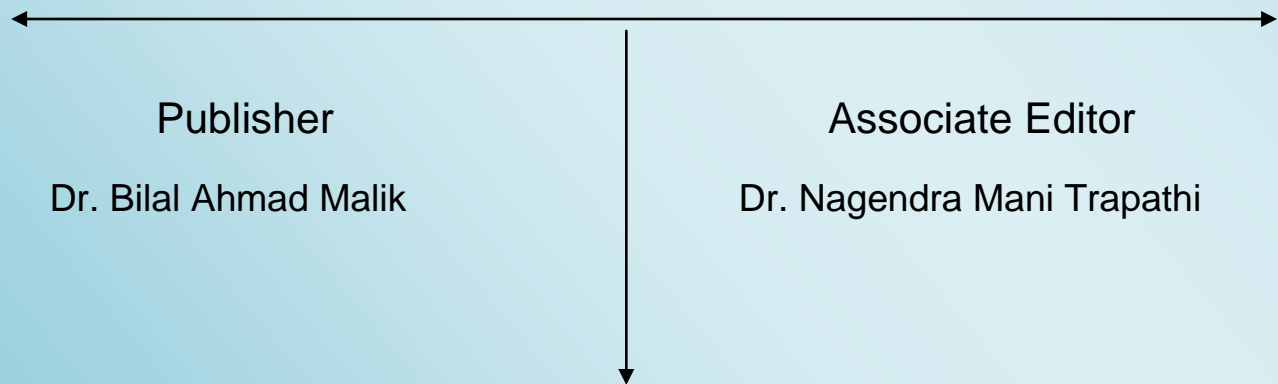


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WATER MANAGEMENT FOR SUSTAINABILITY OF NAGOUR DISTRICT

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ABSTRACT

In the dynamic world with rapid increase in population and technological advancement the water resources are exploited at unsustainable rate. In the global scenario 2005 to 2015 was declared as a water decade, the whole world concentration come on water along with that in 2015 the sustainable development goal also emphasis on water resources.

Nagaur district is blessed with traditional common water harvesting systems in local language these are known as Nadi (pond) but in present scenario in this modernized world at the name of hygiene people are not using these nadi and they become extinct or not properly managed.

In such a situation the whole pressure of water is put on the groundwater. With commercialization in agriculture, the extensive farming has shifted rapidly towards intensive farming. The technological input in farming has managed to raise the standard of well-off farmers of Nagaur but tremendous pressure on water resource. The dependency on water resources has been manifold by submersible tube wells pumps which has successfully supersede traditional wells to extract groundwater. The groundwater of Nagaur district is very toxic along with high TDS and high fluoride value. In these conditions the scarcity of water leads to many social, economic, cultural problems arises such as health hazards(dental and skeleton fluorosis), low level of education of girls (due to fetching of water), marriage denial due to unemployment among the youth, rural to urban out- migration, limited agriculture for poor farmers, less industrial growth, social disputes etc.

This study is based on water management in few villages of Nagaur district, Rajasthan which deals with non-sustainable human attitude to fulfil their desire instead of focusing on their basic needs. The over exploitative nature of groundwater lead to deteriorate water quality and the shift from the conventional and conservation water resource will create a trouble in the near future for the present generation. The forthcoming generation will be left with very scanty amount of water because of this non-sustainable water management.

Keywords: Ground water, Submersible pump, Nadi, Fluoride, Sustainability, out-migration.

INTRODUCTION

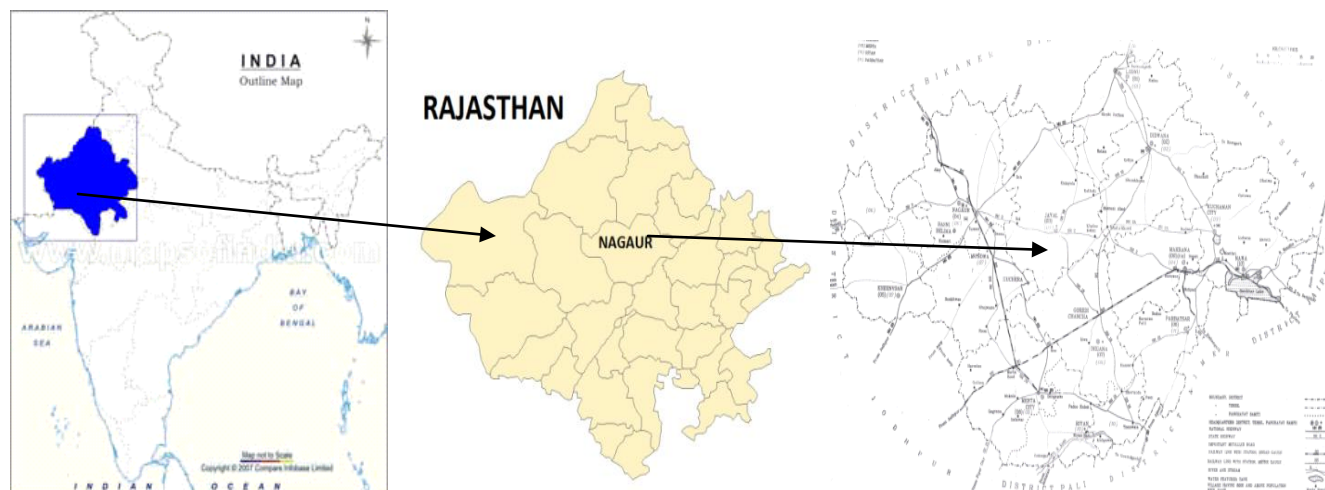
Water is the live sustaining substance and a pre requisite of human life. All civilizations were developed near water sources and indication the standard of the life of the people. It is very unfortunate that most of the available water on the earth surface is saline and not used for drinking purpose. Only one percent of available water on earth is fresh and suitable for fulfilling the needs and desire of human kind. Still there are certain regions on the earth surface where people starving for the potable water.

Nagaur is one of the district of western Rajasthan in the Thar Desert. The semi-arid condition of desert having very limited natural resources specially water. The scarcity of water is the main problem of the region. The rainfall is very scanty less than 40 cm with 18 to 30 rainy days in a year. The ground water condition of the region is also very worse out of the 11 blocks 4 critical and 6 are over exploited with high concentration of fluoride and TDS. (Ground water report, Nagaur, 2013).

Over the years, with rapid increase in population, fast industrialization, and expanding agricultural activities have increased the demand of water. It is estimated that by the year 2025 the demand for potable water is likely to increase by 56% more than the present limit of water use. (Jethoo at. al.). Simultaneously, the technological advancement further enhance the demand of water and also avail easy supply of water by tube wells, submersible pumps, tractor tankers etc. As the per capita availability of water has reduced and the per capita utility increases because water is easily available and accessible. This easy availability of water is so lucrative but for a very short span of time. The people of this region misuse the water resource and make un sustainable use of it. And over the time passes, there were certain practices evolved and caused depletion of tradition water conservation system and make over dependence on ground water. In this background ground water depleted at certain extend where the quality of ground water is worsen and became toxic.

STUDY AREA

Nagaur district is located almost in the middle of the state of Rajasthan and extends between 26°25'N to 27°40"N and 73°10' E to 75°15 E. It covers an area of 17178 sq. km, which is 5.18 percent of the total area of the state. Which is divided into 10 tehsils and 11 blocks.



The general topography of the area is fairly even. Slope of the land surface is towards west and elevation varies from 250 meter above msl (mean sea level) in south to 640 m above msl in north. South-eastern part of the district comprises small scattered hillock and rest having sand dune. There is no river which originated from the district however; the river Luni crosses the district in the southern part flowing for about 37 km in the western direction. It is an ephemeral river and carries runoff that is generated in the upper reaches. There are four types of soils have been reported in the district viz, clay, clay loam, sandy loam and sandy soil. A longitudinal belt from Didwana to Nawa extending up to Sambhar Lake has the characteristics of alkaline soil.

The Region experiences arid to semi-arid type of climate. Mean annual rainfall (1981-2015) of the district is 410 mm with 15 to 20 rainy days in a year. The rainfall in the district is highly seasonal. The monsoon enters the district in the first week of July and withdraws by the middle of September. As the district lies in the desert area, extreme of heat in summer and cold in winter is the characteristic of the desert. The temperature varies from 46 degree in summer to 7 degree in winter. January is the coldest month with both mean maximum and minimum temperatures being lowest at 22.5° and 6.7° respectively. The humidity is highest in August with mean daily relative humidity is 80%. The annual maximum potential evapo-transpiration in the district is quite high and it is highest in the month of May and lowest in the month of December.

Nagaur district has population of **3,309,234** ranking 102nd in India (out of a total of 640 districts).The district has a population density of **187** inhabitants per square kilometer .Its population growth rate over the decade 2001-2011 was **19.25 %**. Nagaur has a sex-ratio of **948** female for every 1000 males. The literacy rate is **64.08 %** where female literacy rate is only **48.63%** which is very low. (Census of India, 2011).The income index of the

region (.396) is nearly half that of the Rajasthan (.640) and Human Development Index value is.610 against Rajasthan i-e .710. (Directorate of Economics & Statistics, 2008)

Table.1. General Characteristics of Sample Villages of Study Area.

S. No.	Parameters/villages	SV 1	SV 2	SV 3	SV 4
1	Rainfall (cm)	410mm	390mm	400mm	400mm
2	Common water body	0	1	0	0
3	Quality of water	medium	poor	poor	Very poor
4	Source of water drinking	Ground water	IG canal, Nadi	Rainwater	Ground water
5	Source of water – other use	Ground water	Ground water	Ground water	Ground water
6	Land holding	5-50 Begha	20-80 Begha	20-150 Begha	20-300 Begha
7	Avg. Family size	10	7	12	6
8	Migration	yes	yes	yes	yes
9	Health issues due to water	No	yes	yes	yes
10	Agriculture	Cash crop irrigation	Coarse grain rainfed	Coarse grain rainfed	Coarse grain rainfed

Note: SV1- Deepura, SV2- Barani, SV3-Inderpura, SV4- Mokhampura

METHODOLOGY AND DATA BASE

The present study was conducted in the 5 villages of Nagaur district and water and soil samples were also collected and tested in the laboratory.

Random sampling method has been used to selected the villages and stratified random sampling has used to selecting the households among OBC, SC, ST Families, women folk etc.

Questionnaire: An exhaustive questionnaire has been prepared to obtain ground realities of water problems and generate primary data related to water utilization for water management in the region. For this purpose 100 respondents were selected from the various households in the villages. The respondents were included every section of the society.

Focus Group discussion: Informal discussion methods have been used to collect the information from almost every stage holder beneficiary of water of the society such as elders, farmers, teachers, young people, shopkeepers etc.

Data analysis: the collected data is feeded in Ms. Excel and produce tables and figures and then interpret it according.

Analysis

As the population-resources pressure has increases in present scenario, with the new and innovative technological advancement put immense pressure on water resources in the region. Water is a vital component on earth for every form of life. It is very essential to maximize both quantity and quality of potable water. Water has to be used in the right amounts at the right time in order to achieve the optimum utilization of water and better livelihood of the people. At the same time, the application of water should avoid waste of a valuable resource and be in sympathy with the environment as a whole. Understanding, measuring and assessing that how much precious water flows around the houses, on roads and farmlands, and recognizing how these practices affect flows, will help the habitat of the region to manage water efficiently. These suitations are leads to increase the gap between demand and supply of water and the economic competition has increased at a very fast pace.

Environmental, economic and social indicators are the expression of sustainability which need to value and concern about the resources and playing an effective role in water management. In this region water is the limited resource as the rain is very scanty (which is less than 40 cm and very little rainy days with a very short periods) and the fluoride contaminated ground water with a deep depth. So in this semi-arid water scarcity region water management is the prime concern for sustainability.

ENVIRONMENTAL WATER SUSTAINABILITY:

The aspects of environmental water sustainability looking at source of water availability, quality of water, quantity of water and irrigation, water conservation practices and the establishing a comprehensive water management.

Sources of water Availability: there are three sources of water in the region i.e. Water through rain, ground water and the IG canal water (in few villages). As the rain water is very scanty in the region less than 40 cm, not fulfill the demand the region.

Rain water: Earlier people of this region used to harvest the rain water in common water harvesting systems called 'Nadi' in local language. But with the technological advancement and mechanization, the availability and the accessibility of water became easy, leads to deplete the common water harvesting systems. In every village 2 or 3 or sometimes more common water harvesting systems are there to fulfilling the demand of water for every household purpose. But in present time, at the name of Hygiene and the cheap as well as easy water availability through tap water supply of ground water, tractor-tanker water supply water is reached at the door step of the houses. This supplied ground water is stored in the house by constructing a Tanka of variable capacity. These practices leads to increase the water demand in the region and put immense pressure on ground water.

Table. Temporal change in common water harvesting systems in sample villages.

Village Name	Common water harvesting system (1980) Practiced	Common water harvesting system (2016) Practiced	Reasons for not practiced.
Deppura	1	0	Ground water used through pipes.
Barani	2	1	Maintained
Inderpura	3	1 (only for Animals)	No maintenance, depleted
Mokhampura	3	1	Not used, Fluoride contained Ground Water used.

Based on Field survey.

Ground water: As the convectional water harvesting system are depleting the whole water pressure put on the ground water. The region is already scare in ground water resource and come under the over exploited region There are only few patches in the district where the good quality ground water is available mainly in the eastern Kuchaman tehsil, north eastern Ladnu tehsil and some patches of western part of Merta and Kheenvsar (Ground water Report, 2013). But in modernized world, with the development of tube wells and very resent submersible pumps leads to deteriorate the quality and quantity of ground water.

Irrigation: In earlier days, most of the farming was rainfed and very less irrigated land is recorded. But as the advancement of these submersible pumps many of the rich farmer introduced the submersible pumps in their farm

lands. As we know this region has semi-arid type of climatic conditions so the coarse grains are the suitable crops of the region but with the introduction of submersible pumps cash crops are grown in this region.

Table.3. Ground Water depletion with the intensification of cash crops.

S. No.	Village	Year-1990	Year-2015	Reason
1	Deeppura	100 feet	650+ feet	Onion cultivation, horticulture and submersible pumps
3	Mokhampura	250 feet	350+ feet	Ground water quality is very bad with high fluoride contamination.(less used)
4	Barani	350 feet	400+ feet	Rainfed Agriculture with bad quality of water.
5	Inderpura	300 feet	450 feet	Tube wells (only few) wheat and cumin seed.

Source: Based on field survey.

The focus has shifted from dryland traditional cropping pattern of coarse grains, oil seeds, pulses to water intensive cash crops like cotton, mustard, groundnuts, Isabgol, vegetables etc. which give high economic return. These water intensive cash crops are sustained by the introduction of submersible tube wells which assure the supply of water for irrigation round the year. The nature of crops have changed from dryland farming, drought resistant and prone to crop failures to cash crops as mentioned in the table below.

Table.7. Change in cropping pattern after the introduction of submersible tube wells.

<u>Kharif Crops(1990's)</u>	<u>Changed to (2015)</u>	<u>Rabi crops (1990's)</u>	<u>Changed to (2015)</u>
Bajra	Cotton	Gram	Mustard
Jowar	Linseed	Wheat	Onion
Pulses	Husk (Isabgol)	Chilly	Carrot
Moth	Gwar	Barley	Tomato
Millet	Spinach	Arhar	Cummins seed

Source: based on the field visit survey.

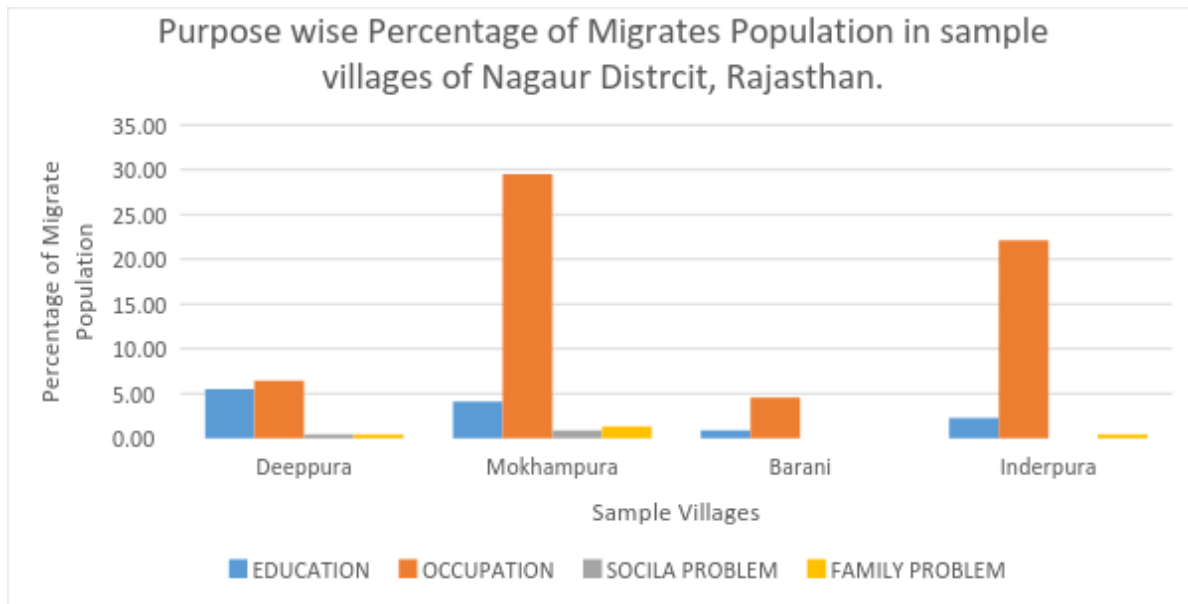
Economic water sustainability: Growing pressure on water resources from increasing population and economic growth, climate change, pollution, and other challenges has major impacts on our socio-economic well-being. In the semi-arid water scarcity region the sustainable agriculture is not developed, industries are not developed, life style is affected, unemployment increases, migration increases. These parameters leads to make the region underdeveloped.

Agriculture: Agricultural land use has been witness a major change in recent past. Earlier this region had a sustainable agriculture by using organic manure, climate suitable crops of low-yield, low-value and short-duration crops and the major dependence on livestock such as cows, buffaloes, goats, sheep etc. But in present scenario, with the improvement in technology tube well and submersible pumps make easy availability of water and that leads to introduction of water intensive cash crops instead of dry land farming and coarse grains. Table 3 shows the change in cropping pattern in last 15 years. This introduction of these cash crops give high value to some farmers and on the other hand exploit the some of the farmers that's leads to increase the gap between poor and rich among the farmers.

Industries: in rural areas most of the industries are depend on agricultural products. Water is the main component or backbone of the industries as well as agriculture. In such situations the industrial development is very less in the region.

Unemployment: Agriculture and industries are the two major sector which provide employment of youth of the region. In this region due to the lack of water availability and saline nature of water and soil not support the good agriculture in the region. Though some of the farmer are doing but in a very un-sustainable manner. As a result some of the blocks (7 out of 10 blocks) are declared as dead zone, no one can construct the tube wells in these blocks. There are few non water based industries are there such as marble industry in Makrana, stone industry in khatu etc. where the some of the people are employment on daily basis. In such a situation many are unemployed so they migrated in the urban cities like Jaipur, Delhi, Ahmedabad, Mumbai etc.

Migration: Migration leads to economic development, social integration and Cultural diffusion in the society. Migration is the process of development of people and improve their living standard. On these tracks habitat of these villages is very much believed in migration to achieve sustainable livelihood in urban areas. They migrate to take higher education, better job opportunities etc. the major reason behind this migration are poor quality of water with high fluoride content and declining water table in the region and less job opportunities that leads to reduce the carrying capacity of the region.

Figure 1. Migrate Population and Purpose of migration in Sample villages, Nagaur, Rajasthan.

Source: Produced by Ms. Excel and based on field visit data.

The above graph illustrates that Mokhampura has the high rate of migration as the ground water of this villages is having high fluoride content and even not suitable for agriculture. Followed by Inderpura as the quality of water is not good. Deep pura have comparatively less migrate population because the ground water quality of deep pura is quite good. Barani village is very nearer to Nagaur city and the IG canal water supply is also available. This is the reason Barani has low migration. Mokhampura and Inderpura have more migration due to employment and the main reason is toxic water quality and less potable water availability. Generally people of these villages are migrated to big cities such as Jaipur (Dal mills, Tranport and service activities.), Delhi (Marble market), Surat and Ahmedabad (textile market) etc. The male selective migrates is visible in different towns or cities in search of job and employment because the region has very low carrying capacity in term of agricultural productivity. So the water scarcity in the region have an adverse impact on the livelihood of the region.

Social Water Sustainability: Social perspective of this region is impact on Health, Education, women contribution in resource development, Conservational behavior toward water resource, life standard, and community engagement etc.

Health condition: In every section of society it is considered that health is wealth. In the study area health condition of this region is not so good. Many of the people are affected with dental and Skelton fluorosis in the

region due to the high fluoride content in the ground water.(Gautam,2010, Vyas, 2011), Mokhampura village is most affected by these health problems. Due to excess fluoride intake bones are enlarged by which bones are either distorted or lock the joints, sometimes some of the bend in C or L shaped that's why this region is also known as kabad pati. (Fluoride affected region). The joint pain is very common in very early age due to fluoride intake. The poor health of the people reduce the working efficiency in the region.

Education: In developing countries like India, the water collection task done by women and young girls. Often, these women and girls spend hours to collect water to meet their family's water demands. As this task is so time consuming, they are often unable to finish their education, focus on domestic duties. Many girls do not have time for their education because they are needed to collect water daily for their family's everyday needs. This is the reason that the female literacy rate in this regions is 48 % (Census of India, 2011) which is very less as compare to national average as well as state average. Education allows women to improve their futures and the future of their communities. But in this water scare region women and girls are busy in water related work and fetching of water from the water source. So the education of female is adversely effected due to the water related problems.

Women contribution: Women are the world's principal food producers and providers and are assuming an increasing role in agriculture, partly because of the rural-to-urban migration of men. Medical research has documented cases of permanent damage to women's health attributed to carrying water. Problems range from chronic fatigue, spinal and pelvic deformities, to effects on reproductive health such as spontaneous abortions. In some parts of arid and semi-arid region, where women expend as much as 85% of their daily energy intake fetching water, the incidence of anaemia and other health problems are very high (SIDA, 1997). Similar situations are found in the study area as women are busy in fetching water from the distance. Women is the main stake holder water in the society. Women are most often the collectors, users and managers of water in the household as well as farmers of irrigated and rainfed crops. Because of these roles, women have considerable knowledge about water resources, including quality and reliability, restrictions and acceptable storage methods, and are key to the success of water resources development and irrigation policies and programmes. Above all these situations women are rarely take any decision in the development process in this water resources and their decision are considered in the rural society.

Life standard: In the modernized life style, the consumption and demand of water increases. But the supply of water not matches the pace of demand. That creates the imbalance of demand and supply situation. As the life standards are improve and the conservational practices are not practiced that leads to increase the gap of demand

and supply. So the water become scare day by day at faster rate. The present generation in rural areas are quite less sensitive about water resource. In last 20 years there has a technological advancement such as tube well, submersible pumps, tractor tankers etc. make the availability of water in the region and reduce the sensitivity to the water resources.

RESULT AND SUGGESTION

Dependency on rainwater harvesting is decreasing rapidly and dependency on ground water for drinking and irrigation purpose. Widespread Depletion of the traditional common water bodies due to the introduction of submersible tube wells and they also depleting ground water table rapidly. Cropping pattern shifted from food grain crops to cash crops and shift from dryland farming crops to water intensive crops. Seasonal rivulets and rivers are losing the identity due to depleting catchment area. Dependency on Livestock is increasing from farming and horticulture. Depleting ground water table increases the TDS value and sodacity. The productivity of the crops are decreasing with increasing pH value. The community participation for water conservation is getting minimized. Ground water with increasing depth is decreasing the capacity of the soil. Settlements are shifting from river margin (lost rivers) to road sides. Introduction of Hods started depleting the ground water table alarmingly. Rampant and regular rural to urban outmigration of male working youth force. Carrying capacity of the rural area is decreasing with modern technology. Dependency on ground water increases the health hazards in the region. The piped ground water supply for drinking deviated from rainwater harvesting. Missing link among masses about the quantity, quality and usages of water. Ground water as common resource is probe to depletion at rapid pace. Non visionary action programme of MNREGA depleting the traditional ponds. Conservative attitude of water get depleted with the introduction of tanker supply.

Suggestion for sustainability

- Improve rain water harvesting techniques which are conventionally pratished in the region.
- Government should check in over exploitation of ground water.
- Ground water meters should be introduced for the proper watch, categorized the slab of water extraction and put charge accordingly.
- Community should involve with government and NGO for better water management in the region.
- Give equal decision power to the every stake holder of water specially women.
- Traditional water conservation practices should be reinvented in accordance to recent time.

- Water education should impart to society especially to the farmers.
- Formulate some common resource maintenance laws in the villages for Nadi or ground water etc.
- Local Media should also participate in spreading awareness among the masses about the water resources problems.
- Exhibition of some real time water conservation models in the villages.

CONCLUSION

With rapid increase in the population put acute pressure on the natural resources. Advancement in technology that has helped in increasing the mechanizing the farmland process which has resulted into agricultural intensification. It is visualize that technology has solved the problem of water temporarily but the benefits gained by it will have for a short span of time. The convectional and traditional knowledge and the technological use doesn't go hand in hand. The situation can be explained by taking the case study of Nagaur uplands of Rajasthan where the introduction of technological innovations has received a surprising response. People of the region have shifted the methodology of tradition farming and water management practices to an intensive farming system and overexploitation of water. Though this change in the path can manage to give temporary benefits to the people but the price that the society will have to pay in the future in infinity. The people of the region compromise with both quality and quantity of water as high fluoride content ground water and the groundwater table of the region will soon deplete because of the non-sustainable approach for farming. A regular check has to be kept in the depletion of the groundwater table in order to ensure that the future generation doesn't have to live in a more water-scarce region and carrying capacity of the region will deteriorate.

There is one sustainable pathway of solving the problem is engaging the population in secondary and tertiary economic activity which will reduce pressure from the land and water resources. And the other one is the management of water for optimum utilization of precious resource i.e. water. All sectors of the society should lend a helping hand for sustainable development in Nagaur uplands of Rajasthan considering the availability of present natural resources.

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