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RELATIONSHIP BETWEEN RAINFALL VARIATIONS AND HARVESTING OF RAINFALL WATER IN CHOLISTAN DESERT, PAKISTAN

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ABSTRACT

This paper examines the rainfall variations and fresh water availability in the Cholistan desert. The comparative analysis shows recent trends of rainfall and the efforts of fresh water harvesting. The analysis mainly focused on the climatic factors and availability of drinking water. The findings provide valuable information about the rainfall distribution throughout the year and storage of drinking water. Climatological data have been obtained from Pakistan Meteorological Department (PMD) and data concerning water harvesting is collected from Pakistan Council of Research in Water Resources (PCRWR). Analysis of rainfall trends of Bahawalpur, Bahawalnagar and Khanpur is helpful to understand the climatology of the Cholistan desert. These three stations are located in surrounding of the study area. The only AWS (Automatic Weather Station) in Cholistan at the place of Dingarh operates by PCRWR (Pakistan Council of Research in Water Resource). According to an estimate, there are 1500 natural depressions or 'tobas' in the Cholistan area. While the government, on its part is making efforts to create rainwater storages in different locations in the respect of overcoming to water scarcity. On pilot basis, 92 rainwater-harvesting ponds have been developed by the PCRWR. Rainfall is the only source of water for these 92 rainwater pond.

INTRODUCTION

The major part of southern Punjab (Pakistan) is covered with the Cholistan desert and is locally known as 'Rohi'. It is an extension of The Great Indian Desert (The Thar Desert) and covers an area of 26,330sq km between 27° 42' to 29° 45'N of latitude and 69° 52' to 73° 05'E of longitude. In the north and west of Cholistan desert is river Sutlej, to its east and south lies the desert region of Rajasthan (Indian Great Desert), while the southwestern boundary is bounded by the desert region of the Sindh province. Administratively, three districts of the Punjab province namely Bahawalpur, Bahawalnagar and Rahim cove most of the Cholistan desert (Khalid and Qayyum, 2000).

The Cholistan desert has an arid type of climate. In summer, the temperature is as high as 51.6 °C and in winter goes down freezing point (Khan et al., 1996). It is hot hyper sandy desert May and June are the hottest months of the year. The peak rainy months are July and August. Most of rainfall associated with summer monsoon. This area is least influenced by summer monsoon and most of the year remains handicap of water and droughts are quite common in this region (Ali et al., 2009; Ahmed, 2005).

Due to the small amount of rainfall, scarcity of water is quite common which leads to meteorological droughts in this area, which can extend from

a few months to little year time. Drought is a normal and frequent feature of climate (Ceglar et al., 2008). It occurs in all global climatic zones, but its characteristics vary from region to region. For proper assessment of drought, rainfall is the only parameter (Mogil, 2007). Drought affects the both, humid and arid regions (Shiau and Modarres, 2009). In fact, drought is a normal part of climate, it can develop as extreme climatic event and at last turn into natural hazard. Drought differs from other natural hazards and it is difficult to determine its onset and end (Turgu, 2008). The effects of a drought may linger for years after the termination of the event (Wilhite, 2000; Khan et al., 2004). At simplest way, drought is a shortage of water and lack of precipitation usually is seen as the primary cause (Kirkham, 1984; Khan et al., 2009). In reality, a drought event is occurring long after it has started and characterize as creeping phenomenon (Rossi et al., 2007).

In Cholistan, a large area has been affected by prolonged drought spell (Pomee et al., 2005; Ahmed, 2008). In severe dry spell or drought period, harvesting of rainwater is challenging job in Cholistan desert. In this desert, water resources have been considered into two main categories, i.e. surface water (fresh water) and groundwater. Groundwater in the respect of the few excceptions is highly saline, is unable to drinking, and as well as agriculture purpose. However, for agriculture, ground water is the ultimate choice in scanty rain. The only source of fresh water in the Cholistan desert is little amount of rainfall. This fresh water collected in manmade ponds or natural depressions, locally called as *'Toba'*. The amount of water in these *'Tobas'*, is primarily dependent upon summer rainfall. Other secondary factors like, topology, catchment structure, soil composition and size of Toba are correspond to water quantity in Toba or pond. The main purpose of this present study is to investigate the rainfall variations in the Cholistan desert and to analyze the availibility of freshwater.

MATERIALS AND METHODS

The Cholistan Desert is a vast landmass unfortunately there is no any weather observational station of Pakistan Meteorological Department (PMD) inside the desert (Figure 1). One of the only AWS (Automatic Weather Station) in Cholistan at the place of Dingarh operates by PCRWR (Pakistan Council of Research in Water Resource). In order to describe the rainfall trends and variations of this region, three nearest weather stations of Pakistan Meteorological Department (PMD) i.e. Bahawalpur, Bahawalnagar and Khanpur. Altogether three stations are located in surrounding of the Cholistan Desert and well covered the study area. Mean annual rainfall data during 1969 to 2008 of these three stations have been used in this study. Besides, mean annual rainfall data from Dingarh (AWS) during 1989 to 2008 has been used in this study. To analyze the availability and harvesting of

fresh water, the data of water ponds/tobas have been used and obtained from PCRWR.

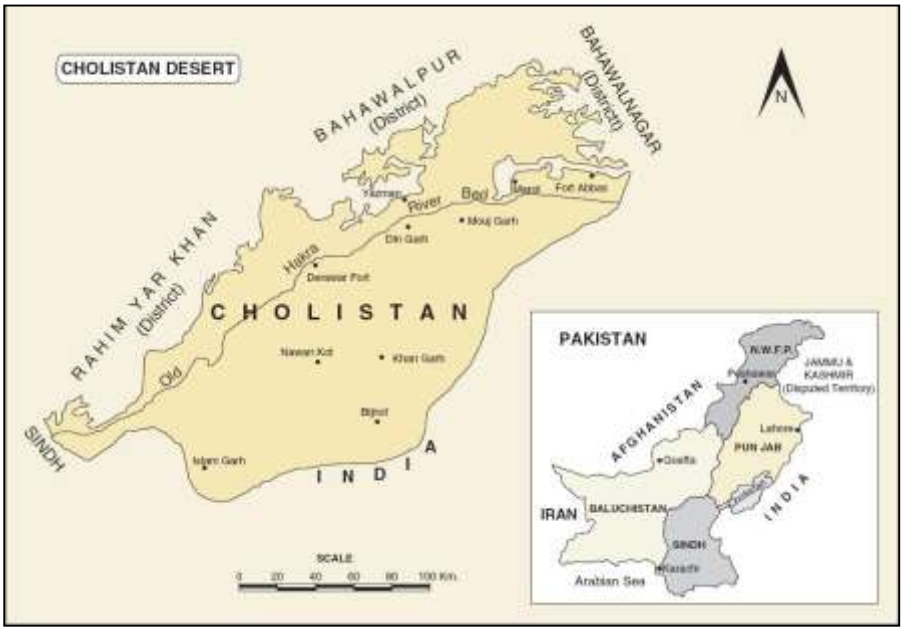

Figure 1. Location of the Cholistan Desert in Pakistan (Source: Wariss et al. 2013).

RESULTS AND DISCUSSIONS

Annual Rainfall trends in Cholistan

Rainfall characteristically is variable and torrential atmospheric event. It is responsible for floods and droughts worldwide. As stated earlier, the Cholistan region is amongst the driest regions of Pakistan shortage in water supplies represents a constant threat to drinking water as well as agriculture purpose. Charleston has no perennial rivers and there is almost no surface water except for natural depressions or man-made ponds that are dry most of the year. Analysis of rainfall trends of Bahawalpur, Bahawalnagar and Khanpur is helpful to understand the climatology of the Cholistan desert. These three stations are located in surrounding of the study area.

Bahawalnagar is located in north of Charleston desert and administratively covered a small part of an east northern Cholistan desert. The results are shown, an increasing annual rainfall trend of the Bahawalnagar station during last 40 years. Total annual rainfall is between 200mm to 400mm therefore 1992 and 1995 rainfall has amplitude between 400mm to 500-mm. Bahawalpur is located in the west of Cholistan desert. The station of Bahawalpur shows a decreasing trend of rainfall during the studied period. Total annual rainfall is between 200mm to 300mm, but the 1973 year is showing rainfall 670mm. The trend line is shown constantly minor decline

of rainfall. The immense reason of this rainfall decline at Bahawalpur station is the lack of vegetation cover. Due to the rapid increase in urban area and the development of new infrastructure, the surrounding green cover of the city destructed severely. The Khanpur station is located in west, south of Charleston desert. Annual rainfall of Khanpur is between 100mm to 200mm, occasionally it increased to 300mm. The trend of rainfall in Khanpur during studied period is increased.

Mean monthly trend of rainfall in all of the three stations is almost same with little bit variation. The month of July and August are showing the regime of rainfall. Average rainfall of the Bahawalnagar station is 75mm in the month of July. Similarly, Bahawalpur and Khanpur stations have 45mm and 25mm rainfall in the month of July. October to May, the rainfall is between 1mm to 10mm (Figure 2). The months of June, July and August have summer monsoonal influence.

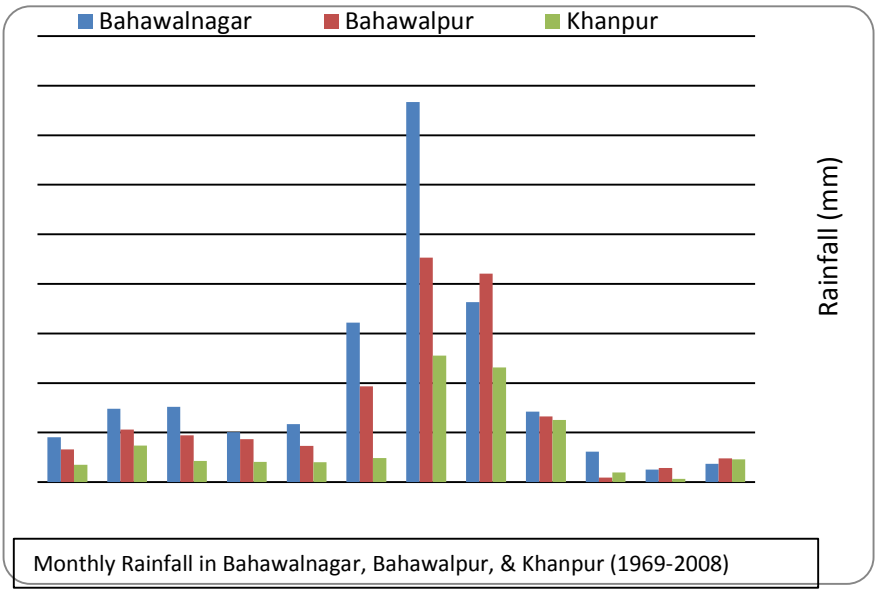

Figure 2. Monthly rainfall trend in Bahawalnagar, Bahawalpur and Khanpur (1969-2008).

Dingarh is the only place in Cholistan desert, where operating an AWS by PCRWR. The annual trend of rainfall during study period has no any big variation. Annual total rainfall is between 100mm to 200mm, therefore the years of 1994 and 2008 are showing high rainfall between 200mm to 300mm. The evaporation rate is much higher than rainfall in Cholistan desert. The months of May, June and July are showing the high rate of evaporation between 400mm to 450mm. July average rainfall is around 15mm but in same month evaporation rate is 470mm (Figure 3).

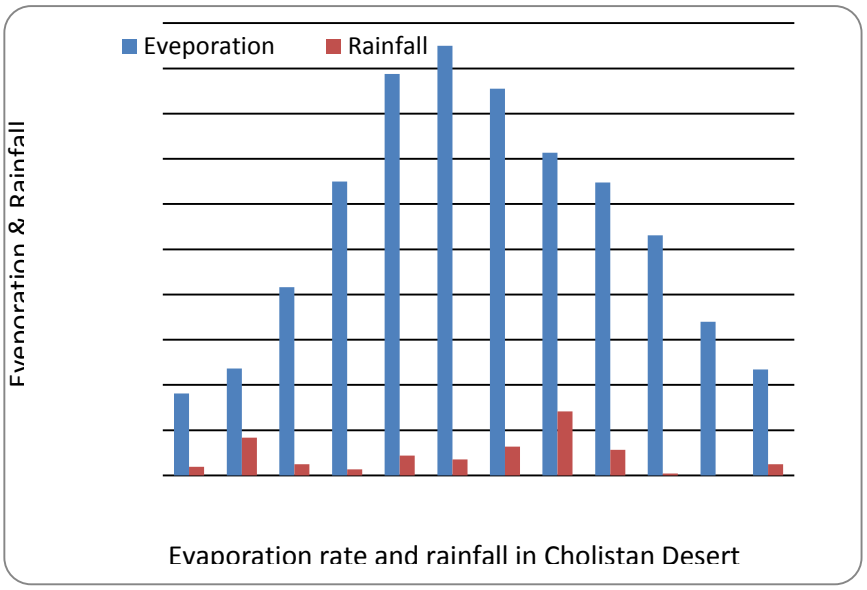

Figure 3. Monthly evaporation rate and rainfall in Cholistan during 2001 to 2008.

Harvesting of Rainwater in Cholistan

Spatial and temporal variation of temperature has the effects on rainfall. The important feature of Choilstan is the sand dunes. The most part of water spread runoff and evaporates through the sandy soils and increase in temperature variation. On the contrary, the average annual rainfall in the desert ranges from 100 mm to 200 mm. Because of extreme aridity in Cholistan desert, it does not possess enough freshwater resource to cater the needs of about 110,000 inhabitants and their approximately 2 million heads of subsistence livestock (Kahlown, 2007).

As stated earlier, availability of freshwater is rather limited to nonexistent. There are no permanent / perennial or even ephemeral streams. Surface water or sweet water is harvested from rainfall collected in either man-made or natural depressions/toba. Increase in rate of infiltration would lose the water as seepage due to a feature of the sandy soil structure. As a result, a small amount of water is collected and stored which usually supply water for only three to four months. This climatology leads to drought condition and the situation of water availability, which forced the local population to migrate causing huge financial losses and high mortality of their livestock. Harvested rainwater is also stored for household use in large circular tanks, locally called as 'Kunds'. However, the storage capacity of Kunds is smaller than tobas.

Additionally, the smell spread in storage water and water contaminated would increase the breeding of mosquito in such favorable surrounding. Recently, more than 200 kunds in Cholistan desert observed.

According to an estimate, there are 1500 natural depressions or 'tobas' in the Cholistan area. While the government, on its part is making efforts to create rainwater storages in different locations in the respect of overcoming to water scarcity. On pilot basis 92 rainwater-harvesting ponds have been developed. Rainfall is the only source of water for these 92 rainwater ponds. These fresh water-harvesting ponds are located randomly in the desert area. Administratively, 49 ponds are located in Bahawalpur, 22 in Rahim Yar Khan and 21 in Bahawalnagar (Figure 4).

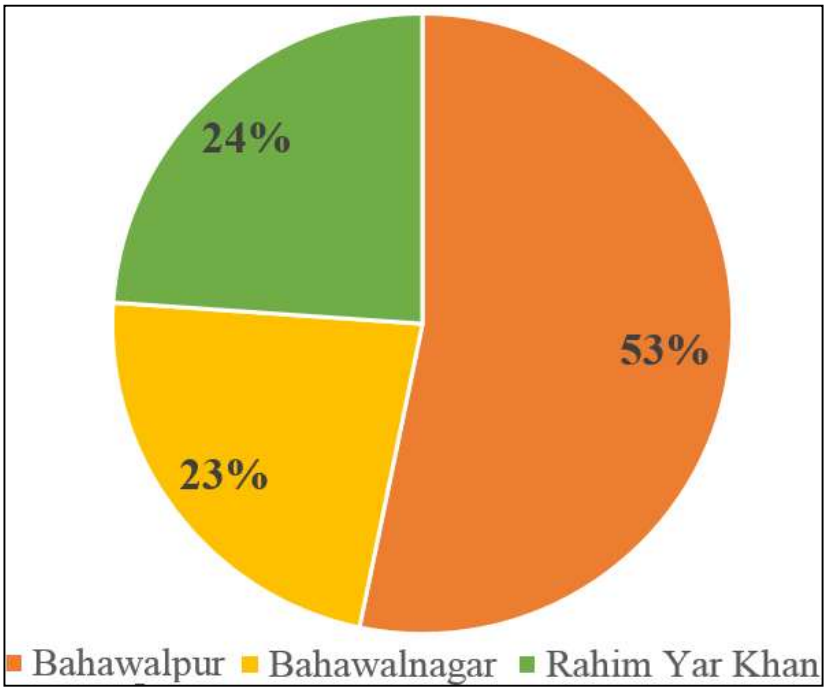

Figure 4. District wise availability of rainwater harvesting ponds.

DROUGHT AND WATER AVAILABILITY

Due to lack of availability of hydro data about the intensity and period of drought, analyzing the variation of rainfall is not possible. In the investigated region, drought extends usually from months to years. This is because of lack of availability of ground and surface water. However, there is a need for development of rainwater harvesting potential to justify the water demand that sustains the future economic growth and development. There are many sources of water like, tobas, kunds and ponds must be fully regulated. Increase in storage capacity of water reservoirs would reduce the stress of water and drought. However, the global future scenario of climate change and variation would increase the stress on the livelihood of the Cholistan desert due to the negative effect on water availability.

CONCLUSION

This study concluded that the Cholistan desert is a dry and rain scanty land. The major constraint to livelihood in Cholistan desert is the shortage of sweet water. In Cholistan desert, where rains are fewer, fresh water resources become critical even for survival. A high evaporation rates, contamination of water, the low storage capacity of the *tobas* and siltation are the major factors for this water scarcity which still persists because of the extent of the desert, Water harvesting as a strategic tool for drought mitigation can be realized throughout a policy framework to develop a mechanism to water harvesting at different levels such as domestic use, local government and central government. There are 92 rainwater-harvesting systems on a pilot scale in the desert. These constructed ponds have are designed to collect maximum rainwater within the shortest possible time and to minimize seepage and evaporation losses. However, more sincere efforts are required to include the construction of large multipurpose water reservoirs to harvest the fresh water in Cholistan desert.

REFERENCES

Ahmad, F. (2005). Agro-pastoral systems in Cholistan. *Pakistan Geographical Review*, *60*(2), 65-69.

Ahmad, F. (2008). Runoff farming in reducing rural poverty in Cholistan desert. *Sociedade & Natureza*, *20*(1), 177-188.

Ali, I., Chaudhry, M. S., & Farooq, U. (2009). Camel rearing in Cholistan desert of Pakistan. *Pakistan Veterinary Journal*, *29*(2).

Ceglar, A., Zalika, C., & Lucka, K. B. (2008). Analysis of meteorological drought in Slovenia with two drought indices. *Proceedings of the BALWOIS 2008*, 27-31.

Khalid, N. A. and Qayyum, M. (2000). Orbis Atlas of Pakistan, Career Books Publishers, Lahore.

Khan, A. A., Chaudhry, M. S., & Aziz, S. (2004). Natural resource diversity in cholistan desert (Pakistan) and possible conservational measures. *J. Pure App. Sci*, *23*(1), 25-47.

Kahlown, M. A. (2007). Rainwater Harvesting in Cholistan Desert:Pakistan. *PCRWR, Islamabad, Pakistan*.

Khan, F. M. (2009). Ethno-veterinary medicinal usage of flora of Greater Cholistan desert, case study of Pakistan. *Pakistan Veterinary Journal*, *29* (2).

Khan, N. Z., Ali, K., & Anania, J. R. (1996). Productivity constraints of Cholistani farmers. *The Pakistan Development Review*, 549-563.

Kirkham, M. B. (1984). Drought resistance in crops with emphasis on rice: International Rice Research Institute, Los Baños, Laguna/Manila, The Philippines, 1982. 414 pp., US $16.25 plus airmail (US $14.50) or surface mail (US $1.75) postage. ISBN 971-104-078-6.

Mogil, H. M. (2007). Extreme Weather, New Holland, London.

Pomee, M. S., Zaheer-ul-Ikram, K., & Ali, I. (2005). Drought mitigation measures: An overview under Pakistan's perspective. *Pakistan Journal of Water Resources*, *9* (2), 2-3.

Rossi, G., Vega, T., & Bonaccorso, B. (2007). *Methods and tools for drought analysis and management* (Vol. 62). Springer Science & Business Media.

Shiau, J. T., & Modarres, R. (2009). Copula-based drought severity-duration-frequency analysis in Iran. *Meteorological Applications: A journal of forecasting, practical applications, training techniques and modelling*, *16*(4), 481-489.

Turgu, E. (2008). Using standardized precipitation index for monitoring drought and analyzing drought. *BALWOIS 2008Ohrid, Republic of Macedonia 27*, *31*.

W**ariss, H. M., Mukhtar, M., Anjum, S., Bhatti, G. R., Pirzada, S. A., & Alam, K.** (2013). Floristic composition of the plants of the Cholistan Desert, Pakistan. *American Journal of Plant Sciences*, *2013*.

Wilhite, D. A. (2016). *Droughts: A Global Assesment*. Routledge.