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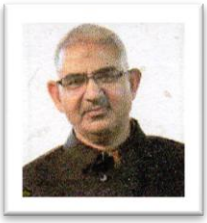
Sustainable Development of Vegetation and Groundwater in Didwana Block of Nagaur District, Central Part of Rajasthan, India



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Abstract

Rajasthan, the biggest state of the country has great reverence for trees and water. Due to arid climatic condition and scarcity of surface water resources, vegetation in the State is sparse and inhabitants are dependent largely on groundwater for drinking and agriculture purposes besides monsoon rain. Plants with only xerophytic adaptations are able to establish themselves. The bulk of vegetation consists of stunted, thorny or prickly shrubs and perennial herbs capable of drought resistance. Permanent vegetation of the entire area is, therefore, xerophytic in character and shows various xerophytic features like deep root, dry, hard and rod-like, thick or fleshy stems; spines and indumentums well-developed; leaves either absent or much reduced usually with a coating of wax or hair to prevent excessive evaporation. Due to unfavorable Hydrogeological and meteorological conditions groundwater resources are limited and its impacts reflected in vegetation type and pattern present in the state. Nagaur district falls in central part of Rajasthan and covers an area of 17718 sq. kms. and lies between 26° 23′ 35′′ to 27° 42′ 16′′ north latitude and 73° 04′ 32′′ to 75° 21′ 39′′ east longitude. Like other contiguous districts of the State, Nagaur, in terms of climate, is conspicuous for extreme dryness, large variations of temperature and highly variable rainfall. The district experiences an arid to semi arid type of climate. The rainfall is scanty (average 450 mm per annum), and surface run off is insignificant. Well-developed drainage is lacking and mostly the area is having internal drainage system. Geologically, Nagaur district has a wide spectrum of rock formations i.e. the Archaean basement rocks to the recent alluvial and desert sands of great Thar Desert. Six major aquifers demarcated in the district. Depth to water in these aquifers varies from 3 meters to 80 meters below ground level. Groundwater movement is in southeast to northwest direction. Fluoride's presence in groundwater has drawn attention of society, due to its impact on human physiology. High concentration of fluoride in a particular belt of this district is so remarkable that people call that area as BANKA PATTI (Banka -distorted, Patti-belt). Arid to semi-arid climate, low, and erratic rainfall, absence of surface water resources, recurrent famines and lowering of the water table aggravates the miseries of inhabitants. The study area of Didwana block of the Nagaur district lying in the northeastern part of the district covers about 1637.59 sq.kms area. Saline patches covering large tracts, occur in Didwana block. They are converted into swamps in the rainy season and into desert in the dry season. Such tracts are equally unfavorable to the native as well as introduced species, the principal exceptions to this being some members of the Chenopodiaceae. This family includes a number of lime-loving or salt-loving herbs. These plants are so characteristic of the saline lands that they can well serve as soil indicators. Groundwater quality and Depth to water varies considerably in the block. Overexploitation of groundwater resources in the block resulting in depletion of water table at alarming rate, desaturation of aquifers and deterioration in chemical quality of groundwater. Therefore study area is recommended for adoption of adequate measures for conservation and judicious management of groundwater resources. Groundwater storage of depleted aquifers can be improved by adopting various suitable artificial recharge methods. Rainwater harvesting through roofs of the houses to the underground tanks for drinking purposes should be promoted in the study area. Application of remote sensing and geographic information system (GIS) can be used for better management schemes to look for new promising sites for proliferation of climate friendly vegetation and for check on water level depletion for sustainable development (Quereishi, J. and Vyas, A. 2008).

Keywords: Nagaur District, Banka Patti, Didwana, Sparse Vegetation, Groundwater.

Introduction

Like other contiguous districts of the State, Nagaur, in terms of climate, is conspicuous for extreme dryness, large variations of temperature and highly variable rainfall. While the period from April to June is the summer month, November to March constitutes the winter season. The period from July to September comprises the rainy season. The relative humidity is generally low. Barring moderate to strong winds during May- August, winds are generally light to moderate. From November to February, the winds blow is mainly from directions between north-west and north. Westerly to south- westerly winds begins in March and these become more common with the advance of directions between west and south. During October, winds are light and variable in direction.

The normal annual rainfall in the district is 38.86 cm. Temperature keep on rising intensely from March till May and June which are known as the mean hottest month. The maximum temperature in Nagaur district goes up to 47^0 C and the minimum 0^0 C. The mean temperature remained at 23.5^0 C. With the onset of south-west monsoon by July, there is a significant fall in the day temperature. However, after the monsoon is over by the first week of September, the day temperature shows a steady rise while the night temperature continues to fall, till January which is considered as the coldest month.

Didwana is situated at a distance of 92 kilometers east of district head quarter, Nagaur and 165 kilometers to the north-west to the Jaipur. Didwana is famous for salt lake which is locally known as "KHARDA". The study area lying in the northeastern part of the district covers about 1637.59 sq.kms area (Figure-1).

Aim of the Study

Arid to Semi Arid climatic conditions prevailing in the study area of Didwana block. The rainfall is scanty and erratic. Scarcity of water resources in the study area compels the inhabitants to use water resources without considering the quality of water (Table-1) (B.I.S.,1992). Fluoride problem in groundwater has drawn attention of the society in recent years. On the other hand the general vegetation in this part of semi-arid region is sparse. Plants with only xerophytic adaptations are able to establish themselves. The bulk of vegetation consists of stunted, thorny or prickly shrubs and perennial herbs capable of drought resistance. Therefore aim of the study is to aware inhabitants about sustainable development of groundwater resources and vegetation in the study area and to develop suitable management schemes by using Remote Sensing and GIS technologies.

Regional Physiography

Nagaur district is located between latitude $26^0$23'35'' and $27^0$42'16'' N and longitude $73^0$04'32'' and $75^0$21'39'' E. Because of its central situation in Rajasthan, it shares its border with several other districts of the state. On the North, it is bounded by Bikaner and Churu districts, on the east by Sikar and Jaipur districts, on the south by Ajmer and Pali districts and on the west by Jodhpur district. The district is irregular in shape and resembles a deformed parallelogram. Two strangulated triangles with their vertices protruding in the neighboring districts are on its eastern and western sides. The topography generally is fairly even. A part of the district falls in the category of "Desert" as the north-western region is covered with large sand dunes, extending sometimes in a continuous series. The district has its general slopes towards the west. Its elevation is about 300 meters; ranging between 250 meters in south and 640 meters in the north.

The district is conspicuous in the absence of high hills. Dots of hillocks, particularly in the south-eastern sector, are sporadically scattered. At Jayal and Khatu, the hillocks are utilized for stone extraction. There is no vegetation anywhere on these hillocks. Tikli hills are situated near Raisinghpura village in Didwana block (Tehsil). Koliya and Patan hills coming within the jurisdiction of Didwana block are not very high. In Merta, Nawa and Parbatsar blocks (Tehsils), off- shoots of Aravalli range are projected specially along the common border with Ajmer district. Hills near Kuchaman and Nawa attain some height. Masonary stones especially "Pattis" used as beams in the building are extracted from these hills.

A segment of the Great Indian Desert covers the north, north-west and north-east parts of the district. No river has its source in the district. Seasonal streams and nallahs do not have a sizeable number and their flow depends on the frequency of rainfall. Harsor stream which has its source from the Aravalli off-shoots flows north-west for a run of about 48 kilometers. Subsequently, it meets other streamlets past Harsor village where after both the streams combined together lose their identity by discharging into the Pundlotasar. Some river lets and nallahs rise during monsoons and disappear after a short run into sandy plains near Khatu, Barnal, Jayal and Jani villages. A big salt lake exist about 4 kms to the south-west of Didwana (Figures-2&3). Tanks are uncommon in the district but some of them are maintained by the State Irrigation Department.

Review of Literature

Geology, Hydrogeology and Hydrochemistry

Geologically, Nagaur district comprises wide spectrum of rock formations ranging in age from the Archaean basement rocks to the recent alluvium and desert sands of the great Thar Desert (Paliwal, 1999a). Groundwater, the important resource for mankind, depends on physiography, climate and geology (Paliwal and Shakuntala, 1993). Six major aquifers demarcated in the Nagaur district include Older alluvium, Tertiary sandstone, Nagaur sandstone, Bilara limestone, Jodhpur sandstone and Precambrian metamorphics (Granite/Gneisses, Schists and Phyllites). Depth to water generally increases towards western part of the district. Groundwater movement is in south – east to northwest direction (Gouran and Vyas, 1998). Older alluvium, Jodhpur Sandstone and Schist, Phyllites, Granite /Gneiss are hydrogeological formations demarcated in the Didwana block. Groundwater

generally occurs under water table conditions in alluvium and schist but semi confined to confine in sandstone due to presence of overlying argillaceous beds. Depth to water varies considerably in the study area (Vyas A., 1999, 2015; Vyas, A. and Paliwal, B. S., 2001; Vyas, etal.2006).

Older alluvium in the Didwana block occurs in the central and southeastern parts and covers an area of 1089.75 sq Kms. Depth to water ranges from 10 to 50 meters below ground level in this aquifer. Yield of wells and tube wells from these aquifers varies from 36 to 250 M^3/day and groundwater associated with these resources having electrical conductivity less than 4000 micro- siemens /cm. at 25° C. In Jodhpur sandstone depth to water ranges from 12 to 35 meters b.g.l. It is located in the southwestern part of the block and covers an area of 62.50 sq Kms. The discharge of wells and tube wells varies from 18 to 300 M^3 / day and the groundwater quality is potable having electrical conductivity value less than 4000 micro- siemens /cm. at 25° C. Other water bearing formation schist that is less productive located in the north–western part of the Didwana block and covers an area of 485.34 sq Kms. The depth to water ranges from 10 to 35 m b.g.l. The discharge of wells and tube wells varies from 18 to 150 M^3 / day the groundwater quality is potable having electrical conductivity value less than 4000 micro- siemens /cm. at 25°C. In these aquifers groundwater is available only in weathered zone and yield from these is low to moderate (Gouran and Vyas, 1998; Vyas, etal.2006).

Chemical analysis reveals that groundwater quality varies widely in the Didwana block and high concentration of dissolved salts; nitrate and fluoride are major quality problems associated with groundwater in the study area. 40% groundwater of the Didwana block has more than 1500 mg/lit. of T.D.S (Total number of 30 villages of the Didwana block surveyed) and therefore not suitable for drinking water supply. 38% groundwater of this block has more than 100 mg /lit of nitrate (Total number of 29 villages of the Didwana block surveyed). Acute toxicity of fluoride is observed in Didwana block. 56% groundwater of this block has 1.7 mg /lit and above of fluoride (Total number of 152 villages of the Didwana block surveyed). 74 % groundwater of this block has more than 200 mg /lit of chloride (Total number of 152 villages of the Didwana block surveyed). About 40% groundwater of this block have more than 200 mg /lit of sulphate (Total number of 122 villages of the Didwana block surveyed). Intake of excessive fluoride, nitrate, sulphate, chloride, and T.D.S. through groundwater causes some health problems (Paliwal, 1999b).

Vegetation

Most of the area under investigation comes under arid and semi-arid climate. Consequently, it is characterized by sandy, salty and gravelly plain, more or less barren of vegetation except in the rainy season when multitudes of ephemerals come up and transform the bare land into a green carpet. These ephemerals complete their life- cycle before the advent of summer heat and the bulk of the area is again transformed into open sandy, salty and gravelly plain. (Bhandari, 1990)

In general the vegetation in the semi-arid region is sparse. Plants with only xerophytic adaptations are able to establish themselves. The bulk of vegetation consists of stunted, thorny or prickly shrubs and perennial herbs capable of drought resistance. These occur in open clump formations with plenty of vacant spaces between them. Distinctly scattered trees of stunted growth are found along depressions. Such type of vegetation is known as desert scrub. In the semi-arid region the vegetation mainly consists of dwarf grasses interspersed with few characteristic desert shrubs. Permanent vegetation of the entire area is, therefore, xerophytic in character and shows various xerophytic features like deep root, dry, hard and rod-like, thick or fleshy stems; spines and indumentums well-developed; leaves either absent or much reduced usually with a coating of wax or hair to prevent excessive evaporation. Though the floral composition of the vegetation of western Rajasthan is fairly well- known through the exhaustive work of Blatter and Hallberg (1918-21), yet adequate details on ecology are lacking. Blatter and Hallberg call the main types of plant communities as formations which are exclusively controlled by edaphic factors; they divided these formations into smaller units known as associations and families. Almost all the subsequent workers have followed these authors in describing the vegetation of the this region. Since the climate is more of less homogeneous, the vegetation can better be said to be edaphically controlled. Depending upon the rain water, the vegetation can also be distinctly divided into ephemerals and perennials.

The vegetation of Didwana block (Tehsil) represents the characteristic natural flora of the State, which is a thorny, secondary forest, or an arid, open, scrub forest (Quereishi, J., 2002). Such forests are widely distributed in the arid and semi-arid zones of the earth where the total rainfall ranges from 50-100 cm. The vegetation presents a very open appearance so that the trees and shrubs are widely spaced. The bulk of the vegetation consists of co-dominant, spinous shrubs and trees, capable of great drought resistance. It may be classified under two categories (1) the permanent vegetation occurring throughout the year, and (2) the temporary vegetation consisting of the annuals growing mainly during the short, rainy season. Corresponding to these, the vegetation of the area presents two distinct, seasonal aspects: (1) The summer and winter aspects when most of the trees and some of the shrubs flower and the soil is devoid of any ground cover, (2) the rainy season aspects when the vegetation is at its best and the soil which is otherwise bare between the trees and shrubs is covered by a vivid green carpet of temporary vegetation. The latter flower and fruit in a short time and disappear as soon as the layer of the soil dries up and winter sets in (Quereishi, J., 2002).

The permanent vegetation is xerophytic in character and shows various xeromorphic features such as a thick tomentum, succulence, stunted

growth, coating of wax, thick cuticle protected stomata, etc. The plants occur in open, clump formations with plenty of vacant spaces between trees and shrubs. Most of the woody species regenerate vegetatively by throwing out the root suckers and coppicing shoots and some propagate even by natural layering. Unless the stumps and roots are grubbed out, the thorny forest tends to maintain itself by producing root suckers and coppicing shoots. These features appear common in dry situations. The noteworthy examples are: *Prosopis cineraria, Acacia nilotica*, *Balanites roxburghii, Grewia tenax, Capparis decidua,* (Figure-4)*.Zizyphus nummularia* and *Anogeissus pendula*. The trees comprising perennial vegetation of Didwana block (Tehsil) are both indigenous and introduced (Quereishi, J. 2002). The former are represented chiefly by *Prosopis cineraria, Acacia leucophloea, A. senegal, A. nilotica, Salvadora persica, S. oleoides, Wrightia tinctoria*, *Cordia mixa*. *Tecomella undulata, Zizyphus mauritiana* and *Balanites aegyptiaca.* Among the latter, the noteworthy example is *Prosopis chilensis*, an evergreen, spiny, small tree, native of the arid regions of Mexico and Central America. It was first introduced into India in 1877 from England. It is very common on the entire area and has become a part and parcel of the native flora. Other successfully introduced trees are: *Azadirachta indica, Dalbergia sissoo, Parkinsonia aculeata, Albizzia lebbeck,* and *Acacia tortalis* (Quereishi, J., 2002).

The thorny shrubs occur in widely spaced clumps supporting a number of twinners and climbers. Of these *Capparis decidua* is very common and abundant, growing along or associated with *Grewia tenax, Maytenus emarginatus* and *Clerodendrum phlomidis*. Other shrubs occur in localized, isolated patches include *Mimosa hamata*. There are no epiphytes in a thorny, scrub forest because of adverse climate but few lianas like *Maerua arenaria* and *Cryptostegia grandiflora* are known to occur on the common trees. Other undershrubs which come into vigour and growth after rains are: *Indigofera tinctoria, I. astragalina, Tephrosia purpuria, T. villosa and Ocimum americanum.* The Peer pahari hill is dominated by *Euphorbia caducifolia* and *Grewia tenex*, and Tikli dungari is dominated by *Acacia tortalis* and *Maytenus emarginatus,* although other trees and shrubs like *Acacia leucophloea, Prosopis cineraria, Grewia tenex, Balanites aegyptiaca* are common and Koliya dungari is dominated by *Wrightia tinctoria* (Quereishi, J., 2002).

Marked changes are induced by the monsoon when all the three hillocks wear a new cloak of green and the whole ground becomes carpeted with a variety of herbs which cover the surface with a vivid green. These plants complete their life history in three to four months after the rains. They help in increasing the humus content of the soil and extending the vegetation to barren areas. The commonest and most successful annuals belong to the families Amaranthaceae, Tiliaceae, Capparidaceae, Papilionaceae, Asteraceae, Convolvulaceae (Fig-5), Pedaliaceae, Cleomaceae, Boraginaceaea, Aizoaceae, Molluginaceae, Acanthaceae, Commelinaceae, Cyperaceae, and Poaceae (Quereishi, J., 2002).

Among them the most common annuals are *Corchorus aestuans, Tribulus rajasthanensis, T. terrestris, Cleome viscosa, Trianthema portulacastrum, Vernonia cineria, Bidens biternata, Heliotropium curassavicum* (Figure-6)*, H. ovalifolium, H. subulatum, Trichodesma amplexicaule, Sesamum indicum, Peristrphe bicaliculata, Justicia simplex, Boerhavia diffusa, Achyranthes aspera, Pupalia lappacea, Euphorbia hirta, Phyllanthus fratenus, Commelina benghalensis, Cyperus rotundus, C. triceps, C. irio, Heteropogon contortus, Cenchrus setigerus, C. ciliaris, Eragrostis cilianensis, Digitaria pennata, Eleusine compressa, Brachiaria ramosa, Dactyloctenium aegyptium* and *Aristida adscensionis.* Besides, a number of annual and perennial twiners and climbers belonging to the Convolvulaceae, Asclepiadaceae, Cucurbitaceae and Papilionaceae add to the rainy season aspects of the vegetation. Among the common ones are: *Ipomoea obscura, I. pes-tigridis, I. sindica, Rivea hypocrateformis, Coccinia cordifolia, Melothria maderaspatana, Rhynchosia minima, Cryptostegia grandiflora* (Quereishi, J., 2002).

In areas where the soil consists of gravel or a thin, superficial mantle of soil over the rock, *Indigofera linneaii* forms a dense tufted growth and form a pioneer plant community on the parent rock. Amongst introduced weeds, *Heliotropium curassavicum, Glinus lotoides,* and *Xanthium strumarium, Launaea resedifolia, Eclipta indica* thrive commonly in depressed areas or more often along roadsides and paths. There are also met some perennial weeds which occurs almost all round the year, e.g. *Calotropis procera, Withania somnifera, Abutilon indicum* and others (Quereishi, J., 2002).

Vegetation Types

Main series of natural vegetation in Didwana block (Tehsil) have been categorized as follows:

***Acacia nilotica- Maytenus emarginata- Balanites aegyptiaca* series**

This is most characteristic of lower hill fringes and foothills, extending to the sandy plains.

***Prosopis cineraria- Crotalaria burhia- Leptadaenia pyrotechnica* series**

This is characteristic of the sandy expands. The vegetation is extremely sparse with scattered trees and bushes. (Figure-7)

***Prosopis cineraria- Capparis decidua- Tephrosia purpuria* series**

This series occurs naturally in all over the block (Tehsil).

***Suaeda fruticosa- Aristolochia bracteata – Cocculus* series**

This is characteristic of the salty area which is situated in the southern part of Didwana block (Tehsil), mostly near the Didwana salt lake and at Daulatpura (Quereishi, J., 2002). (Figure- 8).

Ephemerals, which constitute the bulk of vegetation of the area, appear suddenly above the ground just after first showers complete their life cycle in an incredibly short time. They die out as soon as the soil gets dry or perennate by underground stems.

Plants, depending upon the sub-soil waters are well adapted for xeric conditions. They generally possess well developed root system of extra ordinary length in comparison to their aerial parts. Most of these plants occur in open clump formations with plenty of vacant spaces between them, often occupied by ephemerals during monsoon period. Although rather poor in the number of species in a particular area, the whole region harbours a large number of well- defined plant associations confined to various edaphic conditions.

The plants growing on sandy habitats form some of the characteristic association of the region. *Cyperus arenarius, Crotalaria burhia, Aerva javanica, Leptadenia pyrotechnica* etc. are some of the pioneer species to colonize these sandy areas. These associations consisting of a few leading perennials and many ephemerals are very variable in composition on different dunes. *Crotalaria burhia* is often a dominant perennial and together with *Aerva javanica* and *Leptadenia pyrotechnica* forms a characteristic association on low sand-dunes and plains.

Intermixed among these tufts are *Convolvulus arvensis, Polygala irregularis, Mollugo cerviana, Tephrosia purpurea, Cenchrus biflorus* and species of *Eragrostis. Clerodendrum phlomodis, Lycium barbarum* are other leading plants of such habitats, but of local distribution only. *Balanites aegyptiaca* Intermixed with such plants also forms pure association.

Gravel covers fairly large area of this region. Some of the common plants of this habitat are *Fagonia schweinfurthii*, *Indigofera linnaei*, *Heliotropium rariflorum*, *Leptadenia pyrotechnica*, *Blephris sindica*, *Sericostoma pauciflorum*, *Salvia aegyptiaca* and *Corchorus depressus*. *Salvadora oleoides*, *Prosopis cineraria*, *Capparis decidua, Maytenus emarginatus* and *Zizyphus nummularia* are some of the more common elements forming scrub vegetation with isolated tree specimens intermixed. Most of these plants are often covered with characteristic ramblers like *Coccinia grandis* and *Melothria maderaspatana*. In such habitats the typical rock plant, *Euphorbia caducifolia* becomes prominent and along with *Acacia senegal* supports large number of climbers (Quereishi, J., 2002).

Discussion

The study area of Didwana block of Nagaur district lying in the northeastern part of the district covers about 1637.59sq.kms area. Due to unfavorable Hydrogeological and meteorological conditions groundwater resources are limited and impacts of it reflected in vegetation type and pattern present in the state.Arid to semi arid climatic condition and scarcity of surface water resources are main factors responsible for sparse vegetation in the State. Inhabitants are dependent largely on groundwater for drinking and agriculture purposes besides monsoon rain. Plants with only xerophytic adaptations are able to establish themselves. The bulk of vegetation consists of stunted, thorny or prickly shrubs and perennial herbs capable of drought resistance. Permanent vegetation of the entire area is, therefore, xerophytic in character and shows various xerophytic features like deep root, dry, hard and rod-like, thick or fleshy stems; spines and indumentums well-developed; leaves either absent or much reduced usually with a coating of wax or hair to prevent excessive evaporation. Saline patches covering large tracts, occur in Didwana block (Tehsil). They are converted into swamps in the rainy season and into desert in the dry season. Such tracts are equally unfavorable to the native as well as introduced species, the principal exceptions to this being some members of the Chenopodiaceae. This family includes a number of lime-loving or salt-loving herbs. These plants are so characteristic of the saline lands that they can well serve as soil indicators. Flora of western Rajasthan on whole is referred to as “Grass Legume” type. But in Didwana block (Tehsil) it may be referred as “Legume-Grass” type on the basis of dominance of legumes in its flora followed by grasses (Quereishi, J., 2002).

Groundwater is a diminishing resource and it’s over exploitation though out the world has warrant classifying this as a SCARCE RESOURCE. Population explosion have created deep crisis in availability of these resource. Groundwater quality and Depth to water varies considerably in the block. Depth to water level depleted at an alarming rate in the Didwana block due to the increased pumpage for supply of drinking water and in irrigation sector. Frequent drought conditions, reduced precipitation and high temperature during summer further decrease natural groundwater recharge. Tremendous rate of depletion was responsible for reduced well yields in the study area. Groundwater storage of depleted aquifers can be improved by adopting various suitable artificial recharge methods. Factors affecting in the selection of suitable artificial recharge methods include local topographic, geologic, and soil conditions, the quantity of water to be recharged and the ultimate water use. Pondage of water in “Nadis”, construction of percolation tank and subsurface barriers, and recharge by injection wells are some artificial recharge methods should be adopted for the management of these precious groundwater resources. Overexploitation of groundwater resources in the block resulting in depletion of water table at alarming rate, desaturation of aquifers and deterioration in chemical quality of groundwater. Therefore study area is recommended for adoption of adequate measures for conservation and judicious management of groundwater resources. Groundwater storage of depleted aquifers can be improved by adopting various suitable artificial recharge methods. Rainwater harvesting through roofs of the houses to the underground tanks for drinking purposes should be promoted in the study area. Roof top rainwater harvesting in the study area offers a good source of drinking water. For long term solution of potable drinking water and irrigation, Canal will be the next alternative in near future. Application of remote sensing and geographic information system (GIS) can be used for better management schemes to look for new promising sites for proliferation of climate friendly vegetation and for check on water level depletion for sustainable development. Remote sensing techniques

sense characteristics of the soil surface. The normalized difference vegetation index (NDVI) is one of the most commonly used vegetation index in global vegetation and change detection studies (Sashikkumar et al. 2017).

Vegetation flourishes only when good amount of water availability in the region is handy around the year so for sustainable development of vegetation we must conserve water and use it very judiciously. Development of Vegetation pattern according to water availability in the region is need of the hour and for that detail study of nature of Soil, Surface and Groundwater availability, geomorphological and geological setting, climatic conditions, crop pattern and other related parameters are to be taken into consideration. Multidisciplinary approach will definitely produce encouraging results in this part of the State.

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Table- 1. Characteristics of Ideal Drinking Water (after Bureau of Indian Standards, 1992) (All values in milligrams per liter)

S.N.	**Characteristics**	**Desirable Limit**	**Emergency Limit**
1.	Color Hazen Units	5 Units Maximum	25 Units Maximum
2.	Odour	Unobjectionable	Tolerable
3.	Taste	Agreeable	Tolerable
4.	Turbidity Maximum	5 N T U	10 N T U
5.	P^H value	6.5 to 8.5	No Relaxation
6.	Hardness (Total)	300	600
7.	Iron (as Fe)	0.3	1.0
8.	Chloride (as Cl)	250	1000
9.	Residual free chlorine	0.2	–
10.	Total Dissolved Solids (TDS)	500	2000
11.	Calcium (as Ca)	75	200

12.	Copper (as Cu)	0.05	1.5
13.	Manganese (as Mn)	0.1	0.3
14.	Sulphate (as SO_4)	200	400
15.	Nitrate (as NO_3)	45	100
16.	Fluoride (as F)	1.0	1.5
17.	PhenolicCompounds (asC_6H_5OH)	0.001	0.002
18.	Mercury (as Hg)	0.001	No Relaxation
19.	Cadmium (as Cd)	0.01	No Relaxation
20.	Selenium (as Se)	0.01	No Relaxation
21.	Arsenic (as As)	0.05	No Relaxation
22.	Cyanide (as CN)	0.05	No Relaxation
23.	Lead (as Zn)	0.05	No Relaxation
24.	Zinc (as Zn)	5	15
25.	Anionic Detergents (as MBSA)	0.2	1.0
26.	Chromium (as Cr)	0.05	No Relaxation
27.	Polynuclear Achromatic-Hydrocarbon (as PAH)	Nil	Nil
28.	Mineral Oil	0.01	0.03
29.	Pesticides	Nil	0.001
30.	Radioactive Materials		
a.	Alpha Emitters Bq/1	__	0.1
b.	Beta Emitters pcl/1	__	1.0
31.	Alkalinity	200	600
32.	Aluminum (as Al)	0.03	0.2
33.	Boron	1.0	5.0

Figure- 1. Location Map of the Study Area

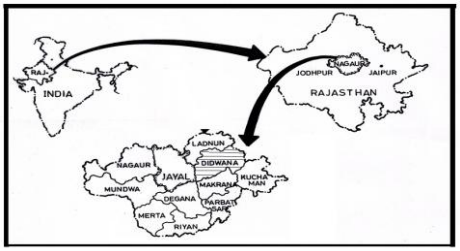

Figure- 2: A View of "KHARDA" in the Saline Lake

Figure- 3. A Brine well, nearby the "KHARDA" in the Saline Lake

Figure- 4: Fowering twig of *Capparis decidua* (Family: CAPARACEAE), the Most Drought Enduring Xerophytes of The Study Area

Figure- 5: *Cressa Cretica* (Family: CONVOLVULACEAE) in the Saline Belt of the Study Area

Figure- 6: *Heliotropium curassavicum* (Family: BORAGINACEAE) in the Saline Belt of the Study Area

Figure- 7: A view of sparse vegetation in the saline Belt of the Study Area

Figure- 8: *Suaeda fruticosa* (Family: BORAGINACEAE) in the Saline Belt of the Study Area