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Full Length Article

Flood Management via Zoning Extreme Rainfalls In Sistan and Baluchistan, I.R. of IRAN

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ABSTRACT
Rainfall is one of the most important climatic phenomena. Knowing the spatial distribution of precipitation has a clear role in environmental planning, water resources management and flood risks. Using GIS software, statistical data and daily rainfall during a period of 20 years from 1992 to 2012, reported by the stations of synoptic, climatology and rain gauge of Sistan & Baluchistan province, this research studied the numbers of 24 hour rainfall occurrences in the extreme thresholds of 20, 30, 50 mm and maximum rainfall in 24 hours occurred at the sestations. Then, the zoning maps of each part of the thresholds were extracted. Checking zoning maps showed the greatest impact of the various extreme precipitations is in southern coastal part of the province. Finally, according to the results of zoning and environmental conditions of the area, some practical flood management strategies have been suggested.
Keywords: extreme rainfall, geographical information system, Sistan and Baluchistan.

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INTRODUCTION

The extreme chimerical events are phenomena with very scarce frequency but high degree of intensity. During their occurrence, they bring about major changes in the normal conditions of the ecosystem and its inhabitants. The possible occurrence of these events is estimated to be an average of less than 5% [7]. So many phenomena related to rainfall have happened in the world and have caused environmental hazards and abundant human and financial losses. Flood is the movement of water that takes along whatever is on its way. Major flood damage include destruction of bridges, roads, agricultural land, wells , canals and dams , degradation of residential homes , propagation of vectors (malaria), water pollution, loss of crops and livestock (malnutrition) and damage to health and communication places. Losses of flood occur when water covers the land and puts it under pressure. Flood may displace water or sewage pipes. *Lano and Borgino* (2000), used the spectral analysis to determine the unusual rainfall pattern of Barcelona for the monthly precipitation in 128 years. *Livada* and et al [3] using data from 110 rain gauge stations in period between 40 and 50 years studied spatial and temporal characteristics of precipitation in Greece. In Iran, *Taghavi* and et al [6] made use of spectral and clustering analyses as well as climatic indicators of the maximum rainfall of 24 hours per month, monthly minimum and maximum during the period of 1986 to 2005 for 65 synoptic stations to do climate zoning. *Razieeand Azizi*[5] ,using principal components analysis and clustering methods classified rainfall regime in the west of Iran. *Sistan and Baluchistan*, a province in the south easternmost of Iran, is located in the latitudes of 25 to 31 degrees north and longitudes of 57 to 63 degrees east. Due to its proximity to the Tropic of Cancer and the Equator and locating in an area where the Indian Ocean summer monsoon influences it from both east and south, the influence of *Siberian* high tabs through the northern side and the waves of western winds, this province is facing with intense weather events such as extreme rainfalls. *Sistan* area of 8117 square kilometers is located in the northern part of the province; it is a blocked flat area made up of the old and current alluvial delta of the *Helmand River*. *Baluchistan* area of 179,385 square kilometers is a vast mountainous region limitedto *Lut Desert* in the north and *Oman Sea* in the south. The westerly winds and

their consequent high and low waves are among the factors affecting the rainfall rate in Iran and *Sistan* and *Baluchistan*. Because it is located in the easternmost part of *Persia* and latitudes lower than other areas of the country, it is less affected by these waves; therefore, fewer long and short waves are passing through it. Moreover, the distance of its northern half from the water resources and the absence of other precipitation mechanisms, such as *ascent mechanism* in the southern half of the province and beaches, make it the driest province with the lowest provincial rainfall average. *Monsoon System* of summers is effective on the amount of rainfall of southern stations in the province especially in mountainous areas of *Makran*. Figure 2 is the map of rainfall distribution in the province; it shows that the highest average annual rainfall has occurred in the range of *Khash* stations with annual average of 160 mm and *Rask* and *Iranshahr* with annual average of 150 mm [1].

MATERIALS AND METHODS

This paper deals with the rainfall zoning, occurrence of maximum 24- hour rainfalls of 50, 30, and 20 mm or more, and the maximum 24-hour rainfall occurred, using statistical data and daily maximum 24 -hour rainfalls of synoptic, climatology and rain gauge stations in *Sistan and* Baluchistan province for a period of 20 years between the years 1992 to 2012, as well as geographical information system (GIS). The data is taken from *Sistan and Baluchistan* center of weather data. After that, the maps were analyzed and discussed.

RESULTS AND DISCUSSION

In this study, data related to the maximum 24-hour rainfalls of 20, 30, and 50 mm or more, the maximum 24-hour rainfall of *Sistan and Baluchistan Province*, as well as the zoning maps, has been studied. Figures 3 to 6 show the southern part of the province, including the cities of *Nikshahr*, *Rask*, *Chabahar*, south *Saravan*, *Iranshahr*, and south *Khash* are further exposed to rainfalls with high degrees. Number of days with maximum rainfall of 20 mm and more, about 50 cases during the period under study, is mostly related to southern and coastal areas. Proximity to the sea and the mountainous status of the region, especially in the *Rusk* area, are of the reasons to be named (60 cases). Number of days with maximum rainfall of 30 mm and more has mostly happened in *Rask* and *Nikshahr* regions that are influenced by *monsoon rainfalls*. Likewise, the number of days with maximum 24-hour rainfall of 50 mm and more is common to coastal regions (10 occurrences during the period under study). The northern part of the province, *Sistan,* has had only cases of 20 mm and more; no rainfall of 30, 50 mm and more has occurred in this region (figures 3, 4, and 5). According to figure 6, the maximum 24-hour rainfall in this region is 28.8 mm.

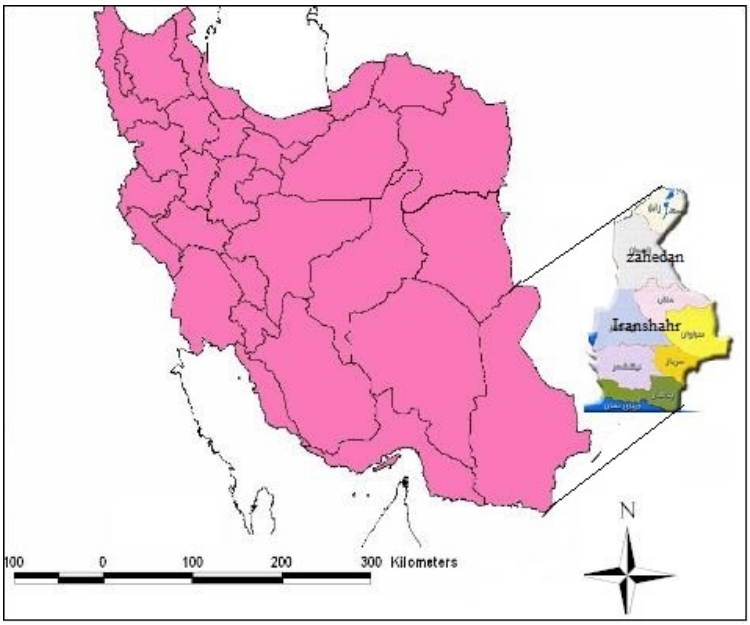

Figure 1. The geographical position of Sistan and Baluchistan Province in Iran

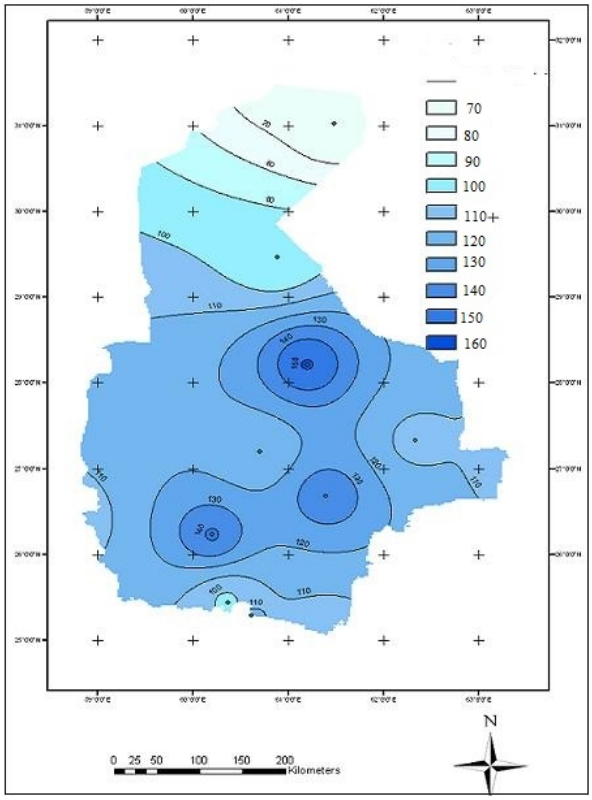

Figure 2.: The distribution of climatological precipitation (average rainfall) in the province of Sistan and Baluchistan

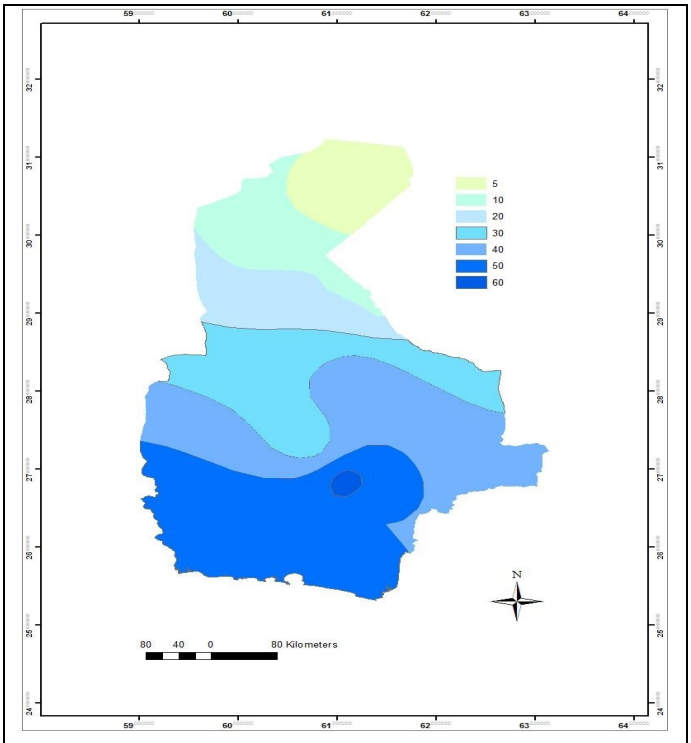

Figure 4: Map of the number of days with precipitation greater than30 mm during statistical period , Sistan and Baluchistan
(1992-2012)

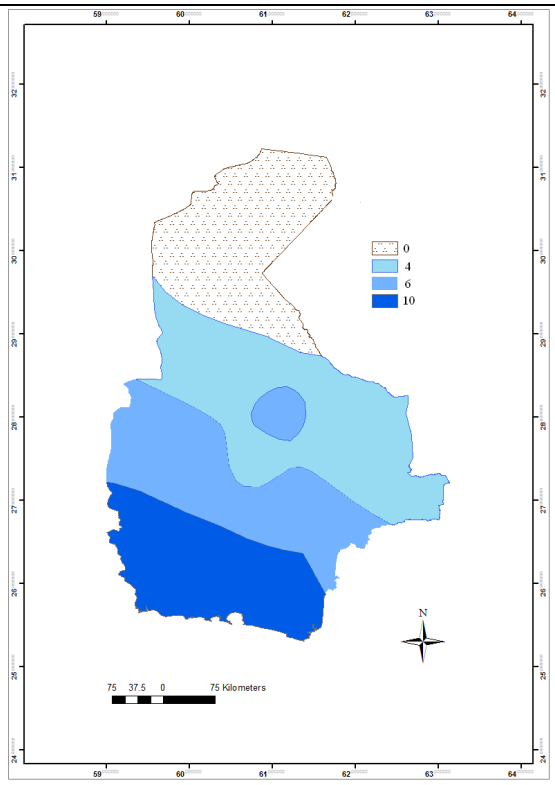

Figure 5: Map of the number of days with precipitation of 50 mm and above during the statistical period, Sistan and Baluchistan Province(1992-2012)

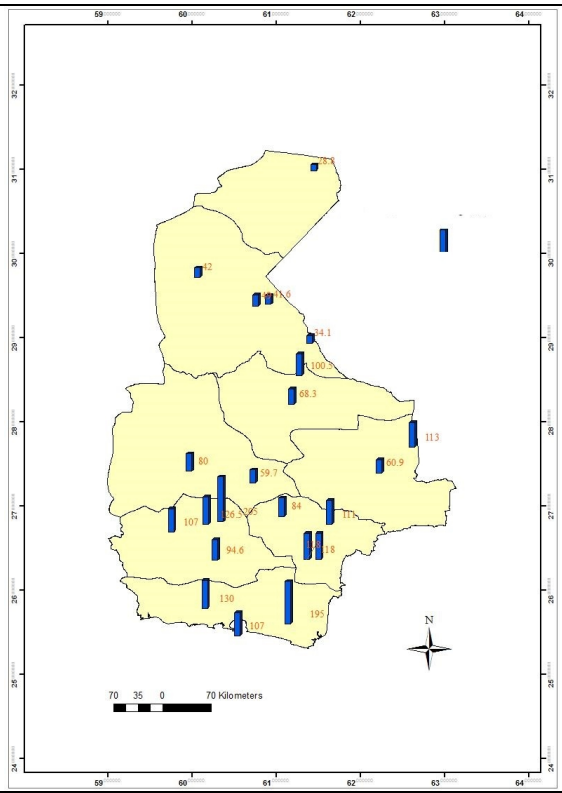

Figure 6: Map of the 24-hourmaximumrainfallatsome stations in Sistan and Baluchistan, the period(1992-2012)

CONCLUSIONS

Sistan-Baluchistan province, due to its special geographical position and climate, is somewhat exposed to climatic events. With regard to the hot and dry climate of the province, its poor soil vegetation, mountainous feature, and the high slopes of watersheds, make rainfalls of 20,30,50 mm and higher change into runoff and flood .A survey of the maps 1 to 6 shows that the southern regions of the province has the potential conditions for flood occurrence. With respect to figure 2, (a map of the average rainfall), sometimes, however, the maximum of 24-hour rainfall occurred, exceeds the annual average (figure 6). Disorder and lack of proper distribution of rainfall, soil conditions, poor vegetation, mountainous regions in the south of the province, economic activities and residential areas along rivers and floodways, all may have the outcome of some environmental hazards caused by flooding. Therefore, the following recommendations with regard to the management of water resources and flood zoning maps are presented below:

1 – With respect to the maximum rainfall in the coastal area, southern highlands of the province, the need for studies of flooding in these areas titled *risk management* is evident.

2. With regard to the fact that the volume of rainfall occurred over a single day, may include a considerable amount of annual rainfall in most parts of the province, watershed management and the construction of feeding pond dams in this dry province is more significant.

3 – In any economic construction, particularly buildings, roads and bridges, the precipitation conditions in different zonings, especially the maximum amount of rainfall occurred need to be regarded.

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