That site, from the Gunnison River near Gunnison, CO, has high discharge despite a low annual average precipitation amount. The seasonality of river flow may explain the anomaly, given that the river is fed primarily by snowmelt from nearby mountains so that peak flows are in the spring and early summer before high summer and fall temperatures increase evapotranspiration demand.

The data support a inverse correlation between water deficit (the higher the number the greater the deficit) and percentage water yield. In general, higher percentage water yields are found in sites with annual water surpluses. Again, the Gunnison River site is an anomaly, with 94.2% water yield despite an annual water deficit of 20 cm. As before, the seasonality of runoff may explain the anomaly.

REFERENCES

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Table 1. Hydrological and climatological characteristics of 10 selected drainage basins in the western United States.

River	Annual Discharge ($m^3\ y^{-1}$)	Record Length (yr)	Watershed Area (m^2)	Annual precipitation ($cm\ y^{-1}$)	Water Yield ($m\ y^{-1}$)	Water Yield (%)
Bayou Pierre						
Lake End, LA	8.77×10^8	31	2.23×10^9	131	3.94×10^{-1}	30.0%
Cimarron River						
Guthrie, OK	1.03×10^9	74	3.10×10^{10}	78.9	3.31×10^{-2}	4.19%
Gunnison River						
Gunnison, CO	6.66×10^8	101	2.62×10^9	27.0	2.54×10^{-1}	94.2%
Huerfano River,						
Boone, CO	2.84×10^7	32	4.81×10^9	33.1	5.90×10^{-3}	1.78%
Pecos River						
Anton Chico, NM	1.07×10^8	83	2.72×10^9	43.7	3.95×10^{-2}	9.03%
Platte River						
Grand Island, NE	1.41×10^9	70	1.37×10^{11}	51.7	1.03×10^{-2}	1.99%
Prairie Dog Town Fork Red River						
Wayside, TX	2.52×10^7	43	2.41×10^9	51.2	1.05×10^{-2}	2.05%
Red River						
Index, AR	1.15×10^{10}	67	1.09×10^{11}	120	1.06×10^{-1}	8.85%
White River						
Oacoma, SD	5.14×10^8	82	2.55×10^{10}	47.0	2.01×10^{-2}	4.29%
Yellowstone River						
Miles City, MT	1.01×10^{10}	89	1.25×10^{11}	53.1	8.07×10^{-2}	15.2%

Table 1. Hydrological and climatological characteristics of 10 selected drainage basins in the western United States.

River	Weather Station and GHCN Daily ID	Annual precipitation (cm y^{-1})	Annual Potential Evapotranspiration (cm y^{-1})	Water Yield (%)
Bayou Pierre	Red River Research Sta., LA			
Lake End, LA	USC00167738	131	100	30.0%
Cimarron River	Okeene, OK			
Guthrie, OK	USC00346629	78.9	87.1	4.19%
Gunnison River	Gunnison, CO			
Gunnison, CO	USC00053662	27.0	47.2	94.2%
Huerfano River,	Red Wing, CO			
Boone, CO	USC00056977	33.1	46.8	1.78%
Pecos River	Pecos, NM			
Anton Chico, NM	USC00296676	43.7	63.0	9.03%
Platte River	Ogallala, NE			
Grand Island, NE	USC00256200	51.7	66.1	1.99%
Prairie Dog Town Fork Red River	Canyon, TX			
Wayside, TX	USC00411430	51.2	79.3	2.05%
Red River	Paris, TX			
Index, AR	USC00416794	120	101	8.85%
White River	Interior, SD			
Oacoma, SD	USC00394184	47.0	70.5	4.29%
Yellowstone River	Lake Yellowstone, WY			
Miles City, MT	USC00485345	53.1	40.5	15.2%

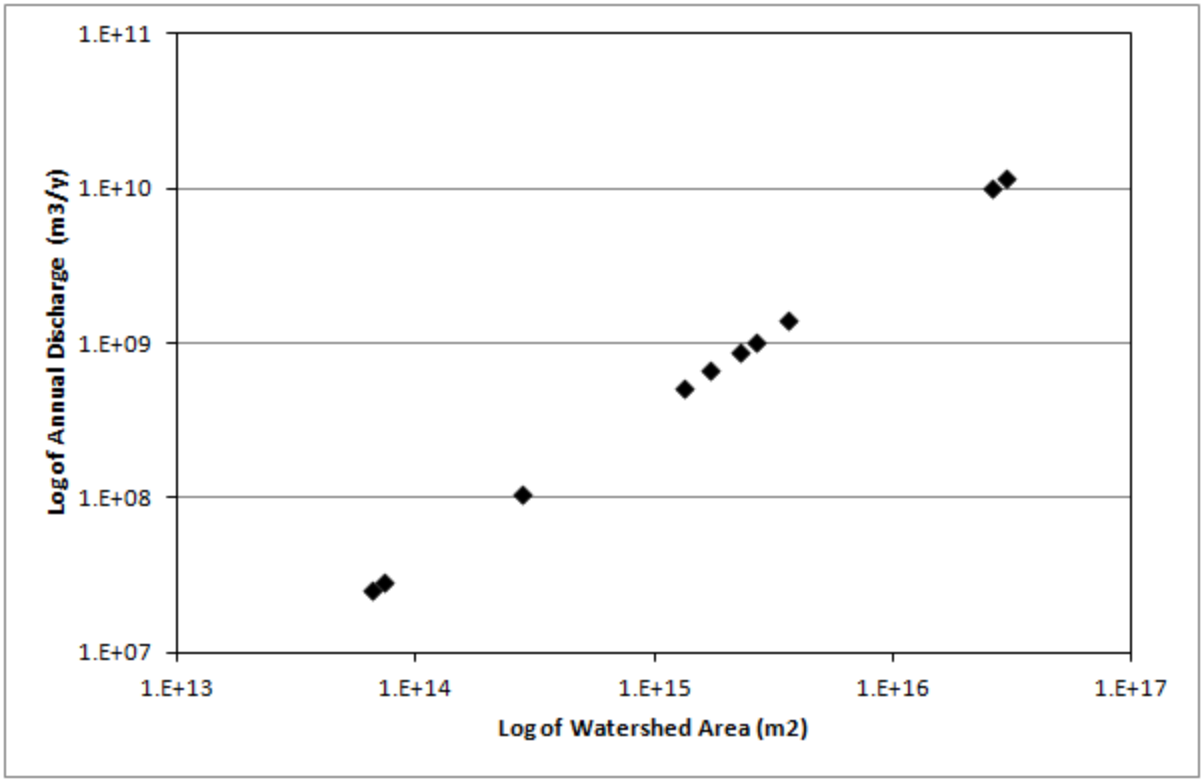

Figure 1. Plot of the logarithm of selected rivers' annual discharge (m^3 y^{-1}) by the logarithm of their respective watershed areas (m^2).

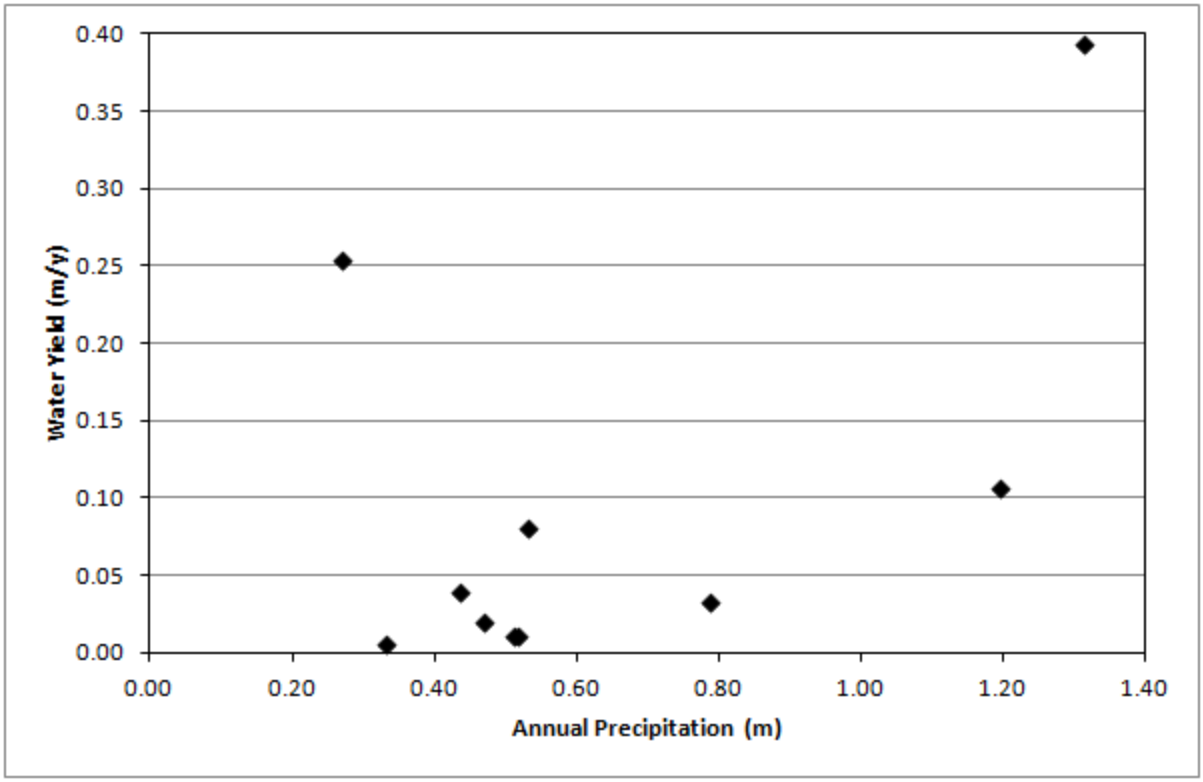

Figure 2. Plot of a watershed's water yield (m y^{-1}) by mean annual precipitation (m).

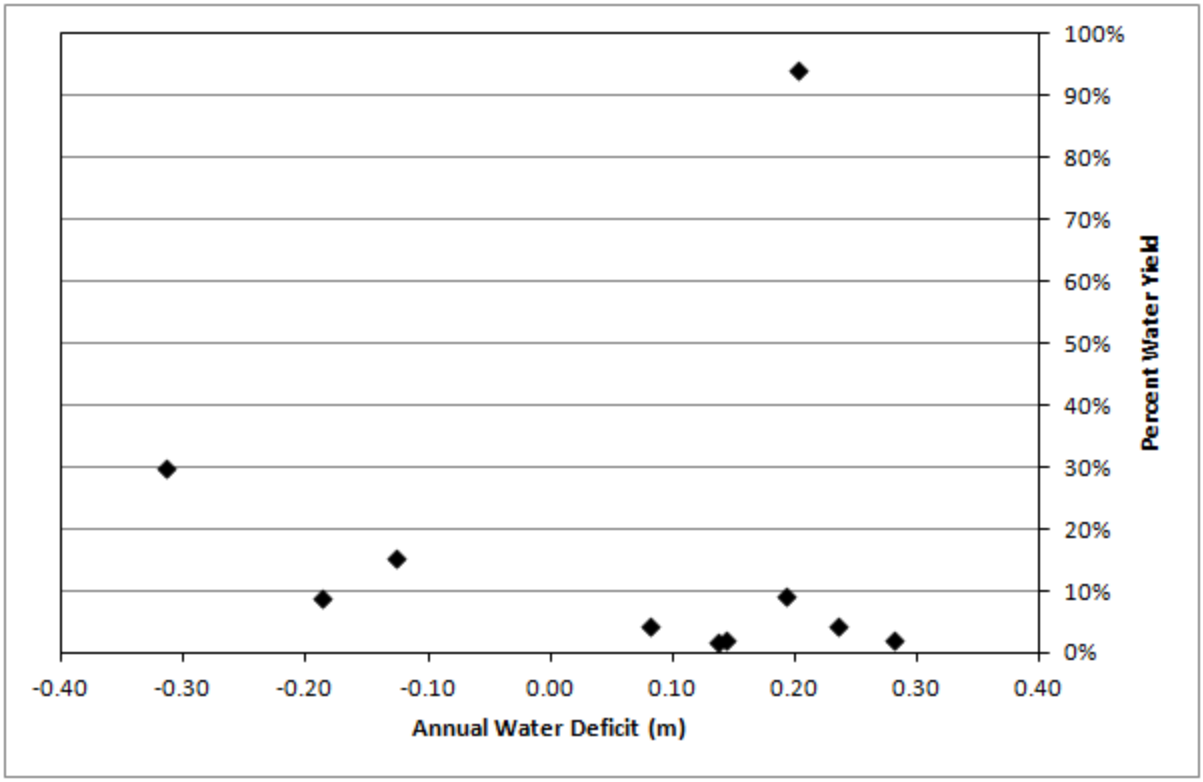

Figure 3. Plot of annual percent water yield by mean annual water deficit (m). A positive water deficit value means higher potential evapotranspiration than precipitation; a negative value means higher precipitation than potential evapotranspiration, i.e., a water surplus.