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Solar Energy based Dual Pump Drinking Water supply Scheme a Boon For Rural drinking Water security

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Abstract

At present approximately 783 million people in the world lack access to safe potable drinking water. The solar energy based submersible- dual pump has been seen to be a viable option for supply of drinking water throughout the year. In this scheme a solar energy based submersible as well as hand pump is fitted in the same bore well. This drinking water supply scheme gives continuous water supply throughout the year as people can extract water by hand pump when there is no solar power available particularly in rainy season. When the water level goes down i.e. below 36m particularly in summer season below the lifting capacity of Mark-II hand pump people face lot of problem in collecting potable drinking water. During summer season when there is frequent power shortage and failure this scheme can give uninterrupted drinking water supply and drinking water security. Once this project is implemented (approximate cost in India is Rs 6 lakhs , $10,000) by the government the operation and maintenance cost is around Rs 30.00 ($ 0.5) per family per month. With the present socio-economic condition, rural people can afford for the monthly maintenance which is important for the sustainability of the project.

Keywords: Solar, drinking, yield, sustainability, recharge.

Introduction

Water resources worldwide are under increasing stress through a combination of factors that includes population growth, pollution and the consequences of climate change. The current rate of global population growth will put a strain on the earth's natural resources, with another 2.3 billion people likely to be added to the global population in the next 40 years[1]. In the Millennium Summit of the United Nations in 2000 at New York Millennium Development Goals (MDGs) declaration was made. The target of the Millennium Development Goals was halving the number of people who do not have safe drinking water and basic sanitation facilities by the year 2015[2]. The UN General Assembly recognized safe drinking water and sanitation as a human right in its 2010 resolution[2]. This means that the UN believes every person should have access to safe water and basic sanitation. As per UNICEF report approximately 783 million people still lack access to safe potable drinking water and most of them live in the developing countries of Africa and Asia. Inadequate access to safe water and sanitation services, coupled with poor hygiene practices, ultimately leads to malnourishment and death of thousands of children every day, and leads to impoverishment and diminished opportunities for thousands more. As a result, International agencies like UNICEF are working for ensuring that all schools have adequate child-friendly water and sanitation facilities and hygiene education programmes. To meet these targets, UNICEF is guided by a new set of strategies that defines the shape of UNICEF WASH (Water, Sanitation and Hygiene) programmes to 2015[3].

Poor sanitation, water and hygiene have many other serious repercussions. Children – and particularly girls – are denied their right to education because their schools lack private and decent sanitation facilities. In much of the world, women and girls are traditionally responsible for domestic water supply and sanitation, and maintaining a hygienic home environment. As managers at the household level, women also have a higher stake in the improvement of water and sanitation services and in sustaining facilities. UNICEF is working to ensure that women are directly involved in the planning and management of water supply and sanitation programmes, and that hygiene promotion interventions are specifically designed to reach women and girls[3]. Collection and carrying of drinking water is women's work in rural India. In the villages of the desert district of Banaskatha, western India women spend up to six hours a day for collection of drinking water from a distance source. They carry up to 15 liters on their heads on each trip, often walking barefoot[4].

Study area: The study is in central and eastern part of India underlain by hard rock's of Precambrian age such as granite, gneiss, schist, quartzite and Deccan Trap basalts of Cretaceous age. The location map of the study area is given in figure-1[5]. The area is covered with Eastern and Western Ghat hill ranges and highly undulating in nature. The average annual rainfall of India 1120 mm. The area experiences a tropical to sub-tropical climate with cold winter and high heat in summer with temperature exceeding 45^0C[6]. There is acute scarcity of water in some areas during summer season particularly in the hard rock terrain where the fluctuation of water level between pre and post- monsoon is more than 10 m. In the hard rock terrain of Peninsular India in Pre-monsoon depth to water level is highly variable in different places. At some places it may be less than 10 mbgl, but generally varies between 10-20 m. In the topographical high, along hill slopes and recharge areas the depth to water level is more than 20 m [7].

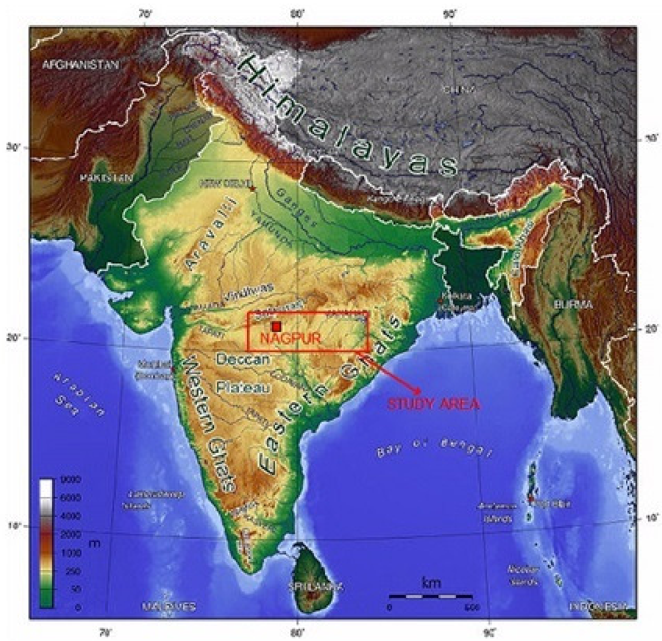

Figure-1
Location map of the study area

Material and Methods

The Central Ground Water Board, MOWR, Govt. of India is engaged in ground water exploration as well as supply of drinking water in rural area throughout India in co-ordination with government agencies in all states. It is also involved in supply of drinking water in rural areas in coordination with government agencies in all the states. In India more than 80% of the drinking water needs are met from ground water. Besides, CGWB, many state agencies like the GSDA are involved in the supply of drinking water in their respective states. The usual practice is that of bore wells being fitted with submersible pump. But in rural areas there is frequent power failure. As a result, the submersible pumps do not work and people face a lot of problem for collection of drinking water. Most of the rural people are dependent on hand pump for their daily needs of drinking water. In pre-monsoon water level goes down below the lifting capacity of Mark-II hand (36m) pump and yield of the aquifer is also significantly reduced. To overcome the problem Ground Water Survey and Development Agency (GSDA) Nagpur, Maharashtra has first installed a submersible solar pump and hand pump in a single bore well and it is a huge success as people get water supply during the summer season when sufficient sunlight is available and more water is needed. Government of India is planning to implement these schemes in other states. In this scheme people do not have to pay monthly electricity bills. Operation and maintenance cost is about Rs 30.00($ 0.5) per family per month in India.

Results and Discussion

Hydrogeology: The ground water behaviour in the Indian sub-continent is highly complicated due to the occurrence of diversified geological formations with considerable lithological and chronological variations, complex tectonic framework, climatological dissimilarities and various hydrochemical conditions. In India broadly two groups of water bearing formations are encountered such as hard rock and porous formation which are further classified into unconsolidated (alluvial) and semi-consolidated formations. In India formation ranging from Archean to Recent (aeolian deposits/ sand dunes in coastal areas) are found[8].

In a hard rock terrain ground water resources are limited, unevenly distributed and vary within a short distance (figure-2). Groundwater occurs in secondary fractures developed due to folding, faulting, jointing etc. and the surface signatures of such features are manifested as lineaments representing mainly subsurface tectonic features. Analysis of yield data of 1167 borewells in hard rock terrains of Orissa, drilled by Central Ground water Board, reveals that 54% of the bore wells are of low discharge (< 3 litre per second) and 46% are of high discharge (> 3 litre per second) in nature. Out of 54 % of the low-discharge bore wells, 29% have discharge between 1 and 3 litre per second and the rest has < 1 litre per second. Wells having a yield of 1-2.5 litre per second are underutilized[9,10]. These wells have to be utilized only after proper pumping test to know the sustainability of the aquifer.

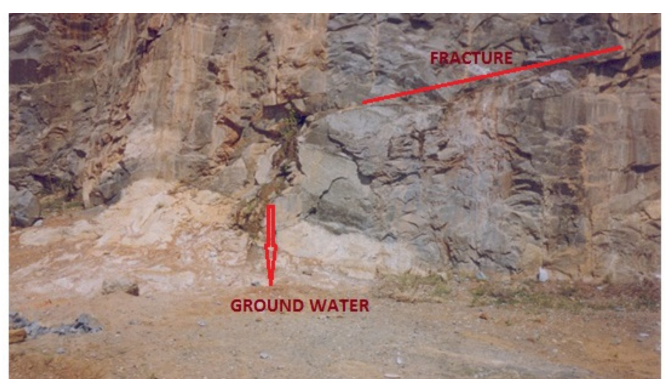

Figure-2
Deeper fractures in hard rock terrain of peninsular India showing flow of ground water

In hard rock terrain of Peninsular India different types of rock occur, viz. granite, gneiss, charnockite, khondalite and quartzite which are hard, massive and at some places devoid of any secondary porosity. Pre-monsoon water level in alluvial areas of east coast of India in states of Orissa, Andhra Pradesh and Tamil Nadu varies from 2-5 m. In the western parts of the country deeper water level is recorded in the depth range of 20-40 m below ground level. In North Gujarat, part of Haryana and western Rajasthan water level more than 40 m below ground level is recorded. In these areas due to erratic monsoon and deficient rainfall there is depletion of water table and severe scarcity of drinking water in summer season. The fluctuation between pre and post-monsoon water level is high in the hard rock terrain of peninsular India. The problem is more acute around mining and industrial belts[7].

Solar energy based dual pump drinking water scheme: Upto last century most of the people were drinking surface water from pond, streams, springs and dug wells. Then the focus was shifted to hand pump. Presently borewell fitted with submersible pump water supply scheme is most popular. But in low discharge bore wells (yield less than 2 litre per second) water supply scheme is not economically viable. So in low discharge bore wells submersible pump is fitted and a overhead tank is made. People from nearby areas collect drinking water. Also when the water level goes down i.e. below 36 metre particularly in summer season below the lifting capacity of Mark-II hand pump people face lot of problem in collecting potable drinking water[11]. The yield of the aquifer is also reduced significantly. But in rural areas particularly during summer season there is frequent power failure and people face lot of hardship for collecting potable drinking water. As a result solar energy based dual pump drinking water scheme is the most suitable option. In this scheme a solar energy based submersible pump is installed in the bore well as well as a hand pump is fitted. So when there is no solar power available during rainy days people can collect water from hand pump.

Description of the water supply scheme, Design: The water supply scheme should have a bore well of yield not less than 2800 litres per hour (0.77 litre per second). Solar photovoltaic submersible water pump of 900 watts with required photovoltaic panels. A hand pump is also installed in the same borewell (figure 3). Where borewell is not feasible water can be supplied from sources like shallow tube well, sanitary dug well, intake well, springs etc. A 5000 litres HDPE (High density polyehylene) tank mounted on a 3m high pre fabricated steel structure. House to house tap distribution system or stand post are installed as per the necessity.

Cost: In India present approximate capital cost of one project with 1 H. P. submersible pump is 6 lakh rupees ($10,000) and operation maintenance cost is Rs 30.00 ($ 0.5) per family per month[11.] This scheme can cater to the needs of small scattered population upto 500 population. Once the project is implemented the monthly expenditure for maintenance of the project is very less which is good for the sustainability of the project. Otherwise in a developing country like India where more than 6 lakhs rural village are there payment of monthly electricity bill is a big challenge. Some of the projects get defunct because of non –payment of the electricity bills after few years of implementation because of the present socio-economic condition of the rural people.

Figure-3
Solar energy based dual pump drinking water supply scheme in Nagpur, central India

Benefits of the project: Effortless pumping. Assurance of 24 X 7 water supplies. No electricity charges. Security of water due to 5000 litres storage tank. Arrangement of special water chamber for easy removal of hand pumps for the maintenance, without disturbing submersible pump. Availability of spare time to rural women for agriculture and other house works. Leads to student reporting in schools on time due to the assured supply of water. Sustainability of scheme and source. Uninterrupted water supply during summer (when hand pump become non functional due to depletion in static water) due to functioning of solar water pump[12] .

Artificial Recharge for sustanability of the water source: Every drinking water scheme should be supplemented by Rain Water Harvesting Structure. Wherever feasible there should be implementation of roof top rain water harvesting (RTRWH) structure or the rainwater should be recharged by recharge pit preferably in nearby location of solar water pump schemes (figure 4). This will check depletion of ground water and the project will be sustainable for a longer period and a balance between ground water exploration and recharge will be maintained.

Figure-4
Check dam with recharge pit for recharge of rainwater in Nagpur central India

Participaton of stakeholders for sustainability of the project: The success of any project depends on the participation of stakeholders. It has been observed that about 1/3 of the project implemented in developing countries like India gets defunct within first few (about-5) years of their implementation because of non involvement of people. The community participation of stakeholders in managing the water resource has been advocated and pursed vigorously in India by Shri Anna Hazare of Maharastra state in 1975 and Shri Rajendra Singh of Rajasthan state in 1985. The most successful example of participatory water management in India is Andhra Pradesh Farmer's Ground Water Management System (APFAMGS)[13]. The core concept of APFAMGS was that sustainable management of groundwater is feasible only and if users understand its occurrence, cycle and limited availability, and they accept that groundwater conservation through collective decisions is ultimately a safeguard of their own interest. The corollary was that once concepts of hydrogeology and groundwater management which had hitherto remained in the domain of scientific communities were translated for and mastered by poorly literate farmers through what was called the "demystifying science" approach, groundwater users would agree to take appropriate action for its sustainable management. Awareness and participation of all people is necessary for ground water management for sustainable and efficient domestic water supply in rural areas. People should know the importance of safe potable drinking water. Selective local persons in the village can be trained towards attending to minor repair and maintenance of solar and hand pumps so that system can work unhindered. They should be made aware regarding different fundamental parameters such as yield, drawdown, static water level, capacity of pump etc. for long term sustainability of any project. Solar energy based drinking water supply schemes will bring drinking water security in rural India.

Conclusion

This project is suitable in small hamlet and particularly hilly inaccessible areas and having scattered population. It can be installed in villages having no communication and electricity. This economical and environment friendly scheme may give solace to women who travel very far distance to fetch water. Socio- economic scenario in the rural area is definitely up lifted due to this project. As water is available near their house rural woman has spare time for agriculture and other house works.

Solar energy based submersible pump can reduce the demand of thermal power. As burning of fossil fuel has the major impact on climate change, it shall reduce the impact of climate change. In countries like India there is shortage of electricity. So this is a boon, particularly in summer season when there is frequent power failure and in rural areas the problem is more alarming. During the hot summer months, when water requirements are highest, a solar pump will provide reliable assured supply.

Climate change affects the reliability of water, and from the perspective of a farmer, variable rainfall can mean the difference between well-being and poverty. A recent article in the journal nature cites studies that show that recent catastrophic rainfall events, such as those witnessed in Brazil, Australia and Srilanka, demonstrate that climate change and temperature variation can be linked to extreme weather incidences[14]. The implications of climate change on poor farming communities is far greater because of the weak asset base of rural communities and the precariousness of agricultural livelihoods. Use of solar pump will reduce the impact of climate change and bring drinking water security in rural areas.

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References

1. Nature, Editorial, How to Feed a Hungry World, Nature 466: 531–532. Published online at: http://www.nature. com/ nature/journal/ v466/n7306/ full/ 466531a. html 28 July, **(2010)**
2. http://www.un.org/apps/news/story.asp? NewsID=35456 #.Uj_aefnn_IU., **(2014)**
3. http://www.unicef.org/wash/index_ bigpicture. html., **(2014)**
4. http://www.wri.org/ publication/content/ 8603., **(2014)**
5. http:/upload.wikimedia. org/ wikipedia/ commons/7/7a/ India_Geographic_Map.jpg., **(2014)**
6. Manual on Artifical Recharge to Ground Water, CGWB, MOWR, Govt. of India, **(2007)**
7. Ground Water Year Book- India, CGWB, MOWR, Govt. of India, (**2012**)
8. Dynamic Ground Water Resources of India,CGWB, MOWR, Govt. of India, **(2011)**
9. Naik P.K., Drinking water problem in rural India, Current science, **94(8),** 964 **(2008)**
10. Naik P.K., Naik K.C., Choudhury A. and Chakraborty D., Solving drinking water crisis in hard rock terrain of Peninsular India, Current science, **99**(**10**), 1309-1310 (**2010**)
11. Deshpande S.V., Directorate of the Groundwater Surveys and Development Agency, Pune, Govt. of Maharashtra (**2011**)
12. Rajiv Gandhi National Drinking Water Mission, Ministry

of Drinking Water and Sanitation, Govt of India, http://www.mdws.gov.in/, **(2014)**

13. Andhra Pradesh Farmer Managed Groundwater Systems (APFAMGS), Evaluation of FAO cooperation with India **(2008)**

14. Schiermeier Quirin, Increased Flood Risk Linked to Global Warming, Nature 470: 316. Published online at http://www.nature.com/ news/2011/110216/full/ 470316a.html, 16 February, **(2011)**