Water Balance of Emamzadeh-Jafar Basin South West of Iran

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Abstract

Recent development of Geographic Information System (GIS) makes it possible to capture and manage a vast amount of spatially distributed hydrological parameters. In this paper, a spatially distributed hydrologic model is used to analyze water balance of the Emamzadeh Jafar Basin, Iran. The data used in this study consist of: surface water inflow, groundwater inflow, precipitation, evapotranspiration, groundwater outflow and surface water outflow. The water balance is an accounting of the inputs and outputs of water. The results of water balance show that in some parts of the study area, the amount of the balance is between 1294.01 to -5815.46 m³ per pixel. Because of the lack of rain and overuse of water in some parts of the study area balance is negative. So the study area should be management.

Keywords: Water Balance, Distributed Hydrological Model, Emamzadeh Jafar

1. Introduction

A Geographic Information System (GIS) is a system designed to capture, store, manipulate, analyze, manage, and present all types of geographical data. The acronym GIS is sometimes used for geographical information science or geospatial information studies to refer to the academic discipline or career of working with geographic information systems and is a large domain within the broader academic discipline of Geo informatics (ESRI, 2011). Geographic Information System (GIS) provides representations of these spatial features of the earth, while hydrological modelling is concerned with the flow of water and its constituents over the land surface and in the subsurface environment. With GIS-based distributed hydrological model one can simulate and determine the rate of different hydrological processes such as interception, depression storage, snow melt, runoff, infiltration, water balance and flow and its components that is, surface flow, interflow and groundwater flow (Kabir & Bahremand, 2011).

A water balance is an inventory of water moving through a hydrologic system. They range from simple accountings of surface water transport across specific sites to watershed-scale simulations of hydrologic systems. The purpose of the water balance is to characterize water quantities associated with climate, surface water, groundwater, and net consumptive demand. The water balance was designed to be appropriate for the available data and included the following estimates (WRIA 54 Planning Unit, 2007):

- Average monthly and annual precipitation and temperature
- Average monthly and annual evapotranspiration (the combined loss of water to evaporation and uptake by plants)
- Average monthly and annual stream flow entering and exiting the watershed
- Average annual groundwater flow entering and exiting the watershed
- Annual domestic and non-domestic net demand

Water balance models have been developed at varying de-
degrees of complexity. Water balance models were first developed in the 1940s by Thornthwaite (1948) and Thornthwaite & Mather (1955 and 1957). Water balance models have since been applied to a wide spectrum of hydrological problems (Gabos & Gasparri, 1983; Alley, 1984, 1985 and Vandewiele et al, 1992). Recently, they have been employed to climatic change (Schaake & Liu, 1989; Arnall, 1992 and Xu et al, 1996). They also have been utilized for long range stream flow forecasting (Alley, 1985).

2. Material and Methods

2.1. Study Area

The study area is located in the South-West of Iran. The mean annual precipitations are recorded as 291.3 mm. Figure 1 shows the study area of Emamzadeh Jafar watershed which is located at 30° 28' to 30° 15' N latitude and 51° 9' to 52° 30' E longitude.

2.2. Water Balance Methodology

The water balance estimates the quantity of water entering through various pathways. Components of the water balance were evaluated using monthly averages when available data allowed, and the monthly averages were totalled to estimate annual averages. The overall water balance is presented on an annual basis. For a water balance analysis, basins are grouped into two categories: those that contain the headwaters of the primary drainage and those that do not. Precipitation is the main hydrologic input for basins that contains the primary drainage headwaters. A minor amount of water is also imported into the watershed via potable water and wastewater systems. The Total Basin Inputs can therefore, be represented by the following:

Total Basin Inputs = SWI + GWI + PPT

where:
SWI = Surface Water Inflow
GWI = Groundwater Inflow
PPT = Precipitation

The quantity of water exiting the watershed was assumed to consist of the following components:

Total Basin Outputs = ET + ND + GWO + SWO + DW

where:
ET = Evapotranspiration
GWO = Groundwater Outflow
SWO = Surface Water Outflow

In a basin where there is no change in storage over the time period of the analysis, total basin inputs equal total basin outputs.

3. Results

3.1. Surface Water

Surface water inflow and outflow estimate by analysis of stream flow data from available stream gauges and dam sites. In the study area, there is not surface water. So surface water inflow and outflow is zero.

3.2. Groundwater

Groundwater outflow consists of discharge from wells, drinking, industrial and agriculture. Groundwater inflow is shown in following (Figures 2-4):

3.3. Penetration by Precipitation and Runoff

The mean annual precipitations are recorded as 291.30 mm as shown in Figures 5-6.

3.4. Evapotranspiration

Due to the absence of permanent rivers in the region, evapotranspiration rate is zero.
3.5. Water Balance

The water balance is an accounting of the inputs and outputs of water. The water balance of a place, whether it be an agricultural field, watershed, or continent, can be determined by calculating the input, output, and storage changes of water at the Earth's surface. The major input of water is from precipitation and output is evapotranspiration. The input and output maps are given in Figures 7-8.

4. Discussion

With GIS-based distributed hydrological model one can simulate and determine the rate of different hydrological processes such as interception, depression storage, snow melt, runoff, infiltration, water balance, and flow and its components that is, surface flow, interflow and groundwater flow. Water Balance is between -5815.46 m$^3$ per pixel. Because of the lack of rain and overuse of water in some parts of the study area balance is negative. So the study area should be management.

5. Conclusion

The results show that in some parts of the study area, the amount of the balance is negative and in some parts of the study area, the amount of the balance is positive. Because
of the lack of rain and overuse of water in some parts of the study area balance is negative.

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References


