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Ground Water Crisis in Jodhpur district: Problems, Analysis and Remedies

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Abstract
Western Rajasthan has arid type of climate characterized by high temperature and low rainfall. There is absence of any major river in the western region. Due to the limited availability of surface water resources, there is very high dependence on the ground water resources to meet water needs in industrial, commercial and domestic sectors. The desert terrain of Rajasthan understands the importance of every single drop of water and each drop is counted as silver drop. Several kunds, tanka, kui, talabs can be seen dotting the entire Thar landscape. However, with increasing population pressure and the growth of industries, water is being extracted at an unprecedented rate without sufficient measures being taken to recharge the ground water resources. Jodhpur occupies 6.68 % part of the state. The district is divided into 12 sub divisions namely Jodhpur, Bhopalgarh, Bilara, Bap, Lohawat, Bawari, Balesar, Luni, Osian, Phalodi, Piparcity and Shergarh and it comprises of 16 tehsils. Total population of the district according to 2011 census is 3687165 which puts immense pressure on the water resources of the region. Most part of the district is covered by hard rock formation like Jodhpur sandstone, Malani rhyolites, granites, and Delhi super group metamorphic. Thus, these rocks have very poor water yielding capacity. Also, in the recent years due to the growth of textile industries and stainless re rolling industries a lot of industrial waste is being generated which is discharged in the Jojari River flowing South of the city. In this way pollution of both surface and ground water resources are degrading the quality of water resources. There is a need for conservation of the sacred water resource in the entire region and also stress should be laid on reviving the ancient wisdom of harnessing each and every droplet of fresh and pristine rain water.

Keywords: Ground water, desert, ground water resources, recharge, Thar landscape

Introduction
In an arid landscape like Jodhpur, ground water resource is the most exploited due to the absence of any perennial river. It is the only source of irrigation in the district. According to the data of Agricultural statistics, (2014) gross area of irrigated land by wells and tubewells account for 478676 hectares. Water has always been a limiting factor in Jodhpur district due to the low rainfall in the region and also because of poor ground water reserves due to the underlying rocks. In this situation, it becomes imperative to use it judiciously in the recent times. There has been dependence on several traditional water harvesting structures like Tanka and Khadins as the methods to harness the surface run off since the ancient times. Both are also the sources of Ground water recharge.

Tanka are the underground water structures that were constructed to store rainwater during the times of scarcity and to utilize it for domestic uses. The local community in hot and arid Jodhpur knew the importance of having a water harvesting structure for their sustainable growth. As a result of which every household had a compulsory water harvesting structure like tanka.

Another important source of water conservation in Jodhpur district has been khadin which are locally called as dhoras. There structures have been streamlined to harness surface run off which is then used for agricultural purposes.

Nadis, wells, talabs, baoris and jhalara also constitute some prominent water harvesting structures in the district which presently lack attention and the shift has been upon the tubewell drilling or borewell leading to over exploitation of water resources.

Study region

Jodhpur district

Jodhpur district is situated in the western part of Rajasthan. It is located between 26°0´and 27°31´North latitude and 72°55´and 73 °53´East longitude. In the North of it lies Bikaner and Jaisalmer, Pali, Jalore and Barmer to its South, Pali and Nagaur are to its East, and in its west is Jaisalmer. The total area of the district is 22,850 sq. kilometer which is 6.68 percent of Rajasthan.

Till 2019, the district is divided into 12 sub divisions and 16 tehsils. (District Gazetteer, Jodhpur).

Geomorphology of the district

Jodhpur is a part of the Great Thar desert of Rajasthan. There is an expanse of sand in the region, alluvial areas are dotted with some hillocks, and some hill chains are scattered in the region. The area between Bilara and Jodhpur is covered by the alluvium deposited by the fluvial action of Luni River. General elevation of plain varies from 300 m amsl in North to 150 m amsl in the south. Sand dunes of transverse and longitudinal type is found here. Ridges comprising of resistive rocks like granite, rhyolite and Jodhpur sandstone are found extending form Shergarh in the west to Bilara in the east. In the northern part of the district, hills are found with a height of maximum 284 m amsl. Boulder belt is found around Bap and low-lying outcrops of limestone, shale and sandstone layers are observed near Phalodi.

Soil types of the region

Red desertic soils are spread over central, eastern and southern parts of the district. They are loose and drained and texture varies from sandy loam to sandy clay loam. Desert Soil is found in the northern and western part of the district. Sand dunes occupy a small part in the northern and north western margin of the district. They are sandy to loamy sand, loamy sand and loose and structure less. The central and western part of the district is overlain by lithsols and regosols.

Drainage

The major river of the region is Luni, which enters Jodhpur district near village Jakh in Bilara tehsil and leaves the district near village Dhundara. Total length of Luni River in the district is 125 kilometers. The drainage of Luni River in the district is mainly ephemeral and internal. Mithri and Bandri are the other major tributaries of Luni. Other streams in the district are Jojari, Golasmi, Guniamata, Bastua which are all ephemeral. Internal drainage starts from the isolated hilocks and disappears in the sandy bed.

Some major talabs of the region are Balsamand in the North, which is an artificial lake. Surpura, Jaswant Sagar, Goljod, and Birai are the other important talab in the region. To the west of Jodhpur, there is Kailana Lake which was built in 1872 A.D. by the then Prime Minister of Jodhpur district Pratap Singh. It is spread over an area of 84 sq kilometer. Near to the lake Kialana is the Ummed Lake constructed in 1931 A.D.

Climate

According to agro climatic condition the district is divided into two zones:

1. Dry western plain which covers Mandore, Osian, Luni, bap, Phalodi, Shergarh, dechu, Lohawat, tinware, shekala, Bapinia and Balesar Panchayat Samiti.
2. Transitional plain of Luni Basin covers bilada, Pipar, bawari, Bhopalgarh panchayat samiti.

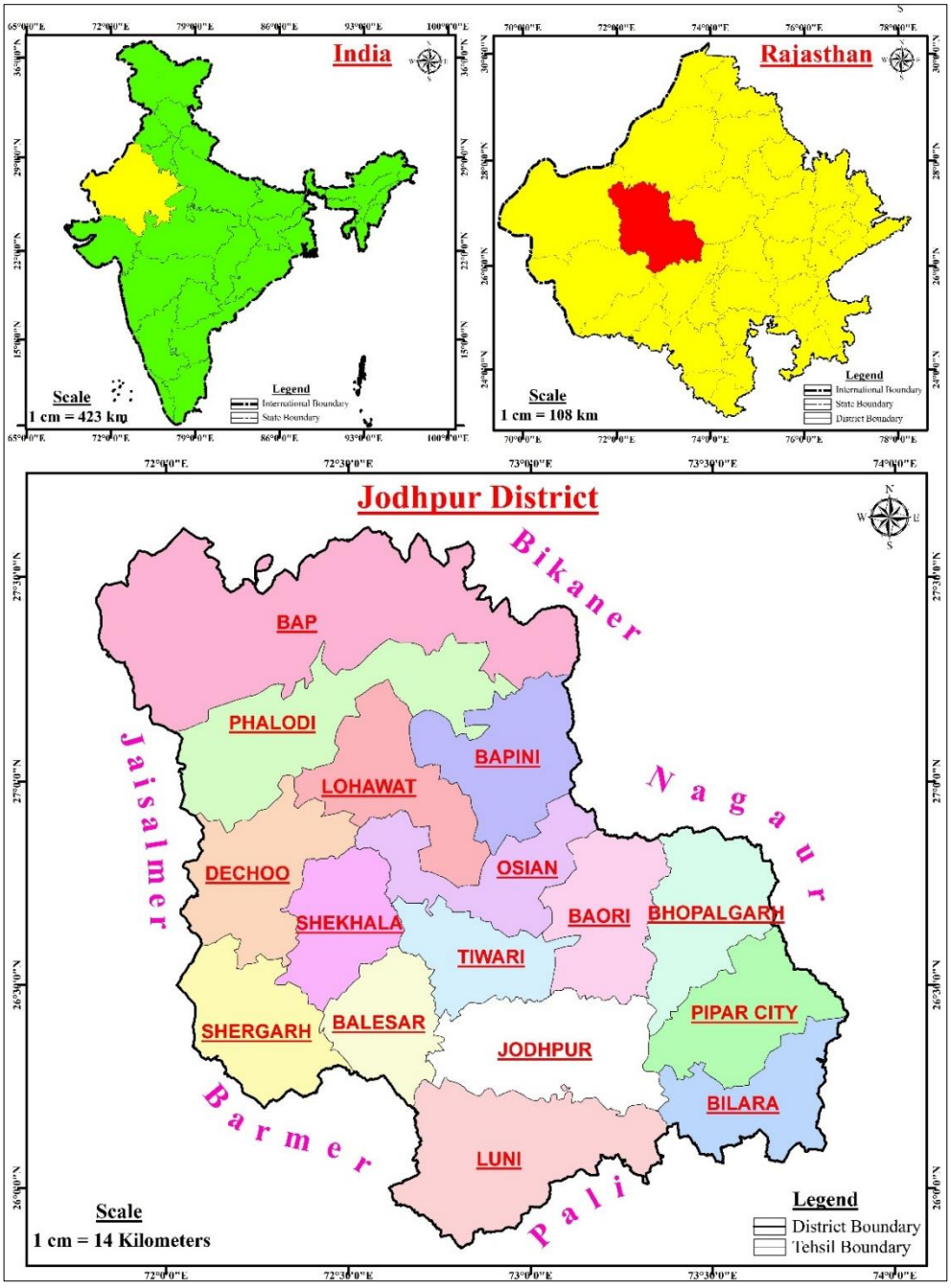
Maximum temperature is reported in the month of May when the temperature rises to as high as 48 °Celsius. The summers are succeeded by the rainy season which begins from second week of July to first week of September. Average rainfall received in the region 314.7 mm which makes it an arid topography. The winter season which commences from November is marked by the lowering of temperature where the minimum temperature recorded during nights is 8-9 °Celsius and it rises to 26 °Celsius in the day time. Average maximum temperature of the district is reported to be 34 °Celsius and average minimum temperature recorded for the district is 20 °Celsius. (Source IMD). The region has arid type of climate and drought resistant varieties of crops are generally grown here. Humidity is about 70 percent during the monsoon while during rest part of the year, dry winds blow. Winds are extremely dry during the summer season when the relative humidity is 20 to 25 percent. Clouds cover remain during the rainy season. The sky is generally clear during the remaining part of the year. Due to western disturbances, in the winter season the sky gets clouded sometimes. Winds blow from west to east in the summer and monsoon season. During monsoon the direction of wind is from west to the south west. There is a change in the direction of winds after the rainy season.

Other seasonal weather phenomenon

Hailstorms, thunder lightning occurs occasionally during the rainy season. Loo is a common phenomenon in the summer season which is a warm local wind of the region.

Natural Vegetation and Land Use

Dry trees and climbers are the major vegetation cover in the region which makes the forest reserves under dry forest. Area under forest is 245.13 sq kilometer. As the region is devoid of water resources, only those plants are found here which can withstand high temperatures and less water. Ker, khejarli, Rohida, Bordi, jal, thor are natural vegetation of the region. Aak, Nagphani, Khep, etc are medicinal plants grown here. As the western desert terrain is a drought prone region, there is a deficit of grass in the region and grasses are transported from other region during droughts for livestock consumption. Dhaman and sewan are the major grasses grown here. Land is arid and as a result there is single cropping which is irrigated by wells and tube wells. Kharif crops are jowar, millets, jawar, pulses, ground nut and guar and winter crops include wheat, barley castor seeds, mustard and isabgol.



Map 1: Key Map of Jodhpur district

Objectives

1. To explore the surface and ground water resources of the study region and their present situation.
2. To analyze the groundwater exploitation in various sectors like agriculture, industries and domestic sector and its importance in the region.
3. To discuss the suggestive measures that can be taken for the restoration of healthy ground water reserves in the district despite increasing urbanization and industrialization.

Data Base and Methodology

Both primary and secondary data has been used for the study. Secondary data has been collected from government departments like Central Ground water Board, NAQUIM reports (National Aquifer Mapping and Ground water Management), IMD reports on rainfall and temperature, reports of NGO's etc. Primary survey was conducted in some random villages of the district to see the situation of water usage there in agriculture and domestic sector and remedial measures taken there.

Hypothesis

- Increasing Urbanization and industrialization has put tremendous pressure on the limited ground water resources of the region.
- The quality of ground water reserves is degrading due to anthropogenic factors.

Discussion

Several efforts were made to harness every single drop of rain in the Jodhpur district. Jodhpur is one of the few cities in India where several water harvesting structures both surface and ground water were constructed in large number to harness the runoff. But today due to lack of attention and apathy of government and local communities many such

structures have been lost and as a result the dependence on ground water reserves has increased manifold. Here is a brief description of the water resources of the study region.

Surface water resource of the study region

Following is a brief description of the water resources of the study region.

Maharaja Jaswant Singh of jodhpur laid great emphasis on the water supply schemes in Jodhpur district, Kailana Lake was constructed in the famine year. Ranisar and Balsamand bunds were raised and long canals were constructed to feed the city tanks. (Dying Wisdom, Rise and Fall of Traditional water Harvesting System, 1997)

- Nadi- It is a local name given to the village pond used for storing water from an adjoining natural catchment during the rainy season which was an ancient source of harnessing the surface run off. Every village had their own nadi and they were constructed by the local villagers who selected the site themselves keeping in mind the water storage potential and natural catchment of the area. The oldest nadi is Jodhnadi constructed in 1458 A.D. Some nadis have been rejuvenated and some like Range ki nadi and Pritaro nado have been lost. (Centre of science and Environment)
- Talabs- It is a local word for water reservoirs. Some talabs have been lost now like Chankelao, Phoolalao and Naya Talab due to urbanization. Ranisar and Padamsar are the prominent talabs in the region. Jaswantsagar is the youngest talab. Many talabs in the study region have been lost due to new colonies being developed, parks being made and increasing urbanization.
- Tanks- Some prominent tanks in the study region are Fatehsagar (1780), Gulabsagar (1794), Baija Ka Talab (1877), Mansagar (1870) and Paota (1887).
- Lakes- Jodhpur district has five large reservoirs which are located in the outskirts of the city. The oldest is Balsamand (1126 A.D.), Lalsagar (1800 A.D.), Takhtesagar (1932 A.D.), and Umedsagar (1932 A.D.)
- Canal Systems- Jodhpur district has an elaborate canal system consisting of numerous water courses, channels and aqueducts to carry rain water to the city's various nadis and talabs. Jodhpur is one such cities in the country where every effort was made to conserve the single drop of rainwater. For achieving this, every catchment and hillock was drained by canals.

Ground water resources of the study region

- A larger number of Baoris, wells and jhalaras constitute the major source of ground water reserves in Jodhpur district. Among the most popular baoris in Jodhpur district are Mandore bawari the oldest one which was constructed in 784 A.D. in Mandore. Bheru Baori at Mandore was constructed 600 years back. Chand Baori (1460), Jagu baori (1465), and Idgah Baori are amongst the oldest baoris in Jodhpur. RameshwarMandir baori, Achalnath Baori, Shiv baori, Barli baori are some other bawaris which were supplying water some years back. Many baoris in Jopdhpur district have been abandoned with the passage of time and many have been lost. No attention is paid to the restoration of the left baoris.
- Jhalaras constituted other important water resource in Jodhpur district. The water of jahalara was used for bathing purpose and not for the drinking purposes. Jhalaras are rectangular in design they had steps on three or four sides. The Mhamandir Jhalara is the oldest one which was constructed in 1660 A.D. Kriya ka Jhalara and Mandore Jhalara are some 400 and 500 years old. Many of the jahalaras are in a dilapidated situation today.
- Wells constituted some prominent sources of water for use in the domestic and irrigation sector. In old records some 125 wells have been listed and many of them have become abandoned today due to low water resource base.
- There is 500 years old rain water harvesting structure at Mehrangarh fort Chidiya Nath ji ka tank is an important water body in the interior of the Mehrangarh fort. Other kunds which are located at the entrance of the fort are Rasolai kund and Dev kund which captured rainy water from the hills to the premises. This allows water to be available to the public.

Today due to inability of these water harnessing structures there has been a massive dependence on the ground water reserves. The problem of ground water deterioration has been compounded by the drilling of tubewells and borewells which has resulted in the decline of ground water table in the district

Ground water scenario in the district

To understand the ground water resources of any area it is important to understand the geology and hydrogeology of the area which is discussed as under.

Geological Framework

Various igneous, Sedimentary and metamorphic rocks are found in the district. Delhi super Group litho units form a very limited part of the district. The southern part of the district is overlain by the Erinpura granite and Malani igneous rocks. The district is traversed by major lineaments: Jaisalmer- Barwani lineaments trending NW-SE, Luni Sukri lineament trending NE-SW are some. (Aquifer Mapping and Ground water Management report, CGWB, JODHPUR)

Hydrogeology

Sandstone aquifers comprise the most prominent source of ground water in the district which covers 12602 sq km (56.63%) and is found in Osian, Bawri, Balesar, Shergarh, Phalodi and Bap blocks of Jodhpur district.

a) **Delhi super Group:** Rocks comprising of schists, phyllites, slates, and quartzites form aquifer in isolated patches in small area in the south eastern part of the district. Since they occur in the granitic aquifer they form poor aquifers.
b) **Granites and Rhyolite:** Granites and Rhyolite covers a vast area in the southern part of the district forms poor aquifer.
c) **Jodhpur and Nagaur Sandstone:** They form a major aquifer in the larger part of the district in the central and northern parts of the district. It is the principal aquifer of the district. In such formation, friable and soft nature often leads to the formation of small cavities in the saturated zones. Thus, it is a very good aquifer in the district. A large number of light to medium duty wells have been constructed in such areas for irrigation and water supply purpose.

d) **Bilara Limestone:** It is the most potential aquifer in the district.
e) **Bap – Boulder belt:** It occurs in the narrow stretch in the northern part of the district having NE-SW extension. It consists of ill-sorted boulders, pebbles, cobbles embedded in salty matrix.
f) **Paleocene and associated formation:** Semi consolidated formation which comprises of soft, friable sandstone, grit and conglomerate ranging from Permian to Paleocene aquifer in extreme north west part of the district.

Unconsolidated sediments: The unconsolidated sediments which comprises of alluvium, valley fills, and aeolian sand form aquifer in districts like Shergarh, Luni and bilara block. (Aquifer Mapping and Ground water Management report, CGWB, JODHPUR)

So, the hydrogeological studies of the region indicates that the ground water reserves are found prominently in Jodhpur and Nagaur sandstone aquifer. Already the ground water reserves are skewed and due to increasing urbanization and industrialization pressure on these reserves has accentuated to a great extent.

Population pressure and demand for water resources

Table 1: Area and population in various tehsils of Jodhpur district (2011 census)

S. No	Tehsil	Population	Area (sq kilometer)
1	Phalodi	564560	7696.91
2	Osian	465257	3543.41
3	Bhopalgarh	320952	2491.64
4	Jodhpur	1378224	1968.42
5	Shergarh	452134	3866.64
6	Luni	221979	1616.85
7	Bilada	284059	1666.22
	Total	3687165	22850.00

Source: Rajasthan District Gazetteer, Jodhpur

Stages of ground water reserves in various tehsils of Jodhpur district

As the ground water reserves are the only means to meet water demand in the agriculture and industrial sector, there is a fall in the water table over the years. The table below depicts the status of ground water reserves in different tehsils of Jodhpur district.

Table 2: Ground water resources, draft and Stage of Development (2017)

Block	Area in sq.Km	Total Annual Ground water recharge in MCM	Net annual Ground water Availability in MCM	Existing Ground water draft for irrigation	Existing Ground water draft for Domestic and Industrial uses
Balesar	1888.25	25.6388	22.00445	50.85	10.4
Baori	1387.33	32.8707	28.4425	118.54	22.46
Bap	4393.31	63.0015	64.8397	29.006	10.59
Bhoplagarh	4393.31	56.9810	50.6564	105.94	10.41
Bilara	1757.69	47.4325	40.3010	100.84	8.01
Luni	1504.33	23.3537	22.4102	12.34	1.09
Mandore	1978.95	29.2687	26.6456	39.83	3.01
Osian	1260.96	59.0402	54.1478	174.22	59.78
Phalodi	2861.07	51.2995	54.2680	93.81	32.28
Shergarh	3118.13	40.6384	32.5675	50.61	17.45
Total	22250	429.5249	396.3234	776.09	175.511

Source: Aquifer Mapping and Ground water Management Report, Central Ground Water Board, Jodhpur

From the above table it can be inferred that irrigation contributes for the maximum extraction of the ground water reserves in the Jodhpur district. Against the annual recharge of 429.52MCM the ground water usage in the irrigation sector is 776.09 MCM and in the industrial and domestic sector it is 175.511 MCM. Ground water is highly exploited in the district.

Table 3: Status of Ground water Reserve in Jodhpur district

Block	Stage of Ground water Development	Category
Balesar	277.03	Over Exploited
Baori	300.25	Over Exploited
Bap	61.16	Over Exploited
Bhoplagarh	229.70	Over Exploited
Bilara	270.11	Over Exploited
Luni	59.96	Over Exploited
Mandore	160.78	Over Exploited
Osian	432.18	Over Exploited
Phalodi	232.36	Over Exploited
Shergarh	209.01	Over Exploited
Total	226.03	Over Exploited

Source: Aquifer Mapping and Ground water Management Report, Central Ground Water Board, Jodhpur

As can be seen from the following table that all the blocks are in the over exploited category, highest rate of extraction is in the Osian, Baori, Balesar blocks. Thus, it poses serious threat and remedial measures are to be taken for judicious usage of ground water resources.

The overexploitation of ground water resources results in the fall of ground water table, the district also faces other issues that are related with ground water quality which are discussed as under.

1. Highly mineralized ground water is found in the Rann area.
2. Highly saline water is found in the Southern, South-eastern, and South Western parts of the district.
3. High Fluoride contamination is found in the major parts of the district covering western halves of Bap, Balesar, and Phalodi blocks, major parts of Shergarh block, eastern and south-central parts of Osian block and in isolated patches in other parts of the district.
4. High Nitrate concentration is reported from parts in Osian, Bhopalgarh, Mandore and Luni block.
5. The potential zones in the district have registered heavy ground water development which has led to the reduction of the water table in the district.
6. Besides these, Jodhpur is fast emerging as an industrial center. These industries are located in the Basni

industrial area of Jodhpur district. The industrial effluents are discharged in the Jojari river flowing south in the city. As a result, the water is left unfit for human consumption and even for consumption by the livestock.

Table 4: Average water table level in Jodhpur district (Average water level in meter)

Zone	Region	April 2009	October 2019	Change
1	Chandpole, Kharbuja Bawari Region	1.38	2.67	-1.29
2	Baiji ka talab	3.60	6.71	-3.11
3	Gulab Sagar-fateh sagar region	2.61	4.08	-1.47
4	Laxminagar, BJS region	3.62	3.258	+0.34

Source: Rajasthan District Gazetteer, Jodhpur district

Table 5: Minimum, Maximum and average water table according to Panchayat samiti (Pre-Monsoon, 2020) (Water level in meter)

S. No	Panchayat Samiti	Minimum	Maximum	Average
1	Balesar	7.66	60.99	34.16
2	Bawadi	11.90	169.50	74.18
3.	Bap	8.25	114.50	63.70
4.	Bapini	82.80	148.50	119.10
5.	Bhopalgarh	13.45	141.00	67.75
6.	Bilada	4.35	127.15	37.71
7.	Dechu	36.36	96.90	69.33
8.	Lohawat	73.90	115.12	100.24
9.	Luni	1.81	64.25	21.96
10.	Mandore	4.83	103.60	27.25
11	Osian	42.20	143.65	94.06
12	Phalodi	6.60	154.10	99.60
13	Pipar City	8.05	162.25	42.54
14	Shekhala	20.70	103.33	64.86
15	Shergarh	26.00	54.40	38.28
16	Tinwari	40.50	113.85	69.90
	Average of district	23.34	117.09	64.03

Source: Rajasthan District Gazetteer, Jodhpur

From the above table it can be inferred that very deep-water levels have been reported from Bawari, Bap, Bapini, Bhopalgarh, Lohawat, Osain and Phalodi. The average water level is below 50 meteres in these areas.this shows that the rate of ground water draft is very high in the district. Thus, remedial measures are needed to be taken in a fast-growing urban agglomerate like Jodhpur.

Suggestions to restore urban water resources

(A) Conservation of Surface water: Many major water sources like ponds of the village and their drainage have not come under the influence of urbanization, so they should be protected and their water course must be kept intact.

The urban areas are facing shortage of water resources, there are several traditional water harvesting structures in the urban areas, they should be restored and made functional to solve urban water crisis.

(B) (B)Conservation of Ground water: The development of new technology has enabled us to yield water from great depth as a result of which ground water table has fallen considerably. This problem is more acute in the urban areas as there are no open spaces there. Due to the shrinkage of the open areas the ground water reserves are declining fast. So, there must be emphasis on promoting greenery by planting local species of plants in the region.

(C) Roof Top rain water harvesting structure: Since ancient times there has been an extraordinary level of water management in the Thar region. People have used igneous techniques to preserve every droplet of rainy water. Roof top rain water harvesting had a prominent place in the society and was used to reserve the rain water underground to be used at the times of scarcity. It's present implementation must be strictly enforced.

(D) Ground water Regulatory Measures: In the dry environ of Jodhpur, drip and sprinkler irrigation methods are most effective and efficient methods of cropping. They yield better results along with no wastage of water. Jodhpur crops drought resistant varieties of crops like Bajra, Jawar, pulses, castor seeds, the dry bed of Luni is known for the melon cultivation. To control overextraction of ground water resources, registration of drilling agencies and ground water abstractions structures must be made mandatory.

(E) Industrial sector: Industries are rapidly growing in the region like industrial region around Basani has grown fast. The industrial effluents of the waste water is discharged into the Jojari River without any treatment which is a cause of Surface water pollution. The industrial waste must be treated and supplied to the agricultural fields for irrigation

Other remedial measures

- The conservation of water can be made successful by bringing mass awareness and literacy about conservation of water.
- Micro irrigation techniques like drip irrigation and sprinkler irrigation be subsidized and promoted in the dry arid landscape of Jodhpur.
- Water resistant varieties of crops along with animal husbandry is ideal for the water stressed region like Jodhpur.

- Under Mukhya Mantri Jal Swavablamban Yojana and NREGA the ruminants of the abandoned water harvesting structures should be restored.
- Reviving the need for water conservation using ancient wisdom of water harvesting.
- Sewage treatment plants be set up in the district so that the domestic wastewater can be reused and recycled.
- Stringent rules be made for the borewell/tubewell drilling.
- Climate resilient agriculture be promoted.
- Close cooperation between Government and private players like NGO'S must be ensured. NGO's like Gramin Vikas Vigyan Samiti is working for natural resource management and sustainable development in the district. 500 years old talab in the Andesar village in Jodhpur has been renovated by them. Water is now available for 1600 families in the nearby villages.

Fig 1: A renovated Naadi at Andesar village. Source (Gramin Vikas Vigyan Samiti)

Fig 2: Tanka, A prominent water harvesting structure in the Western Rajasthan

Government schemes and measures to restore ground water resources

A number of policy initiatives have been taken up by the Government to promote ground water reserves. Here is a list of some nation-wide projects which are working for fostering ground water recharge through construction of rain water harvesting structures and reviving the old ones.

- Jal shakti Abhiyan: Launched in 2019, it focuses on rain water harvesting and water conservation across urban and rural districts.
- Atal mission for Rejuvenation and Urban Transformation (AMRUT 2.0) which promotes rain water harvesting.
- Atal Bhujal yojana- Targets water stressed Gram Panchayats in 80 districts across 7 states, focuses on ground water management.
- Pradhan Mantri Krishi sinchayee Yojana- focuses on improving water use efficiency through Har Khet ko Pani, repair and renovation of water bodies and surface minor irrigation schemes.
- Mission Amrit sarovar- it aims to rejuvenate 75 amrit sarovars in every district to enhance water harvesting and conservation.
- National Aquifer Mapping - promotes ground water recharge by scientifically mapping aquifer and knowing about the geology and geomorphology of the area,
- National water Policy- focuses on promoting water harvesting.

Conclusion

Arid to semi-arid conditions prevail over Rajasthan. The state also faces uncertainty and unevenness of rainfall. The city of Jodhpur is facing increasing water scarcity as the surface water sources have diminished and the ground water resources are getting fast exhausted. There is demand deficit in water supply. So, there is an overdependence on the ground water reserves. Use of Artificial Intelligence and Internet of Things can be effectively used to monitor ground water reserves. There is a need to adopt integrated water resource management, research new ground water resources availability, rain water harvesting, water audit for domestic uses, treatment of industrial and domestic water through sewage treatment plants. Higher tariffs prevent excessive consumption pattern. In turn it will change the practice of water consumption. So proper measures be taken by the concerned authorities to prevent misuse of water.

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