

Influences Of Human Activities On The Hydrologic Cycle

Some aspects of the hydrologic cycle can be utilized by humans for a direct economic benefit. For example, the potential energy of water elevated above the surface of the oceans can be utilized for the generation of electricity. However, the development of hydroelectric resources generally causes large changes in hydrology. This is especially true of hydroelectric developments in relatively flat terrain, which require the construction of large storage reservoirs to retain seasonal high-water flows, so that electricity can be generated at times that suit the peaks of demand. These extensive storage reservoirs are essentially artificial lakes, sometimes covering enormous areas of tens of thousands of hectares. These types of hydroelectric developments cause great changes in river hydrology, especially by evening out the variations of flow, and sometimes by unpredictable spillage of water at times when the storage capacity of the reservoir is full. Both of these hydrologic influences have significant ecological effects, for example, on the habitat of salmon and other aquatic biota. In one unusual case, a large water spillage from a reservoir in northern Quebec drowned 10,000 caribou that were trapped by the unexpected cascade of water during their migration.

Where the terrain is suitable, hydroelectricity can be generated with relatively little modification to the timing and volumes of water flow. This is called run-of-the-river hydroelectricity, and its hydrologic effects are relatively small. The use of geologically warmed ground water to generate energy also has small hydrological effects, because the water is usually re-injecting back into the aquifer.

Human activities can influence the hydrologic cycle in many other ways. The volumes and timing of river flows can be greatly affected by channeling to decrease the impediments to flow, and by changing the character of the watershed by paving, compacting soils, and altering the nature of the vegetation. Risks of flooding can be increased by speeding the rate at which water is shed from the land, thereby increasing the magnitude of peak flows. Risks of flooding are also increased if erosion of soils from terrestrial parts of the watershed leads to siltation and the development of shallower river channels, which then fill up and spill over during high-flow periods. Massive increases in erosion are often associated with deforestation, especially when natural forests are converted into agriculture.

The quantities of water stored in hydrologic compartments can also be influenced by human activities. An important example of this effect is the mining of groundwater for use in agriculture, industry, or for municipal purposes. The best known case of groundwater mining in North America concerns the enormous Ogallala aquifer of the southwestern United States, which has been drawn down mostly to obtain water for irrigation in agriculture. This aquifer is largely comprised of "fossil water" that was deposited during earlier, wetter climates, although there is some recharge capability through rain-fed groundwater flows from mountain ranges in the watershed of this underground reservoir.

Sometimes industrial activities lead to large emissions of water vapor into the atmosphere, producing a local hydrological influence through the development of low-altitude clouds and fogs. This effect is mostly associated with electric power plants that cool their process water using cooling towers.

A more substantial hydrologic influence on evapotranspiration is associated with large changes in the nature of vegetation over a substantial part of a watershed. This is especially important when mature forests are disturbed, for example, by wildfire, clear-cutting, or conversion into agriculture. Disturbance of forests disrupts the capacity of the landscape to sustain transpiration, because the amount of foliage is reduced. This leads to an increase in streamflow volumes, and sometimes to an increased height of the groundwater table. In general, the increase in streamflow after disturbance of a forest is roughly proportional to the fraction of the total foliage of the watershed that is removed (this is roughly proportional to the fraction of the watershed that is burned, or is clear-cut). The influence on transpiration and streamflow generally lasts until regeneration of the forest restores another canopy with a similar area of foliage, which generally occurs after about 5-10 years of recovery. However, there can be a longer-term change in hydrology if the ecological character of the watershed is changed, as occurs when a forest is converted to agriculture.