TITLE:- GROUND WATER MANAGEMENT- ARTIFICIAL RECHARGE OF GROUND WATER

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ABSTRACT

Ground Water can be defined as the water present in the subsurface in a specific area during a specific period of time. Ground water recourses play a major role in ensuring livelihood security across the world. But at the same time the increasing demand for water in world has led to the implementation of more intensive water management measures to achieve more efficient utilization of limited available water supplies. As we are aware that the natural replenishment of groundwater occurs very slowly and hence if groundwater is exploited at a rate greater than that of its natural replenishment this will cause declining groundwater levels and, in the long term, destruction of the groundwater resource. To augment natural replenishment of groundwater reserves, the artificial recharge of groundwater has become an important issue to be taken at hand all over the world.

Artificial recharge may be defined as augmenting the natural infiltration of precipitation or surface water into underground formation by some methods. The purposes of artificial recharge can be named as-promoting recovery of overexploited aquifers, storage of surface waters during flood periods to maintain and improve supply in the dry season, storage of local or imported water in the aquifer, preventing seawater intrusion by creating freshwater barriers , increasing the value of aquifers for water distribution in areas with a high density of wells, discharging certain wastewaters, such as cooling water, reducing groundwater salinity in agricultural areas, reducing subsidence caused by high pumping rates and groundwater quality improvement. There are many advantages of this technique and it has been used in almost all the countries where there is a scope and possibilities to adopt this very much important method to recharge the ground water for the betterment of mankind.

1-INTRODUCTION

Although about three fourth of earth is water, the estimate volume of fresh water is about only 2.5 %

The rest being sea /salt water. Most of the fresh water are either in the form of ice/permanent snow cover in South/North pole areas which is amounting nearly about 70 % or is stored under ground in the form of deep under ground basins aquifers, soil moisture etc amounting nearly 28.5 %. As per the WHO estimate only 0.007 % of all water on earth is readily available for human world consumption. This indicates that fresh water on earth is finite and also unevenly distributed. And as such the study made by IWMI-Global Water Scarcity study program, scenario of availability of water is not good and it revels that by 2025 more than 1.8 billion people will live with absolute water scarcity.

The above facts points out for the urgent need of good and efficient water conservation all over the world.

India ranks second country in the world having the highest precipitation. In our country 85 % of water is used for farming, 10 % for industrial sector and only 5 % for domestic use. The competition between these all are increasing.

The facts about the present scenario of water resources and the status of availability of water in India, is also not giving a happy sign. In India per capita average annual fresh water availability has reduced from 5177 cubic meter in the year 1951 to about 1586 cubic meter for the year 2010, and as per the estimate recently carried out the per capita available water will be only 1341 cubic meter in the year 2025 and 1140 cubic meter in the year 2050. All these is due to the population rise from about 500 Million in the Year 1951 to estimated population of 1640 Million in the year 2050 and lack of water conservation and recharging the ground water as per our requirements at present and for the future generation to come. One has to answer about the use of natural

resources. Considering the above facts time now reach that we have to urgent steps of water conservation and recharging of ground water as much as possible with all the techniques available for these.

2-GROUND WATER

Sub surface water or ground water is fresh water located in the pore space of soils and rocks. It is also water that is flowing with in aquifers below the water table. The main difference between the surface water/sub surface water is that due to its slow rate of turnover, sub surface water storage is generally much larger compared to inputs than it is for surface water. This is why humans are able to use sub surface water unsustainably for a long time with out severe consequences. The natural input to sub surface water is seepage from surface water. The natural output from sub surface water are springs and seepage to the oceans.

2.1 WATER CONSERVATION

Water resources conservation-efficient management of rain water through storage, allocation and transfer for use and preservation of the quality of the resources including the supporting ecosystems.

Water use conservation:-Water supply and distribution with minimal losses and consumption through prevention of wastage.

Efficient use of water through adoption of water saving technology and cropping pattern.

3. ARTIFICIAL RECHARGE

Artificial recharge may be defined as augmenting the natural infiltration of precipitation or surface water into underground formation by some methods. Artificial recharge is a method of storing water underground at times of water surplus to meet demand in times of shortage. The main objectives of artificial recharge are to increase available reserves of water and the water-resource potential of aquifers more generally.

In most of the artificial recharge scheme, aquifers are used for water storage and reuse. Natural and artificial ground water recharge involves the same basic physical and geochemical process, but the some important differences. In artificial ground water recharge, the infiltration rate is much higher, thereby decreasing the period over which pollutant are exposed to the natural cleaning process. Due to this problem both for the quality of the water and for the operation of the artificial recharge plants may occur.

3.1 INFLUENCE OF RECHARGE FACTORS

Not all aquifers can be artificial recharged. The hydraulic characteristics of the aquifer, the nature of existing ground water and the catachrestic of the recharge water can have a major influence on the out come of a artificial recharging operations. The factors affects the artificial recharge of ground water are Geological Factors, Hydro geologic Factors and some type of Physical & Chemical Factors.

3.2- GROUND WATER RECHARGING PRECAUTIONS

Before doing the artificial recharging of ground water, the area should be identified such as –

Area of recharging should be as far as possible, where ground water levels are declining due to over exploitation, where sustainable part of the aquifer has already been desaturated, where availability of water from wells and hand pumps is inadequate during the lean months and where ground water quality is poor and there is no alternative source of water.

Controlled sites should be equipped with protective installations making use of best available technology. Monitoring should be carried out by the competent authority. Regulations or guidelines should be drawn up for all the relevant issues for ground water recharging.

Water that is used for recharging should not contain any compound that are toxic, persistent bio-accumulative or radio-active and may thus put ground water at risk. Water should be subject to special treatment.

Rain fall over the required area, large roof area from where rain water can be collected and diverted for recharging, canals from large reservoir from which water can be made available for recharge, properly treated waste water and natural streams.

4. METHODS OF ARTIFICIAL RECHARGE

This can be classified into two major techniques,
4.1-Indirect artificial recharge technique
4.2- Direct artificial recharge technique

4.1 INDIRECT ARTIFICIAL RECHARGE TECHNIQUE

4.1.1 Channel Spreading

Construction of small 'L' shaped bunds within a stream channel so that water moves along a longer path thereby improving natural recharge. This method is useful where a small flowing channel flows through a relatively wide valley, however this is not useful where rive/streams are prone to flash floods and the bunds (levees) may be destroyed.

4.1.2 Ditch and Furrow method

In areas with irregular topography, shallow, flat bottomed and closely spaced ditches or furrows provide maximum water contact area for recharge area from source stream or canal. This technique requires less soil preparation than the basins and is less sensitive to silting. Generally three patterns of ditch and furrow systems are adopted: 1) With a "zigzag" course following the contours and land slopes 2) With branches from a main channel or 3) With ditches arranged perpendicular to the main channel. The excess of recharge flowing from the ditches is collected in a discharge channel. Ditches vary in width from 0.3 to 1.8m, the slope must be very slight to minimize erosion and to increase the wetted sections. These methods may differ in areas with irregular topographic surfaces.

4.1.3 Recharge of dug wells and hand pumps

In alluvial as well as hard rock areas there are thousands of dug wells which have either gone dry, or the water levels have declined considerably. These dug wells can be used as structures to recharge the ground water reservoirs. Storm water, tank water, canal water etc. can be diverted into these structure to directly recharge the dried aquifer. By doing so, the soil moisture losses during the normal process of artificial recharge are reduced. The recharge water is guided through a pipe to the bottom of the well, below the water level to avoid scouring of bottom and entrapment of the air bubbles in the aquifer. The quality of source water including the silt content should be such that the quality of ground water reservoir is not deteriorated.

In urban and rural areas the rooftop rain water can be conserved and used for recharge of ground water. This approach requires connecting the outlet pipe from rooftop to divert the water to either existing wells, tube wells, bore wells or specially designed wells.

Many NGOs and other trusts have been supporting this method and have helped in applying this technique to recharge the bore and tube wells in farms and even in homes. For example the "Nirmal Neer" initiative taken by the NGO of Pujya Pandurang Shastriji – "Swadhyay Parivar" has helped recharged many wells in rural areas and tube wells in urban areas. This has benefitted a lot of people and helped save and reuse a lot of water, particularly in the states where water is scarce. A lot of states provide subsidies and financial support for this purpose.

4.1.4 Holes

Holes are generally small and relatively shallow, and are used in areas where the ground has low permeability. Abandoned quarries are often used. Suspended solids in the water settle on the bottom of the hole while the walls remain permeable to the recharge water.

4.1.5 Floods

This method is used on level ground, where waters are spread directly on the natural surface to produce a thin water layer. The ground must retain its natural vegetation cover.

4.2 DIRECT ARTIFICIAL RECHARGE TECHNIQUE

This is usually carried out using wells. Radial wells and infiltration galleries are used in direct recharge technique. While an artificial recharge well can be compared with a pumping well operated in reverse, in fact the hydraulic behaviour is quite different. A pumping well is considered to be in hydraulic equilibrium if its pumping level is stationary over a fixed period and if the cone of influence remains unchanged over time. In recharge wells, the recharge cone spreads, even if the water level inside the well remains stationary. Near the recharge well the saturated thickness increases, due to the formation of a recharge cone. Another difference between pumping wells and recharge wells is that recharge tends to reduce ground subsidence rather than promoting it.

4.2.1Water Recharge wells

There are two factors which are to be considered- in this direct recharge technique- efficiency and cost. The cheapest process is to inject recharge water by force after removing the valve from the bottom of the pump. In this way the flow resistance through the pump impeller is very high. Another method is to alternate recharge periods with pumping periods in order to flush the well; while this operation is not expensive it is potentially dangerous because air contained in recharge water may block the aquifer.

A well filter may be located some metres above the top of the water recharge level or aquifer to eliminate any danger of aquifer blockage by the air carried into the system in the recharge water. In this way air may free itself easily through the top of filters and arrive at the surface through little breather pipes. Using this system it is possible to alternate recharge operations with pumping because air is conveyed along the space between the covering and the pump pipes. It is always preferable to recharge the aquifer with a flow lower than the pumping flow, to control the system it is sufficient to install a regulation valve in the pipe. The duration of recharge and pumping phases is not always the same. Usually a pumping period of two hours for every 24 hours recharging gives good results.

The evaluation of aquifer recharged can be made with the help of Piezometric map analysis. Aquifer recharge is affected by the amount of water that infiltrates the groundwater flow. Groundwater represents only one step in the hydrologic cycle, for this reason measurements of other components of the cycle may be useful in estimating the scale of water resources by calculating the hydrologic balance.

5. ADVANTAGES OF ARTIFICIAL GROUND WATER RECHARGE

5.1 The technology is sound and generally well understood, both by technicians and the general population.
5.2 Very little special equipment is needed to construct drainage wells.
5.3 In rock formations with high structural integrity, few additional materials may be needed to construct the wells.
5.4 Groundwater recharge stores water during the wet season for use in the dry season, when demand is highest.
5.5 Aquifer water can be improved by recharging with high-quality injected water.
5.6 Recharge can increase the sustainable water yield of an aquifer significantly.
5.7 Recharge methods are environmentally attractive, particularly in arid regions.
5.8 Most aquifer recharge systems are easy to operate.
5.9 In many river basins, controlling surface water runoff to provide aquifer recharge reduces sedimentation problems.
5.10 Recharge with less saline surface waters or treated effluents often improves the quality of saline aquifers, facilitating use of their water for agriculture and livestock.
5.11 Aquifer may be used for the storage and distribution of water and for removing contaminants by natural cleaning processes that take place as polluted rain and surface water infiltrate the soil and percolate down through the various geological formations.

6. DISADVANTAGES OF ARTIFICIAL GROUND WATER RECHARGE

6.1 In the absence of financial incentives, laws, or other regulations to encourage land owners to maintain drainage wells, they may fall into disrepair and ultimately become sources of groundwater contamination.

6.2 There is potential for contamination of the groundwater from injected surface runoff water, especially from agricultural fields and road surfaces. In most cases, surface runoff water is not pre- treated before injection.

6.3 Recharge can degrade the aquifer unless quality control of the injected water is adequate.

6.4 Ground water recharge may not be economically feasible unless, significant volumes can be injected into an aquifer.

6.5 A very full knowledge of the hydrogeology of an aquifer is required before any full scale recharge project is implemented, e.g. in karstic terrain, dye tracer studies can be useful.

6.6 Disturbances of soil and vegetation cover during the construction of water traps may cause environmental damage to the project area.

CONCLUSION

Ground water resources play a major role in ensuring livelihood and security across the world, especially in economies that depend on agriculture. India is now the biggest user of ground water for agriculture in the world. Ground water irrigation has expanded at a very rapid pace in India since the last 3 decades. The share of ground water in the net irrigated area has also been on the rise. Of the addition to the net irrigated area of about 29.75 million hectares, during the last 3 decades, ground water accounted for 24.02 million hectares. On an average about 61% of the irrigation in the country was sourced from ground water.

The most dramatic change in the ground water scenario in India is that the share of tube wells in irrigated areas rose about 40% and have become the largest single source of irrigation water in India. Though ground water overuse was recognized as a serious problem for quite some time, conventional approaches to ground water in India until the mid 90s have involved a clear focus in the “Development” of ground water resources. But considering the importance of ground water and the status of availability of ground water, the thinking have been changed from a view of “Development” to “Management” mode. The problems of conservation of water resources and the judicious use of available water resources have developed an attention. According to the latest available data from the National Sample Survey 56% of the rural household get drinking water from hand pumps or tube wells, 40% from open wells and about 25% from piped water system based on ground water. All this leads further development of recharging techniques of aquifers for the more availability of natural water resources – A blessing of God. Now people all over the world recognize the importance of water and have started using judicious use of water. At this moment a saying of John F. Kennedy, the former US President, would be apt. *“If a person solves the problem of water, he is worthy of receiving two Nobel prizes, one for the research he has done and the other for peace developed in the world in relation with the water battle.”*

RECOMMENDATIONS

1) Laws regarding judicious use of water should be formulated.
2) Water meters be installed in households.
3) More and more areas be covered under artificial recharging and promoting it by giving subsidies wherever necessary.
4) Awareness creation programmes should be developed and promoted.
5) Affordable and viable technologies for ground water recharging need to be developed.

BRIEF PROFILE OF THE AUTHORS

Er. Kirit B. Trivedi, 54, graduated in Mechanical Engineering Branch from the L.D. College of Engineering of Gujarat University, Ahmedabad. He joined as an Assistant Engineer (Mech.) in the Government of Gujarat after he was selected for the post of Assistant Engineer (Mech.) by the GPSC in the year 1981 & carried out various tasks as a Mechanical Engineer during his tenure of 29 years. He was than promoted as a Deputy Executive Engineer (Mech.) in the year-2010 and posted in the Narmada, Water Resources, Water Supply & Kalpsar Department at Gandhinagar. He has done Master of Business Administration-(MBA) in Marketing and a Post Graduate Diploma in Disaster Management from IGNOU-New Delhi. He has presented Technical Papers at the Vigyan Bhavan- New Delhi during the "International Conference on Habitat" in the year-1997 & "World Congress on Natural Disaster Mitigation" in the year -2004, both conferences were organized by the Institution of Engineers-India & WFEO. He was also invited to deliver talks on various subjects by All India Radio-Rajkot. He also presented papers on Disaster Management at various conferences. He is life member in Mechanical Division of the Institution of Engineers-India and also worked as an Executive committee member at its Saurashtra Local Branch-Rajkot for 14 years. He is a **Fellow** of the Institution of Valuers-New Delhi also. At present he is working as a Deputy Executive Engineer (Mech.) at Gandhinagar-Gujarat.

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