CONSERVATION OF GROUNDWATER BY ARTIFICIAL RECHARGE IN DELHI AND HARYANA STATE OF INDIA – A REVIEW

Pallavi Saxena[1]*, Abhishek Chandra[2] , Abhinav Garg[1] , Gaurav Sharma[3] and Prateek Varma[4]

[1]Department of Environmental Biology, University of Delhi, Delhi-110007, India

[2]Institute of Environmental Studies, Kurukshetra University, Kurukshetra-136119, India

[3]School of Environmental Studies, University of Delhi, Delhi-110007, India

[4]Department of Mechanical Engineering, Maharaja Agrasen Institute of Technology (MAIT),GGSIP University, Sector-22 Rohini, Delhi-110086, India

*corresponding author's email: pallavienvironment@gmail.com

ABSTRACT: The water scarcity is one of the major issue which is yet to not solve completely and depletion of the water table has become a major problem across the world. Demands for water increases as our population grow. Though 75% of the earth is covered by water, only a small percentage of it is fit for human use. The excessive demand has put a strain on our water resources. In many areas groundwater, which makes about 20% of our fresh water supply, is being used extensively for a variety of human, agriculture and industrial use. The recharge rate is much less than the rate at which the water is being pumped out. This overexploitation has a lot of environmental effects which include degradation of water quality, reduced quantity of water in wells and springs, and land subsidence to name a few. In India the groundwater problem is more prominent in areas with a high agriculture economy, though it is high in urban areas also. The overexploitation in the National Capital Delhi has reduced the water table depth by a considerable amount in the last 5 years. Artificial methods to recharge the groundwater can be used to supplement our water resources. Different methods, based on the climatic and geographical conditions, can be used. In dry areas, for example, watersheds can and are being used to manage water resources. In this paper we have reviewed and summarized different studies to suggest a variety of methods to recharge groundwater. Artificial recharging of aquifer is one of the option, in order to improve groundwater crises which is sustainable in the long term. Some of the techniques are already been used and many could also be easily put in use by the villagers with local resources availability in terms of manpower and materials (www.megphed.gov.in). We have studied the groundwater recharge process in relation to the climatic and geographical conditions and make a list of pros and cons for different methods with secondary date available in literature. Moreover, in support of this we have also narrate the case studies of two states (Site–1 and Site–2) to explain the conservation of groundwater by artificial recharge. The overall efficiency of the methods used to artificially recharge groundwater have sufficiently explained.
Keywords: Cost-effective techniques, water table, Delhi.

INTRODUCTION

Water scarcity has become the major problem especially in most arid regions of the world which ultimately affect food security, natural ecosystems, plant and human health (Seckler et al., 1999). According to Seckler et al., 1998 during International Water Management Institute (IWMI) study estimated that about one-fourth of the population of the world (1.4 billion people), will experience the problem of scarcity of water within the first quarter of the next century. Water scarcity has arised from various factors one of them is the depletion of the natural resource that is, groundwater. But nowadays due to over-use, or overdraft it leads to its depletion.

The water table is also becoming lowered which ultimately beyond the reach of existing wells (Bianchi and Muckel, 1970). Interestingly, wells has become more deepened to reach to groundwater like in India, where the water table has gone hundreds of feet more down due to the enhanced activity of well pumping. In Indian contest, some regions of Punjab, the level of groundwater have dropped down to 10 metres since 1979, and the interesting thing is that the rate of its depletion is running at a fast rate (Lall, 2009). On the other hand, low rainfall receiving areas of the country have less utility and availability of surface water so people have largely use groundwater for their agricultural and domestic work leading to the higher exploitation of groundwater resource (Bose, 1994). Moreover, the problem has become more complicated by reducing permious surface for groundwater table recharge due to rapid increase in industrialization and urbanization (Finnemore, 1995). The enhancement of new technologies like civil engineering helps in rapid movement of surface water which ultimately helps in artificial recharge of groundwater. The main target of artificial recharge: i) to improve the water table in overexploited areas in terms of over-development and increased use of groundwater for sustainable use and ii) groundwater quality is highly variable with change in seasons as well as respect to time and to elucidate pathological which consisted of other impurities to dilute the existing groundwater so that it can become fit for use (Sivanappan, 2006). There are various factors or criteria's for carrying out the planning of ground water artificial recharge. Micro-watershed or a minimum watershed, as far as possible are selected for implementing recharge scheme (Cavelaars et al., 1994) which will benefice the small villages on the local level. The scheme of micro-watershed is no doubt prove to be very advantageous but it‘s been suggested that before to start recharge scale, one should look for accessibility and availability for ample amount of water In each local area there is some amount of precipitation which may not be sufficient for recharge purpose, in these cases water from other sources are been directed to the recharge site. Saturation of vadose zone is determined by infiltration capacity of soil which is measured by various field tests performed by State Agricultural Departments or Land Survey Organization (District Agriculture Officer maintained this data) (Binh et al., 1994; NPRL 1997). Other factors like storage coefficient, storage space mediates aquifer's suitability. High and low permeability results in sub-surface drainage resulting in loss of recharge water and reduce recharge rate respectively. To get the sustainable use of recharged groundwater lean period and moderate permeability is mandatory (Khan et al., 2008). Hydro-meteorological studies are also important for artificial recharge. According to Rathore 2005, these studies are undertaken to understand the rainfall pattern and evaporation losses and thereby to determine the amount of water that would be available from a given catchment and the size of storages to be built (Rathore, 2005). Another important factor is geophysical study. Advanced skills and technology with time and money have required conducting these kinds of studies and hence these are feasible only for big groundwater development projects not for artificial recharge scheme at small level (Ministry of Rural development, 2004). According to Singhal et al., 2010, the main purpose of applying geophysical methods for the selection of appropriate site for artificial recharge studies is to assess the unknown sub-surface hydro geological conditions economically, adequately and unambiguously. The aims of present investigation are I) assessment of the best and cost-effective techniques for artificial recharge of groundwater and ii) to narrate the case studies of two states (Site-1 & Site-2) to explain the conservation of groundwater by artificial recharge.

DIFFERENT METHODS FOR ARTIFICIAL RECHARGE

Artificial recharge is proving to be one of the best methods to conserve the groundwater. There are various methods for artificial recharge. In this paper we conclude some of the techniques in detail like direct recharge, induced recharge, channel spreading, ditch and furrow method, site characteristics and design guidelines, check dams/nalabunds, percolation tanks/spreading basins, recharge of dugwells/handpumps, recharge shaft, injection wells and induced recharge. Among all the techniques we suggest some of the daily use and cost-techniques which can be implemented for conserving the groundwater.

DIRECT RECHARGE

Direct recharge is itself a combination of three subdivided techniques i.e. spreading method, recharge shafts and injection wells. Spreading method is also of different types like channel spreading, ditch and furrow method, site characteristics and design details, check dams/nalabunds and recharge of dug wells or hand pumps (Hantush, 1967; Metcalf and Eddy, 2000). The most prevalent methods used nowadays which are not only cost-effective but convenient in use also are ditch & furrow method, percolation tanks and recharge of dug wells or hand pumps. Undulated areas and closely spaced ditches/furrows act as a contact area for recharging water from the source of recharge like canals, streams (McDonald and Harbaugh, 1988). The percolation tanks technique been implicated in areas of Karnataka, A.P., M.P., Gujarat and Maharashtra (Rao and Sarma,1983). In dry areas where water level has gone down, handpumps or dugwells are putting use in recharge (Todd, 1980). Now we move towards the second technique of direct recharge. Apart from spreading method, recharge shafts are for aquifer recharge. It is also helpful in areas of non-uniform water availability. The main advantages of this technique are- i) small piece of land, ii) less moisture and evaporative losses, iii) rapid recharge and iv) immediate benefit (Kamble et al., 2009; Marino, 1974). The third method of direct recharge is through injection wells. This is the best method where the land is scarce and for confined aquifers on deep seated aquifers. Injection method is not suited with high permeability but is effective in fracturised hard rocks and karstic limestones but it is important to keep a check on the quality and purity of recharged (source) water, to avoid clogging of injection structures (Nassar et al., 2007; Marmion, 1962).

INDIRECT RECHARGE

The technique of artificial recharge is indirect method i.e. involving or uses pumping of water by hydraulically connected with surface water from aquifers, to recharge the groundwater reservoir. This technique is popularly known as induced recharge (Yoneda et al., 2001; Latinopaulos, 1986). The greatest advantage of this method is that quality of surface water enhances as it passes through the aquifer zone therefore, making its way in pumping wells (Glover, 1961). According to Rao and Gupta, 1999, collector wells are constructed where large water supplies from riverbed, lakebed deposits or waterlogged areas are high. “In India such wells have been installed in Yamuna Bed at Delhi and other places in Gujarat, Tamil Nadu and Orissa. The large discharges and lower fit heads make these wells economical even if initial capital cost is higher as compared to tube well. The other induced recharge techniques are contour bunding, contour trenching, bench terracing, gully plugging etc. Hence, the above all techniques are playing a remarkable role in the conservation of groundwater through different artificial recharge techniques” (Rao and Gupta, 1999).

CASE STUDY OF SITE – I (DELHI)

In urban areas like Site – I (Delhi), due to boom of industrialization and population explosion, depending on groundwater is increased to a level which results in scarcity of natural resources (groundwater). Rainwater harvesting also act as a helping hand in replenishing groundwater by artificial means. According to Central Ground Water Board (CGWB), 2007, “some projects has initiated pilot projects in Jawaharlal Nehru University (JNU), Sanjay Van for artificial recharge experiments. In JNU and Indian Institute of Technology (I.I.T) are comprising of 5 micro watersheds, 0.46 Million Cubic Meters (MCM) storm water was going waste which could be stored in purpose-built structures and ultimately recharge the depleted aquifers. Four check dams were constructed on rivulets and sixteen piezometers were established to monitor the impact of artificial recharge on ground water regime. The storage capacity of 49,000 Cubic Meters was created in these dams and 1,25,000 Cubic Meters water had already been recharged to the aquifer. Rise of water level maximum up to 4 m has been observed. Apart from sustainable yield of tube wells and more vegetation cover around the check dams. The efficiency of check dams is around 98%” (CGWB, 2007).

CASE STUDY OF SITE - II (HARYANA)

At Site – II (Haryana) two districts Ambala and Kurukshetra has adopted injection well technique for artificial recharge. According to CGWB, 2007, "the Dabkheri site in the Narwana Branch area, Kurukshetra district was selected for the artificial recharge studies by the injection well method after detailed hydro geological surveys. An injection well tapping aquifer at different depth levels was developed with cement sealing from ground level to a depth of 15 m. The injection experiment was carried out using canal water with an injection rate of 43.3 LPS under pressure. It was observed that the injection pressure of 1.6 atmosphere raised to 1.96 atmosphere within 30 minutes of injection and remained constant for about 4 hours. Sudden and violent vibrations in the injection line were reported to have been witnessed and the injection pressure shot up to 2.5 atmosphere and it was reported that it was due to clogging of foot valve with grass etc. After construction and development of another injection well with improved design, second injection recharge experiment was conducted with a recharge rate of 40 LPS for 389 hours and with 22 LPS for another 24 hours" (CGWB, 2007; Tanwar, 1983).

CONCLUSION

The best and simplest plus cost-effective technique is direct recharge of groundwater which further includes ditch & furrow method, percolation tanks and recharge of dug wells or hand pumps.In addition, case histories of two of the states are also discussed to explain the type of techniques used there and provide sustainability to groundwater development.

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