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CHANGING PATTERN AND MANAGEMENT OF GROUND WATER RESOURCES IN JHUNJHUNU DISTRICT, RAJASTHAN

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Abstract: *A natural resource is anything which needed by an organism or a group of organisms gifted by the nature in the form of plants, animals, air, water etc. Whatever is available in the nature free of cost like forest, water, wildlife etc. may be termed as a natural resource. Water resources are sources of water that are useful or potentially useful. Uses of water include agricultural, industrial, household, recreational and environmental activities. The majority of human uses require fresh water. 97 percent of the water on the Earth is salt water and only three percent is fresh water; slightly over two thirds of this is frozen in glaciers and polar ice caps. The remaining unfrozen fresh water is found mainly as groundwater, with only a small fraction present above ground or in the air. Human activities can have a large and sometimes devastating impact on these factors. Humans often increase storage capacity by constructing reservoirs and decrease it by draining wetlands. Humans often increase runoff quantities and velocities by paving areas and channelizing stream flow.*

Kew words: Water Resources, Changing Pattern, Ground Water, Management

Introduction

Water resources are sources of water that are useful or potentially useful. Uses of water include agricultural, industrial, household, recreational and environmental activities. The majority of human uses require fresh water.97 percent of the water on the Earth is salt water and only three percent is fresh water; slightly over two thirds of this is frozen in glaciers and polar ice caps. The remaining unfrozen fresh water is found mainly as groundwater, with only a small fraction present above ground or in the air. Fresh water is a renewable resource, yet the world's supply of groundwater is steadily decreasing, with depletion occurring most prominently in Asia and North America, although it is still unclear how much natural renewal balances this usage, and whether ecosystems are threatened. The framework for allocating water resources to water users (where such a framework exists) is known as water rights. Surface water is water in a river, lake or fresh water wetland. Surface water is naturally replenished by precipitation and naturally lost through discharge to the oceans, evaporation, evapotranspiration and groundwater recharge. Although the only natural input to any surface water system is precipitation within its watershed, the total quantity of water in that system at any given time is also dependent on many other factors. These factors include storage capacity in lakes, wetlands and artificial reservoirs, the permeability of the soil beneath these storage bodies, the runoff characteristics of the land in the watershed, the timing of the precipitation and local evaporation rates. All of these factors also affect the proportions of water loss.

The total quantity of water available at any given time is an important consideration. Some human water users have an intermittent need for water. For example, many farms require large quantities of water in the spring, and no water at all in the winter. To supply such a farm with water, a surface water system may require a large storage capacity to collect water throughout the year and release it in a short period of time. Other users have a continuous need for water, such as a power plant that requires water for cooling. To supply such a power plant with water, a surface water system only needs enough storage capacity to fill in when average stream flow is below the power plant's need. Groundwater is fresh water located in the subsurface pore space of soil and rocks. It is also water that is flowing within aquifers below the water table. Sometimes it is useful to make a distinction between groundwater that is closely associated with surface water and deep groundwater in an aquifer (sometimes called "fossil water"). Groundwater can be thought of in the same terms as surface water: inputs, outputs and storage. The critical difference is that due to its slow rate of turnover, groundwater storage is generally much larger (in volume) compared to inputs than it is for surface water. This difference makes it easy for humans to use groundwater unsustainably for a long time without severe consequences. Nevertheless, over the long term the average rate of seepage above a groundwater source is the upper bound for average consumption of water from that source.

If the surface water source is also subject to substantial evaporation, a groundwater source may become saline. This situation can occur naturally under endorheic bodies of water, or artificially under irrigated farmland. In coastal areas, human use of a groundwater source may cause the direction of seepage to ocean to reverse which can also cause soil salinization. Humans can also cause groundwater to be "lost" (i.e. become unusable) through pollution. Humans can increase the input to a groundwater source by building reservoirs or detention ponds. It is estimated that 70 percent of worldwide water is used for irrigation, with 15-35 percent of irrigation withdrawals being unsustainable. It takes around 2,000 - 3,000 liters of water to produce enough food to satisfy one person's daily dietary need. This is a considerable amount, when compared to that required for drinking, which is between two and five liters. To produce food for the now over 7 billion people who inhabit the planet today requires the water that would fill a canal ten meters deep, 100 meters wide and 2100 km. long.

Around fifty years ago, the common perception was that water was an infinite resource. At that time, there was fewer than half the current number of people on the planet. People were not as wealthy as today, consumed fewer calories and ate less meat, so less water was needed to produce their food. They required a third of the volume of water we presently take from rivers. Today, the competition for water resources is much more intense. This is because there are now seven billion people on the planet, their consumption of water-thirsty meat and vegetables is rising, and there is increasing competition for water from industry, urbanisation biofuel crops, and water reliant food items. In the future, even more water will be needed to produce food because the Earth's population is forecast to rise to 9 billion by 2050. An additional 2.5 or 3 billion people, choosing to eat fewer cereals and more meat and vegetables could add an additional five million km. to the virtual canal mentioned above.

An assessment of water management in agriculture sector was conducted in 2007 by the International Water Management Institute in Sri Lanka to see if the world had sufficient water to provide food for its growing population. It assessed the current availability of water for agriculture on a global scale and mapped out locations suffering from water scarcity. It found that a fifth of the world's people, more than 1.2 billion, live in areas of physical water scarcity, where there is not enough water to meet all demands. One third of the world’s population does not have access to clean drinking water, which is a more than 2.3 billion person. A further 1.6 billion people live in areas experiencing economic water scarcity, where the lack of investment in water or insufficient human capacity makes it impossible for authorities to satisfy the demand for water. The report found that it would be possible to produce the food required in future, but that continuation of today's food production and environmental trends would lead to crises in many parts of the world. To avoid a global water crisis, farmers will have to strive to increase productivity to meet growing demands for food, while industry and cities find ways to use water more efficiently.

In some areas of the world, irrigation is necessary to grow any crop at all, in other areas it permits more profitable crops to be grown or enhances crop yield. Various irrigation methods involve different trade-offs between crop yield, water consumption and capital cost of equipment and structures. Irrigation methods such as furrow and overhead sprinkler irrigation are usually less expensive but are also typically less efficient, because much of the water evaporates, runs off or drains below the root zone. Other irrigation methods considered to be more efficient include drip or trickle irrigation, surge irrigation, and some types of sprinkler systems where the sprinklers are operated near ground level. These types of systems, while more expensive, usually offer greater potential to minimize runoff, drainage and evaporation. Any system that is improperly managed can be wasteful; all methods have the potential for high efficiencies under suitable conditions, appropriate irrigation timing and management. Some issues that are often insufficiently considered are salinization of groundwater and contaminant accumulation leading to water quality declines.

As global populations grow, and as demand for food increases in a world with a fixed water supply, there are efforts under way to learn how to produce more food with less water, through improvements in irrigation methods and technologies, agricultural water management, crop types, and water monitoring. Aquaculture is a small but growing agricultural use of water. Freshwater commercial fisheries may also be considered as agricultural uses of water, but have generally been assigned a lower priority than irrigation. It is estimated that 22 percent of worldwide water is used in industry. Major industrial users include hydroelectric dams, thermoelectric power plants, which use water for cooling, ore and oil refineries, which use water in chemical processes, and manufacturing plants, which use water as a solvent. Water withdrawal can be very high for certain industries, but consumption is generally much lower than that of agriculture. Water is used in renewable power generation. Hydroelectric power derives energy from the force of water flowing downhill, driving a turbine connected to a generator. This hydroelectricity is a low-cost, non-polluting, renewable energy source. Significantly, hydroelectric power can also be used for load following unlike most renewable energy sources which are intermittent. Ultimately, the energy in a hydroelectric power plant is supplied by the sun. Heat from the sun evaporates water, which condenses as rain in higher altitudes and flows downhill. Pumped-storage hydroelectric plants also exist, which use grid electricity to pump water uphill when demand is low, and use the stored water to produce electricity when demand is high.

Water is also used in many large scale industrial processes, such as thermoelectric power production, oil refining, and fertilizer production and other chemical plant use, and natural gas extraction from shale rock. Discharge of untreated water from industrial uses is pollution. Pollution includes discharged solutes (chemical pollution) and increased water temperature (thermal pollution). Industry requires pure water for many applications and utilizes a variety of purification techniques both in water supply and discharge. Most of this pure water is generated on site, either from natural freshwater or from municipal grey water. Industrial consumption of water is generally much lower than withdrawal, due to laws requiring industrial grey water to be treated and returned to the environment. Thermoelectric power plants using cooling towers have high consumption, nearly equal to their withdrawal, as most of the withdrawn water is evaporated as part of the cooling process. The withdrawal, however, is lower than in once-through cooling systems. It is estimated that 8 percent of worldwide water use is for domestic purposes. These include drinking water, bathing, cooking, toilet flushing, cleaning, laundry and gardening. Basic domestic water requirements have been estimated by Peter Gleick at around 50 liters per person per day, excluding water for gardens. Drinking water is water that is of sufficiently high quality so that it can be consumed or used without risk of immediate or long term harm. Such water is commonly called potable water. In most developed countries, the water supplied to domestic, commerce and industry is all of drinking water standard even though only a very small proportion is actually consumed or used in food preparation.

Recreational water use is usually a very small but growing percentage of total water use. Recreational water use is mostly tied to reservoirs. If a reservoir is kept fuller than it would otherwise be for recreation, then the water retained could be categorized as recreational usage. Release of water from a few reservoirs is also timed to enhance whitewater boating, which also could be considered a recreational usage. Other examples are anglers, water skiers, nature enthusiasts and swimmers. Recreational usage is usually non-consumptive. Golf courses are often targeted as using excessive amounts of water, especially in drier regions. It is, however, unclear whether recreational irrigation (which would include private gardens) has a noticeable effect on water resources. This is largely due to the unavailability of reliable data. Additionally, many golf courses utilize either primarily or exclusively treated effluent water, which has little impact on potable water availability. Explicit environment water use is also a very small but growing percentage of total water use. Environmental water may include water stored in impoundments and released for environmental purposes (held environmental water), but more often is water retained in waterways through regulatory limits of abstraction. Environmental water usage includes watering of natural or artificial wetlands, artificial lakes intended to create wildlife habitat, fish ladders, and water releases from reservoirs timed to help fish spawn, or to restore more natural flow regimes. Like recreational usage, environmental usage is non-consumptive but may reduce the availability of water for other users at specific times and places. For example, water release from a reservoir to help fish spawn may not be available to farms upstream, and water retained in a river to maintain waterway health would not be available to water abstractors downstream.

Study Area

The district is irregular hexagon in shape in the northeastern part of the State lies between 2702” east longitudes. It is surrounded by Churu district on the northwestern side Hissar and Mahendragarh district of Haryana State in the northeastern part and by Sikar district in the west, south and south eastern part-2. For the propose of administration the district is divided into five administrative subdivision viz, Chirawa, Udaipurwati, Jhunjhunu, Khetri and Nawalgarh Six Tehsil viz Jhunjhunu, Chirawa, Khetri, Nawalgarh, Buhana, Udaipurwati and eight Panchyat Samities viz Jhunjhunu, Chirawa, Khetri, Nawalgarh, Buhana, Udaipurwati, Alsisar and Surajgarh. The total geographical area of the district is 2928 square kms. This stands at 1.73 percent of the total area of the state from the points of area, Jhunjhunu district stand at 22nd place among the existing 33 districts of the state most of the part of the district is coerce by blow sand and dunes which for part of the great that desert sand shifting and active dunes are main hazards to cultivation. Soil erosion is the Result of constant deforestation and mining activity which have resulted in baring the slopes.

GROUND WATER SCENARIO

Hydrogeology

Quaternary alluvium is the principal water bearing formation (occupies 4663sq.km. forming 78.70 percent of district) and hard rocks of Delhi Super Group including post Delhi Intrusive (covers 1265 sq.km. forming 21.30 percent of district) form ancillary aquifers in the district. Alluvium (composed of sand, silt, clay, kankar and gravel) forms the principal and potential aquifer in the area. Thickness of alluvial sediments increases from south (having less than 60m) to north and north eastern parts of district (more than 100m). Ground water occurs under unconfined to semi-confined conditions in the primary porosity i.e. pore spaces. Exploratory bore hole data has revealed the presence of aquifer system down to the depth of 100 m in general and reaching maximum to 135 m in the Buhana block. Saturated thickness has been significantly reduced in parts of Jhunjhunu and Bhuana blocks and in areas around Singhana and Khetri, no more alluvial aquifer exists as water level declined and reached into hard rocks.

Quartzite, schist, phyllite, gneisses and limestone of Delhi Super Group including granites, amphibolites and pegmatites of post Delhi intrusive form the ancillary aquifer and occupy the south eastern area of the district covering parts of Khetri and Buhana blocks. Ground water occurs under unconfined condition in the weathered mantle (ranging in thickness from 10 to 15 m) and under unconfined to semi-confined conditions in deep seated secondary porosity i.e. fractures, joints, contacts etc. of hard formation. The total number of hydrograph stations in the district is 24 including 5 dug wells and 19 piezometers. Depth to water level varies from 16.45 to 73.29m during pre-monsoon, 2007 and 15.23m to 75.67m during post-monsoon, 2007. Deeper water level i.e. more than 40 m is constituted by 70.84 percent stations and rests in entire north eastern part of district covering entire Surajgarh, Buhana blocks, most part of Chirawa, Nawalgarh and Jhunjhunu blocks. Depth to water level between 20 to 40 m is constituted by 20.83 percent of stations covering most part of Alsisar, Udaipurwati and Khetri blocks. 8.33 percent of stations forms water level less than 20m which rests in isolated pockets falling in Khetri and Udaipurwati blocks. 85.70 percent of stations exhibit negative seasonal water level fluctuation (pre versus post-monsoon, 2006) has been noticed in major part of the district. Amplitude of negative fluctuation ranges from less than 0.08 m to 4m. Positive fluctuation (ranging from 0.57m to 1.53m) has been observed at local pockets falling in Khetri block.

The study of long term water level trend for the last ten years (pre-monsoon, 1998-2006) reveals that 89 percent of hydrograph stations exhibit declining trend ranging from 0.02 to 0.20 m/ year whereas only 11 percent of stations show marginal rising trend ranging from 0.008 m to 0.017m/ year indicated by only those stations falling in saline area having negligible ground water draft. Maximum declining trend has been noticed in eastern part of the district covering parts of Surajgarh, Bhuana and Khetri blocks. The representative hydrographs of select stations (Paporna, Mandasi Sandasi and Badgaon) have been depicted in Figure 7, which are showing falling trend. The study of water table contour map reveals that general direction of ground water flow is from the hills areas in south and south eastern to northern side except in the south eastern part (i.e. in the eastern part of Khetri) where it is from west to eastern side. In south eastern hilly areas of the district, movement of ground water is comparatively fast due to steep gradient while it is considerably slow in the remaining parts covered by alluvial formations having gentle gradient. The average hydraulic gradient of ground water table is southern part is 4m/km and is about 2 to 3 m/km in the northern part. The maximum elevation of water table has been observed in the south, south western part of area at village Rampura .i.e 449.9 mamsl (Nawalgarh block) while minimum elevation in the north eastern part of area at village peepli .i.e.225.60 mamsl (Surajgarh block).

Ground Water Quality

The ground water is alkaline type having pH value more than 7 and is potable in major part of the district except in northern part Alsisar block, northern most portion of Chirawa block, area lying south of Buhana and isolated pockets lying east of Surajgarh, south east of Chirawa and in south eastern border (located at midst) of Khetri block. The electrical conductivity ranges from

450 ms/cm at 250 C (minimum at Parasrampura in Nawalgarh block) to 10600 ms/cm at 250C (maximum at Jawaharpura in Alsisar block); however in general it rests between 450 and 3000 ms/cm at 250 C which is constituted by 78 percent of stations. The electrical conductivity between 3000 and 6000 ms/cm at 250 C is represented by 17 percent of stations while more than 6000 EC is by only 5 percent of stations.

Fluoride content ranges from 0.12 to a maximum of 15.3 mg/l (on Anasagar road, Jhunjhunu town) but in general lies between less than 0.5 and 3 mg/l. 57.87 percent of stations represent fluoride concentration within desirable limit of 1.0mg/l, 21 percent stations fall between 1.0 and 1.5mg/l, 11.23 percent stations between 1.5 and 3.00mg/l and 8.99 percent stations constitutes fluoride concentration beyond 3.00mg/l. The Jhunjhunu urban faces very high fluoride hazard having fluoride concentration reaching maximum to 15.3mg/l which is substantiated by the fact that 66.67 percent of stations constitute fluoride concentration above permissible limit of 1.5 mg/l. Apart from this, most part of the Alsisar block and north western corner of Chirawa block have fluoride content more than 1.5mg/l. Isolated pockets having fluoride content more than permissible limit have been noticed in Surajgarh, Buhana, Udaipurwati blocks. Most of the stations have iron concentration with permissible limit of 1.0mg/l.

The sodium absorption ratio ranges from 0.60 to 28.85. Irrigation suitability of ground water has been determined based on the USSL diagram which indicates that ground water belongs mostly to C3-S1, C3-S2, C3-S3 class connoting moderate suitability of ground water for irrigation. The high sodium absorption ratio poses problem for irrigation water but sandy, highly porous and permeability nature of soil permit the use of ground water for irrigation. Ground water in Jhunjhunu urban area belongs to C3S3 and C3S4 class indicating the ground water's low suitability for irrigation purposes.

GROUND WATER RELATED PROBLEMS

Declining Water Level

Long term water level data (pre-monsoon, 1997-2006) have indicated declining water level trend ranging from 0.0222 to 0.2010m/year. As a result of which all the blocks except Alsisar block have entered into the over-exploited category which is needed to be controlled through notifying the blocks and further imposing ban on construction of ground water abstraction structures except under indispensable cases. Three blocks i.e. Chirawa, Buhana, Surajgarh have been notified by Central Ground Water Authority, New Delhi.

Fluoride Hazards

The Jhunjhunu urban faces very high fluoride hazards having fluoride concentration reaching maximum to 15.3 mg/ l which is substantiated by the fact that 66.67 percent of stations constitutes fluoride concentration above permissible limit of 1.5 mg/l. Apart from this, most part of the Alsisar block and western corner of Chirawa block have fluoride content more than 1.5 mg/l.

Nitrate Hazards

Nitrate concentration more than permissible limit i.e. 100 ppm is constituted by 30.86 percent of stations in the district area. Nitrate concentration more than permissible limit has been found in the entire Alsisar block, Northern part of Jhunjhunu block , south of Mandawa, North east of Surajgarh, around Bhuana, area lying south west of Bhuana and isolated pockets falling in Bhuana. Udaipurwati blocks.

High Sodium Absorption Ratio Hazards

Irrigation suitability of ground water is moderate as it belongs to mostly to C3-S1, C3-S2, C3-S3 class. The high sodium absorption ratio poses problem for irrigation water but sandy, highly porous, and permeability nature of soil permit the use of ground water for irrigation. Ground water in Jhunjhunu urban area belongs to C3S3 and C3S4 class indicating the ground water's low suitability for irrigation purposes.

GROUND WATER DEVELOPMENT AND MANAGEMENT

Ground Water Development

The stage of ground water development for the district is 200.05 percent. Out of total 8 blocks, seven blocks viz. Chirawa, Buhana, Surajgarh, Udaipurwati, Nawalgarh, Jhunjhunu and Khetri have more than 100 percent stage of ground water development ranging from minimum 107.41 percent in Khetri block to a maximum of 314.78 percent in Chirawa block and have been categorized under over-exploited category. No recommendation is extended for additional ground water development. Alsisar block has 88.34 percent stage of ground water development and is categorized in safe category. Alsisar block has lesser ground water draft being area laden with saline ground water.

Ground Water Management

1. As the district has 200.05 percent stage of ground water development (all the blocks except Alsisar rest in over-exploited category having 107.41 percent to 314.78 percent stage of ground water development), thereby leaving little scope of further ground water development for irrigation except for drinking purpose which may be taken up only in very restricted and planned way to avoid becoming further over-exploited.
2. Ground water should be used judiciously taking in to account of modern agriculture water management techniques by cultivating crops requiring less watering and use of sprinkler system and drip irrigation should be encouraged.
3. A modern agriculture management has to be taken into account for effective water management techniques involving economic distribution of water maintaining minimum pumping hours and also be selecting most suitable cost effective crop pattern i.e. for getting maximum agriculture production through minimum withdrawal. Adopting proper soil and water management even the ground water with somewhat dissolved solids may also be suitable for irrigation for salt tolerant crops in the area having high salinity.
4. Desalination and de-fluorosis plants may be installed in the villages facing ground water salinity and fluoride hazards.
5. Area is underlined by unsaturated moderate thickness of alluvial which provides sufficient scope of artificially augmentation of the ground water body as alluvial formation has very good storage and transmission capacity in the district. In the district, there is rainfall of about 2878.64 mcm considering the area and average annual rainfall. Out of this, 235.1238 mcm is annual natural recharge as per the ground water. The above data indicate the availability of surplus water which can be used for artificial recharge through the various techniques feasible in alluvial and hard rock terrain.

Suggestions

The stage of ground water development of the district is 200.05 percent which reflects excessive withdrawal of ground water in comparison of recharge, resulting in depletion of ground water levels and reduction in yields of wells. In view of this, three blocks viz. Buhana, Chirawa and Surajgarh in Jhunjhunu district have already been notified by Central Ground Water Authority, New Delhi for regulation and control of ground water development. Now regulation on ground water use in the area should be implemented effectively. The following measures should be adopted:

1. Roof top/paved area rain water harvesting for recharge to ground water in urban and industrial area.
2. Village water runoff/roof top water harvesting by dug wells/percolation tanks in rural area.
3. Construction of recharge shafts with gabion structures in nalas.
4. Recharge by dug well/percolation pit in agriculture farm. In hard rock terrain nala bunding, anicuts, dug wells, percolation tanks etc. are feasible structures which may be used to recharge the ground water body. Technical guidance is provided to various organizations as and when approached.
5. Mass awareness programmes should be arranged at local level to make common mass aware of importance of ground water resources, its better practices of use in domestic, irrigation and industrial fronts, present status of ground water scenario, its conservation etc.
6. Training programmes should be arranged at local level to teach the common mass of various techniques of artificial augmentation to ground water resources.

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