International Seminar on Hydrology of Extremes

1-3 December, 1988
Roorkee (India)

# FLOOD IN ARID ZONE—A CASE OF IRAN

Abdolah Koshan Manouchehr Mahjoub Taghi Mashayekhi

Tehran Regional Water Board, Tehran (Iran)

**SYNOPSIS**

The aim of this paper is to establish a relationship between the peak annual floods and the related drainage area in arid zones similar to those in Iran. To achieve the aim the hydrological characteristics of Iranian plateau are described and about 90 river gaging stations throughout Iran, 1645000 square kilometers, are chosen and their peak annual flood data are analysed. Results of this study are summurized in Figure 3.

## INTRODUCTION:

We start the introduction with Langbien's statements[1]: Floods have been many things to many people . To Noah and his people the Deluge was a manifestation of a wrathful God. To the Pharahos 16 "ells" on the Nile gage meant Wafa- a period of abundance, a contended people, and above all a freedom to tax without fear of unrest. To the people of Far East floods have made plains and deltas on which to subsist in spite of a life-long threat of death by drowning. To hydrologists floods mean

the immediate translation of measurements of rain, snow, wind, and ground conditions into forcasts of river gages. To statisticians they mean a series of events among which they look in vain for the alchemy of cyclic variations.

This paper attempts to evaluate flood peak in arid zones, the regions similar to Iran that are faced with shortage of water but about 60 percent of rivers' annual yeild is in the form of flood. There are several definitions of aridity in the literature.McMahon [2] defined the zone that includes all regions with mean annual precipitation of less than 500 mm and mean annual potential evapotranspiration of greater than 800 mm. By that definition, as Figure one [2] shows, whole Middle East including Iran may be considered an arid zone.The margin which is between the Caspian sea and north side of the Alborz ranges with mean annual precipitation more than 1000 mm is an exceptional region. Walton [3] defined the arid and semi-arid zones as regions whose rainfall will not support regular rainfed farming.This defination encompasses all the seasonally hot arid and semi-arid zones classified by means of rainfall, - temperature and evaporation indices. Considering the latter definition,the southeastern part of Iran is typical example of arid regions.

## PHYSIOGRAPHY AND SOURCE OF MOISTURE

The plateau of Iran is generally above the altitude of 1000 meters with two distinct high rugged ranges of mountains the Alborz and Zagross run respectively from northwest to east along the Caspian Sea and from northwest to southeast.Centeral

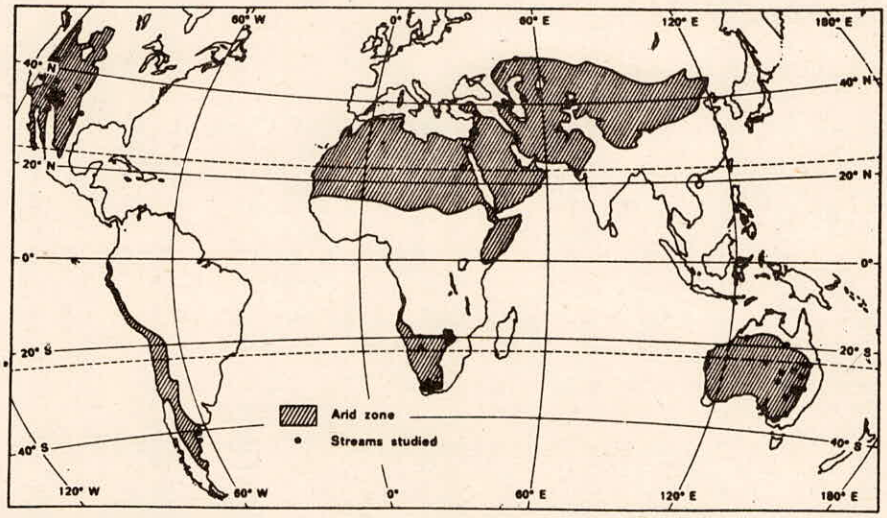


FIGURE 1. The arid zones.

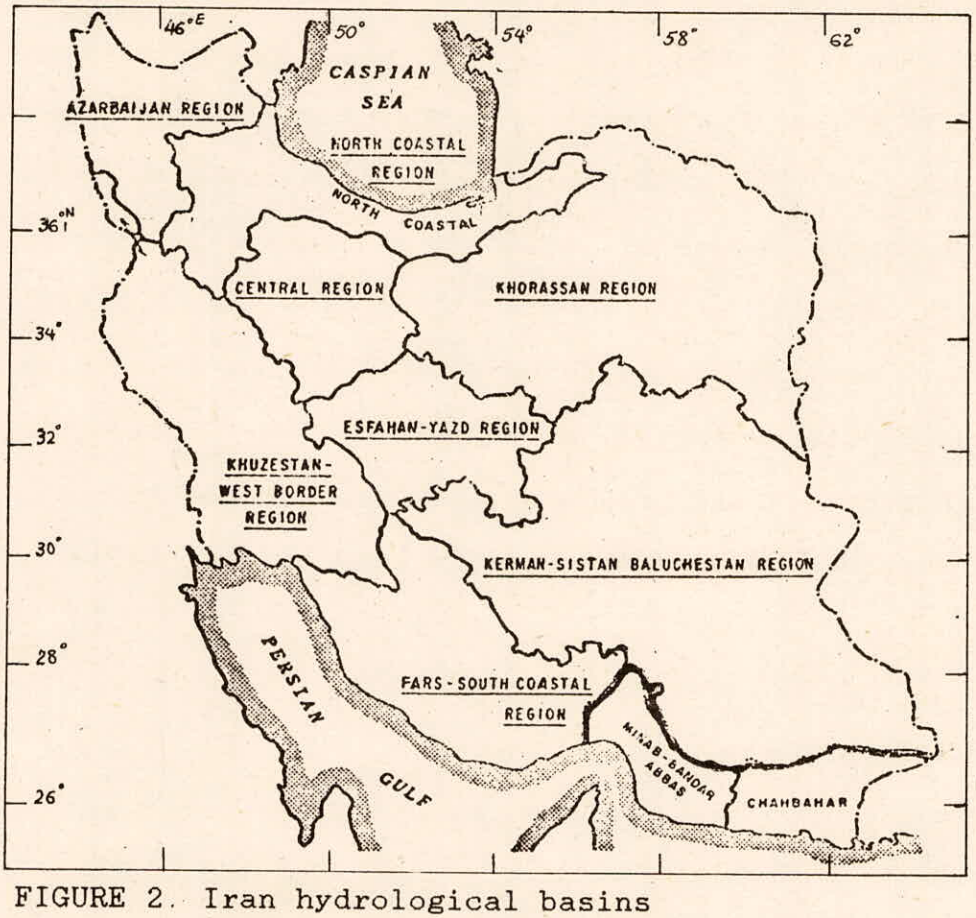


FIGURE 2. Iran hydrological basins

Iran is relatively lower than the rest of the plateau and is mostly desert.These physical features associated with the general directions of wind movement have divided Iran into three major basins, i.e. the Caspian, the Centeral and the Persian Gulf-Oman Sea basins.Of the above basins,the Caspian Sea basin is directly exposed to moisture moving inland from the Sea.The high range of the Alborz mountains prevents most of the Caspian Sea moistures from moving into the Iran plateau,thus creating a very humid region,distinctly different from the rest of Iran plateau. In spite of the relatively large amount of precipitation, the occurence of very severe storms is not very common in this region. Moisture from the Persian Gulf and Oman Sea has some influence on precipitation in southern Iran.However, the general direction of the wind prevents them from coming far inland.Occurrence of sever storms,however,is common in this region. The widespread Centeral basin which is farther away from the source of moisture is located in the general direction of moist wind blowing inland from the Mediterranean Sea. Storm centers are believed to move to the Iran plateau - from the Mediterranean Sea after passing over Syria, Iraq and the high range of Zagross mountains.The distance from the source of moisture reduces the possibility of very sever storms in Iran.

PRECIPITATION

Precipitation in Iran is a result of Mediterranean depressions which governs the weather patterns of the country throughout the winter and spring seasons.During their passage,these depressions cause rain at low altitude and snow at high eleva-

tions. Occasionally, however, these Mediterranean cyclons fail and, following such winter, Iran is faced with severe drought.

In the spring, unstable air masses produce a considerable amount of precipitation over much of the country, in the form of locally scattered convection storms. This is particularly true of the mountains areas of the northeastern and western parts of the country.

Summer is dry everywhere,except along the Caspian littoral. There is practically no rain in the interior deserts and lowlands, but areas along the higher peripherals may experience occasional local showers. The southeast of Iran, especilly the southeastern mountains, are occasionally subjected to Indian monsoonal influence with some summer rain.

Autumn is the transitional season between dry summer and - the wet winter. Mediterranean depressions begin to make themselves felt by mid-autumn and rains start in many parts of Iran in October. In this season the Caspian littoral receives its maximum seasonal precipitation.

In addition,precipitation in Iran varies considerably with time, both during the rainy season and from year to year.Precipitation frequently departs widely from the mean from year to year, and a several year period of greater than mean precipitation can be followed by a period of several years of less than mean precipitation.

Average annual precipitation in Iran is about 220 mm. The averages vary from less than 10 mm in desert interior to more than 1700 mm in th southwestern Caspian region. The mountain - areas of Iran are chracterized by cold winters, mild summers -

and a short rainy season. Winters in the higher mountains are severe and often long,exceeding six months and extendindg into the late spring months . Many of the higher peaks are crowned with snow until late in the summer. Mean annual precipitation and coefficient of variation for selected stations are listed in Table 1. Seasonal variation of high intensity rainfall in the three major basins is given in Table 2.

Table 1-Location and mean annual precipitation of selected rain gages

| Station | Latitude | Logitude | Altitude | Mean annual prec. (mm) | Coef.of var.(%) |
|---|---|---|---|---|---|
| Rasht | 37-15 | 49-36 | -7 | 1270 | 17 |
| Gorgan | 36-51 | 54-16 | 130 | 638 | 47 |
| Bakhtran | 34-16 | 47-07 | 1320 | 450 | 34 |
| Uromieh | 37-32 | 45-05 | 1310 | 364 | 26 |
| Shiraz | 29-32 | 52-35 | 1490 | 333 | 34 |
| Tabriz | 38-05 | 46-17 | 1360 | 272 | 37 |
| Mashad | 36-16 | 59-38 | 980 | 228 | 28 |
| Tehran | 35-41 | 51-21 | 1190 | 223 | 35 |
| Ahvaz | 31-20 | 48-40 | 20 | 216 | 33 |
| Kerman | 30-15 | 56-58 | 1750 | 166 | 41 |
| Bandar-Abas | 27-13 | 56-22 | 10 | 131 | 60 |
| Esfehan | 32-37 | 51-40 | 1590 | 110 | 52 |
| Zahedan | 29-28 | 60-53 | 1370 | 105 | 45 |
| Zabol | 31-20 | 61-29 | 490 | 59 | 47 |
| Yazd | 31-54 | 54-24 | 1230 | 56 | 48 |

Table 2-Occurrence frequency of high intensity rainfall(percent)

| Basin | Autumn | Winter | Spring | Summer |
|---|---|---|---|---|
| Northen | 50 | 20 | 15 | 25 |
| Central | 45 | 2 | 50 | 3 |
| Southern | 5 | 75 | 15 | 5 |

FLOOD

Severe floods in Iran are the results of high intensity rainfall rather than snowmelt . The flood season is usually from

late winter to mid-spring. A good portion of arid zone on the earth belongs to the less developed counteries ; in which the accuracy of streamflow records is somewhat questionable, especially for peak discharges of the early years of river gaging . The remoteness of gage locations, poor conditions of access roads, insufficient technical personnel and shortage of equipment are the main causes of relatively poor,but improving data. Considering all of the above points, 90 river gaging stations in Iran with more than 8 years of record,were selected and their annual flood are estimated for several return periods by means of different methods.Specific discharge (litre per second per square kilometer) of mean annual floods are plotted, in Figure 3, versus the drainage areas. On the other hand, the ratio of peak floods with different return periods to the mean annual flood are listed in Table 3. Hence one can find the peak flood for a given drainage area and several return periods using Figure 3 and Table 3. Since the Persian Gulf-Oman Sea basin is influenced by different sources of moisture and consequently different forms of precipitation ,it has been divided into three subbasins i.e. southwestern, southern, and southeastern which are indicated by I, II,III respectively.

Table 3-Ratio of annual flood to mean annual flood

| Basin | $Q10/\bar{Q}$ | $Q100/\bar{Q}$ | $Q1000/\bar{Q}$ | $Q10000/\bar{Q}$ |
|---|---|---|---|---|
| Northen | 2.3 | 4.8 | 8.0 | 12.4 |
| Central | 2.3 | 5.0 | 9.0 | 15.2 |
| Southwestern | 2.5 | 5.4 | 9.3 | 14.9 |
| Southern | 2.7 | 5.8 | 10.4 | 17.2 |
| Southeastern | 2.6 | 4.7 | 6.8 | 8.5 |

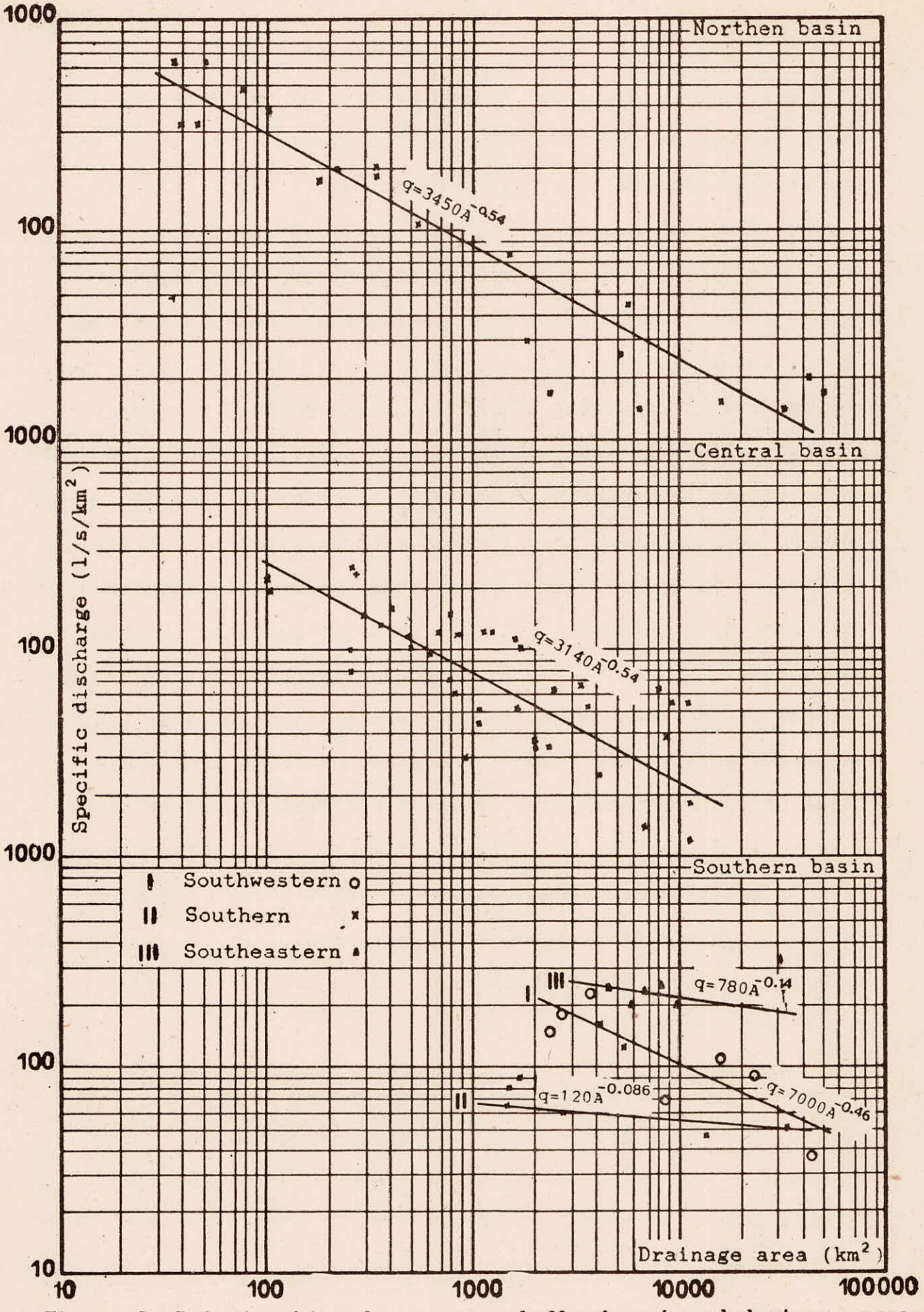


Figure 3: Relationship of mean annual flood peak and drainage area

CONCLUSION AND RECOMMENDATIONS:

-The drier the regions the higher coefficient of variation for annual precipitation.

-For drier regions the specific discharge is higher.

-Hydrological characteristics based on humid region data - should not be extrapolated to arid zones.

-Because of sporadic rainfall and inadequate data in arid regions more importance should be attached to data collection.

REFERENCES:

1. Langbein Walter B. and William G. Hoyt,(1955),"Floods", Princeton University Press,Princeton, New Jersey,USA.

2. McMahon T.A.,(1979),"Hydrological chracteristics of arid zones", Monash university,Clayton,Victoria,Australia.

3. FAO,(1981),No.37 "Arid zone hydrology".

4. Bureau of water planning,(1978 & 1988),"National water plan", Ministry of Energy ,Tehran,Iran.