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Regional generalization of flood characteristics in Karun River basin

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Abstract The Karun River, which flows from the Zagros mountains to the Persian Gulf with an average annual flow of 24 km^3 at Ahwaz, was studied. In the Karun River Basin, streamflow data from several locations and for various lengths of time have been collected. A widely used method for generalizing flood characteristics is to prepare a regional frequency curve. In addition, the flood of any specified return period is estimated by multiple-regression based basin characteristics such as the size of catchment, precipitation, channel slope, shape factor, drainage density, etc. As a result, several models are presented for estimating design floods, and some aspects were proposed for further investigations.

INTRODUCTION

Frequency studies are essentially an application of the theories of probability and are based on available records of flood experiences. Several methods of analysis, based on the mathematics of probabilities, have been proposed which, when applied to the same series of data, yield frequency curves which are in reasonable agreement throughout a useful range of probabilities. A widely used method for generalizing flood characteristics is to prepare a regional frequency curve in which discharge is expressed as a factor times the mean annual flood, or the median annual flood.

KARUN RIVER DRAINAGE BASIN

The Karun River with an drainage area of 58 100 km^2 at Ahwaz is the largest river in Khuzestan and discharges into the Persian Gulf. The Karun River begins high in the Zagros Mountains 75 km southwest of Isfahan and flows in a general westerly direction through a descending series of anticlinal ridges and synclinal valleys before emerging on to the Khuzestan Plain at Gotvand, 400 km downstream. The drainage area above Gotvand is 31 400 km^2 and ranges in elevation from 100 to 3500 m. The estimated long-term average annual runoff rate of the drainage area above Gotvand is 410 $m^3\ s^{-1}$.

The Dez River is the only major tributary downstream from Gotvand, and it contributes about 230 $m^3\ s^{-1}$. This river has been regulated by the Dez Reservoir since 1963 and the Dez Irrigation Project diverts a portion of its regulated flow.

The headwaters of the Karun River are located in very high mountain terrain, almost unpopulated, where agriculture is seldom practical. Its main upstream tributaries are the Khersan, the Vanak and the Bazuft. The Karun River passes near the city of Ahwaz, the principal inland city of the Khuzestan plain, and then continues southward for 185 km to discharge into the Arvand-rud at Khoramshahr. Figure 1 shows the location of the Karun drainage area.

THE CLIMATE OF THE REGION

The study area is spread over three climatic zones: a high mountain zone containing the

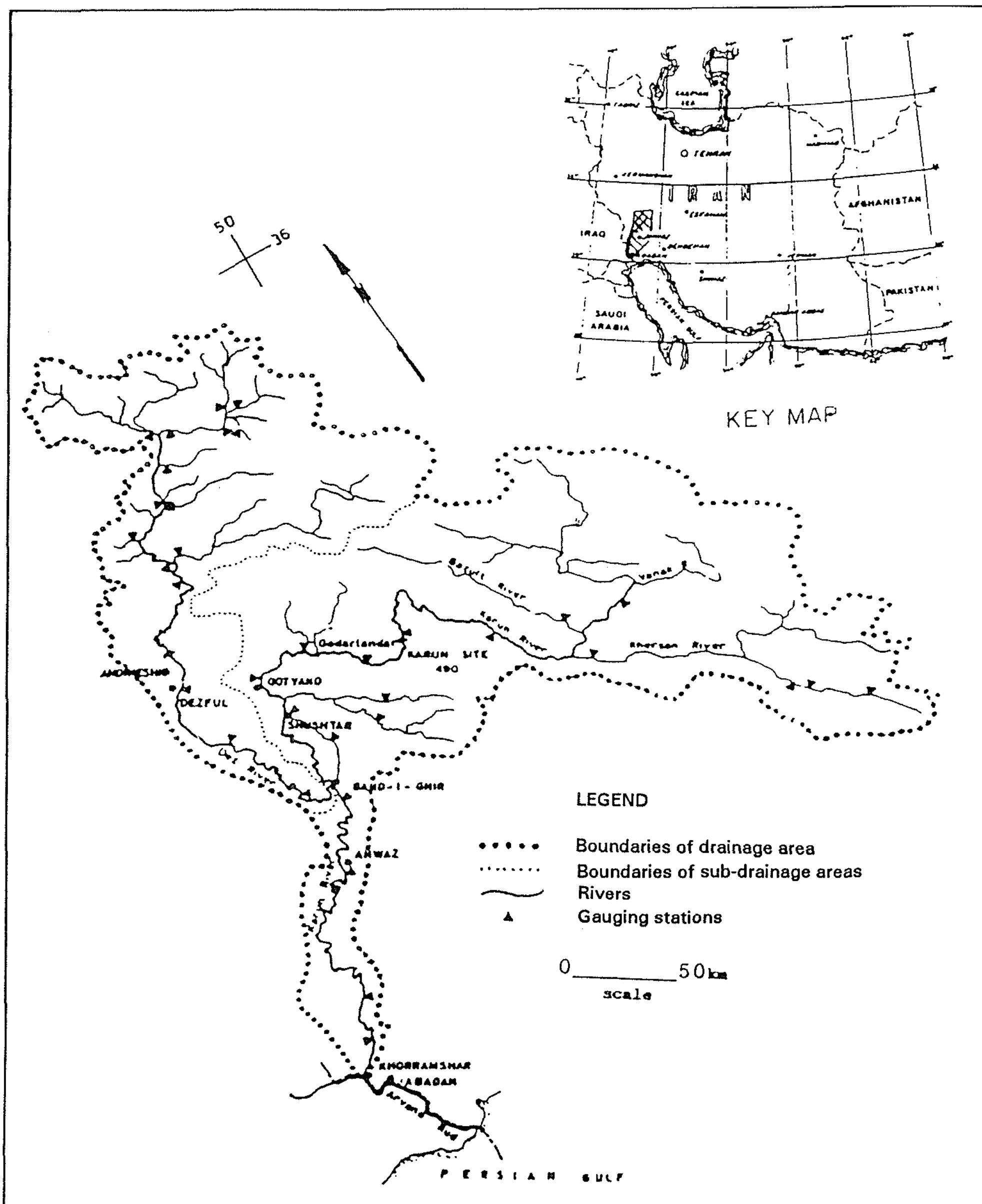

Fig. 1 Karun River drainage basin.

dam site and reservoir basin, a foothill and inland desert zone containing the irrigation areas recommended for development, and a coastal desert zone containing the downstream water use areas which require regulation for existing uses. Climatic data for the high mountain zone (Isfahan to Gotvand) are scarce, due to the inaccessibility of the area. But comparative data from stations outside the zone give indications of the climatic characteristics of this zone. This zone receives snow each year on those portions of the basin above 2500 m in elevation.

The climate of the region varies from an extremely hot, dry summer accompanied by air temperatures as high as 54°C to mild winter with sub-zero temperatures for most areas of the region. Total annual precipitation, occurring mainly in the winter months (November through April or May) ranges from 150 mm in the plain to 1200 mm in the high mountains in a normal year.

THE PROCEDURE

The procedure for completing a regional flood frequency analysis for the Karun River basin is as follows:

(a) Flood data from 35 gauging stations and for various time periods have been collected, with 1958-1986 generally the longest period of record.
(b) The missing data for the corresponding years have been generated through correlation.
(c) The six distributions: lognormal, three-parameter lognormal, two-parameter gamma, Pearson type III and Gumbel were fitted by the programs. A detailed study was carried out of the lognormal distribution and it has fitted our data well.
(d) For each station estimation of floods of return periods $T = 2, 5, 10, 25, 50$ and 100 years were obtained from a lognormal distribution.
(e) In order to define a homogenous region the Langbein test has been applied.
(f) The analysis provided two curves: variations in the ratio of Q_T to Q_2 versus recurrence interval (Fig. 2) and variation of the mean annual flood with the drainage size (Fig. 3).

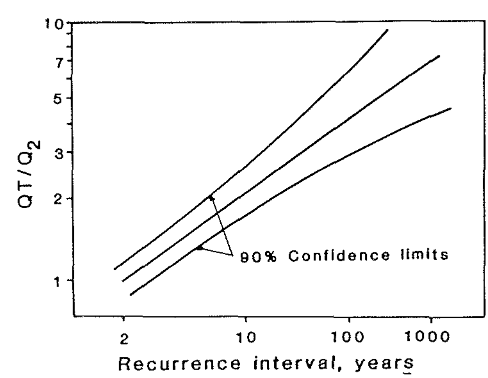

Fig. 2 Karun regional flood frequency curve.

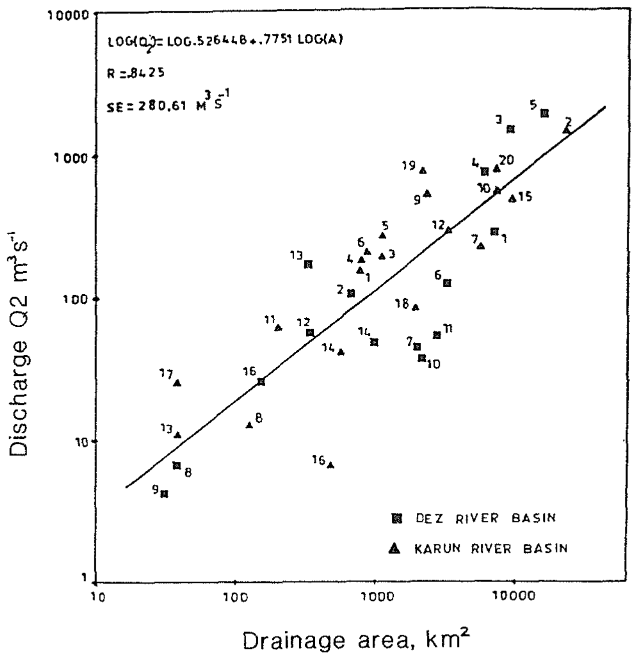

Fig. 3 Variation of the mean annual flood with the drainage basin size.

Regional generalization of flood characteristics

The flood of a specified return period is estimated by multiple regression from basin characteristics such as size of catchment, annual precipitation, shape factor, drainage density etc. Among these parameters, the size of drainage basin is the most important and available factor. As a result, several models are presented for the estimation of design floods. The relationship developed for Karun River basin is:

$$Q_T = KA^a P^b C^c S^d E^e D^f \tag{1}$$

where:

Q_T = T-years annual maximum discharge;
A = drainage area;
P = annual precipitation;
C = main channel slope;
S = shape factor;
E = elevation of gauging station; and
D = drainage density.

Many variables were tested. Two variables P and A in the above equation had an essential effect. For example, a 3-dimensional data distribution for a 100-year flood correlated to P and A is presented in Fig. 4.

CONCLUSIONS AND DISCUSSION

It has been observed that empirical equations are used for estimation of hydrological

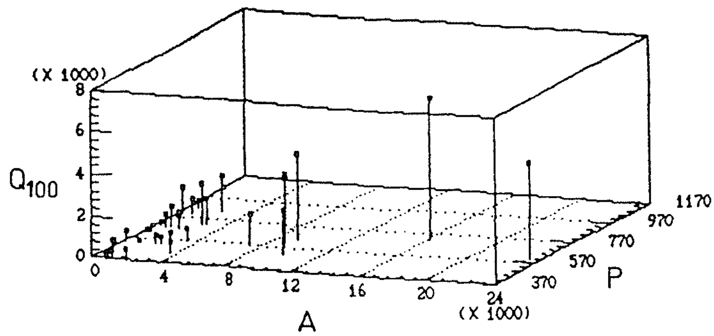

Fig. 4 Plot of Q_{100} versus drainage area (A) and annual precipitation (P).

parameters on basins which lack gauged records. Based on some estimates, this method is believed to be uncertain. Therefore, in order to estimate hydrological data on basins with no observed data, regional analysis may be used to some degree of certainty for a certain return period. Of course in practice all the effective factors cannot be incorporated into the model, and cannot influence model results.

Since flood runoff is rapid, there are problems of adequately recording data due to the sparsity of data provision in the country. To some extent, the flood records can be uncertain and it is necessary to evaluate these data, in order to determine their degree of certainty.

The following recommendations can be made to extend the study in this region.

(a) evaluation of regional floods based on small and large basins;
(b) evaluation of the correlation residue with the purpose of finding the effect of other parameters on geographical and geological maps;
(c) including adjacent basins in the regional flood analysis;
(d) providing an isohyetal map of maximum 24-h rainfall and incorporating this into a regional flood analysis; and
(e) increasing the number of gauging stations.

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