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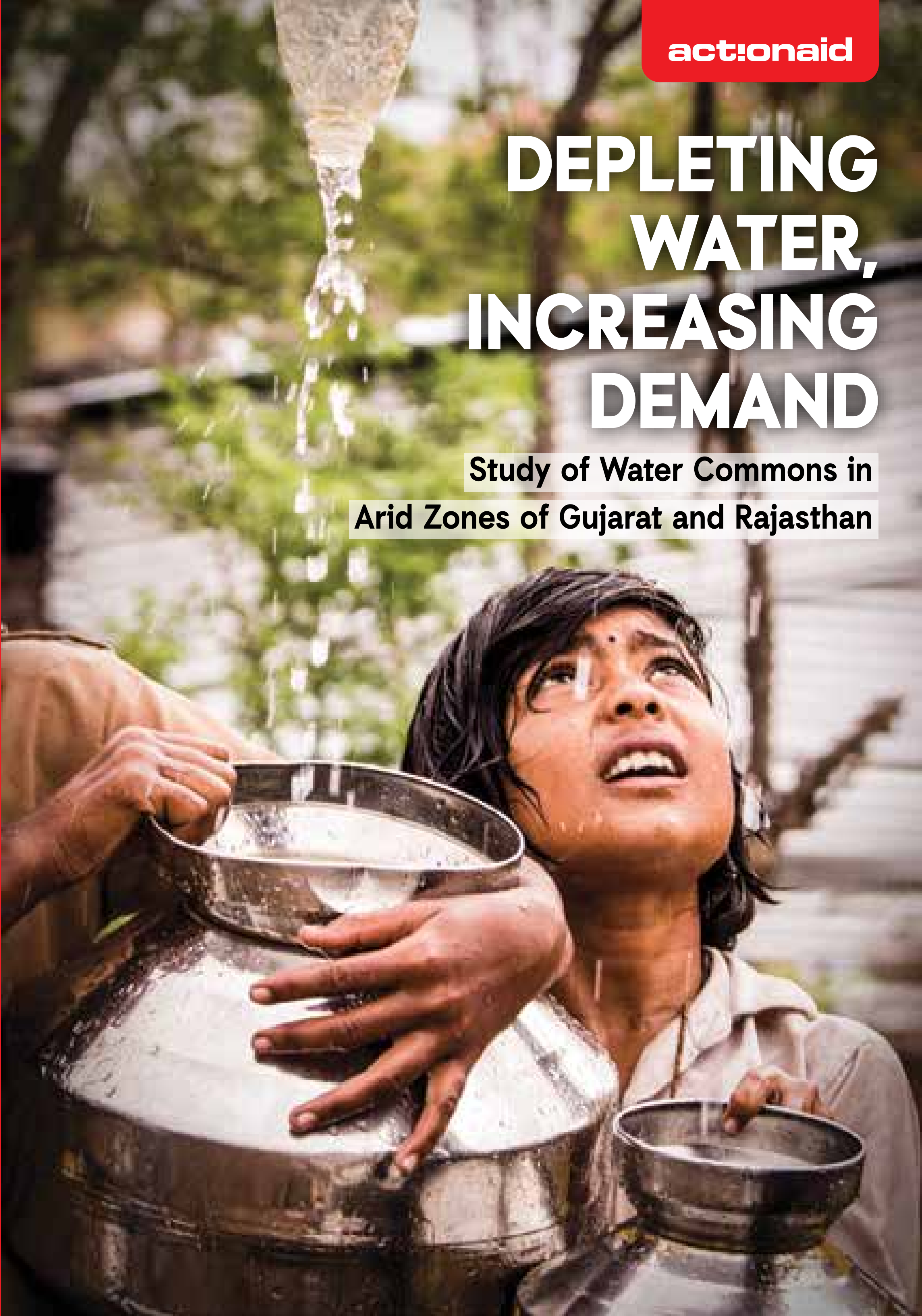
# DEPLETING WATER, INCREASING DEMAND

## Study of Water Commons in Arid Zones of Gujarat and Rajasthan



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# FOREWORD

The impact of climate change is being felt most by communities that are least responsible for it. We need to recognize the importance of the intertwined goals of ecological and social justice. We need to recognise that while land, forests and water commons are vital to the sustenance of all humankind, these are especially important for the vulnerable landless agricultural workers, small farmers, pastoralists, tribal communities and fisher-folk communities. Commons represent the human collective and nature, and furthering of the commons supports and protects individuals, communities and nature itself. Thus we need to work on both "water as a human right" and "water as commons" - as we work for the establishment of individual rights and entitlements to drinking water and water for agriculture and livelihood; we also need to recognize the need to protect ecosystems and look towards recharging aquifers, rivers and waterbodies.

Water plays a crucial role for life in arid zone. Communities living in arid zones are especially at risk to the changing climate, and the growing shortage of water caused by overdrawing from aquifers and water bodies. People in arid zones struggle hard to create water opportunities with less or no rainfall putting their wisdom and innovation to preserve and use whatever water is available. People living in drylands have been very innovative in their effort to cope with water challenges they face in their day to day life. It is no surprise that these regions have rich traditions of innovative management of water resources to overcome water scarcity. Their experience, learning, skills, structures and knowledge have contributed a lot to sustain life in arid regions. It is important to understand traditional knowledge and recognize its relevance to deal with water scarcity. *Depleting Water, Increasing Demand* seeks to document the traditional water harvesting structures and knowledge in arid zones in Gujarat and Rajasthan so that it can be revived and used for the betterment of life in the desert. This is of great importance in the context of growing desertification and mounting pressure on water availability.

*Depleting Water, Increasing Demand* also presents a compilation of case studies from different rural villages, and deals with the difficulties faced by women and people from Dalit communities to fetch and manage water. The report brings recommendations from people on water commons, pastureland and pastoral life in desert area. These recommendations would contribute to policy formulation in this direction.

I am grateful to all the organisations who have collaborated with us on this study – Universal Just and Action Society, Sahyog Sansthan, Lok Adhikar, Ekal Nari Shakti Manch, Ujjash Charitable Trust, Central Arid Zone Research Institute, Arid Communities and Technologies and Unnati. I believe such collective efforts will help in bringing transformations to water scarcity in arid regions. I thank colleagues of ActionAid Association working on the water commons thematic area and in the Rajasthan & Gujarat Region for the efforts to prepare this report and bring the issue of water commons in arid areas to public discourse.

I look forward to comments and suggestions so we can be better equipped to engage with these issues.

In solidarity,

**Sandeep Chachra**
Executive Director
ActionAid Association

# ACKNOWLEDGEMENTS

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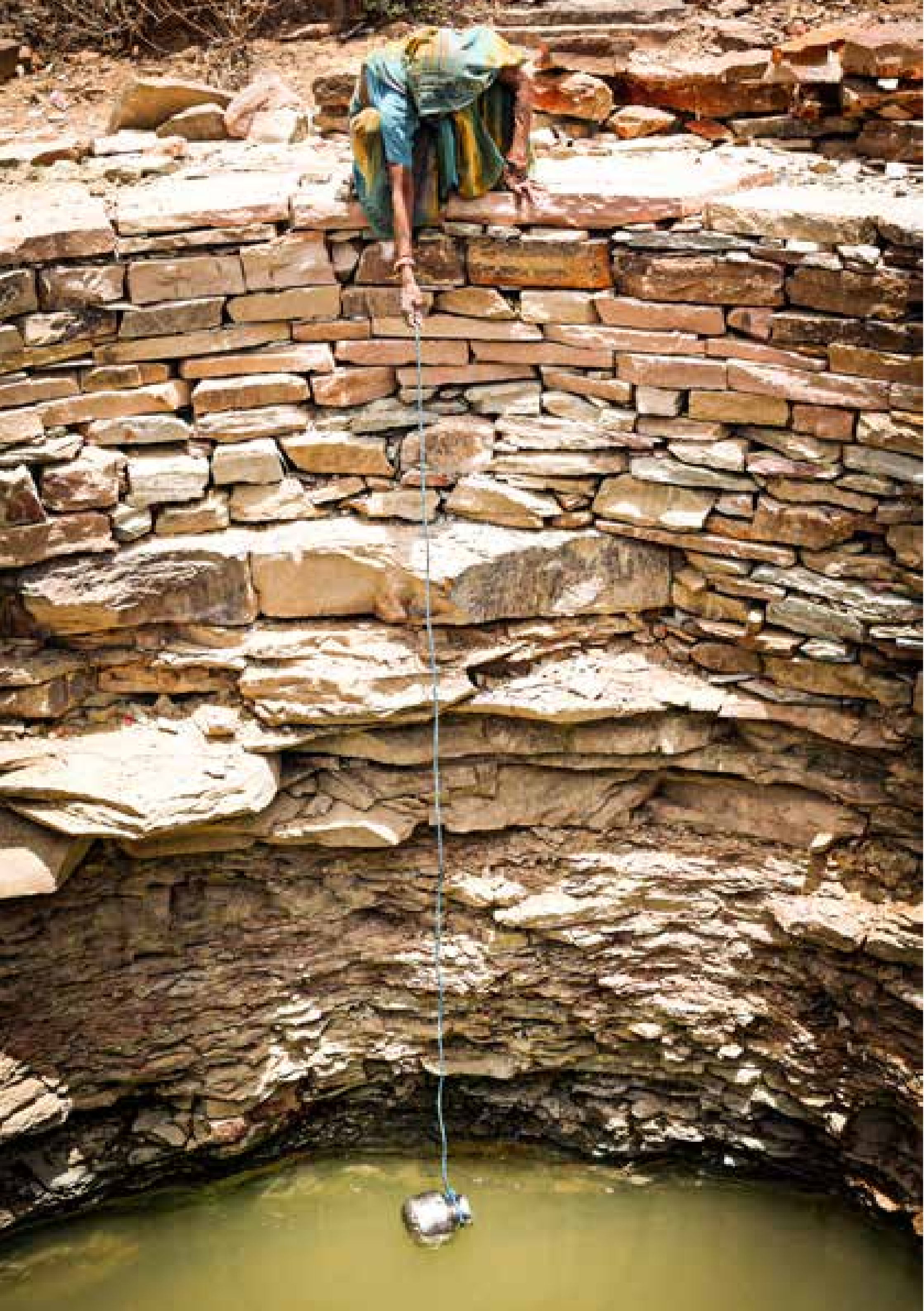


# ABBREVIATION

| | | |
|---|---|---|
| ASI | : | Archaeological Survey of India |
| CAZRI | : | Central Arid Zone Research Institute |
| DW | : | Dug Well |
| FGD | : | Focused Group Discussion |
| GEN | : | General |
| GW | : | Ground Water |
| GWR | : | Ground Water Recharge |
| HP | : | Hand Pump |
| IGNY | : | Indira Gandhi Nehar Yogna |
| JBF | : | Jal Bhagirathi Foundation |
| MGNREGA | : | Mahatma Gandhi National Rural Employment Guarantee Act |
| NGO | ; | Non-Government Organisation |
| OBC | : | Other Backward Community |
| PVC | : | Polymerisation of Vinyl Chloride |
| RO | : | Reverse Osmosis |
| RWH | : | Rain Water Harvesting |
| SC | : | Scheduled Caste |
| ST | : | Scheduled Tribe |
| TW | : | Tube Well |
| UJAS | : | Universal Just and Action Society |

# EXECUTIVE SUMMARY

It is difficult to derive a definition of aridity because of diverse environmental conditions. Aridity is a state of being very dry and without enough rains for plants. It is basically a comparison between water supply and water need. Water supply in general means the amount of water received from precipitation while water need is measured in terms of evapotranspiration. A region is arid when it is characterised with severe lack of available water to the extent of hindering or preventing growth and development of plants and animals.

Water is a scare commodity in arid zones, and much of the rainfall is lost by evaporation. In arid zones, vegetation is typically sparse and there is poor growth of woody species. Arid zones are located in almost all the continents. Arid zones face a plethora of problems, but increasing desertification and land degradation are issues that demand global concern, attention and action.

The hot arid zone of India is situated between 24° and 29° N latitude and 70° and 76°E longitude, and covers an area of 31.70 million hectares. The arid areas of western Rajasthan, Gujarat, Punjab and Haryana, together constitute the Great Indian Desert, better known as the Thar Desert, which accounts for 89.6 per cent of the total hot arid zone of India. Thus, Thar constitutes the principal hot arid zone of India. The north western portion of Rajasthan is generally sandy and dry. Most of this region is covered by the Thar Desert, which extends into adjoining portions of Pakistan. Northern parts of the Gujarat receive less rainfall and that too for very few days in a year. Moreover, the region of Kutch is adjacent to the Salty plains of Rann of Kutch and Arabian Sea.

People in these areas did not wait for any miracle to happen to solve their water crisis, rather over a period of time they proactively developed various structures and systems for water conservation so that each and every drop of rain water gets saved. Different kinds of structures have been developed over the years to conserve water in this region. Parr, Kuis, Booris, SazaKuva, Naada/Bandh, Rapat, Talab, Chandala Tank, Bundel Tank, Kunds/Kundis, Jhalaras, Nadis and Tobas are different traditional structures that have been found in different locations to conserve water. Some of these structures have been maintained and are still in use while some are no longer in use since the modern water harvesting structures have come into existence.

Modern water structures that include canals, bore wells, open wells, tube wells, RO plants and piped water supply with overhead water tanks are now found in most of the villages in place of traditional water structures.

It was felt that in order to address the crucial issue of water conservation in the arid zone, it is necessary to conduct a research study targeting the arid parts of western Rajasthan and north-western Gujarat to document the relevant status and changes in trends, particularly in rainwater harvesting practices and systems to pave the way for its advocacy for relevant policy change.

One of the major objectives of this study was to suggest required advocacy steps for policy and practice change aimed at campaigning for promotion and nurture of rainwater harvesting that is rooted into cultural practices, traditional knowledge and historical learnings. The focus of this study is to understand the importance of traditional water harvesting structures and their relevance in the present context, particularly in the context of socio, cultural, environmental and ecological aspects of arid zones.

The study covered 5 districts, 15 blocks, 18 Gram Panchayats, 20 villages and 35,186 households of Rajasthan and Gujarat states. Apart from focused group discussions, individual interactions, PRA technique and transect walk to water site was done during the study. However, small size, lack of scope for combined discussion with men and women and limited time are some of the limitations of this study.

It was learnt that across the study area of both Rajasthan and Gujarat; historically and traditionally rainwater harvesting has remained a key source of water for people to fulfil their water related needs. The Study findings reveal that in both the states (of the total visited villages), about three-fourth of villages have admirably got access to canal-fed lift-water supply schemes mainly for drinking water purposes. But the remaining one-fourth of the villages, which do not have access to canal water, exclusively depend on groundwater as a key water source, with rainwater serving as supplementary source.

As far as access to canal water is concerned, it is creditable that around three-fourth of the visited villages have access to canal water mainly through lift-water supply schemes in order to meet their drinking water needs. One third of these villages have reportedly been given the canal water link either a few months or a few years back. The remaining two-third of the villages received access to canal fed lift-water supply schemes around a decade back or in some cases, even earlier. By and large, people are very happy to have canal water in their villages. But the water supplied through canal is limited and is mostly used for drinking purposes. Moreover, canal link has adversely impacted the traditional water system of the region. Based on experiences people don't believe that canal water can be a constantly available source or that it has the ability to totally replace rain and ground water supply.

Study findings reveal that almost all the studied villages have access to tube wells or motor pumps (on an average there are 2 motor pumps per village) installed 10 to 20 years back. In one-fourth of the visited villages, ground water schemes were reportedly non-functional. The reasons for their non-functionality were mainly increased depth of ground water level and failure of proper area identification and extracting mechanism.

The study area is reportedly suffering under significant menace of underground natural resources' mining. Particularly, in desert of western Rajasthan the fossil fuel resources including coal, oil and gas are either being exploited continuously, or such exploitation is feared to commence in the future. This indicates that impending fear of water insecurity due to the hazards of mega mining of coal along with excessive exploitation of groundwater must generate awareness among the people to keep alive at least one indigenous source of water like rainwater harvesting practice.

Study findings disclose that the provision of both groundwater and canal water dependent water supply schemes in the villages have tremendously augmented the households' access to water in the last two decades. The study further reveals that people of around three-fifth of the villages are reportedly engaged in farming with the help of tube-wells using groundwater. On an averagely six tube wells are installed per village by well-off people in order to irrigate their agricultural fields.

It is well known that rainwater harvesting is entirely dependent on the pattern of rainfall in the area. The study identified areas of western Rajasthan and its adjacent areas of Gujarat that fall under low rainfall category which is averagely around 150 mm to 250 mm annually. However, rainfall metrological data of last 10 decades shows that in every decade there also occur two to three heavy rains that create a flood like situation. One positive finding of the study is that despite influx of modern water solutions, including canal fed lift-water schemes and groundwater extracting motorised schemes, though the use of traditional rainwater harvesting systems has dwindled, but it has not disappeared altogether.

It can be concluded that the advent of abundant groundwater schemes in last two to three decades have led to criminal over-exploitation of groundwater leading to aquifer depletion/ drastic fall of water table and deterioration of water quality. This has naturally put adverse impact on groundwater dependent arid ecology and has also led to increased desertification. History bears testimony to the fact that traditional rainwater harvesting and groundwater recharge system remained sustainable water solutions in this most water scarce zone for centuries.

It has been learnt that historically traditional rainwater harvesting in villages remained deeply connected to different religious and cultural practices. These had social sanction and motivated people to adopt a number of practices for promotion and protection of water bodies. Since water was so precious for communities, they developed expertise using indigenous technology and knowledge to harvest rain water in the best possible manner. Many people developed techniques to identify sweet ground water source and appropriate locations for excavation of ponds. Hence, centuries old structures made for harvesting rainwater are still alive even without proper maintenance in many parts of western India. People in the study villages have shared many experiences related to their life, water and environment in arid zone. The recommendations are drawn based on their views and ideas.

## Recommendations

- It is important to protect all water bodies which are largely encroached for construction of road, buildings and other structures. The study recommends for strong policy to prevent any kinds of encroachments or diversion of any water bodies at any place. Catchment area of all water bodies also need to be free from encroachment.
- Many water bodies have been built using traditional knowledge and technique. Those water bodies contribute to water harvesting. People in many areas have suggested and recommended that all such water bodies need to be protected for water percolation and ground water recharge.
- The study recommends for protection of pasture land and pastoralist rather than promoting agriculture activities to deal with water contamination due to use of chemical fertiliser and pesticides in crops. There should not any diversion of pasture land for agriculture or any other activities.
- Establish 'rainwater harvesting & groundwater recharge' demonstration stations representing all effective indigenous/traditional relevant models with value additions of advanced appropriate technologies.
- All relevant governmental schemes across departments must appropriately incorporate/integrate component of 'rainwater harvesting and groundwater recharge'.
- All schemes related to 'rainwater harvesting and groundwater recharge' must integrate with promotional materials and advertisements for promoting literacy and awareness on the subject.
- District and state level advocacy groups must be established/strengthened, taking all concerned stakeholders on board, with the mandate of reviving/promoting 'rainwater harvesting and groundwater recharge'. There is need for raising awareness, conducting various drives/campaigns, organising theme related events and other appropriate measures.
- Feasible areas with wider catchments (prone to flooding) and dense vegetation should be identified for new rainwater harvesting schemes. There is a need to campaign for desert friendly tree-plantations in the surroundings of rainwater harvesting structure.
- Wherever naturally built feasible catchments are not available, manually built catchments may be created for this purpose.

- Ensure that wasted/leaked water in villages should be used/reused in tree-plantation/gardening or for other environment friendly measures.
- Robust 'rainwater harvesting and groundwater recharge' models should be built in schools and schools syllabi should include importance and functionalities of 'rainwater harvesting and groundwater recharge'.
- Identify and rehabilitate non-functional/under-utilised RWH & GWR (dug-wells) structures
- Take appropriate measures ensuring that all concerned actors should adopt indigenous, cost-effective and contextually proper designs and architectures for erecting effective and sustainable structures of 'rainwater harvesting and groundwater recharge'.
- Appreciate and award roles and contributions of individuals and communities around promotion/revival of 'rainwater harvesting and groundwater recharge'.
- Water budgets of government must have separate allocation for 'rainwater harvesting and groundwater recharge' creating a balance among schemes related to Groundwater Extraction, Canal Water, Rainwater Harvesting and Groundwater Recharge.
- Chemical uses in mining, commercial/industrial activities and agricultural inputs leads to pollution of groundwater, canal water flows and rainwater runoff. Thus, there is a need to protect water resources from such pollution.
- Extracting groundwater through bore-wells, supply through water tankers and other such contractual/commercial phenomenon in water distribution/supply tends to promote water privatisation in this zone. Hence, commoditisation and privatisation of drinking water must be stalled.
- All government schemes of 'rainwater harvesting and groundwater recharge' must be reviewed and revisited and their design upgraded for effective implementation and achieving desired objectives and results.
- While promoting traditional 'rainwater harvesting and groundwater recharge', advanced technologies must be integrated to identify feasible lithology/strata and aquifers for recharging groundwater resources.
- Canal water has its own limitation to meet the growing water needs for domestic and agricultural purposes. This is the reason why exploitation of groundwater has reached alarming levels in most parts of the study area. There is a need to shift focus of contemporary means of modern water accessibility to historically tested and proven durable source. Hence it suggested that 'traditional rainwater harvesting and groundwater recharge' must be revived and scaled up as sustainable water solution of this water scarce zone.

- Available metrological data reveals that the area has witnessed three-fold increase in the incidence of floods during last decade. More than 95 per cent rain water goes waste through runoff and evaporation causing devastations to the area. Hence this challenge can be converted to opportunity by focusing on 'rainwater harvesting and groundwater recharge' structures.

# 1 INTRODUCTION

Aridity is a state of being very dry and having to do without enough rain for plants. It is basically a comparison and disparity between water supply and water need. Water supply in general means the amount of water received from precipitation while water need is measured in terms of evapotranspiration. A region is arid when it is characterised by severe lack of available water to the extent of hindering or preventing growth and development of plants and animals. Arid environments are extremely diverse in terms of their land forms, soils, fauna, flora, water balances and human activities. On account of this diversity, no single and practical definition of arid environments can be derived. However, the one binding element to all arid regions is dryness. Aridity is usually expressed as a function of rainfall and temperature.

Three arid zones can be delineated by index: namely, hyper-arid, arid and semi-arid. Of the total land area of the world, the hyper-arid zone covers 4.2 per cent, the arid zone covers 14.6 per cent and the semiarid zone covers 12.2 per cent. Therefore, almost one-third of the total area of the World comes under arid land.

The hyper-arid zone (arid index 0.03) comprises dry-land areas without vegetation, with the exception of a few scattered shrubs. True nomadic pastoralism is frequently practiced in these areas. Annual rainfall is low, rarely exceeding 100 millimetres. Rains are infrequent and irregular, sometimes long periods witnes no rain.

The arid zone (arid index 0.03-0.20) is characterised by pastoralism and no farming except with artificial irrigation. For the most part, the native vegetation is sparse, and includes annual and perennial grasses and other herbaceous vegetation, shrubs and small trees. There is high rainfall variability, with annual measurements ranging between 100 and 300 millimetres.

The semi-arid zone (arid index 0.20-0.50) can support rain-fed agriculture at more or less sustained levels of production. Sedentary livestock production is also practised. Native vegetation is represented by a variety of species, such as grasses and grass-like plants, fortes and half-shrubs, and shrubs and trees. Annual precipitation varies from 300-600 to 700-800 millimetres with summer rains, and from 200-250 to 450-500 millimetres with winter rains.

## Arid Zone Climate

The arid zone is characterised by excessive heat and inadequate, variable precipitation; however, contrasts in climate also occur. In general, these climatic contrasts result from differences in temperature, the season in which rain falls and in the degree of aridity. Three major types of climate are distinguished when describing the arid zone: the Mediterranean climate, the tropical climate and the continental climate.

In the areas with Mediterranean climate, the rainy season is during autumn and winter. Summers are hot with no rains; winter temperatures are mild. In areas with tropical climate, rainfall occurs during the summer. The greater the distance from Equator, the shorter is the rainy season. Winters are long and dry. In the areas with continental climate, rainfall is distributed evenly throughout the year, although there is a tendency towards greater summer precipitation. In Alice Springs, Australia, for example, each monthly precipitation is less than twice the corresponding mean monthly temperature; hence, the dry season extends over the whole year.

As mentioned earlier, arid environments are extremely diverse in terms of their land forms, soils, fauna, flora, water balance, and human activities. The binding element of all arid environments is aridity. Water is a scare commodity in arid zones, and much of the rainfall is lost by evaporation. In arid zones, vegetation is typically sparse, and growth of woody species is poor. Arid zones are located in almost all the continents. Arid zones face a plethora of problems, but increasing desertification and land degradation are issues that demand global concern, attention and action.

The hot arid zone of India is situated between 24° and 29° N latitude and 70° and 76°E longitude, and covers an area of 31.70 million hectares. The arid areas of western Rajasthan, Gujarat, Punjab and Haryana, together constitute the Great Indian Desert, better known as the Thar Desert, which accounts for 89.6 per cent of the total hot arid zone of India. Thus, Thar constitutes the principal hot arid zone of India. It extends for 640 km from northwest to southeast with an average width of 300 km. A little more than 10 per cent of the arid region lies in Andhra Pradesh, Karnataka and Maharashtra states, and is referred to as the peninsular hot arid zone. In general, climatic and edaphic conditions of the Indian hot arid zones are inhospitable; however, this is the most populated arid zone of the world, with a density of 101 persons/ km2 against the world average for arid zones of 6–8 persons/km2 . The Indian hot arid zone is also the most vegetated arid zone. Farmers grow arable crops in association with suitable tree species. Since most of these trees are drought resistant, they are still able to provide fuel, fodder, fruits and other products, when other crops fail due to the frequent droughts. Precisely, the hot arid areas are those places that have little and highly variable rainfall, extreme variation in temperature (daily and annual) and high potential evapotranspiration. In general, hot arid climates have excessive heat and strong prevailing winds, unhampered by obstacles on the ground, and as a result Aeolian erosion is common with frequent seasonal occurrence of dust storms.

Water is a scare commodity in arid zones. Much of the rainfall is lost by evapotranspiration, and as a result, groundwater is recharged only locally by seepage through the soil profile. However, it is a common phenomenon in arid zones of the World that groundwater is frequently used at rates that exceed recharge. Moreover, the water that is available for use in many arid areas of the world is affected to varying degrees by salinity. Mineralisation of groundwater resources is also a common problem. The reasons for mineralisation include evaporation from water surface, fossil brines from ancient river courses and lakes, and airborne salts deposited by precipitation, and also in the form of dry fallout.

## Rainfall

The rainfall that comes from the atmosphere at a particular location is either intercepted by trees, shrubs and other vegetation, or it strikes the ground surface and becomes overland flow, subsurface flow and groundwater flow. Regardless of its deposition, much of the rainfall eventually is returned to the atmosphere by evapotranspiration processes from the vegetation or by evaporation from streams and other water bodies into which overland, subsurface and groundwater flows move. The relative dynamics of the hydrological cycle in an area are determined, in large part, by the spatial and temporal nature of rainfall patterns, temperature and atmospheric humidity regimes, soil and topographic features and vegetative characteristics of the area.

Rainfall also varies from one year to another in arid zones; this can easily be confirmed by looking at rainfall statistics over time for a particular place. In most instances, the expected rainfall in a given place is not the same as the mean annual rainfall recorded over a number of years. Rainfall intensity is another parameter that must be considered. Since the soil may not be able to absorb all the water during a heavy rainfall, water may be lost due to runoff. Likewise, the water from a rain of low intensity can be lost due to evaporation, particularly if it falls on a dry surface. Rainfall intensity can be measured as the number of rainy days or, more preferably, as the amount of rain per hour or per day.

Growth of plants can take place only between certain maximum and minimum temperatures. Extremely high or low temperatures can be detrimental to plants. Plants might survive high temperatures, as long as they can compensate for these high temperatures by transpiration, but their growth will be affected negatively. High temperatures in the surface layer of the soil result in rapid loss of soil moisture due to high levels of evaporation and transpiration. Although problems of low temperatures, in general, are less common in arid zones, when they do occur for relatively long periods of time, plant growth gets restricted and at temperatures below 0 centigrade, plants may die.

Although rainfall and temperature are the primary factors upon which aridity is based, other factors too have an influence. The moisture in the air has importance for the water balance in the soil. When the moisture content in the soil is higher than in the air, there is a tendency for water to evaporate into the air. When the opposite is the case, water will condense into the soil. Humidity is generally low in arid zones.

The northern arid regions are entirely dependent on groundwater and above-the-ground tanks, ponds other traditional stores of water. The groundwater tables are low, rainfall is low and the water run-off is high.

The annual average rainfall in Rajasthan does not go beyond 60 cm whereas the national average is 110 cm. Rajasthan's average thus amounts to only half of what the country receives. However, the figures showing average cannot give a true picture of the state's rainfall on account of regional disparity wherein the rainfall can be up to 100 cm at some places and less than 25 cm at others.

Water connected practices developed for temperate climates may not work as well in arid regions for technological, environmental, economic and cultural reasons. There is a need for fresh, innovative approaches to water technologies, particularly those that are designed to meet the needs of arid regions in the less developed World.

Basically there are two approaches: increasing the supply of usable water and reducing the demand for water. Supply and demand, as well as delivery, has to be considered as an integral system. Also there is need to consider traditional water conservation practices developed in arid regions.

The amount of annual rainfall in the desert is generally low, ranging from about 4 inches (100 mm) or less in the West to about 20 inches (500 mm) in the East. Precipitation amounts fluctuate widely from year to year. About 90 per cent of the total annual rainfall occurs during the season of the southwest monsoon, from July to September. May and June are the hottest months of the year, with temperatures rising to 122 °F (50 °C). During January, the coldest month, mean minimum temperature ranges between 41 and 50 °F (5 and 10 °C), and frost is frequent. Dust storms and dust-raising winds, often blowing with velocities of 87 to 93 miles (140 to 150 km) per hour, are common in May and June.

## Water in Arid Zone

Water availability or scarcity is more related to socio-cultural practices of a region and is not solely dependent on rainfall pattern. Just as a water surplus region may suffer from both floods and droughts in the absence of proper water management system in place, similarly a water scare region may have the needed amount of water like in Rajasthan but it needs to be utilised properly and judiciously. Shri Anupam Mishra explains this beautifully in his book, The *Radiant Raindrops of Rajasthan (Rajasthan Ke Rajat Boonden)*. Collection, conservation and proper management of water has been a traditional practice in arid zone. There were large numbers of and types of water harvesting structures across the region. In the earlier times kings, rich people and most communities were putting together their hard work and resources for construction of various types of rain water harvesting structures. In this the local experts and indigenous technology and knowledge played an important role. This entire process was linked with different festivals of the year and it involved physical labour of all the people beginning from king to the pauper as a sacred task. All the mud excavated from the pond was taken to the fields by farmers to enrich the sandy soil. This process added necessary nutrients to the soil without any extra expense and there was no tension for excavated mud management. In recent times, these systems have changed on account of dwindling social systems, lesser community togetherness and increasing urbanisation. People are less concerned about being water conscious. However, different types of water supply systems have been developed in recent times but one is not certain about their sustainability as not merely arid regions but the whole world is confronted with a serious water crisis.

## Water and Women

In many villages, the burden of having to fetch water for the household from long distances falls on women. Leaving aside the implicit assumption that this is essentially a woman's task, the answer to this problem is to improve access of the village to a nearer source of water, thus freeing women from the drudgery of having to bring water from distant sources.

The concept of the right to water implicitly assumes that the basic water needs of men and women are the same. It is necessary to recognise that women have some special water and sanitation needs. Women play important roles as providers and managers of water in the household context. In many instances, they are also farmers, farm workers, managers and entrepreneurs. However, they are rarely consulted in water-policy or water-management decisions. Most 'participatory' schemes recognise only men as economic agents. This must change. Women must be participants in all water-related institutions (managerial, policymaking) at all levels. Inclusion of women in such bodies must be non-exclusionary, with no reference to title, to property or other restrictive criteria; their participation must be real and effective and not nominal or illusory; and there must be programmes in place to enhance their effectiveness.

# 2 STATE PROFILES AND STATUS OF WATER COMMONS

Thar Desert extends between Aravali Hills in the north-east, Great Rann of Kutch along the coast and alluvial plains of the Indus River in the west and north-west. Most of the desert is covered by huge shifting sand dunes that receive sediments from the alluvial plains and the coast. The sand is highly mobile due to strong winds occurring before the onset of monsoon. The Luni River is the only river integrated into the desert. Rainfall is limited to 100–500 mm (3.9–19.7 inches) per year, mostly falling from July to September. The name Thar is derived from 'thul', the general term for the region's sand ridges.

Two Indian states come under the geo location of Thar Desert – Rajasthan and Gujarat. The desert climate facilitates different kinds of vegetation, flora, fauna and different types of wild life and birds. All these are also in some way linked to the rainfall pattern of the states.

## State Profiles

### *Rajasthan*

The state was formed on 30th March 1949 when Rajputana merged into the Dominion of India. Rajasthan literally means "Land of Kings" or "King's Abode" (raja "king" and sthan "land/ abode" from Sanskrit sthā□na). The geographic features of Rajasthan are the Thar Desert and the Aravalli Range, which runs through the state from southwest to northeast, almost from one end to the other, for more than 850 kilometres (530 miles).

The north western portion of Rajasthan is generally sandy and dry. Most of this region is covered by the Thar Desert which extends into adjoining portions of Pakistan. The Aravalli Range does not intercept the moisture-giving southwest monsoon winds off the Arabian Sea, as it lies in a direction parallel to that of the coming monsoon winds, leaving the north western region in a rain shadow state. The Thar Desert is thinly populated; the town of Jodhpur is the largest city in the desert and is known as the gateway of the Thar Desert. The desert has some major districts like Jodhpur, Jaisalmer, Barmer, Bikaner and Nagour. This region receives less than 400 mm of rain in an average year. Temperatures can sometimes exceed 54 °C in the summer months or 129 degrees Fahrenheit and drop below freezing in the winter.

Six of the 11 districts in West Rajasthan — Jodhpur, Jaisalmer, Barmer, Bikaner, Churu and Shri Ganganagar lie wholly in the arid zone while other districts in some percentage area that fall in the arid zone are Nagaur (96 per cent), Jalore (88 per cent), Jhunjunu (69 per cent), Sikar (65 per cent) and Pali (48 per cent).

Rajasthan's acute water crisis is well known. Within Rajasthan the western parts, mainly consisting of Marwad (land of the dead) region, face the most critical water scarcity dilemma. It is a well-known fact that historically Marwad has been a land of extreme agonies with low annual rainfall, highest annual reference evapotranspiration, lowest amount of renewable groundwater resources with uppermost over-exploitation, non-perennial and extremely limited river-basin water resources, lowest per capita arable land, saline groundwater and parts of which are also under potential threat from mining menace for natural resources' exploitation. Besides these issues, the region is also exposed to extreme temperatures. Marwad has also been identified as one of the most vulnerable areas of India to be adversely affected by global warming (Majra and Gur, 2009) and is fast becoming an ecological hotspot marked by increasing desertification (Pimental, et al., 2007), depleting groundwater resources, marginal forest cover (less than one per cent) and marked increase in barren and uncultivated land areas (JBF-2010). Due to these adverse circumstances, water has become a scarce resource for the villages in this region, many of which do not have even a single source of safe drinking water within a 1.6 km radius of their homes (JBF-2010).It is no surprise then that all these precarious conditions make the predominantly rain-dependent agro-pastoral livelihoods of overwhelming number of inhabitants of this densely populated desert area, most vulnerable and threatened.

### *Gujarat*

Moving beyond the south of Rajasthan, the arid zone covers the whole region of Kutch and partially some districts of Jamnagar, Surendra Nagar, Junagadh, Banaskantha, Sabarkantha, Mehsana, Ahmedabad and Rajkot of Gujarat. Northern parts of Gujarat, geographically adjacent to and ecologically closer with western parts of Rajasthan, are more water scarce.

Northern parts of Gujarat receive less rainfall and that too on very few days of the year. Moreover, the region of Kutch is adjacent to the Salty Plains of Rann and was formerly a vast shallow of the Arabian Sea. Sea water used to intrude into the aquifers of the area leading to increase in salinity and polluting the groundwater. However, salinity and comparatively excessive fluoride concentration in groundwater is a common issue of northern Gujarat. Parts of the northern areas of the state have been provided access to canal water, which is used mainly for irrigation purposes. In such areas there is a common complaint of increased water logging and salinity, posing serious threat to cultivable lands. Across the northern areas of the state, it has been observed that the dependency on groundwater has increased extensively, resulting in an abrupt and drastic water depletion of 3 to 5 meters annually, which is much more than the groundwater recharge. In only the short span of previous two decades, the state of Gujarat has lost about 27 per cent of its ground water resources, the loss being 50 per cent in north Gujarat (Hirway 1999). Likewise, the per capita availability of water supply has declined from 1,322$m^3$ in 1991 to 1,137$m^3$ in 1999-2000 only; against the norm of 1,700$m^3$ which is the satisfactory level. This availability is only 427 M3 in north Gujarat, which indicates the worst “water stress” situation in the region. Besides, it has also been noticed that the age old, tried and tested techniques of rainwater harvesting, which were believed to be indigenous and sustainable practices to ameliorate the water scarcity woes, are disappearing from the area; thus making the region more exposed to severe water scarcity.

## Flora and Fauna of Desert

The word "desert" gives the impression of a long stretch of hot sand bed with little vegetation, thorny bushes and depressing surroundings with animal carcasses scattered around. However, The Great Indian Desert, or the Thar Desert, does not conform to this impression. Climatologically also, the Great Basin extends from Sahara to the Thar and is considered to be a continuous unit. Geographically, the Indian desert holds a rather debatable position as it exhibits an admixture of peninsular, extra-peninsular and Indo-Gangetic features. Geologically, the desert has resisted orogenic forces and has been subjected to marine transgressions, particularly in Jodhpur, Bikaner and Kutch regions. Despite water scarcity and strong heat in sandy terrain, this is considered as the most alive desert of the world.

The native plant species have adaptations that enable them to reproduce, grow and survive in the most inhospitable conditions. Some plants have evolved special root systems, while others have unique leaf characteristics that allow them to withstand prolonged periods of drought. Many woody species simply lose their leaves when soil moisture conditions become too dry (Sharma and Tewari 2016:4).

The desert area is dominated by the shrub commonly known as *phog* (*calligonum polygonoides*). It is a favourite fodder for camel and a useful source of fuel for the desert dwellers. It is highly adapted to arid conditions; the leaves are long, needle-like and the plant possesses a very efficient root system. In saline soil *lana* (*haloxylonsalicornicum*) is common. It measures about a metre in height and is much branched but leafless. It flowers from October to March loaded profusely with tiny yellow flowers.

On the sandy plains there grow familiar shrubs that have adaptations to reduce the surface area of leaves. Xerophytic plants such as *kumatiyo* (*acacia senegal*), *ber* (*zizyphus mauritiana*) and *googal* (*commiphora wightii*) are also common that have fewer branches, smaller leaves and thorns/spines. The *kair* bush (*capparis decidua*) has new leaves for less than a month around March and usually exists as an untidy thicket of leafless twigs. Some plants have fine hair on the surface of their leaves to break the airflow or a wax coating on the leaf surface to reflect sunlight. Both these adaptations can be seen in *aak* (*caliotropis procera*), a common shrub that also acts as a sand binder on the dunes. Succulents like cactus are able to store water in their tissues. *Thhor* is the most visible cactus of this region that grows in a widening circle, providing, within its stalks, a protected, shady microhabitat for other plants. Species such as the *khejri* tree (*prosopis cineraria*) and the *kair* shrub (*capparis decidua*) have a deep root system to tap into ground water reserves.

*Khejri* (*prosopis cineraria*) is vital to the ecology of the region with its deep root system penetrating up to 30 metres, as it provides both fodder and food. Its pods are gathered when green and cooked as a vegetable. The bark paste of *rohira* (*tecomela undulata*) is applied to cure eczema and syphilis. The powder of root bark is used as a cure for leucorrhoea and diabetes. The timber is used for building of houses, carts and furniture. It offers numerous medicinal applications to treat asthma, leukoderma and leprosy. Its flowers are pounded, mixed with sugars and eaten by pregnant women to safeguard against miscarriage. The grounded inflorescence mixed with sugar in water is used for prevention of boils and skin diseases. The dried bark and its paste are used to cure rheumatism. The tangy-sweet fruit of *ber* (*ziziphius mauritania*) is rich in Vitamin C. It is eaten raw, or dried, powdered and mixed with molasses or bajra flour. The flowers yield honey. The leaves provide fodder, and the root, bark and fruit are used in traditional medicine to treat inflammation, rheumatism and digestive ailments. *Badh* (*ficus benghalensis*) is a venerable tree, all parts of which have varied medicinal uses. Its latex is used to treat rheumatic pains, the leaves cure abscesses and root fibres are used to treat gonorrhoea. Infusions of the bark serve as a tonic, and bark paste with pepper is used against snakebites. The fruits and flowers of *kair* (*capparis decidua*) are cooked as a vegetable, usually with *khejri* pods. Stems and new leaves are ground and the paste is applied to cure boils and swellings. Paste of coal from wood is applied externally to muscular injuries. Powdered root bark is taken with hot water to cure asthma and cough, and also as a laxative. The desert vegetation not only provides food but also fodder, fuel, transportation and construction material to the local communities.

The Bishnoi tribal population dominates some parts of Thar and they practice a form of 'Eco religion' that holds all life forms including trees to be sacred and steadfastly conserve the ecology of their area. Courageous Amrita Devi Bishnoi's efforts to save khejri tree are legendary, and seen as a predecessor of the later Chipko movement. She sacrificed her life and led by example to protect the khejri tree. In 1730, 294 Bishnoi men and 69 women sacrificed their lives to protect trees, inspired by the example of Amrita Devi. When officials of the Jodhpur state arrived to cut the trees in her Bishnoi village for wood, she hugged the first khejri tree and literally came between the tree and the woodcutter's axe. Her three daughters followed suit, followed by other Bishnois. "This mass slaughter led to a royal order that prohibited the cutting of any tree in a Bishnoi village" (Thapar 1997:179).

Arid-land forests and trees play an important role in land stabilisation, desertification control, watershed protection and other functions along with providing wood (especially wood fuel) and non-wood products including fodder for domestic animals. They provide subsistence for dependent communities and are integrated to rural societies. Yet the productive and protective functions and vitality of forests and trees in arid lands are often jeopardised by human-caused stresses and natural hazards. Despite their importance for local economies and for the people, arid land forests and forest products are still largely neglected in natural resource management policy and decision-making processes. Expansion of land for agricultural purposes, especially with the advent of tractors, has sounded the death knell for a variety of naturally grown species.

## Livestock of Thar Desert

The economy and livelihoods of people belonging to the Thar Desert in western parts of Rajasthan and north-west peripheries of Gujarat mainly depend on rain-fed agricultural activities and livestock rearing.

A large number of farmers in the Thar Desert depend on animal husbandry for their livelihood. Cows, buffaloes, sheep, goats, camels and oxen consist of major livestock variety in Thar. Chokla, Marwari, Jaisalmeri, Magra, Malpuri, Sonadi, Nali and Pungal breeds of sheep are found in the region. Thar region of Rajasthan is the biggest wool-producing area in India and sheep-wool from Rajasthan is considered to be the best in the world for the carpet industry. The wool of the Chokla breed of sheep is considered to be of high quality. Breeding centres have been developed for Karakul and Merino sheep at Suratgarh, Jaitsar and Bikaner.[1] The best breed of cow is named after district Sindh – known as Sindhi or Tharparkar. This variety is well adapted to the extreme climatic conditions and is very useful in fulfilling the nutritional requirements of inhabitants.[2] Livestock is very important to the people of Thar Desert.

Prevailing constraints and growing challenges with regards to inaccessibility of water in this water scarce region, are the critical factors that are threatening the livestock dependent economy and nutritional well-being of the people of the area. Historical records demonstrate that when the primitive practices of traditional rainwater harvesting and groundwater recharge were used extensively in the study focused area, they were helpful in providing sweet water to livestock and increasing the groundwater table to replenish the vegetation for fodder and thereby making the desert a more conducive region for breeding of livestock. However, with all these factors the region has remained a most attractive livestock market since long.

Unfortunately, the gradual decline in use of rainwater harvesting and groundwater recharge practice has resulted in occurrence of increased runoff and subsequent land erosion, falling of groundwater table and water depletion. This is further abetted by over exploitation of groundwater. This has in turn contributed to deforestation and water scarcity; thereby turning this region into a land of adversities and non-friendly environment for breeding of livestock. It is imperative to break this vicious cycle by reviving the age-old traditional rainwater harvesting and groundwater recharge practices if the objective is to make this region a water secure zone conducive for livestock breeding in order to save fragile livelihoods of marginalised pastoral communities residing in the area.

1. Gupta, M. L. (2008). Rajasthan Gyan Kosh. 3rdEdition. Jojo Granthagar, Jodhpur. ISBN 81-86103-05-8.
2. Bakht Baidar Khan & G. B. Isani. Breeds and types of livestock in Pakistan. Animal Husbandry by S. Iqbal Shah. National Book Foundation Islamabad, 1994. Page 59.

## Traditional Water Harvesting Practices, Structures and Systems in Arid Regions

Both luck and duty underpins the water tradition of Rajasthan. "It was luck that after the Mahabharata war, as Sri Krishna was returning with Arjuna from Kurukshetra to Dwarka, his chariot passed through the deserts of Rajasthan. At the place where modern Jaisalmer stands, on mount Trikut, he met Rishi Uttung who was practising austerities there. Sri Krishna bowed to him and pleased with his devotion, told the rishi to ask for a boon. The rishi was indeed a sage of high thinking and never asked anything for himself. Instead he said to the Lord: 'If I have any merit, my Lord, may this region never suffer from scarcity of water.' 'Let it be so,' granted the Lord."[3] However, people never waited for any miracle to happen to secure their water resources. Rather, over a period of time they developed various systems for water conservation so that each and every drop of rain water gets saved.

***Parr*** is a common water harvesting practice followed in western Rajasthan region. It is a common place where the rain water flows from the catchment area and gets percolated into the sandy soil. People dug kuis or beris in the storage area to access this deposited water. Paar structures are constructed by using traditional masonry technology. Number of kuis or beris to be dug depends on the size of the paar. These paar structures can be seen in Jaisalmer district. This is the most predominant form of rainwater harvesting technique in the region. The water harvested through this technique is known as Patalipaani.

***Kuis/Beris and Dakeriyan*** are 10-12 m deep pits dug near the tanks to collect the seepage. Kuis can also be used to harvest rainwater in areas with meagre rainfall. The mouth of the pit is usually made very narrow to minimise evaporation of water. The pit gets wider as it burrows under the ground, so that water can seep in to a large surface area. The openings of these are entirely kuchcha (earthen) structures that are generally covered with planks of wood, or put under lock and key. The water is used sparingly, as a last resource in crisis situations.

3. Mishra Anupam (2009) 'Rajasthan ki rajat Bunde – The Radiant Raindrops of Rajasthan' Page 10

***Baoris/Bers*** are community wells that are used mainly for drinking purpose. Most of them are very old and were built by banjaras (nomadic communities) for their drinking water needs. Baoris can hold water for a long time because of almost negligible water evaporation. They do not have a catchment area of their own nor are they connected to any water course. Instead, they access water from the seepage of talab or a lake situated nearby. The baoris occupy minimum space, thereby saving money, time and energy. Jodhpur is especially famous for its baoris. There is very little water evaporation from the baoris compared to other water bodies. The present condition of half of the baoris is fairly good while the remaining require maintenance.

***Saza Kuva:*** An open well with multiple owners, this is the most important source of irrigation in the Aravalli hills in Mewar, eastern Rajasthan. The soil dug out to make the well pit is used to construct a huge circular foundation or an elevated platform sloping away from the well. The foundation is built to accommodate the rehat, a traditional water lifting device; the sloping platform is for the chada, in which buffaloes are used to lift water. Construction of sazakuva is generally taken up by a group of farmers with adjacent landholdings; a harva, a man with special skills in groundwater detection, helps fix the site.

***Naada/Bandha:*** *Naada/bandhas* are common in Thar Desert. It is a stone check dam, constructed across a stream or gully, to capture monsoon runoff on a stretch of land. Submerged in water, the land becomes fertile as silt deposits on it and the soil retains substantial amounts of water.

***Rapat:*** This is a percolation tank, with a bund to impound rainwater flowing through a watershed area and a waste weir to dispose of the surplus flow. If the height of the structure is small, the bund may be built of sandstone, otherwise soil is used. Rajasthan rapats, being small, are all masonry structures. Rapats and percolation tanks do not directly irrigate land, but recharge wells within a distance of 3-5 km downstream. Silting is a serious problem with small rapats and the estimated life of a rapat varies from 5 to 20 years.

***Talab / Bandhis / Pokhariyan / Sagar:*** These may be natural or human-made. A reservoir area of less than five bighas is called a *talai;* a medium sized lake is called a *bandhi* or *talab;* bigger lakes are called *sagar* or *samand.* The *pokhariyans* serve irrigation and drinking purposes. A large number of *talabs* are lost due to urbanisation and industrialisation. Earlier, they used to serve the drinking needs of the community, but of late they are being increasingly used for cattle and irrigation purposes. When the water in these reservoirs dries up a few days after the monsoon, the pond beds are cultivated with rice. Talabs are otherwise known as lakes or large reservoirs constructed in natural depressions or valleys. They are traditionally constructed by villagers on community lands, using lime masonry walls on the sides, with soil as the filling material between the walls. Some talabs have wells in their beds. The Kharasan talab was a historically important water harvesting structure. It was constructed by an earthen embankment on the downstream side and a curvature on the upstream side to give more strength to the structure. Talabs are famous in the Mewar region and the city of Udaipur has a large number of talabs.

Tanks are different from talabs and are constructed with huge masonry walls on four sides. Either square or rectangular in shape, these can hold massive amounts of water. These are invariably provided with a system of canals to bring in rainwater from the catchment areas. Most of the famous tanks were constructed in Jodhpur but have been abandoned now.

***Chandela Tank:*** These tanks were constructed stopping the flow of water in rivulets flowing between hills by erecting massive earthen embankments, with a width of 60m or more. These hills with long stretches of quartz reefs running underneath them, acted as natural ground water barriers helping to trap water between the ridges. The earthen embankments were supported on both sides with walls of coarse stones, forming a series of stone steps. These tanks are made up of lime and mortar and this is the reason why these tanks survived through the ages. Siltation is the only problem these structures face now. Chandela tanks usually had a curved twist somewhere in the middle of the embankment; many older and smaller tanks were constructed near the human settlements or near the slopes of a cluster of hills. These tanks served the drinking water needs of villagers and cattle.

***Bundela Tank:*** These tanks are bigger in size as compared to Chandela tanks. *Bundela* tanks had solidly constructed steps leading to the water in the tank;

but these structures had chabootaras, pavilions and royal orchards designed to show off the glory of the king who built them. But these tanks are not as cost effective and simple as Chandela tanks. These were constructed to meet the growing water demands in the area; maintenance of these tanks was done by the person employed by the king but in case of smaller tanks, villagers collectively removed silt and repaired the embankment.

***Kunds/Kundis:*** These are circular underground wells/ rainwater harvesting structures found in the sandier tracts of the Thar Desert in western Rajasthan and Gujarat. They gently slope towards the centre and wire mesh is put across water-inlets that prevents debris from falling into the well-pit. The sides of the well-pit are covered with lime and ash (disinfectant agents). Most pits have a dome-shaped cover, or at least a lid, to protect the water. These dot the region and are the main source for drinking water. These structures harvest rainwater for drinking purposes.

***Jhalaras:*** These are human-made tanks, found in Rajasthan and Gujarat, meant for community use and for religious rites. Often rectangular in design, jhalaras have steps on three or four sides. Jhalaras are ground water bodies which are built to ensure easy and regular supply of water to the surrounding areas. The steps are built on a series of levels. The jhalaras collect subterranean seepage of a talab or a lake located upstream. The water from these jhalaras was not used for drinking but only for community bathing and religious rites. Jhodhpur city has eight jhalaras, two of which are inside the town and six are located outside the city. The oldest jhalara is the Mahamandir jhalara which dates back to 1660 AD.

***Nadis:*** Nadis are village ponds that are used for storing water from an adjoining natural catchment area during the rainy season. The site selection is based on available natural catchments and their water yield potential. Water availability from a nadi would range from two months to a year after the rains. In the sand dune areas, their depth ranges from 1.5 to 4.0 metres and of those in sandy plains varied from 3 to 12 metres. The location of the nadi had a strong bearing on its storage capacity due to the related catchment and runoff characteristics. These *nadis* are mainly used for the water requirements of the livestock.

***Tobas:*** Tobas is the local name given to a ground depression with a natural catchment area. It is usually created on a hard plot of land with low porosity, consisting of a depression and a natural catchment area. It provides water for human and livestock consumption and the grass growing around it provides pasture for cattle. In order to preserve and enlarge the capacity of the *tobas,* the catchment areas were widened. No encroachment was allowed to damage the catchment. The *tobas* were also deepened to increase the storage capacity.

Many of these traditional water harvesting systems have been in existence in India for many centuries. At present, step well is one of the vital assets of the country that is administered by the Archaeological Survey of India (ASI). The structure of step wells was such that it indicated the number of months for which water would be available. There were statues of horses and elephants erected on the step pillars that also worked as indicators of water storage capacity. They have evolved using the age-old wisdom and knowledge of the terrain developed over many hundreds of years. They serve the essential water requirements of the people, especially in the water deficient areas of the Thar Desert.

## Modern Water Supply System and the Crisis

In the pre independence era, Maharaja of Bikaner, Shri Ganga Singh made an effort to construct a canal to bring water from river Sutlej to Rajasthan. There was a tripartite conference between the princely states of Bikaner, Bhawalpur and the Punjab province on 4th September 1920 and an agreement was reached and signed. Maharaja Shri Ganga Singh laid the foundation stone at Firozpur head works on 5th September 1921. The then Viceroy, Lord Irwin inaugurated the canal project at Shivpur head works of Shri Ganganagar on 26th October 1927. This canal begins from Huseniwala, Firozpur of Punjab and enters Rajasthan through Sankha village of Shri Ganganagar. The canal then travels through Shivpur, Shri Ganga Nagar, Jorabarpur, Padampur, Raisingh Nagar, Swarup city till Anupgarh. The length of the main canal between Firozpur to Shivpur head is 129 km (112 km in Punjab + 17 km in Rajasthan) and the length of canal distributary is 1,280 km. At places like Lakshmi Narayanji, Lalgarh, Karniji and Samikshya are the branches of the main canal. This canal is connected to Ganga Nahar link for regular water flow and maintenance. This link canal starts from Lohagarh of Haryana and connects with the main Ganga Nahar canal through Sadhubali village of Shri Ganganagar. The central water board provided financial support for maintenance of this canal on 21st May 2000.

This entire legacy of modern water solutions not only continued but scaled up and expanded even after independence across India. During last two and a half decades, the influx of modern technological and mechanised water solutions have no doubt provided immediate water access and have also emancipated women from the drudgery of carrying water over long distances. But on the other hand, these solutions have also contributed to creating future water crisis and insecurity in the area. Traditional practice of being 'water wise' is largely neglected in many places.

### *Canal Lift-Water Collection Points*

A lift scheme to supply drinking water to villages has been put in place. The scheme supplies water to villages through pumping-led water distributary points set up at convenient locations linked with groups of villages. Inside individual villages, there is one or more water collection points with concrete-built ground level water storage tanks. These tanks are filled with water once or twice in a week. People collect water through taps from these water collection points inside villages. Thus far no user charges are collected from villagers for this facility.

### *Bore Wells/ Tube Wells*

In order to meet the growing water needs in rural regions of the study area, it was observed that the trend of installing bore wells/ tube wells has become very common in around the last two decades. Bore wells and tube wells are almost similar. These are vertical drilled wells, bored into an underground aquifer in the earth's surface to draw out water. The slight difference in these two facilities is with regards to the type and depth of casing used and the type of soil where these are drilled. The casing functions to push back the excavated surface of the borehole from inside against any possible collapse. Casing may be used at certain intervals in the depth, and usually is made up of PVC pipes. Different kinds of power (mainly electrical) pumps are usually used to pump out the water from these wells. The extracted water is mostly stored in water storage tanks built in the villages. These storage tanks serve as either water collection points or distribution points to supply water to households in the villages. Major part of power and other expenditures are reportedly subsidised by the government and maintenance expenditures are also mainly incurred by the government. It has been observed that this convenience of subsidised pumps has badly amplified the depletion of groundwater at an increased pace.

### *Hand Pumps*

Hand pumps are manually operated devices that lift water. These are used to extract water from various sources including surface water sources, reservoirs and groundwater sources. These are easily installable, cost-effective, user friendly and mostly installed at places having inaccessibility of power sources. There are different types of hand pumps that are available, largely operating on a piston, diaphragm or rotary vane principle with a check valve on the entry and exit ports to the chamber operating in opposing directions. Hand pumps are either piston pumps or plunger pumps.

### *Reverse Osmosis (RO) Plants*

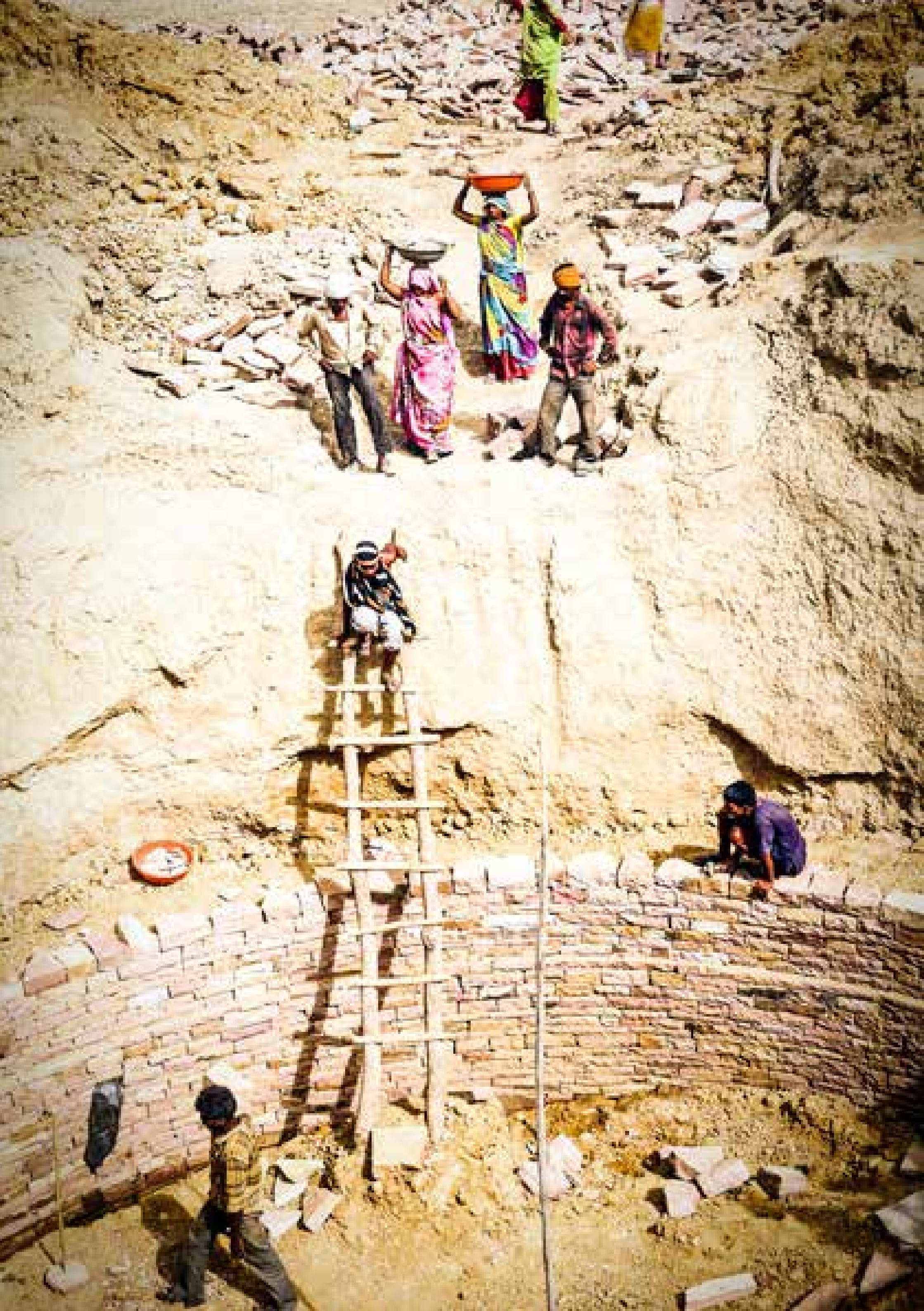
Reverse Osmosis is one of the most popular water treatment and filtration methods available. In this technique, the water is forced across a semi-permeable membrane, leaving contaminants behind that are flushed down the drain. In this process, the clean drinking water is collected in a storage container to be further supplied to the water users. These plants have been reportedly installed on a pilot basis aimed at solving the problem of saline underground water by minimising the total dissolved salts in the water. The contracts of these plants have been given to private companies/contractors who collect nominal user charges from villagers in order to operate and maintain these RO plants. However, a negative fallout of this technique is excessive wastage of water. It would be prudent to work out ways to store and reuse the waste water for non-drinking purposes.

### *Water Tanker Suppliers*

Providing doorstep water supply facility in villages of the study area, a significant number of water tanker suppliers are reportedly available. These suppliers use water tankers mostly on tractors and in some cases on trucks or small jeeps. These suppliers charge the users on the basis of the distance from water collection source to water user location. On account of this being a relatively expensive mode of water supply, this service is availed by only some segments of the society.

### *Household Level Water Tap Connections*

A considerable number of households in the study area reportedly have access to households' level water tap connection providing them doorstep water supply connectivity. These tap connections are reportedly linked with village based water collection points of different water schemes. A significant number of these water tap connections are reported to be illegal and there is rampant siphoning off of water from water collection points of village based water schemes by influential residents of the villages.



# 3 RESEARCH METHODOLOGY

## Context

The challenge of water scarcity is emerging as a daunting issue in many parts of India, which direly needs to be tackled on a priority basis. With this formidable task in mind, the team of ActionAid Association and members of some civil society organisations from Rajasthan and Kutch met at Udaipur towards the end of October 2018. They discussed and agreed to conduct a study with the specific objective of uncovering the reasons behind the grim scenario and also to probe why the rainwater harvesting systems that are in place are unable to cope with the ever growing menace of water scarcity. This peril is threatening the arid zones in India generally and parts of Rajasthan and Gujarat particularly. While brainstorming on the subject it was concluded that India has a rich history and tradition of economically viable and ecologically sustainable water harvesting methods and systems that dates back to the times of Indus Valley civilisation, to the Vedic as well as the medieval times. Many scriptures and historical stories of India also give details of the traditional rainwater harvesting techniques in India that played a laudable role on conserving water and handling water scarcity issue during critical times. In this context, the painstaking and comprehensive research works of Shri Anupam Mishra were discussed and appreciated as a milestone in documenting the rationale, viability, approaches and effectiveness of traditional rainwater harvesting practices and systems.

Furthermore, it was underscored that various governments have come up with different water supply systems like canal, ground water and revival of existing water commons like ponds in last few decades. However, there are still apprehensions about the relevance, viability and efficacy of all these newly built rainwater harvesting schemes of the government. Moreover, there is a criminal neglect of the maintenance and up-keep of age-old traditional rainwater harvesting systems in contemporary times. Hence, it was decided to examine how the contemporary system of government-aided schemes fared in comparison to primitive times – when communities themselves controlled and managed their water needs self-reliantly. It was decided that in order to address this crucial issue, it is necessary to conduct a research study targeting arid parts of western Rajasthan and north-western Gujarat. It is important to document relevant status and changes in trends, particularly in rainwater harvesting practices and systems to pave way for advocacy and relevant policy change. In this regard it was also agreed upon to proceed with the following objectives and methodology in order to conduct the desired research and capture community voices in form of case-studies.

## Objectives

The general objective of the study is to understand importance of water commons in arid zone ecology of the Thar Desert and relevance of traditional water systems in preserving rain water and learn more about the importance of indigenous technologies and knowledge of water conservation, distribution, utilisation and coping mechanisms adopted to deal with water crisis.

The specific objectives of the study to this end are as follows:

- To study importance of traditional water harvesting structures in connection with climate change that result in changing rain patterns — either scanty or heavy untimely rains.
- To analyse relevance of those structures in current socio-economic scenario of water supply and ground water extraction with heightened water crisis.

- To document role of women in conservation and collection of water and continuity of cultural and religious practices. Identify key loopholes to be addressed to revive and upscale rainwater harvesting systems, relevant traditions and cultural traits.
- To understand people's perspective on current water harvesting structures – its relevance, applicability, efficiency and sustainability prevalent in the arid zones of Rajasthan and Gujarat.
- Document the status of contemporary (prevalent since the last 20 years) rainwater harvesting schemes and practices in terms of:
  - their relevance, applicability, efficacy and sustainability factors
  - their impact on traditional rainwater harvesting systems/heritage
- Suggest required advocacy steps for policy and practice change aimed at campaigning to promote and upscale rainwater harvesting; enrooted into the cultural traits, traditional knowledge and historical learnings.

## Focus of the Study

- Study the ecology in arid zones of India with special focus on water commons of Rajasthan and Gujarat
- Understand increasing relevance of traditional water structures in sustaining life and vegetation in the region
- Examine the socio-cultural, economic and religious impact of traditional water commons on communities – especially on women.

## Study Universe

The study was undertaken in the arid zone of Rajasthan and Gujarat. A total of 20 villages were covered under this study.

## Sample Design of the Study

The study adopted stratified random sampling for choosing different villages according to the requirement of the study. It has covered arid area villages of the two states. From both the states of Rajasthan and Gujarat, 20 villages were identified according the following criteria (i) villages having traditional water harvesting structures (ii) villages where the life and livelihood of communities depends prominently on water harvesting structures (iii) communities facing the problems of water pollution and water scarcity.

## Tools and Techniques Used for Data Collection

Both qualitative and quantitative data collection methods were used for collection of primary and secondary data. A questionnaire was developed for primary village level data collection. The questionnaire was designed to get clear responses on demographic structure, socio-economic status, use of traditional water structure, perceived changes over a period of time, impact on livelihood, impact of cultural and religious practices and challenges faced by them in getting pollution free water for use. Focussed group discussions with groups of farmers, fisherman, artisans, women and youth were conducted to know their perspective. Participatory Rural Appraisal method was used where ever possible to involve more women and children in discussion.

## Social Group Distribution of Study Households

Study universe consisted of two states of Rajasthan and Gujarat, 5 districts, 15 blocks, 18 gram panchayats and 20 villages. Community composition consisted of 47% from OBC, 27% General, 29% tribal and 18% Dalits.

## Data Analysis

The data collected from primary sources was processed using MS Excel and analysed to delineate the demographic details of the area, traditional use of water and recent changes in those uses. The other questions that were sought to be answered included:

- What do people think about such changes and what are the causes behind these changes?
- How do the changes impact the communities – do they benefit or lose?
- What measures they have taken to deal with the water-related problems and how are the traditional practices and livelihoods of the people affected?
- Are they aware of the looming water crisis that confronts the entire world and what the future holds?

- Do such issues form a part of the political agenda in their respective areas?
- What recommendations would they suggest to the government to deal with the issue?

The secondary information was collected from the reports and records of the central as well as state governments, official statistics, books and policy documents.

## Study Limitations

- The study findings are limited to a small sample of villages in a large state. Small representation of villages may not give an accurate indication of the extent of the problem as a whole.
- It was difficult to organise meetings of both women and men at one place due to cultural practices and gender relations of the region.
- At times, the community members' inability to accurately recall all information regarding traditional practices also limited the study in some places.
- The study had a time limitation despite having a wide coverage.

Table 3.1: **List of sample states, districts, blocks, gram panchayats and villages covered**

| Name of State | Name of District | No. of Blocks | No. of Panchayats | Village | Total Number of Households | Total Population | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Male | Female | Total |
| **Rajasthan** | Jodhpur | 4 | 4 | Chakhu | 1700 | 4933 | 4797 | 9730 |
| | | | | Choda | 250 | 725 | 700 | 1425 |
| | | | | Salwakalla | 10000 | 27162 | 26838 | 54000 |
| | | | | Bawarli | 700 | 2015 | 1905 | 3920 |
| | Jaisalmer | 4 | 4 | Bhikodai | 800 | 2258 | 2222 | 4480 |
| | | | | Deval Pura Mandwa | 500 | 1411 | 1389 | 2800 |
| | | | | Jaisalmer | 18000 | 49698 | 49302 | 99000 |
| | | | | Dawara | 162 | 459 | 448 | 907 |
| | Barmer | 4 | 4 | Sanwlor | 450 | 1159 | 1141 | 2300 |
| | | | | Kharantiya | 284 | 751 | 743 | 1494 |
| | | | | Kapurdi | 450 | 1283 | 1267 | 2550 |
| | | | | Jhunapatrasar | 450 | 1260 | 1240 | 2500 |
| **Gujarat** | Sambarkantha | 1 | 4 | Gulabpura | 140 | 351 | 349 | 700 |
| | | | | Dadarda | 300 | 723 | 717 | 1440 |
| | | | | Malvaj | 150 | 368 | 367 | 735 |
| | | | | Morli Dungari | 200 | 472 | 468 | 940 |

| Name of State | Name of District | No. of Blocks | No. of Panchayats | Village | Total Number of Households | Total Population | | |
|---|---|---|---|---|---|---|---|---|
| | Kutch | 2 | 2 | Khavada | 70 | 168 | 161 | 329 |
| | | | | Jamkundalia | 156 | 366 | 368 | 734 |
| | | | | Vandh | 74 | 198 | 186 | 384 |
| | | | | Khanut | 350 | 865 | 785 | 1650 |
| **Total** | **5** | **15** | **18** | **20** | **35186** | **96625** | **95393** | **192018** |

**Table 3.2: Social Group Distribution of Study Households**

| Name of State | Name of District | No. of Blocks | No. of Panchayats | Village | Social Group wise Population in % | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | **GEN** | **SC** | **ST** | **OBC** |
| **Rajasthan** | Jodhpur | 4 | 4 | Chakhu | 20% | 10% | 10% | 60.00% |
| | | | | Choda | 15% | 30% | 10% | 45.00% |
| | | | | Salwakalla | 0.20% | 24.8% | 5% | 70.00% |
| | | | | Bawarli | 20% | 22% | 9% | 49.00% |
| | Jaisalmer | 4 | 4 | Bhikodai | - | 40% | 6% | 54.00% |
| | | | | Deval Pura Mandwa | 15% | 35% | 5% | 45% |
| | | | | Jaisalmer | 47% | 28% | 6% | 19% |
| | | | | Dawara | 62% | - | 4% | 34% |
| | Barmer | 4 | 4 | Sanwlor | 25% | 20% | 20% | 35% |

| Name of State | Name of District | No. of Blocks | No. of Panchayats | Village | Social Group wise Population in % | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Kharantiya | 3% | 12% | 25% | 60% |
| | | | | Kapurdi | 5% | 12% | - | 83% |
| | | | | Jhunapatrasar | 5% | 9% | 78% | 8% |
| **Gujarat** | Sambarkantha | 1 | 4 | Gulabpura | 20% | - | 80% | - |
| | | | | Dadarda | 30% | - | 70% | - |
| | | | | Malvaj | 30% | - | 70% | - |
| | | | | Morli Dungari | 35% | - | 65% | - |
| | Kutch | 2 | 2 | Khavada | 20% | 8% | 12% | 60% |
| | | | | Jamkundalia | - | 10% | 25% | 65% |
| | | | | Vandh | 45% | 5% | - | 50% |
| | | | | Khanut | 80% | 5% | - | 15% |
| **Total** | **5** | **15** | **18** | **20** | **27%** | **18%** | **29%** | **47%** |

# 4 STUDY FINDINGS

The study reveals that across the sample villages of both Rajasthan and Gujarat, historically and traditionally rainwater harvesting has remained a key source of water for people. They reportedly use a range of traditional rainwater harvesting practices by making different water storing structures employing indigenous technologies and wisdom. The study captures many stories of exemplary village based water governance systems that were in place, but their footprints are gradually disappearing. The administration and in many cases the communities themselves were responsible for building and maintaining water harvesting structures that proved to be life-savers for them. Consultation with the communities further reveals that their ancestral societies in ancient villages worshipped water as a precious resource and attached great value to rainwater harvesting. Hence importance to conservation of water was inbuilt in most of their cultural, traditional, customary and religious practices.

Despite promoting rainwater harvesting structures in places, people remain very careful about water consumption – they reportedly use it as if it was as precious as *ghee*. Rarely these people experience water shortage until the next rains. It is unfortunate that this worthy legacy has been forgotten over the years and it is even more unfortunate that importance given to conservation of water commons is on decline.

## Current Water Scenario

Based on a review of the overall study findings, it is attempted to outline the current water scenario of villages in this section. The study findings reveal that across both the states, of the total sample villages, about three-fourths have access to canal-fed lift-water supply schemes mainly for drinking water purposes. But, the remaining one-fourth of the villages do not have access to canal water and are solely dependent on groundwater as a key water source, besides rainwater being a supplementary source. Moreover, it was also found that almost all the sample villages have access to motorised groundwater system (mainly government supported) that included either tube wells or motor-pumps. Barring few tube-wells and motor pumps that are non-functional, the rest continue to supply water either free of cost or on a heavily subsidised basis. It is estimated that on an average, 500 litres of water is being consumed daily per household (minimum 30 litres to maximum 800 litres per household) in all study villages – average number of total households are estimated to be around 250 per village. As far as the total water consumption in all the villages is concerned, it is estimated that 56 per cent of water needs (drinking and domestic) are being fulfilled through canal water, 24.5 per cent through groundwater and remaining 19.5 per cent through rainwater harvesting. Out of the total amount of ground water extracted, 60 per cent is used for agriculture and 40 per cent for drinking and other domestic purposes through motorised tube wells. This overall water scenario of villages indicates that the old traditional water solutions that predominantly relied on rainwater harvesting in the study

area, has gradually shifted to modern means of ground water extraction. This new development of government aided schemes embedded in modern water solutions has replaced the traditional practice of manual water fetching from open dug-wells. This has also drastically discouraged the practice of traditional rainwater harvesting; a sustainable source of providing water security in this water scarce zone – for which ancient Rajasthan and adjacent parts of Gujarat have historically remained famous.

**Diagram 1: Water Accessibility Picture of Villages**

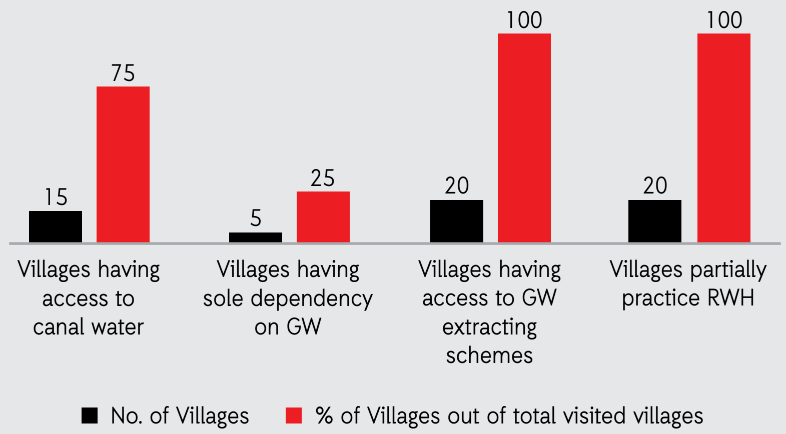



**Table 4.1: Source-wise Water Usage (Drinking and Domestic) Picture**

| Villages with different water sources | % of canal water | % of GW | % of RWH |
|---|---|---|---|
| Villages having access to canal water | 56 | 9.5 | 9.5 |
| GW dependent villages | 0 | 15 | 10 |
| **Total** | **56** | **24.5** | **19.5** |

**Table 4.2: Picture of Total Ground Water (GW) Usage in Study Area**

| Types of GW Usage | Number of Villages | % of GW Usage |
|---|---|---|
| GW usage for drinking and domestic purposes insides villages | 20 | 40 |
| GW usage for agriculture purposes | 12 | 60 |

## Canal Water

It came out from the study that around three-fourths of villages have access to canal water; mainly through lift-water supply schemes to meet their drinking water needs. As regards to period, one-third of the villages have reportedly received this facility either a few months or a few years back. The remaining two-third of the villages have been given access to canal fed lift-water supply schemes around a decade back or even earlier in some cases. It was observed that these schemes provide water either at one distribution point or at more than one convenient point in villages. While some households located closer to such water points had easy access and others located at a considerable distance paid for water tankers supplied by individual contractors.

Regarding storage of canal water, the study reveals that around two-thirds of the households have access to water storage tanks for storing canal water that can last for few days. These tanks are actually provided through different government schemes for rainwater harvesting purposes but are rarely used for the original purpose and are instead utilised for storing canal water. Around one-third of the households that belong to socio-economically vulnerable communities do not have enough water storage facility at the household level and are also unable to afford tankers. However, generally it was observed that people were happy to have the facility of canal water in their villages.

Canal fed lift-water supply schemes to the water scarce regions of both Rajasthan and Gujarat are an appreciable accomplishment. However, in the wake of growing water scarcity, it seems utterly precarious to rely upon this canal water source as the only option to quench the growing future thirsts of water scarce regions. Though these canals fed lift-water supply schemes in villages are mainly used for drinking water purposes lifting of water to long distances works out to be expensive.

A thorough analysis of the village situation having access to canal fed lift-water schemes revealed that around three-fourths of water needs are fulfilled by canal water, and remaining one-fourths of water needs are fulfilled partially by rainwater harvesting and partially by extracting groundwater. It is indeed alarming that in villages that have access to canal water, the practice of rainwater harvesting is being discontinued and forgotten at a rapid rate when compared to villages that have groundwater dependent water supply schemes.

**Table 4.3: Insights (in Percentage) of Villages Having Access to Canal Fed Lift-Water Supply Schemes**

| Access to canal fed lift water supply schemes | Trend in % |
|---|---|
| Villages having access to canal fed lift-water supply schemes | 75 |
| Villages with access to canal water in last few months to 1 year | 33 |
| Villages with access to canal water in around one decade or more | 67 |
| Households having RWH tanks mainly used to store canal water | 67 |
| Households lacking RWH tanks mainly used to store canal water | 33 |
| Water needs fulfilled by canal water in canal-water supplied villages | 75 |
| Water needs fulfilled by GW in canal-water supplied villages | 12.5 |
| Water needs fulfilled by RWH in canal-water supplied villages | 12.5 |

In the latter category of villages, the practice of conservation of rainwater is reduced but has not disappeared altogether. A comparison of magnitude of rainwater harvesting practices between villages having access to canal water and villages having access to tube-wells or motor-pumps water supply schemes over groundwater shows that the first category of villages harvest merely three buckets of water compared to eight buckets of rainwater being harvested in the second category of villages. This proves beyond doubt that canal fed lift-water schemes have been hampering the traditional practice of rainwater harvesting. Though comparatively less guilty, the groundwater dependent water supply schemes have also contributed to the downfall of traditional rainwater harvesting practices that have historically remained effective and sustainable sources of mitigating the water crisis in water scarce Rajasthan and its adjacent parts of northern Gujarat. Besides, in around four-fifth of villages people reported about long delay of water supply in canal for unknown reasons, thus canal cannot be relied upon as a vital source. In all the villages fed by canal water supply schemes, groundwater schemes are also still functioning as an alternative water source. Based on their experiences people do not believe that canal water can be a constantly available source that can totally replace groundwater supply schemes.

## Case Study

Choda village is situated in Tehsil Pipaad of Jodhpur district. It has a large pond with a wide catchment area that has been the only source of water for the village since ages. The villagers have been maintaining this pond effectively. It has steps and sitting arrangement for people. These structures have existed since centuries without much renovation or changes done by communities. But recently an attempt was made to desilt the pond with the help of a government funded scheme wherein modern technique was used and situation of this pond is getting worse by the day. Traditionally desilting was done manually protecting soft stone layers of pond. In mechanised desilting process water conservation layer of pond has got damaged leading to speedy water percolation. That apart the catchment area of pond is being encroached upon by people gradually, reducing it in size. Earlier the pond used to be full with rain water throughout the year but now it remains only for few months and goes dry for several months.

The village also has a natural rainwater runoff pathway (nala) with a bed of natural concrete, to effectively recharge the groundwater in the area and was also helpful in maintaining quality of the brackish water of wells. But now people have cemented the bed of the nala, thus leaving its groundwater rechargeable efficacy badly hampered. Villagers have realised that this change will have adverse implications for both the level as well as the quality of the groundwater. Moreover, this village is supplied with canal water since the last seven years reducing their dependence on both ground water and rain water. Now the canal water remains available in connected water tank in the village – which was also constructed under one government supported scheme five years ago (water is also supplied from this tank to five to six other villages). In the given situation the villagers are naturally very concerned about the depleting groundwater and their growing dependency upon canal water. They are concerned that this situation could lead to heightened water insecurity and realise that they must take appropriate measures to tackle the situation. This will include community mobilisation and approaching the government for support to revive the traditional water harvesting structures using indigenous technology.

## Ground Water

Study findings reveal that almost all villages have access to tube wells or motor pumps (on an average there are two motor pumps per village) installed in the last ten to twenty years. In one-fourth of the villages, GWS schemes were reportedly non-functional; mostly on account of mechanical faults and a few due to cut off of fuel/power source. People in these villages are waiting for the repair of these equipment and restoration of power supply. Most are government supported barring a few that are either installed or managed or both installed and managed by individuals or communities themselves.

It is pertinent to mention that villages that have access to canal fed lift-water schemes rely less on groundwater schemes as an alternate source. They do so only when canal water is disrupted for some reason. Tap water supply is available only in some areas and to influential people. Rajasthan villages were constantly receiving water from motorised water supply schemes except when machines develop faults and require repairs; thus, leading a sizeable group of vulnerable households to severe hardship, as they have no water conservation means and are unable to afford to purchase water from private sources. In Gujarat around one-fourth of the visited villages reported that their motorised groundwater extraction schemes have been non-functional since long and they have to get water from other sources including canals, hand pumps, dug-wells and tankers supplied by the government or in some cases charitable entities.

The main reason behind non-functioning of tube-wells was reported to be increasing depth of groundwater — up to 500 ft in some cases, which makes it difficult for machines to draw deep groundwater constantly. However, on the other hand it was witnessed that hand pumps were reportedly performing better in Gujarat villages than in Rajasthan. It was found that in Rajasthan there exist on an average seven dug-wells in each village – of those one-fifths were functional while the remaining four-fifth were non-functional and dry.

In Gujarat villages, the ratio of hand pumps is high; around three-fourth of the villages have access to hand pumps, while in Rajasthan around three-fifth reportedly have access to hand pumps. Of the total hand pumps, around five out of eight were found to be functional while the rest were non-functional.

As far as the situation of groundwater use, it was noticed that four-fifths of this water is supplied through tube-wells or motor pumps, mainly part of government supported water supply schemes. On rare occasions, pumps are also installed and managed by individuals or communities. While the remaining one-fifth of water is fetched through open dug-wells, hand pumps or water tankers. It is also relevant to mention here that in around three-fifth of the villages, people are mostly engaged in agriculture and for irrigation purposes, they rely on tube-wells that use groundwater. On an average six tube wells have been installed per village by well-off people in order to irrigate their agricultural fields.

It was estimated that roughly, out of the total groundwater extracted in the study area villages, around 60 per cent is being extracted for agricultural purposes while 40 per cent of water is extracted for drinking and domestic purposes. This phenomenon aggravates the already alarming scenario of excessive dependence on groundwater, drastic depletion of water aquifers as well as falling groundwater table. These consequences pose a serious threat to the survival of groundwater resources in this already water scarce region. It is no wonder that in three-fourth of the villages, the quality of groundwater is now reported to be at a non-satisfactorily level. This entire phenomenon has led to dire consequences where around one-sixth of groundwater sources are now non-existent inside villages. These settlements now get water from neighbouring settlements where quality of groundwater is found to be comparatively better.

It is indeed distressing to notice that the trend of over-exploitation of groundwater has hugely increased in the last two decades. This is mainly on account of provision of heavily subsidised electricity for the agricultural sector and massive rural electrification. This has indeed made access to water comparatively easy and affordable for vast majority of populations in villages. But around two-fifth of total water needs, of these groundwater dependent villages, are even today fulfilled by harvesting rainwater and using it mostly throughout the year for drinking and other domestic purposes. One core reason behind this thriving prevalence of rainwater harvesting practices was reported to be the depleting aquifers and deteriorating quality of groundwater. This quality deterioration is indeed mainly due to unrestrained and imprudent groundwater extraction and subsequent depletion of aquifers in most parts of study area. It was noticed that the water supply schemes only extract water and lack the water treatment and desalination functionality. Moreover, there is no groundwater recharge system in place. Hence, in their self-interest and to avoid worse future scenario of groundwater quality deterioration, people inevitably

**Diagram 2: Status of Water Sources in Study Villages**

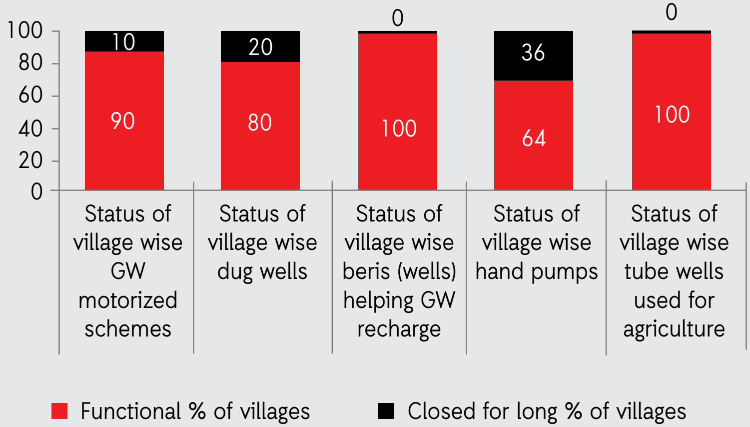
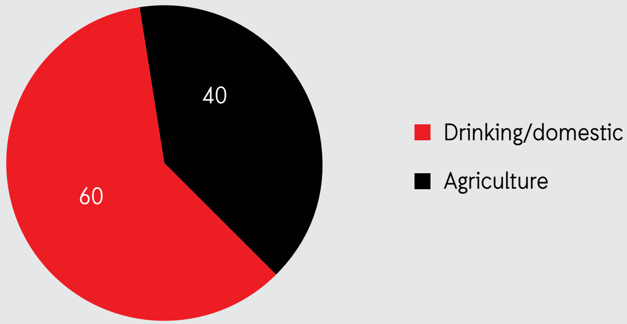



**Diagram 3: Source-wise Status of Groundwater-Supply in Percentages**

Bifurcation status of groundwater usage in 'driking/domestic' versus 'agriculture'



continue to harvest rainwater, fulfilling their drinking and some other domestic water needs.

**Table 4.4: Source-wise Status of Groundwater-Supply**

| Total villages surveyed | Villages having GW quality of satisfactory level |
|---|---|
| 20 | 15 (75%) |
| **Total villages surveyed** | **Villages having GW source from neighbouring village** |
| 20 | 3 (15%) |

**Diagram 4: Name of Source Through Which GW is Supplied**

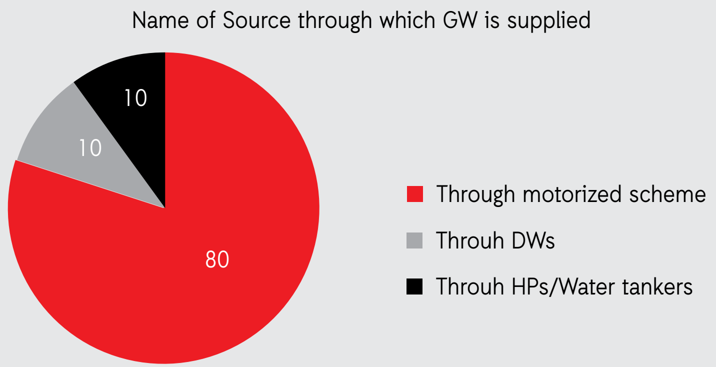



**Table 4.5: Status of Rainwater Usage in Ground Water Dependent Villages in Percentage**

| Water dependency source | Percentage |
|---|---|
| GW | 60 |
| RWH | 40 |

## Case Study

Village Bawarli is in district Jodhpur, located around 40 kilometres north to the main city. There are around 700 households in the village comprising a mixture of different communities. For many years, the groundwater of the village has coped with the water needs of the inhabitants but of late, it has depleted and gone very deep, and has also turned brackish. Thus, villagers are stranded with no other source of water except rainwater.

Like many other desert villages in Rajasthan, this village too has preserved the age-old but extremely effective rainwater harvesting system – very much rooted in the relevant traditional and cultural traits prevalent in the village. Bawarli has a long catchment area that encircles one large pond and a few small rainwater harvesting ponds built in 1523 by Paliwal Brahmans (the community that is believed to be the traditional custodian of rainwater harvesting in Rajasthan). It would be fair to assume that the village was built and settled here due to privileged presence of wide catchment area and suitable puddle clay area for creating the rainwater harvesting system.

The study team visited the location of the pond and found that around 15 long stones engraved with idols of different gods were installed in the surrounding area of the pond. Under some idols, the date of pond construction and names of the people who made the pond were also engraved. It was reported by the people that before each rainy season, villagers used to go to the pond and pray for rains. Having religious symbols around pond make it a sacred place and this contributes towards keeping the place clean, hygienic and pollution free. During the field visit it was found that around 100 women from the village hailing from all castes were engaged in manually cleaning and desilting the pond as part of MGNREGA scheme. This shows that MGNREGA and other government schemes are linked with digging and maintenance of rainwater harvesting structures. This could serve the noble purpose of promoting rainwater harvesting, which will go a long way in mitigating water scarcity problems in the region. For the last five centuries, the rainwater stored in large ponds has always remained adequate to fulfil the water needs of the village. The villagers happily reported that for the last 30 years, they never saw dried bottom of the pond as well as of the scores of beris (shallow wells) dug out by different communities.

A few years back the village has got an alternative source of water through a link of water canal. Bawarli is now much less reliant on the pond water, but people of around 10 nearby villages continue to fetch water through tankers from this pond. Even then the pond is not drying up. This rainwater harvesting resource is so robust that despite poor rains this year, there is plenty of rainwater still in the pond left over from previous year's stock. The pond has down-bowl depth of around 25 feet for storing the rainwater. There is a family to take care and manage the pond and rainwater flow. Villagers exercise a barter practice where all families give grains every year to this family in exchange of the services rendered with regards to the pond. There is a popular belief in the village that someone had cursed this village some generations ago that this village will never be able to access potable groundwater. The veracity of this story cannot be gauged but it has left a legacy to convince the villagers to always steadfastly create, protect and maintain rainwater harvesting structures as a dependable water source for the village. Villagers also reported that in the last few years, many have built their household level rainwater harvesting tanks through MGNREGA.

But more than half of them don't have effective catchment areas thus these tanks serve as water storage tanks only instead of rainwater harvesting mechanisms. It was also interesting to notice that since the last few years when Bawarli started receiving canal water and the villagers depended less on this rainwater pond, people from several adjourning villages started to fetch rainwater through tankers from the pond.

This indicates that large catchment areas are not available in every village and hence, large scale rainwater harvesting is also not feasible in every village. Indeed groundwater turning brackish in the village is one of the key reasons behind thriving of rainwater harvesting practice in this village. Apart from this is linked with the needs and persuasion power of neighbouring villages' need for drawing water from the same source. Hence it can be concluded that like many other this village community built and managed a model of rainwater harvesting that is worthy of study and emulation. Best practices for promoting and upscaling sustainable rainwater harvesting is one potential remedies to cope up with looming threat of water scarcity, particularly in arid regions of the world.

## Groundwater in Mining Area

The study area is reportedly under significant threat of underground mining of natural resources. Particularly in the desert regions of western Rajasthan, fossil fuel resources including coal, oil and gas are already being exploited and are to be further mined in the near future. This process will have an adverse impact on the groundwater resources and the surface desert ecology. Along with depletion of water sources natural growth of flora, fauna and agro-forestry based livelihoods of dependent communities will be impacted.

Village Kapurdi in Barmer district was selected for detailed study to understand impact of on-going decade long lignite mining on ground water sources and surface ecology. It was revealed that the lignite mining process is excessively and relentlessly exploiting groundwater on a regular basis. A large amount of the extracted water is stored in artificially made fragile lakes around the mouth of the mines. These temporary storage lakes indicate haphazard approach of the authorities as they have thus far showed no sustainable plan to reuse this water. In fact, this bulk water accumulation is posing serious environmental, health and fatal flooding threats to the area. The water table has also drastically fallen in wider peripheries of the areas under mining. There is no appreciable economic use of the stored groundwater yet. Due to this colossal groundwater extraction, the tube wells in this area are reported to have gone deeper and deeper at regular intervals. The quality of groundwater has also been badly polluted with poisonous minerals and salts. Vegetation in the surrounding areas of the mining site has also been reportedly disappearing. The agricultural land in this vicinity is reportedly losing its fertility and getting transformed into barren land. The conglomerate involved in the mining business has reportedly maintained its strong control over the situation and is committing excesses both through offering perks to the influential and exerting pressure upon and issuing threats to the ordinary populace. Significant numbers of families have been displaced from this area followed by acquisition of their lands in lieu of some meagre compensation.

The situation of displaced communities is reportedly deplorable. They are living with disturbed community safety network, loss of water resources, desert vegetables, livestock, agriculture base and lack of alternate sources of survival. It is a fact that the current mining scenario and associated situation have dangerously affected the entire water ecology of the area. Ground water dependency of people has shrunk grimly and though canal water supply is providing adequate amount of water, but people have still kept their faith in rainwater harvesting practices and keep continued. The rainwater harvesting ponds of the area reportedly provide water for almost half of the year. Almost every household has access to water storage tanks but many of these tanks are also being utilised for harvesting rainwater. It is astonishing to notice that in other study areas, advent of canal lift-water has adversely affected people's interest in continuing the practice of rainwater harvesting. While on contrary, the practice of rainwater harvesting is thriving in this area that is under the menace of mining.

This indicates that impending fear of water insecurity due to twin hazard of mega mining, excessive exploitation of groundwater has given people wisdom to keep alive their accessibility to at least one indigenous source of water - rainwater harvesting.

**Table 4.6: Status Regarding Access to Rainwater**

| Status Regarding Access to Rainwater | Period/Coverage |
|---|---|
| Rainwater availability/retention in village ponds | 6 months |
| Households having access to rainwater harvesting tanks | 100% |

## Impact of Groundwater and Canal Water Supply Schemes in Villages

Study findings disclose that the provision of both groundwater and canal water supply schemes in villages has immensely increased the access of households to water in the last two decades. It is estimated that two-third households with adequate supply of water in the villages are reportedly consuming five to six times more water than what they were consuming before the advent of these schemes in their villages. Remaining one-third socio-economically vulnerable households, face comparatively more difficulties to access water in current village based water supply setups. They have been reportedly consuming twice to thrice more water than what they were consuming earlier. This increased water consumption is recorded for washing, bathing, cleaning, sanitation and water for livestock.

It is apparent that the abundant availability of water in this historically water scarce zone has made people forget the value of this precious resource. As a result they have become more generous in consuming water and wastage has increased. This has created an environment of water wastage in society but has also made people careless in their water saving and conserving habits. What was once a coveted resource because it was hard to get is now being taken for granted by people. Hence, this more-than-necessary water consumption has triggered groundwater exploitation thereby contributing to the depletion of aquifers and subsequently devastating groundwater dependent ecosystem of the region.

**Table 4.7: Status of Increased Trend of Water Usage/Accessibility**

| | |
|---|---|
| % of well-off households who have increased water usage | 67 |
| Ratio of creased water usage | 6 to 7 times/fold |
| % of poor households who have increased water usage | 33 |
| Ratio of increased water usage | 2 to 3 times/fold |

## Case Study

Chakhu Village is located in Osian Tehsil of Jodhpur District in Rajasthan. It is 140 km away from Jodhpur towards the north-west. The topography is of a desert and arid plains. The village has a large pond that has been the only water conservation and utilisation source since centuries. The pond has a large catchment area comprising around 935 bighas. It was built with support of the Mughal rulers around 400 years ago with the objective of fulfilling the water needs of the village. In earlier times, the people of the village have shown exemplary awareness about water conservation and kept the ponds well maintained.

In recent history also, villagers have demonstrated concern for the pond. They gave protection to the pond by building a large wall, mostly from west side aimed at limiting water losses through evaporation and also to protect it against sand/dust that was getting pushed through by western winds. In fact it was observed that villagers are still concerned about the upgradation of their pond. In this regard they have reportedly approached the government recently for releasing funds to make the village pond a model. But, since last 20 years the village is also getting benefits from government schemes including two tube-wells installed along with canal water supply. However, after the introduction of these new water facilities, the priority of villagers has altered and they are gradually giving less importance to rainwater harvesting. An NGO is also working in the village for last few years promoting vanishing rainwater harvesting systems. This NGO has helped in the construction of a few public tanks as well as private tanks for about two-fifth of the village population. These tanks are made in accordance with traditional techniques harnessing local rainfall and stream flow. They are connected with rooftops hence the rooftops of houses have been used effectively as catchment area to harvest rainwater. Villagers believe that rainfall pattern has changed and has become uneven and irregular in recent years. Village agriculture is totally rain-fed.

## Groundwater Use in Arid Agriculture

The study reveals that the people in around three-fifth of villages are engaged in farming and for irrigation, they rely on tube-wells using groundwater from across the villages' proximities. On an average six tube wells have been installed per village by well-off people in order to irrigate their agricultural fields. It was learnt that an influential and relatively more prosperous group of people in the villages have been brazenly using groundwater through deep bore-wells.

Due to falling water table in the study area the cost of tube-well installation has become so high that it is beyond the affordability threshold of common people. Thus, only a small group of rich landlords are reportedly enjoying this facility. It was roughly estimated that out of total groundwater extraction from study area villages, around 60 per cent of water is being extracted for agricultural purposes while 40 per cent of water is extracted for drinking and domestic

**Table 4.8: Bifurcation Status of Groundwater usage in 'Drinking/Domestic' versus 'Agriculture'**

| | Drinking/Domestic | Agriculture |
|---|---|---|
| Area of Groundwater usage | 40 % | 60 % |

purposes. There is absolutely no water regulatory or monitoring mechanism on ground to control this unchecked exploitation of groundwater.

Also, it has been noticed that there is no mechanism in place for mapping and identifying potential rechargeable zones that can augment level of groundwater. Despite the glaring need, no interdependent mechanism of groundwater recharge is exercised that can replenish the extracted water and allow the monitored used of groundwater for agriculture.

More than half the villages, which reportedly use groundwater for agricultural purposes, have a dire need for advanced water-saving irrigation technologies for practicing sustained ground water irrigated agriculture. This phenomenon of excessive groundwater exploitation is reportedly posing serious threats to both quantity and quality of groundwater resources in this already water scarce region. This entire situation adversely impacts groundwater dependent ecology of the region in general and in particular it negatively affects the vulnerable segment of society whose minimum water needs are utterly dependent on easy access to groundwater.

**Table 4.9: Status of Village-wise Tube Wells (TWs) Used for Agriculture**

| Total Study villages | Number of Villages Having Agriculture TWs | % of Villages Having Agriculture TWs | Number of TWs per Village |
|---|---|---|---|
| 20 | 12 | 60 | 6 |

## Case Study

Malvaj village is situated in tehsil Talaud, district Sabarkantha, Gujarat. It has a population of around 700. People are dependent on farming and daily wage labour. There is no system in place to conserve and store rain water either at village level or at household level. There is a pond which is around 3-4 km away from the village. Water of Meshwo River is accumulated in the pond. A check dam was constructed but now this water is only used for livestock. There is a well which is around 60 to 70 years old but it is not used any more for around 10 years, since the advent of tube wells in the village. Now tube well is the key source of water in the village. Moreover, village panchayat had installed three hand pumps 20 years ago. These hand pumps are in working condition but the water extracted from them is contaminated and unsafe for health. Still, at times when tube-wells develop faults and become non-functional, hand pumps remain the only source of water. The trend of irrigating the farms using tube wells is prevalent in the area by rich families. The tube well installation costs are high due to the increased depth of groundwater and thus it remains unaffordable for poor people to use tube wells at their farms. Around eight families have reportedly installed tube wells at their private lands and are imprudently using the groundwater to irrigate their farms. There was a time when almost every agricultural field in the village had a private dug well but after the falling down of the water table and the resultant water scarcity, around 25 such dug wells have been closed down.

## Rainwater Harvesting

It is a fact that rainwater harvesting is very much subjected to the pattern of rainfall in the area. Areas identified in the study (western Rajasthan and adjacent areas of Gujarat), fall under the low rainfall category - averaging around 150 mm to 250 mm of rainfall, annually. However, rainfall data of last ten decades shows that in every decade, two to three heavy rains occur, creating a flood like situation. This has also been verified and confirmed by people in villages during the study.

People believe that currently less water is either harvested or recharged naturally into underground while the rest, more than 95 per cent rainwater goes waste either through runoff or evaporation. Hence, it is believed that there is a huge potential for harvesting rainwater in order to fulfil the growing water needs of this water scarce region. Moreover, the findings of study consultations and secondary data, indicate that traditional rainwater harvesting practices have historically been accorded a great deal of importance in meeting the water needs of water scarce regions of Rajasthan and its adjacent areas of Gujarat. One positive finding of the study is that despite the influx of modern water solutions, including canal fed lift-water schemes and groundwater extracting motorised schemes, the practice of traditional rainwater harvesting, though greatly dwindled, fortunately it has not gone altogether extinct.

Some practice of traditional rainwater harvesting was seen in the study area to cope with the water needs. Findings suggests that three-fourth of the villages having access to canal fed lift-water schemes have reduced their rainwater harvesting dependency up to 12.5 per cent of total water needs. When compared with remaining one-fourth of villages that solely depend on groundwater, it was found that 40 per cent of water needs are met through rainwater harvesting. Of the total rainwater harvested in both these categories of villages, 27.3 per cent of rainwater is harvested in villages depending on canal fed lift-water schemes and 72.7 per cent of rainwater is harvested in villages solely depending on groundwater extracting schemes. Hence the overall water dependency on rainwater in all study areas is estimated to be around 19.5 per cent of total water usage.

**Table 4.10: Percentage of Rainwater Harvesting (RWH) Practices in all villages**

| Types of Villages | Percentage |
|---|---|
| Canal water dependent villages | 27.3 |
| Groundwater dependent villages | 72.7 |
| Rainwater being harvested/used (out of total water) in all villages | 19.5 |

There is some consolation that traditional rainwater harvesting has not disappeared altogether from the study area. However, it is an alarming trend where traditional rainwater harvesting has been drastically disappearing from villages that have access to canal fed lift-water supply schemes. Dire need of people to access potable drinking water, play an important role in driving their attitude towards continuing practice of harvesting rainwater. This largely lacks in groundwater dependent villages.

The study attempted to explore rainwater harvesting practices are being exercised in the villages, it was learnt that four-fifths of the entire rainwater collection is made through village level ponds. Rest one-fifth of the water collection is undertaken through rainwater harvesting tanks. Interestingly, ponds are the only rainwater harvesting structures found in all the villages, on an average there are two ponds per village. Similarly, about four-fifth of the total visited villages and around three-fifth of the households have access to

**Table 4.11: Comparison of Rainwater Harvesting (RWH) Sources and Amount of Rainwater Being Harvested therein**

| Types of RWH Sources | % of RW Being Harvested through Specific Source |
|---|---|
| Ponds | 80% |
| RWH Tanks | 20% |

household level tanks. The comparison between states in this regard showed that household level water tanks are less prevalent in Gujarat than in Rajasthan. Ponds are most common resource in Gujarat villages to store rainwater.

It was noticed that most household level tanks in the villages of both the states have been constructed during last two decades. Of these tanks, around three-fourth have been built through different on-going government schemes including MGNREGA and state-level rainwater harvesting schemes. Rest around one-fourth of the tanks have been built either by the communities themselves or through some charity support. The household-level tanks are used as rainwater harvesting tanks but in around two third of total household level tanks no catchments are built for harvesting rainwater – an inbuilt part of the scheme's design. Thus, most of the household level tanks are used for water storage purposes rather than rainwater harvesting purposes, in absence of catchment area. Households having tank catchment are mostly located far away from main village, scattered in agriculture fields; this trend is more common in Rajasthan. People staying away from villages do not have easy access to water and they have to inevitably opt for rainwater harvesting. This indicates that there is no strict monitoring mechanism in place to ensure that government rainwater harvesting schemes are built as per given design. During consultations, some people pointed towards the possibility of bribery in the checking and verification as reason for this laxity. One-tenth of the visited villages and one-sixth of the households therein have had their tanks linked with rooftops as catchments for rainwater harvesting common phenomenon

**Table 4.12: Status of Village-wise Rainwater Harvesting (RWH) Sources**

| RWH Source | Villages Coverage/Access | Households Coverage/Access |
|---|---|---|
| Ponds | 2 ponds in every village of study | 100% |
| RWH Tanks | 80% | 60% |

was observed in Rajasthan. Most of these rooftop rainwater harvesting systems have reportedly been introduced by local non-governmental organisations.

Community opinion indicates that groundwater schemes introduced in previous decade have directly led to drastic depletion of aquifers, falling of the water table and deterioration of the quality of water. This is the reason why canal fed lift-water supply schemes have been demanded, accepted and believed to be most suitable by people as an alternate source of water in the current decade. But despite villages having access to canal lift-water schemes for long period, people of almost all villages could not abandon their dependency on motorised groundwater extraction largely for agriculture. However, historical records show that traditional rainwater harvesting and groundwater recharge systems have always remained as sustainable water sources in the study area for centuries. Recently with the advent of new water-arrangements in rural areas, in last few decades created a grave sense of water insecurity for the future. Water supply through canals has its own challenges and limitations in the future. So rainwater harvesting and groundwater recharge are the only ultimate and sustainable means of water supply to cope with water crisis of this water scarce zone on a long term basis.

It can be concluded that the advent of abundant groundwater schemes in the last two to three decades have led to excessive over-exploitation of groundwater that has resulted in issues of aquifer depletion/ drastic fall of water table and water quality deterioration. It has also adversely impacted the groundwater dependent arid ecology, climate change/uneven rainfall (droughts/flooding). Hence, this has created a sort of vicious cycle that is posing a threat to the water security issues in this water scarce region. Moreover, it also proves that

**Table 4.13: Insight Details of Rainwater Harvesting (RWH) Tanks**

| Tanks Built through Govt. Schemes | Tanks Built by Community/ Charity | Tanks with Catchments | Tanks without Catchments | Villages and HHs wise Status of Tanks Connected with Rooftops | |
|---|---|---|---|---|---|
| | | | | % of Villages | % of Households |
| 70% | 30% | 33% | 67% | 10 | 16.7 |

canal fed lift-water schemes cannot be deemed to be proven and sustainable water source. Due to the unreliability of canal water, groundwater extracting motorised scheme is still functioning as an alternative water source even in villages where canal water had reached a decade ago. Traditional rainwater harvesting and groundwater recharge have remained the most sustainable water solutions in this water scarce zone for centuries. Water insecurity can be dealt with only by promoting rainwater harvesting and groundwater recharge schemes and practices recognising it as a sustainable water solution.

## Case Study

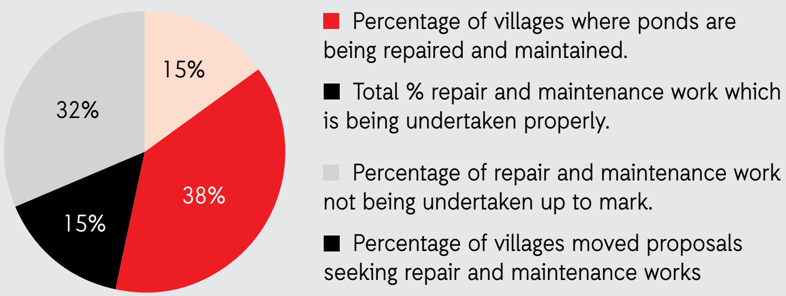
Bhikhodai village is situated 93 km away from Jaisalmer city in Rajasthan consists of diverse communities including Bheels, Meghwals, Bhrahmins, Muslims, Charans, Lohars and Baniyas. Village is at a juncture of sand dunes of Thar Desert and arid plains. The groundwater of the village is brackish with high concentration of salts. The village is enriched with water conservation sources comprising three wells, two large ponds and 14 small water storing tanks. Since last few years, this village is linked with Indira Gandhi Nahar Yogna (IGNY) thus the inhabitants' dependence on groundwater and rainwater has shrunk to a large extent.

Of the two large ponds, one pond named Khejarli was built more than 1,000 years ago, by Charan community and Bheeldar community dug it. A temple of Bhoomia ji was constructed within the catchment area to ensure cleanliness of the pond. Throughout the year, there used to be sufficient water in the Khejarli pond to be supplied to other villages. It was reported that after Independence Panchayat of the village utilised its budget to renovate the pond. During last 20 years importance of the ponds and rainwater harvesting has dwindled and is no longer a priority for the community. Now in the name of pond renovation under famine and MGNREGA scheme people get some income but the actual task is neglected. Another pond in village named Imarti was also built more than thousand years ago to supplement livelihoods of the people — used for cultivation and livestock rearing. Since the groundwater is brackish, the ponds historically served drinking water needs of the villagers over the years. For the last 15 years, the village has been linked with a free pipe water government scheme, built on groundwater source around 12 km away. Now community mind-set has changed with free and adequate water supply and age-old practice of rainwater harvesting lost its importance. Around 20 years ago most water needs of villagers were fulfilled by rainwater based dug-wells, used for manual extraction of water. But now all the water needs are fulfilled by groundwater supply from other villages. This water is supplied to a tank built in the village from where people collect water. Also, there is a tanker supplier in the village who supplies a tanker full of water for 400 rupees, thus only accessible to well-off people of the village. This change has deprioritised village based ponds and wells. Villagers also reported that when dug wells were functional, those were regularly recharged with rainwater and this ensured quality and quantity of groundwater. But now since dug-wells are non-functional, quality of groundwater has further deteriorated. Due to poor quality of groundwater, crops are not irrigated with groundwater and hence, no tube-wells have been installed in and around the village. Water table of neighbouring Mathania village is gradually declining. Community agreed that abandoning the practice of rainwater harvesting systems will aggravate water scarcity situation of the village in the long run but showed little resolve to do something about it.

## Repair and Maintenance

The conditions of water structures are generally found to be deplorable with minimal community concern and involvement in terms of construction of

**Diagram 5: About Repair and Maintenance Related Works of Village-based RWH Structures**



structures, their operation and maintenance. The key rainwater harvesting source is the village pond and on an average there existed two ponds in every visited village. It was a good sign that around four-fifth of the visited villages had reportedly engaged in repair/renovation works of their rainwater harvesting schemes, mainly ponds through government supported schemes. But around two-third of these ponds were either totally ignored or were not repaired properly, thereby defeating the entire purpose. It is interesting to study the reasons behind such negligent repair works funded through different government schemes.

These exercises were aimed to be labour-oriented and providing daily wage labour opportunity to villagers instead of taking this as an opportunity to promote rainwater harvesting and groundwater recharge. However, it was found that around one-third of these ponds are reportedly maintained /renovated properly on a regular basis. Besides, one-third of the total villages have also reportedly prepared and forwarded proposals to the concerned government authorities for seeking help to initiate such repair works. Villages of Gujarat are less inclined to carefully maintain their rainwater harvesting structures compared to the villages of Rajasthan. The study highlighted the augmented tendency of cosmetic renovations of the rainwater harvesting schemes, mainly village ponds. Around one-third of the villages have moved their proposals to concerned government authorities and were waiting for a response. It is worrying that around two-third of such renovation works have already been reported as being completed, but on ground it has been observed as a formality to engage communities to avail daily wage work. So, it cannot be

**Table 4.14: Repair and Maintenance Related Works of Village-based Rainwater Harvesting (RWH) Structures**

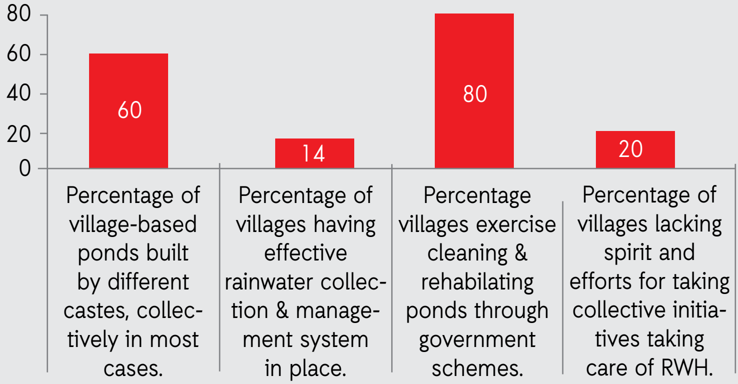
| Details about Ponds | status |
|---|---|
| Number of ponds per village | 2 |
| Percentage of villages where ponds are being repaired and maintained | 80% |
| Total % repair and maintenance work which is being undertaken properly | 33% |
| Percentage of repair and maintenance work not being undertaken properly | 67% |
| Percentage of villages that have moved proposals seeking repair and maintenance works | 33% |

expected that the proposals in pipeline have intention of promoting rainwater harvesting genuinely. In many cases the villagers just used to dig out the ponds as an excavation of puddle clay from the bottoms of the ponds and scraping off the linings further, thus leaving the structures least effective in curbing the seepage. However, around one-third of the renovation works were found to be genuine and serve the desired purpose effectively. It is imperative to study the intricacies of these issues if there is a genuine desire to promote rainwater harvesting and groundwater recharge as a campaign in the study area to cope with the water scarcity menace permanently.

## Management and Distribution of Rainwater Harvesting

All relevant historical scriptures and folklores in the area bear testimony that in western Rajasthan in general and the study area in particular, there have existed exemplary community-led systems for collection, management and distribution of rainwater. The study reveals that in around three-fifth of the villages different rainwater harvesting ponds have been built by different homogeneous communities/castes. With time this traditional system driven by community management has lost its effectiveness as well as scalability and this trend has coincided with shrinking of rainwater harvesting practices in the study areas as discussed in the above sections. However, study findings reveal that still some semblances of this legacy continue to exist in the study area. Community has designated a family or an individual to be solely responsible for taking care of rainwater harvesting, management and distribution with a few differences in operational practices on a village to village basis. In around one-seventh of the visited villages there do exist, though at a smaller scale, appreciable systems of collection, management and distribution of rainwater at village ponds. This system prevails in one-fourth of the study villages of Rajasthan while no village in Gujarat was found to have such a system in place. Moreover, four-fifth of the total villages also exercise cleaning or rehabilitation of the ponds annually or on a two-yearly basis, mostly through government funded schemes. But, as mentioned in an earlier section, the focus of such exercises is more towards providing labour to villagers than to revive and revitalise the rainwater harvesting systems. In one-fifth of the villages in - study area, there was no sense of community understanding, determination or

**Diagram 6: Information About Rainwater Harvesting (RWH) Management, Collection and Distribution**




participation to mobilise communities to take collective initiatives for rainwater harvesting, its management and distribution. Hence in such villages only certain groups of people collect water from village ponds after rains for a certain time period. In most villages people have sufficient access to water from other sources constantly.

## Case Study

Situated at a distance of 66 km from Bhuj in Kutch district towards the north, Khavada village is located in the arid zone of Gujarat. This village is inhabited by Muslim families. Khavada is famous for its excellent potters and leather designs made by locals. The village has a mosque at its centre and all houses are built close to each other. A small stream flows towards the north side of the village that gives flowing water for only one month during the rainy season. People have made small wells inside this rivulet to provide water to their cattle for as long as it is available. In the years when water is available, it is available for three months, and sometimes even less than that. Each house has a water storage tank that is considered to be the most valuable asset and villagers keep it clean and safe. The village also has two tube wells but these are not functional. Some time back, all the villagers contributed money and labour to build a pond to store rain water. Women of this village have taken the responsibility to protect this pond and distribute available water fairly for drinking and cooking purpose amongst all.

Water is available for not more than three to four months every year. The pond and the stream are the only source of sweet water for this village. All other sources supply saline water. People of this village keep livestock including cows, bullocks and buffalos for different purposes. Influential families have a small well inside the stream providing water to their livestock while others have to buy water for them. They keep that well with utmost care and cover it properly so that nobody is able to steal water. Women play a very active role in water management and conservation in this village. Every week they receive two to three tanks of water by charitable entities and it is distributed equitably among all so that they keep water stored in their household level tanks. The community water management system is something people need to learn from this village.

## Religious and Cultural Practices and Rainwater Harvesting

Historically and traditionally, the practice of rainwater harvesting in villages has always been linked to the range of religious and cultural practices to inculcate and implant good habits and practices in people for adopting effective and sustainable rainwater harvesting mechanisms. It was found that worshiping water was an integral part of the culture in entire study area. It was seen that many worshiping places had motifs and symbols related to rainwater harvesting structures. Some rainwater harvesting schemes are also found to be linked with worshiping places. In Ludharva located at the outskirts of Jaisalmer there is a large water tank with the capacity of one lakh litres

that was built centuries ago in the Jain temple of the village. Though now the tank is dilapidated as it was not maintained properly but it bears testimony to how rainwater harvesting is an integral part of places of worship. Trend of worshipping water and venerating it as a precious resource has declined to a great extent, but it is still visible in some villages with different levels of passions. This includes linking the rainwater harvesting points with celebration of religious and seasonal festivals, observing different religious fasts and prayers. Practices associating rains with religious sentiments inlcude making sacred places of gods and goddesses near rainwater harvesting points and placing rainwater harvesting points near cremation grounds.

The study's findings disclose that around two-third of the villages have one or the other such trait associated with rainwater harvesting. All villages reported existence of some story that was passed down generations that confirms the historic existence of such practices. It was observed that around one-third villages effectively used this link between religion and rainwater harvesting to drive behaviours of people to govern rainwater harvesting systems effectively and sustainably in continuity with relevant rich legacies of villages. On the contrary it was noticed that villages that did not use this linkage effectively were more prone to conditions wherein water points and their managements were badly dilapidated and in poor condition. It was seen that the catchment areas of the ponds were either encroached upon, used as sites for defecation on or filled with dumps of dirt and filth. The water bodies too were in a ramshackle state with no visible inclination towards repair and maintenance. When associated with religion and culture, it became mandatory to keep the water points clean and hygienic, which goes a long way in keeping them robust and thriving. Hence, based on all these observations it is understood that the presence of religious and cultural practices around water points in villages has proved as a good source of awareness generation. This works as motivation

**Table 4.15: Religious and Cultural Traits and Rainwater Harvesting (RWH)**

| Details about Traits | Status (in %) |
|---|---|
| Percentage of villages having one or other cultural/religious trait associated with RWH | 67 |
| Percentage of villages effectively exercising cultural/religious traits associated with RWH | 33 |

building for rural masses so that they continue the tradition of rainwater harvesting effectively and sustainably.

## Case Study

Dawara village is situated in district Jaisalmer. Its topography is sandy, muddy and arid. The village has one large rainwater harvesting pond and one small pond. The ponds have been the key source of water for the village over the years. The livelihoods of villagers are dependent on rain-fed agriculture and livestock rearing. Due to traditional beliefs associated with the rainwater harvesting practice the ponds were reportedly maintained collectively by the people of village. The study team learnt that on Janmaashtmi every year, people gathered near the pond and bathed the idol of Lord Krishna and prayed for good rain for their crops. In parts of the ponds people manually dug wells to preserve water for dry seasons. A few years back the government installed a tube well in Dawara village and since then, the people are showing callous attitude towards the importance of rainwater as water from tube well is easily available to all the people of the village. A person has been authorised by the people to run the tube well and in return a sum is paid to him collectively by the villagers and the Public Health Engineering Department. Households that are far from the tube well have setup private tanks to store water and collect rainwater too. The Indira Canal has also been connected to this village. Some households have secured illegal connections through Indira canal.

Most households have individual water storage tanks and also serve as rainwater harvesting tanks. During the course of study, it was found that the pond is not being maintained appropriately to keep it clean. The village has a large catchment area but not enough capacity of water harvesting or groundwater recharge structures, runoff water collected during heavy rains often poses threat of flooding around households of the village. There is a dire need to focus on rainwater harvesting and groundwater recharge activities to deal with water insecurity situation of the village.

## Traditional Knowledge and Indigenous Technologies vis-a-vis Rainwater Harvesting Schemes

It is a fact that historically western parts of India in general and the study area in particular have been famous for using traditional wisdom and indigenous technologies for harvesting rainwater. Centuries old structures made for harvesting rainwater are still functioning even without proper maintenance in many parts of western India. Around two third of village level rainwater harvesting ponds were reportedly built more than two to seven centuries ago. One-fifth of these ponds are just wide embankments excavated in wisely identified muddy plain areas with greater outreach of catchment area for harvesting rainwater. However, in some cases stone and lime mix foundation and boundary work are in dilapidated condition without proper maintenance. At some places stone pillars have been found exhibiting details of communities who built these ponds and time periods when these embankments were excavated. Most such stone landmarks have been engraved with symbols of different gods and goddesses and such structures have been installed in catchment areas of ponds to maintain sanctity of the area. In one-third of villages adults and children still gather at these sites to celebrate festivals and pray for good rains. However, in many villages such legacies are now verbal stories to remember and recall this rich tradition. Rainwater harvesting structures seen in Jaisalmer and Bada Bag including Gadisar Lake and Jait Band are sterling examples of use of traditional wisdom combined with indigenous architecture in creating such mega rainwater harvesting and groundwater recharge models built in mediaeval India. Jaisalmer was then a corridor of the silk-road where camel caravans of traders reportedly stayed. Groundwater in the area was not potable and the city received less than 200 mm of rainfall annually. But both rainwater harvesting and groundwater recharge structures were built in a way that they collected enough rainwater after one rain and also recharged the groundwater at an optimum level through *beris* built at bottom of water bodies. This system was so sound that the area reportedly never faced water shortages for two to three years even if there were no rains.

**Table 4.16: Historic and indigenous record of Rainwater Harvesting (RWH) Ponds**

| Details about Historic and Indigenous Record of RWH Ponds | Status (in %) |
|---|---|
| Percentage of village based RWH ponds built more than two centuries ago | 67 |
| Percentage of ponds merely dug like wide embankments in muddy plain areas built in the last few decades | 33 |

Surprisingly, the groundwater recharge mechanism had created a conducive environment for agricultural and orchard farming. This legacy is still thriving at Jait Band in Jaisalmer. It is astonishing to see the use of advanced science in making infrastructures of these water bodies and wisdom displayed by community in devising sound management practices exercised in rainwater collection, management, distribution, handling and even using the water for different purposes. But on other hand, it is distressing to notice that this rich legacy is losing its roots as most of these old but sustainable water bodies are not maintained properly. Moreover, newly built infrastructures have chosen latest engineering designs, construction modes and materials. All the household level tanks built in last two decades in study area have chosen cement, sand and concrete as materials and built structures using latest engineering technologies. All other newly built water infrastructures in villages have been built on set designs and prototypes as guided by mandates from government engineers with the given schemes. It is observed that the structures built during the last two decades on latest engineering constructional parameters despite being repaired more than once are in a more dilapidated condition than those structures of water bodies built centuries ago that receive no or little maintenance. It appears that the contemporary rainwater harvesting schemes supported by different government programmes are more business oriented, benefiting the engineering fraternity, monitoring staffs, contractors and material suppliers, rather than serving the purpose of rainwater harvesting and groundwater recharge. Hence, the study would strongly recommend reviewing, analysing and amalgamating traditional wisdom rooted in indigenous technologies used in age-old rainwater harvesting schemes.

## Rainwater Harvesting vis-a-vis Social, Geographic and Climate Change Conditions

The study team came across a range of changes related to social, geographic and climate conditions that have put adverse impact on traditional rainwater harvesting legacy in this area. Socially it has been observed that introduction of water supply schemes to villages has spawned the mushrooming of some vested interests groups engaged in the water business with the backing and complicity of local politicians, influential entities and concerned government personnel responsible for water supply schemes. The processes of construction of water infrastructures and installation of associated technologies, their operation, maintenance as well as repair have all been more focused on business oriented tasks for monetary gain. This is one of the key reasons why conventional water supply schemes are more promoted and accepted by influential people in different areas while traditional rainwater harvesting systems are totally ignored. Even rainwater harvesting schemes promoted in the last 20 years are more geared towards contractual business oriented approach of government schemes rather than by learning from and building upon the sturdiness and sustainability of traditional rainwater harvesting systems.

It has also been observed that rainwater harvesting common village sites are encroached and occupied by land, mining and other interest groups leading to shrinkage and disappearance of age-old rainwater harvesting and groundwater recharge structures from villages. This entire phenomenon has caused a lot of damage and has disrupted the community collective approach to fight against water scarcity through village based rainwater harvesting systems. Climate change has also impacted rainwater harvesting. According to the experience of the local people, the trend of climate in the region has been that of drastic fluctuations and extremes. The study area on the one hand has been suffering from long spans of drought or very low rainfall for years; on the other hand it has experienced torrential rainfall with the threat of flooding. But despite these changes, it can be said that there is a huge potential for harvesting rainwater as a sustainable solution to water crises in such a water scarce zone. Focussed research and use of appropriate technologies are needed to introduce climate friendly and changes-adoptive sustainable measures of rainwater harvesting and groundwater recharge.

## Rainwater Harvesting and Arid Zone Ecology

Arid zone of the study area has mostly groundwater dependent ecosystem except in a few areas where canal water has reached. The study indicates that even today, a major part of the economy and livelihoods of people in study area are reliant on groundwater dependent ecosystem. The groundwater is dependent on rainfall. It was found in the study that in many villages water table accessed by bore-wells has fallen to as low as 40 feet in May-June. Before annual rainfall people have arranged for additional pipes at the bottom of bore-wells to reach the dropping water. The water level accessed by bore-wells is reportedly restored after rainfall. People also confirm that falling water table has also badly affected the vegetation in the area. Moreover, the cutting down of trees and clearing of desert bushes have disturbed the rainfall pattern. Now there is either low or no annual rainfall or torrential rain that makes flooding occurs. In absence of systematic rain water harvesting mechanism water drains out or evaporates. This wasteful and heavy runoff in the flood-years further poses threats of land erosion and subsequent deforestation, droughts, floods and climate-warming. This phenomenon ultimately creates a vicious cycle that is extremely detrimental for the arid zone ecology. This vicious cycle can only be broken through reviving age-old rainwater harvesting and groundwater recharge.

### Case Study

Morlidungari village is situated in Sabarkantha district of Gujarat. It has a population of 1,191, mostly Rajputs. Agriculture is the only source of livelihood for the people. There is a pond located 2 km away from the village but water is not stored in sufficient quantity to serve the needs of people due to its poor structure, porous depth and no renovation.

It only stores water for a few months after rains. People of this village were so worried about the pond's capacity; they approached government to restructure the pond to store sufficient water. But no attention has been paid by concerned authorities in this regard. Beyond this pond, there is no other source available in the village to conserve rainwater. This village gets water from a nearby village, Rampur through motorised water supply scheme, twice a week. There is one distributary point in the village from where people collect water. There are three more distributary points with storage tanks in the village, each tank has capacity of 10,000 litres but all these are non-functional. In addition, there are four hand pumps in the village installed 30 years ago. Of these only one hand pump is functional while the remaining three have developed faults. At present this one hand pump is the sole village based water source to supply water to people of the village. Female members of the village go to fetch water from the hand pump which consumes a lot of their time and energy. It was reported that 60 years ago a dug well was used to supply water to the villagers but due to depletion of groundwater in the village, the dug well has also gone dry. Though there is one tube well installed in the village but this too has been non-functional for long. The water table has fallen to abysmal depths in the village. Panchayat is ready to install a tube well but there is no useable water underground even up to 500 ft down. There are also around 15 wells at the farm level but none of them are operational. The study found people of the village to be extremely worried about the future of groundwater dependent ecosystem of the area.

## Groundwater Recharge

Not just human inhabitants but the entire biodiversity and the ecosystem of study area are mainly dependent on groundwater. Excessive exploitation of groundwater poses serious dangers to the underground water reserves. Groundwater is rapidly depleting with falling water table at an alarming level. Historically, it has been seen that people in this area were more conscious and adopted a proactive approach to take appropriate traditional measures to recharge groundwater through various means including dams, bunds, *khadins*, dug-wells and *beris* during annual rainfall. But unfortunately, this practice has vanished from four-fifth of villages where almost all the people seemed either

unaware about the importance of groundwater recharge or they displayed callous disregard towards this issue.

It was found that one-fifth of villages have structures available for groundwater recharge. These mainly include *beris,* dug-wells, check-dams or bunds with natural infiltration zones. But most of these structures have existed since centuries or for last few decades without any maintenance their condition is gradually deteriorating.

Even dug-wells do not serve the purpose of groundwater recharge during rains without maintenance. Secondary data including rich and exhaustive research work of Anupam Mishra, show that there exist rechargeable zones function like natural water storage vessels to provide water in dry periods and supplement an entire ecosystem of the area. Thus, it is imperative that the concerned authorities and stakeholders work out a joint strategy to focus positively on this important issue on an urgent basis.

**Table 4.17: Traditional Working Systems of Groundwater Recharge in Place in Villages**

| Details about traditional groundwater recharge systems and practices | Trend (in%) |
|---|---|
| Villages lacking traditional working groundwater recharge systems and practices | 80 |
| Village having one or the other working system of groundwater re-charge available | 20 |

## Case Study

Sanwlor village is situated around 20 km west of Barmer city at the juncture of desert zone and end of Aravali mountainous ridges. It consists of 400 households whose livelihoods are mainly dependent on rain-fed agriculture and livestock rearing. There are three rainwater harvesting ponds built alongside each other in the village namely Balasar, Kareli and Phulasar that functioned vibrantly and coped with the water needs of the village. Balasar is very large and the main pond, which was reportedly built by Balasar Parjapat. People believe that their ancestors might have chosen this location for their settlement because it has a natural catchment area with good water yield potential. All villagers in general and the Parjapat community in particular were responsible to maintaining and look after the catchment areas and ponds that are situated at around 2 to 3 km from the village.

Villagers reported that the MGNREGA and famine schemes of the government also contribute towards maintaining and nurturing of the ponds and the catchment areas. Mostly, once in every year the catchment area of the ponds inevitably used to be cleaned at the inception of the rainy season. The Village Panchayat had formulated the rules for water harvesting, storage, distribution and cleaning, maintaining and repairing of the ponds. Water availability from ponds lasts for 7 to 8 months followed by rains in order to fulfil the critical water needs of the village. But it is worrisome to notice that the tendency of sole dependence of the village water needs on rainwater harvesting has been gradually reduced since the last 20 years due to the advent of tube wells and other water extracting machines installed on dug-wells that supply water to the households. However, before the arrival of tube wells there were around seven dug wells in the village that served as the key source of water in the absence of rainwater. Besides, there are four hand pumps in the village that are all functional. Currently, two motorised machines/tube wells installed over two dug wells in village regularly work to supply water. Regular supply of free ground water has unfortunately spread disregard among villagers on the importance of traditional rainwater harvesting. Though more than 80 per cent of the households in the village have built household-level tanks through government supported MGNREGA, catchments of most of such tanks are either not constructed or left incomplete or unrepaired. Hence these tanks do not serve the purpose of harvesting rainwater but are only used as water storage tanks. Beside there are 13 public rainwater harvesting circular storage tanks (each 20 ft x 20 ft) built around a decade ago but none has been maintained and they do not have a functional catchment area. Thus, these tanks are left unused and no rainwater is harvested by this infrastructure. There is no vibrant community participation mechanism in place to ensure maintenance and functionality of such rainwater harvesting structures. There are also two check-dams (Khadins) in the village that can serve as an effective means of groundwater recharging. These check-dams were reportedly built more than 20 years back but unfortunately nothing has been done to make these check dams functional and effective. No renovation and maintenance work has been done on them. These are filled with silt deposits reducing their outreach of catchment. Hence these check dams have not been serving their purpose. In addition rainwater harvesting ponds as key resources for rainwater have also been relegated least priority by the community. Thus these ponds are not only becoming overcome by silt deposits but shrinking in size due to encroachment by stone mining crusher machines. The contractor of stone mining is an influential man in the village and supplies tank water to influential households. This is the key reason why well-off people of the village are unconcerned about the importance of ponds. While the poorer Jogi community and a few other marginalised communities have tried to raise their voice against the stone mining contractor, he has always managed to coerce them into silence. There are around 16 private tube wells installed in the surroundings of village for agriculture purposes. As a consequence of heavy exploitation of groundwater through tube wells in western Rajasthan the groundwater table is falling drastically. In the last 20 years in this village, the water table has fallen by around 100 feet and has reached up to 250 feet. It was noted that villagers have traditionally had beliefs and devotion around water extraction and water resource maintenance. Villagers perform Balaji Pooja (in worship of Hanuman) near the ponds for healthy monsoon rains. Even at the time of dug well or tube well installations they reportedly follow folk indicators (suguns).

## Water Wastage

Study findings disclose that traditional means of water collection, management, distribution and usage have gradually shifted to mechanically-derived piped water supply modes. Around one-third of total water supplied through water

**Table 4.18: Status of Water Wastage**

| Water Wastage | |
|---|---|
| Details about water losses | Amount (in %) |
| Water going waste during supply/distribution | 33 |

supply schemes goes waste through leakage in taps and pipes. Incidence of such leakage not only results in wastage of water resource but also a criminal waste of the financial resources and energy that has been used to supply this water. This also adversely impacts both human health and surroundings. It is envisaged that revival and promotion of these traditionally managed water systems can also help prevent loses of water and emerge as a durable model of water solution in all areas suffering from water crisis and scarcity.

## Water Privatisation

The study findings disclose that in most of villages, community-led water management and distribution trends are predominant. In this system of community-led water management system, villagers designate a family or a group of individuals for overall management of water supply schemes including water distribution. The families/individuals are compensated through different commodities, grains or cash. Moreover, in around three-fourth of government supported village-based water supply schemes (groundwater and canal water) a government or Panchayat supported technical/operational personnel is designated. In remaining one-fourth villages such human resources are not available. Apart from half the villages, there is an emerging trend of water contractors particularly engaged in water distribution through private tankers.

These private contractors even manage the entire village's water unofficially. They are either part of the Panchayats or have strong local political backing and financial complicity with local government officials. These contractors collect water through their tankers from village water points (including rainwater ponds) and supply to well-off households within the village or even to neighbouring villages on different charges based on the distance ranging from Rs. 200 to Rs. 1000 per tanker. Most village based water schemes don't have door-step tap provision, thus trend of water distribution through tankers mostly for rich households is on the rise. It is also becoming a predominating practice creating various water governance issues affecting vulnerable communities adversely.

In one of the villages it has been reported that a company has installed Reverse Osmosis (RO) system for water desalination and that RO is being managed by a local contractor who sells water in the village. All these factors indicate that the legacy of old community water management system in villages is badly dismantled and is being gradually replaced by the growing trend of water privatisation. It seems that this trend might uproot the age-old community-led collective and sustainable water management system and bring a shift from rainwater harvesting dependency to canal and ground water supply. This will only adversely affect the poor and the vulnerable segments of society who don't have paying capacity to access water in rural settlements.

**Table 4.19: Status of Water Privatisation**

| Details about Water Privatisation | Status |
|---|---|
| Percentage of villages wherein Panchayat supported scheme custodian is designated | 75 |
| Percentage of villages wherein Panchayat supported scheme custodian is not seen | 25 |
| Percentage of villages wherein contractors supply water through rental-tankers | 50 |
| Minimum charges of supplying water tanker in villages | ₹200 |
| Maximum charges of supplying water tanker in villages | ₹1,000 |
| Percentage of villages having private RO as water enterprise is installed | 5% |

## Case Study

Kharantiya village is situated to the south east of Barmer district in the area bordering Jalore and Jodhpur districts. This village is located on a sandy patch that closely stretches to the wider plain of tough muddy area and on other side is rounded by a mountainous range. The outreach of muddy area is situated right at the foothills of the mountainous range, which serves as a natural catchment area. Perhaps this seems to be crucial factor behind ancestors around three to four centuries ago dugout a very large pond to fulfil their water needs and settled. The pond is built in a circular shape with depth of around 10 to 12 feet and radius of around 200 feet. The pond is named as Naukhadi and has enough capacity to store rainwater and has for centuries fulfilled the water needs of the village. There are 284 households comprising four different castes; Bheels, Meghwals, Jaats and Brahmins.

But about 10 years ago, government provided tube-well to give free water at source and this has resulted in water dependency shifting from rainwater to groundwater. This motorised supply of groundwater has made the villagers careless about rainwater harvesting and they are now not at all bothered about cleaning, maintaining and nurturing their age old pond. However, they avail income generating benefits under MGNREGA and other schemes for renovation of the pond. Last year a contractor from the village started removing silt deposits from the side wall linings and bottom of the pond to revitalise it but left it unfinished due to a community quarrel. Since then, the pond has lost water storing capacity on its side lining. The catchment area of the pond needs to be cleaned to ensure the hygienic harvesting of rainwater. Currently stored rainwater is used for livestock and other domestic uses, particularly when motorised groundwater supply develops faults for few days. Despite all this survey team found some leftover water at the bottom of the pond.

Kharantiya village also has three dug wells that were built probably more than 150 years ago. The groundwater table of dug wells is 150 feet deep. Of these one well has not been functional for a long time while the other two dug wells are linked with water pump machines governed by the Public Health Engineering Department of the Government of Rajasthan. The groundwater here has reportedly some adverse mineral concentrations including fluoride at more than permissible levels. For this reason in 2013 the government installed a Reverse Osmosis (RO) plant on one dug well. This RO plant is managed by one individual contractor who collects user charges from people for treating water through RO. Only 25 per cent of people in the village can afford RO water and the remaining 75 per cent are using non treated contaminated groundwater.

During field visit it was noticed that the RO plant lay defunct, when enquired about the reason, operator informed that only few pay on time and a majority had outstanding bills. This indicates that the idea of privatising water in the given socio-economic scenario of rural western Rajasthan is not feasible at all. It was also reported that the groundwater table is falling drastically in the village. Before rains every year the water level falls up to 40 feet down and villagers are forced to add 40 feet of additional pipe at the bottom inside the tube well machine to reach the fallen water level. The village has a long 25 feet deep ground level reservoir that was built as a part of the tube well scheme 15 years ago. People collect water from this reservoir also. There are two water tankers in the village that supply water at 500 rupees per tank to those who can afford to buy water. Rest of the people fetch water manually from the centralised tank. There are around 70 per cent of households in the village who built small household level rainwater harvesting tanks for harvesting rainwater and storing tube well water when rainwater is over. Many households stay at their fields a few kilometres away from the village and have made their own hamlets. Earlier only around one-fifth of the households had such private household level storage tanks, but this number has increased to four-fifths after introduction of MGNREGA. Design of these private household level storage tanks has also been revolutionised to add up the catchment area for making it rainwater harvesting tanks too. Previously, even if there were catchment areas, these were not pakka, but now most such tanks have pakka catchment areas.

Recently this village has been linked to canal water through a canal that supplies water free of cost to the village based ground level reservoir. But the storage reservoir has heavy leakage in its taps that leads to great deal of water being wasted. The waste water could be seen accumulated and stagnant in a lake shaped area exposing the villagers to the threat of malaria and other associated diseases. The village has four water storage tanks to store water during droughts but these tanks are not in use. Besides the village has also a hand pump that was functional for a few years but has been out of order for several years now.

Both ground water and canal water supply are not sustainable. But over the years people tend to ignore rain water harvesting structures. People suggested that it was imperative to revive community based cultural and religious practices associated with ponds to revive age-old rainwater harvesting practice and ensure sustainable water security of villagers in western Rajasthan.

## Pipe Water Supply — Access and Vulnerability

The study reveals that around two-third of the households have access to village water supply schemes/facilities. Around half of those households have easily reachable access to water distributary points (a few have doorstep taps) while the remaining households have the capacity to pay for water tankers. However, remaining one-third households who belong to socio-economically vulnerable sections (mainly Scheduled Castes and Scheduled Tribes) have to manually fetch water from water distributaries points/schemes. It has been observed that this vulnerable group undergo a great deal of suffering when water supply is hampered due to shortage of fuel or repairs as they do not have household level water storage facility. Around one-fourths of village based water supply provisions (both canal-fed and groundwater dependent) were found non-functional (mechanical faults or ceasing fuel supply) during the visit. People were eagerly waiting for repairing of these provisions. This mismanagement happens despite the fact that everywhere government personnel have been designated to ensure timely repair of machineries and provide fuel for pumps.

It was found out that such situation is created by a 'water mafia'. Influential people use such opportunity to run their water tanker business. This entire dominance of powerful groups on water management not only adds to suffering of vulnerable and silent households but also creates impediments on the path of sustainable water conservation and equitable distribution.

## Water and Women

It was obvious that managing domestic water needs in the study area has traditionally remained the prime responsibility of women. The changes that have occurred in the prevailing water scenario across the study area have affected the situation of women in different ways. Situation of women has reportedly improved with increased access to water. Women from around two-third households are free from the burden of fetching water from far-flung water points. However, within the household level, women still have to play the role of sole custodians of water.

On the other hand the situation of one-third women belonging to socio-economically vulnerable households (mainly scheduled castes and scheduled tribes), without access to water, has turned worse – they still have to make laborious trips from their households to distant water distributary points for fetching water. It is also noticed that in all manual repair and rehabilitation work of rainwater harvesting ponds supported by government schemes, women are mainly engaged as labourers. So they carry double burden of managing household chores and doing labour work.

## Water and Caste Discrimination

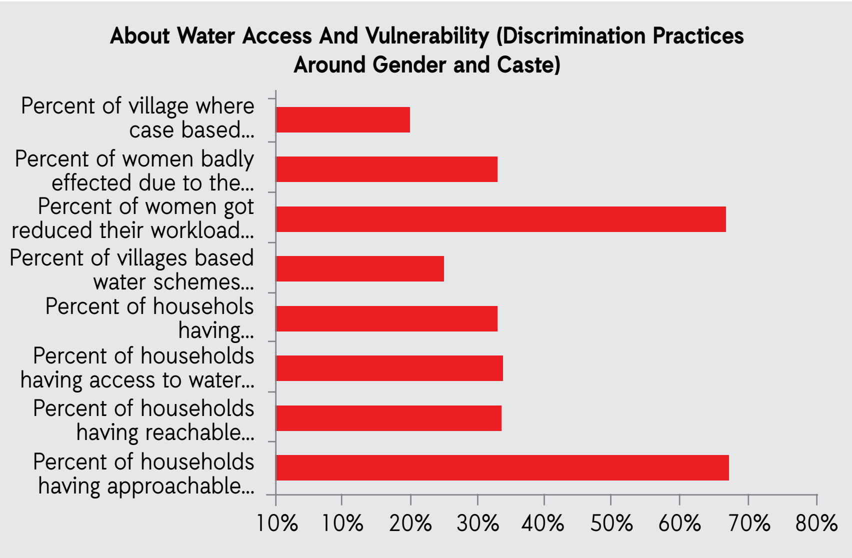
Discrimination in getting access to water is an unfortunate but common phenomenon faced by Indian society. The study reveals that people of around one-fifth of the villages, experience caste based discrimination for accessing water. Certain caste people are not allowed to directly collect water from water storage tanks. In certain cases, water source maintenance, management and supply is done by certain upper caste people. However, in four-fifth of villages, people during consultations denounced the practice of caste discriminations but this is nonetheless visible in practice. This shows that people criticise the age-old curse of castes discrimination but it is taking time to abolish it from their society.

### Case Study

Village Salwakalla located in Jodhpur district has one large and two small ponds with wider catchment area. Earlier, this large pond was the key source of water for most of the year. But around 20 years ago, people installed pumps over the two old dug wells of the village to supply drinking water. Community developed a system to handover the operation and maintenance of the dug wells through low cost bidding. The bidding process was repeated afresh every year on Diwali. The person who succeeded in securing maintenance of the dug wells was supposed to charge fees from

**Table 4.20: Water Access and Vulnerability (Discrimination Around Gender and Caste)**

| Details of the Vulnerability (including Gender and Caste Discrimination) | Status |
|---|---|
| Households having approachable access to water sources within villages | 67% |
| Husehold having reachable access to distributary points | 33.5% |
| Households having access to water through purchasing tanker water | 33.5% |
| Households having difficult/faraway access to water sources | 33% |
| Villages based water schemes found non-functional | 25% |
| Women with reduced workload due to the modern water arrangement system | 67% |
| Women badly affected due to the modern water arrangement system | 33% |
| Villages where caste based discrimination is practiced around water systems | 20% |



every household. Apart from water supply, maintenance of catchment was part of the contract. SC and ST people were not given a chance to participate in the bidding process as the villagers wanted someone from upper caste to handle water at the wells. Even at time of water collection SC and ST people were required to wait until someone could fill their pots as they were not allowed to carry water from tank directly. Small hamlets on the outskirts of the village were supposed to procure water through tankers and tankers were also supposed to pay certain charges to the contractor of dug wells. The contractor was responsible for managing fuel for the machines, repair, maintenance and water distribution. He was supposed to sell organic manure of the well and manage operation.

About 10 years ago, the village got canal water supply from where water has been distributed to 64 nearby villages. With the advent of this scheme the dug wells have ceased to function. Now the villagers get direct water at home through taps. Each house in the village has to pay Rs 50 per month as water bill. It was also reported that the village has public tanks for water storage. Government famine alleviation schemes and MGNREGA have helped people construct household level rainwater harvesting tanks. These tanks have a fenced catchment area and a covering lid. Since 2009 Salwakalla got an easy source of water through link of canal and adequate water is available to every house, water conservation practices are forgotten and villagers display a negligent attitude towards rain water harvesting.

When there was no source of water other than the pond, people were extremely careful and maintained it and regularly cleaned catchment area. Now the only motive to dig/repair the pond under MGNREGA is to earn money. Also earlier, women played a greater role in water collection and management and used to perform prayers at village water sources but now all such practices are vanishing. Tanks constructed at the field level for rainwater are now filled with canal water.

People at village are not much concerned about the deteriorating ground water quality or its recharge ability. They are not at all interested to have any long-term consideration about the water scarcity threat nor does the panchayat seem to mark its involvement in this matter.

# 5 CONCLUSION AND RECOMMENDATIONS

The problem with water in arid zones is crucial to address. People in dry regions have ample knowledge and technology to conserve whatever scarce water resource is available. Traditionally people have explored number of ways and constructed many structures which are relevant till date. However, there is a need to understand these structures and maintain those to conserve water resources. This study has captured traditional knowledge and technology in water conservation and its relevance in the present context. People in the study villages have shared many of their experiences related to their life, water and environment in arid zone. The recommendations have been drawn taking their views and ideas together.

## Recommendations

- It is important to protect all water bodies which are largely encroached for construction of road, buildings and other structures. The study recommends for strong policy to prevent any kinds of encroachments or diversion of any water bodies at any place. Catchment area of all water bodies also need to be free from encroachment.
- Many water bodies have been built using traditional knowledge and technique. Those water bodies contribute to water harvesting. People in many areas have suggested and recommended that all such water bodies need to be protected for water percolation and ground water recharge.
- The study recommends for protection of pasture land and pastoralist rather than promoting agriculture activities to deal with water contamination due

to use of chemical fertiliser and pesticides in crops. There should not any diversion of pasture land for agriculture or any other activities.

- Establish 'rainwater harvesting & groundwater recharge' demonstration stations representing all effective indigenous/traditional relevant models with value additions of advanced appropriate technologies.
- All the relevant governmental schemes across departments must appropriately incorporate/integrate the component of 'rainwater harvesting and groundwater recharge'.
- All schemes related to 'rainwater harvesting and groundwater recharge' must integrate with promotional materials and advertisements for promoting literacy and awareness on the subject.
- District and state level advocacy groups must be established/strengthened, taking all concerned stakeholders on board, with the mandate of reviving/promoting 'rainwater harvesting and groundwater recharge'. There is need for raising awareness, conducting various drives/campaigns, organising theme related events and other appropriate measures.
- Feasible areas with wider catchments (prone to flooding) and dense vegetation should be identified for new rainwater harvesting schemes. There is a need to campaign for desert friendly tree-plantations in the surroundings of rainwater harvesting structure.
- Wherever naturally built feasible catchments are not available, manually built catchments may be created for this purpose.
- Ensure that wasted/leaked water in villages should be used/reused in tree-plantation/gardening or for other environment friendly measures.
- Robust 'rainwater harvesting and groundwater recharge' models should be built in schools and schools syllabi should include importance and functionalities of 'rainwater harvesting and groundwater recharge'.
- Identify and rehabilitate non-functional/under-utilised RWH & GWR (dug-wells) structures
- Take appropriate measures ensuring that all concerned actors should adopt indigenous, cost-effective and contextually proper designs and architectures

for erecting effective and sustainable structures of 'rainwater harvesting and groundwater recharge'.

- Appreciate and award roles and contributions of individuals and communities around promotion/revival of 'rainwater harvesting and groundwater recharge'.
- Water budgets of government must have separate allocation for 'rainwater harvesting and groundwater recharge' creating a balance among schemes related to Groundwater Extraction, Canal Water, Rainwater Harvesting and Groundwater Recharge.
- Chemical uses in mining, commercial/industrial activities and agricultural inputs leads to pollution of groundwater, canal water flows and rainwater runoff. Thus, there is a need to protect water resources from such pollution.
- Extracting groundwater through bore-wells, supply through water tankers and other such contractual/commercial phenomenon in water distribution/supply tends to promote water privatisation in this zone. Hence, commoditisation and privatisation of drinking water must be stalled.
- All government schemes of 'rainwater harvesting and groundwater recharge' must be reviewed and revisited and their design upgraded for effective implementation and achieving desired objectives and results.
- While promoting traditional 'rainwater harvesting and groundwater recharge', advanced technologies must be integrated to identify feasible lithology/strata and aquifers for recharging groundwater resources.
- Canal water has its own limitation to meet the growing water needs for domestic and agricultural purposes. This is the reason why exploitation of groundwater has reached alarming levels in most parts of the study area. There is a need to shift focus of contemporary means of modern water accessibility to historically tested and proven durable source. Hence it suggested that 'traditional rainwater harvesting and groundwater recharge' must be revived and scaled up as sustainable water solution of this water scarce zone.
- Available metrological data reveals that the area has witnessed three-fold increase in the incidence of floods during last decade. More than 95 per cent

rain water goes waste through runoff and evaporation causing devastations to the area. Hence this challenge can be converted to opportunity by focusing on 'rainwater harvesting and groundwater recharge' structures.

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