Original Research Article

Water Management in Desert Ecosystem: A General Account of Bikaner District

Abstract

In the arid eco-systems, water constitutes the most important resource that limits plants growth and yield. There is broadly, three way demands on available fresh water for human uses are for agriculture, animal husbandry, fisheries etc. to provide food, to meet the civic needs of people in rural and urban areas, and water for industrial enterprises.

Water being a decisive component for quality of life and development activities, its supply, demand, quality and distribution for social and economic consumption patterns are important issues for developing a strategy of water management. Water is an essential commodity without which development of culture and economy is neither possible and nor meaningful. Therefore, this paper **"Water Management in the Desert Ecosystem: a general account** is very significant in the present growing water crisis of the arid and semi-arid regions of India.

Keywords – Water Management, Ecosystem

Introduction

Water is one of the most important constituents of our planet and indispensable for existence of life on the earth. It is essential for sustaining all forms of the life, food

production, economic development, and for general well being. It is impossible to substitute for most of its uses, difficult to de-pollute, expensive to transport, and it is truly a unique gift of nature for mankind. The value of water varies for different users depending on the ability to pay, the use of which the water will be put, access to alternative supplies and the variety of social, cultural and environmental values associated with the resource. Water is also one of the most manageable of the natural resources as it is capable of diversion, transport, storage and recycling. All these properties impart to water its great utility for human beings. The surface water and ground water resources of the country play a major role in agriculture, hydropower generation, livestock production, industrial activities, forestry, fisheries, navigation and recreational activities etc. Unfortunately, it is being adversely affected both in terms of quality and quantity by human activities. Potable water, which is hardly 0.1% of all the water available on the planet, the scarcity of water is increasing day by day and it is considered to be more threatening than climate change. India and other semi-arid and arid climatic countries are very soon likely to experience "water stress conditions". There are no more fresh water sources to exploit, therefore, conservation and better management of water is only a practical solution to this mega problem. Precipitation is primary source of fresh water but most of the rainwater goes back to ocean without being properly used. The rapid urbanization has further aggravated the urban runoff problem causing regular flooding in cities during rainfall season and depletion of ground water table.

Selection of the Study Area:

The study area is being part of the Thar Desert of Rajasthan, where harsh desert conditions prevail in such climatic conditions. Scarcity of water is common

geographic phenomena of the desert environment; therefore the study of management of water resources of this arid ecosystem is very important.

Objective-

The main contention of the study is to present a holistic view of the ecological problems of water availability, water quality and water supply in a geographical perspective.

Data collection -

For the present study of Water Management in Desert Ecosystem: A General Account of Bikaner District, secondary as well as primary data are used.

Review of Literature –

A study conducted by Sharma, A. (2000) revealed that after development of modern water exploitation systems like canal, tube-wells etc. the traditional water harvesting systems have been neglected and slowly they are virtually dying.

Mathur, S.K. and Shekhawat, M.S. (2001) studied the impacts of canal irrigation on land-use and cropping pattern of I.G.N.P. command area. They suggested ecologically suitable land-use and cropping pattern along with strategies of optimum use of irrigation water for sustainable development of this desert region.

Johri, S.N. (2002) observed in his study on this desert region that ground water is highly saline or saline-alkaline both. Due to continuous use of these waters the soluble salts are accumulated on the top surface of the soils. Therefore, the quality of irrigation water is of primary concern and the under ground water used as major source of irrigation water contains very high salt contents. The author emphasized on management on watershed basis depending on its land capability may be a viable option for sustained

utilization of land and water resources available in this most thickly populated desert of the world.

John Rockstrom (Nov., 2003) in his paper "Water for Food and Nature in Drought-prone Tropics : Vapour Shift in Rainfed Agriculture" quantifies the eco-hydrological challenges up until 2050 of producing food in balance with goods and services by water-dependent ecosystem in nature. The analysis indicates an urgent need for a new green revolution which focuses on upgrading rainfed agriculture. It indicates that large 'Crop per Drop' improvement can be achieved at the farm level.

Ali, A. and Singh, J.B. *et al.* (2004) studied sustenance of water resources and urban ecology of Bikaner city. The authors examined the quality of water and its impact on human health. They suggested the strategies of rational management of water resources for the urban ecosystem.

Ali, A. and Swami, S.K. (2005) studied impacts of canal irrigation on land-use and cropping pattern of Ganganagar tehsil. They observed that lack of water and land management strategies is responsible for land degradation problems of this irrigated arid tract. They emphasized on optimum use of available water resources along with ecologically sustainable land-use and rational cropping patterns.

Vaidyanathan, A. (2006) in his book "India's Water Resources" explains that there is a clear gap between the policy formulations, implementations, and the governance and management of India's water economy. The volume in detail examines the agro-climatic context, irrigation and agricultural technology, legal-institutional arrangements, and the economic environment. The author lays emphasis towards integrated watershed development in rain-fed regions, reducing waste and over-exploitation of water, resulting in a more efficient use of irrigation water.

Ali, A., Ranga, S.K., Swami, S.K. *et al*. (2008) studied Sustainable Water Management of Churu District : Issues and Prospects. The study highlights the main aspects of water availability, spatial distribution patterns, consumptive patterns and the impacts of the quality of water on human health of the desert ecosystem.

Singhvi, S.L. and Ali, A. *et al*. (2009) made an attempt to study "Land Degradation in the Rawatsar Command Area of I.G.N.P. (Stage-I) : An Environmental Impact Assessment" in which findings of the study indicates that the lack of land and water management strategies is the main cause of these environmental degradation problems of this irrigated arid ecosystem. The study suggests measures to protect, conserve and sustainable development of the region.

Water is that the most essential material indispensable to any or all living things. Without water, there's no life, and therefore the solution to the matter of desertified water has become a worldwide problem (Croke et al., 2000; Wan et al., 2016). The source of water within the desert consists of artificial external water, groundwater, sand adsorbed water, precipitation and air water. Artificial foreign water and groundwater must be limited to the foremost limited amount; the aim is to confirm the benign cycle of ecological restoration and also the economic problems of water application. So far, the research during this field is restricted and mainly focused on mechanical micro-irrigation. However, there's still a large range of research space during this field, especially the introduction of recent material technology may be a ought to have attention.

In recent years, people have tried to revive desert ecology without watering, As a result, bionic condensation materials, sand surface biological crust materials, water absorbent resin materials have emerged (Xinru et al., 2006a; Fan et al., 2017; Mogul et al., 2017; Liao et al., 2017; Wei et al., 2017; Zheng et al., 2010). The looks of

those materials provides a replacement direction for ecological restoration in desertification areas.

A General Account of Bikaner District

The study area of Bikaner district has dry climatic conditions with large variations of temperature, unpredictable and scanty rainfall. Underground water which is the main source for drinking and other purposes is generally found at a depth of about 80 to 120 metres below the ground level. The discharge from the well varies from 18,200 liters per hour (4000 gallons per hour) to 91,000 litres per hour (20000 gallons per hour).

In Bikaner district, there are four major hydrological unit's viz., Bilara limestone, Nagaur sandstone, tertiary sandstone and the quaternary alluvium. The study area has about 227.0832 mm ground water resources and presently 214.9282 mm water is being exploited. The ground water availability for irrigation purposes is about 17.1003 mm and the ground water development rate is about 94.65% in the study area. The alluvium formations cover major part (north-western part) of the district but due to saline ground water and thick sequence small area in north-eastern and south-western part in Lunkaransar and Kolayat blocks have been delineated as ground water potential. In these geological formations depth to water table ranges from 100 to 140 m and these formations occupy about 14% potential area. The general depth to water table increases from south-west to north-east direction. The water table contours indicate that the general direction of ground water flow is south-east to north-west. The ground water studies indicate that hydraulic gradient generally varies from 1.1 to 2.5 m/km. The quality of ground water is suitable for irrigation and drinking purposes. In southern part gradient become more steep (4.5 to 5.0 m/km). In Bikaner and Kolayat blocks quality of ground water is saline.

Ground water study indicates that tertiary sandstone formations occupy south-western part of the Bikaner block where it covers extensive area. These formations also spread in peripheral part of adjoining block. The depth to the water table in these geological formations ranges from 140 m in the west to 200 m in the eastern part of the district. These hydrogeological formations encompass about 56% potential area. The ground water capacity of these formations range from 110 to 200 m^3/day.

The third important geological water bearing formations are Nagaur sandstone which belongs to Marwar super group rocks. The thickness of the litho unit varies from 140 m to 250 m. geographically southern part of Kolayat and Nokha tehsils are covered by these hydrogeological formations.

The depth of ground water in these formations varies chronologically and it ranges from 38.10 to 116.38 m. The quality of ground water of these formations suitable for domestic and non-domestic uses. The depth to the water table ranges from 160 m to 260 m. The depth to the water table increases to north to south. Nagaur sandstone formations occupy about 28% potential area.

The southern part of Nokha tehsil is covered by Bilara lime stone formations where depth to water table is increases more than 260 m. The thickness of the hydrogeological formations varies 115 to 225 m. These litho units covers small area in southern peripheral part of Nokha block, which covers nearly 2% potential area. The depth of ground water ranges from 48.42 m to 78.20 m. The ground water capacity varies from 70 to 120 m^3/day. The quality of ground water of these hydrogeological formations suitable for consumptive uses.

Qualitatively, alluvium geological formations of Bikaner and Kolayat contain saline water, which is not potable. The depth to water table in these formations ranges

from 23.87 m to 47.59 m in the Bikaner tehsil and 11.12 m to 63.48 m in the Kolayat tehsil block.

Presently Bikaner district has about 771 inhabited villages. About 56.81% (438) villages are depended on ground water resources. The remaining 43.19% (333) villages (Poogal, Khajuwala, Chhattargarh) are served by canal water services. The villages of Nokha and Sridungargarh tehsils are fully dependent of ground water resources. Villages of Bikaner, Kolayat, Lunkaransar are served by surface as well as ground water resources.

Bikaner district having total geographical area of 30381.75 sq.km, about 55.22 percent area (16779.24 sq.km.) contains saline ground water, and the remaining part of the district (44.78 percent) has potable water, which is used for domestic as well as non-domestic uses. Over exploitation of ground water for agriculture uses leading to fast depletion of limited ground water resources. The continuous decreasing trends of water table has become matter of concern for hydrogeologists and environmentalists. In view of these circumstances, there is a urgent need to make a sound master plan for protection, conservation, and sustainable management of scarce water resources of this desert region.

The Bikaner district has about 749 villages, about 62.08 percent (465) villages have potable water resources and the remaining 37.92 percent (284) villages have saline water. As far as the spatial distribution pattern of ground water resources are concerned, the northern and western (Kolayat, Khajuwala , Chhattargarh, Pugal and Lunkaransar) part, have saline ground water and remaining more than half part of southern and eastern parts (Bikaner, small portion of Lunkaransar, Dungargarh and Nokha tehsils) have potable water. The availability of ground water in the Bikaner district ranges from 11.12 to 135.15 metres. Geohydrologically, Kolayat and Lunkaransar tehsils are safe ground

water zones, where potable water is found at the depth of about 37.85 m to 135.15 m and 20.53 m to 66.15 m, respectively. Looking to the consumptive patterns of water resources and stage of ground water development. Bikaner and Nokha tehsils are over exploited ground water zones (105.78 and 131.78%) and the ground water resources of the Dungargarh tehsil (96.33%) are in critical stage. The main cause of depletion of ground water resources are continuous increasing of water demand on account of increasing demographic pressure and poor recharge of ground water resource due to little and unpredictable monsoon rainfall. As far as potability of ground water resources is concerned blockwise percentage ranges from 24.13 percent (Kolayat) to 97.68 percent (Nokha block). The south-eastern part of the district where Nokha and Sridungargarh blocks are situated, the percentage of potability of water is above 90%. On the other hand western part of the district (Kolayat, Bikaner, Lunkaransar) has very little percentage of potable water, the percentage of saline ground water ranges from 65.61 percent in the Bikaner block to 75.87 percent in the Kolayat block. Bikaner district has about 227.0832 MCM ground water resources. The percentage of ground water availability of the different blocks of the study area varies from 11.82 percent (Kolayat) to 27.86 percent (Nokha) blocks. Therefore, Nokha block has maximum (63.2686 MCM) available ground water resources.

The consumptive patterns of the water resources of the district indicate that Nokha (131.78), Bikaner (105.78) and Sridungargarh (96.33) block are over exploited blocks, because the ground water development rate is above the availability of ground water resources. The present status of ground water resources indicates that Bikaner and Nokha blocks were critical in 2001 and remaining three blocks were safe hydrogeologically. In 2004, these both blocks (Nokha and Bikaner) were over exploited and Dungargarh block

also reached in critical stage in ground water development. Kolayat and Lunkaransar blocks were safe in ground water development stage.

The problems of water quantity are equally important. Water quality directly affects the health of human beings and animals in a profound manner. The trends of increasing population, urbanization and industrialization are gradually becoming a threat to the quality of surface water as well as ground water resources.

As far as the quality of water is concerned the ground water of Kolayat and Lunkaransar have more salinity in comparison to Nokha and Bikaner tehsils. Therefore, the chemical analysis of TDS indicates that the quality of ground water in the study area is not suitable for consumptive uses. The study highlights that whole district area has heavy concentration of abiotic components like chloride and nitrate in ground water and the values of the contaminants are greater than the maximum recommended values of WHO norms. The spatial distribution of fluoride of the study area reveals that slightly to moderately saline water is normally free from fluoride contamination.

Conclusion -:

The study area is fully depended on ground water, which is free from biotic contaminants. An assessment of biotic contaminants in water is more significant for the reason that most of the water-borne diseases like cholera, diarrhoea, dysentery, typhoid and hepatitis spread through contaminated waters. Therefore, the study area needs a sound strategy to solve the problem of human health.

With the rise in population and steady growth of industries have increased the demand of ground water. Ground water is the sole source of drinking water for local residents, industries and agriculture in the study area. The study area of Bikaner was under safe zone in ground water till 1998. But as the exploitation of ground water with

increasing number of public and field tube wells enhanced since last ten years, the district has reached in critical and very critical stage. In the year 2021, the ground water resources were in critical stage, but continuous three years unplanned and excess use of water (131.78%), resources is the main cause of the change in the stage of over exploitation of ground water development. The exploitation of groundwater for irrigation and adoption of commercial and water loving crops has put Nokha and Bikaner tehsils in very critical zone while Dungargarh has reached in critical level (2015). The other tehsils like Kolayat and Lunkaransar have saline water which is not suitable for cultivation. The remaining three tehsils i.e. Chhatargarh, Khajuwala and Pugal have canal irrigation facilities and have brackish water. Therefore, it is essential to conserve rain water to mitigate the water crisis.

Under such circumstances, it is essential to conserve rainwater to mitigate the ill-effects of drought, stabilize agricultural production and develop water resources for the region. The use of water in a society varies in time and space. There are two different ways in which society makes use of water resources. The first is the traditional and the second is the modern. Traditional methods of water use are devised to make the optimum use of the available water.

In the arid areas of Rajasthan people build unique underground structures of various shapes and sizes to collect rain water for drinking purposes. These structures called tanka, kund or kundi are constructed. Since tanka are the main source of drinking water in these areas, people zealously protect and maintain them. Just before the onset of the monsoon, the catchment area of the tanka is cleaned up to remove all possible pollutants, and human activity and grazing of cattle in the area is prohibited. The stored

rain water is utilized for the whole year. These simple traditional water harvesting structures are useful even during years of below-normal rainfall.

The study area of Bikaner district has higher (56.96%) population growth rate than Rajasthan state (28.33%) and country as well (21.34%) in 2011. This growth rate is running higher since 1971 due to introduction of Indira Gandhi Canal. The livestock population has also increased by two and half time since last 40 years. In the same way per day water demand has also increased from 310.8 lit. per day to 1330.7 lit. per day in 2003. It further enhances the extraction and exploitation of groundwater in Bikaner district. It is therefore essential to revive the traditional method of water harvesting such as Kui, Nadi, Bawri, Tanka, Talab, Johad, Khadin, Jhalra etc. to conserve and protect the limited available water resources of this arid district.

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