DISCUSSION PAPER:

Usefulness of existing hydrologic data

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Abstract

Streamflow gauging in Ghana has been limited to large catchments. However in order to meet the current national goal of supplying rural communities with clean, safe, and acceptable domestic water supply, surface water as well as ground water resources need to be exploited. Thus there is the need for estimating run-off yield from small rural catchments. This paper has explored the appropriateness of extrapolating available hydrologic data for large catchments to estimate streamflow for small catchments. The Pra river basin in south-western part of Ghana was studied. Measured streamflow data from nine rivers in the basin was used to develop regression relations for estimating water yield for ungauged catchments. Limits for extrapolating existing streamflow measurements on large catchments to obtain streamflows for small drainage basins were given. A recommendation was made for initiating a nationwide scheme for gauging runoff from small rural catchments. This scheme will involve extensive data collection and parameter estimation for small rural catchments. The database developed will be vital for rural planning and water resources development.

Introduction

Recently great interest has been shown by the Government of Ghana and foreign agencies in rural water development. Current efforts in rural water development in Ghana have been centered almost exclusively on tapping groundwater resources by drilling of wells since well water requires very little treatment. Groundwater development alone cannot be used to sustain the government's rural water supply scheme since groundwater potential in many parts of Ghana is limited (Buxton-Tetteh, 1990). For the rural water development programme to suceed, it is necesssary that appropriate technology be adopted to integrate surface water as well as groundwater into the scheme.

Planning, design and development of the proposed scheme must be based on streamflow data for small rural catchments. Data on such catchments are almost non-existent in Ghana. Therefore, statistical methods could be applied to existing hydrologic data to generate the required information. There is the need to examine the usefulness of the available hydrologic data for rural water supply planning. The objective of this paper is to examine the appropriateness of extrapolating the existing hydrologic data for relatively large catchments to make reliable estimates of streamflow data for small rural catchments. The Pra river basin was used in the investigation.

Pra river basin

The Pra river basin has drainage area of 23,100 km^2. It is located in southwestern part of Ghana. The basin has an average annual rainfall of approximately 1525 mm and it is drained by the Pra river and its four tributaries namely, Offin, Oda, Anum and Birim rivers. The basin is underlain by Precambrian rocks and is covered by semi-deciduous type of vegetarian (Boateng, 1970) and (Disckson and Benneh, 1977). The Pra river basin is endowed with forest products and the mineral wealth of Ghana. Farming, logging and mining are the major commercial activities in the basin.

Analysis procedure

Nine subbasins in the Pra river basin ranging in size from 1,515 km^2 to 22,818 km^2 and two test basins of sizes 378 km^2 and 2,189 km^2 were used in the investigation. The selected period of analysis was the 1957/58 to 1980/81 water year.

The flow duration curve technique was applied to two data sets comprising the minimum and the mean annual discharges respectively. The first data set was formed by selecting the minimum monthly flow, Q(i), in each year and the second data set consisted of the mean annual flow for each of the N years of record at a particular gauge station. Each data set was ranked from the highest (i=1) to the lowest (i=N). The excedance probability P(i) was calculated using the relation $P(i)=(i-0.44)/N + 0.12$) and the plotting position, denoted by $Tr(i)=1/P(i)$. The volumes of flow corresponding to 2, 5, 10, 20, 30 and 50-year return periods were read from the flow duration curves for each gauge station. Linear regression technique was used to plot all flows of a particular return period against the corresponding drainage areas.

Discussion of results and recommendations

The regression equations developed for relating the minimum water yields and mean annual flow to the drainage area were tested on two subcatchments in the Pra river basin, namely, the Obuo and Anum catchments with drainage areas of 378 km^2 and 2,189 kn^2 respectively. The results showed that the existing hydrologic data for the Pra river basin cannot yield reliable streamflow values if applied to catchments of area less than 1,000 km^2. It is therefore recommended that a nationwide scheme for gauging small rural catchments be initiated to generate a comprehensive database for rural planning and water resources development.