IMPACT OF WATERSHED DEVELOPMENT PROGRAMME ON GROUND WATER RECHARGE AND IRRIGATION POTENTIAL IN VARIOUS WATERSHEDS

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ABSTRACT

In the recent past, a sharp increase in groundwater use is recorded. About two-third of the total irrigation demand is met by ground water source. This expansion of ground water use has resulted in speedy decline in groundwater table in several parts of the country. The evidences indicated that the lowering of water table was quite rapid in water scarce regions. This was resulted in the over exploitation of ground water and recommended an immediate attention towards this serious problem. Most of the farmers across the country are of the opinion that the sustainability of agriculture is possible by harnessing rainwater and improving the ground water, which is possible through soil and water conservation measures. Farmers also reported that soil erosion can be minimized and irrigation potential can be improved through soil and water conservation measures. The review related to 'Impact of Watershed Development Programme on Groundwater Recharge and Irrigation Potential' is discussed in the present paper.

KEYWORDS: *Watershed development, ground water recharge, irrigation potential.*

INTRODUCTION

Since 1960s, many soil conservation and watershed development projects have been undertaken in the world under diverse agro-climatic conditions. These projects usually aimed at reducing soil erosion and preventing land degradation besides increasing crop and biomass productivity. To achieve these broad objectives, a multitude of activities were undertaken, ranging from bunding, terracing, gully control structures, reforestation and horticulture development, off-farm employment and other livelihood support systems. However, while evaluating these projects, during and post project periods, it was observed that no concrete conclusions could be drawn, mainly due to non-availability of tools and techniques for effective monitoring of project outcomes and impacts.

A huge knowledge gap exists with respect to the impact of soil and water conservation technologies in particular, such as the effectiveness of on-farm technologies in controlling soil erosion, their impact on human and natural resources, cost-benefit ratios, or the level of integration into prevailing farming systems. The reasons for this may be numerous. But development programmes generally seem to lay more emphasis on performance rather than impact. For example, a soil and water conservation programme may be responsible for the design and implementation of soil and water conservation measures (performance) but may have no mandate to monitor the consequences in the mid or long term (outcome / impact). Another issue that prevents people from seriously dealing with impact monitoring is the fact that there are always unintended impacts, both positive and negative.

REVIEW OF LITERATURE

Gore et al. (1998) conducted the groundwater modelling study of Wagarwadi watershed near Aundha Nagnath in Hingoli District of Maharashtra State using finite difference method that helped in assessing the ground water recharge as 6.0 ha m per year which resulted into 0.3 to 2.5 m rise in the wells located in 200 m on the downstream side of conservation structures.

Kerr et al. (2000) evaluated the watershed development in dry land areas of India and revealed that due to variations in seasonal rains during the crops growing period, crops may face drought and sometimes water logging due to torrential downpours causing runoff. In order to conserve rainwater, minimize land degradation, improve groundwater recharge, increase crop intensity and crop productivity a watershed management approach is adopted.

Khepar et al. (2001) reported an increase in ground water table in open wells as high as 1.0 m and consequently, the irrigated area in the Kandi watershed project registered an increase of 172% compared to the pre treatment period resulting in 70% higher crop yields. It was also observed that the soil and water conservation works implemented in the watershed project area resulted in an average increase in the ground water level of about 5.9 cm/year.

Drasana (2002) in a case study surveyed the impacts regarding the cultivation, environmental and socio-economic aspects of projects pertaining to the watershed management of the Tsiazompaniry region in Madagascar. Based on the results of the study, where the project was exposed to the three grounds mentioned above (cultivation, environmental and socio-economic), the results of the assessment proved successful. The most important cause for this was noted to be embedded in the public participation, the rural populace that was permitted to plant saplings in government owned lands, which also brought about a sense of reliance between the project authorities and the local inhabitants.

Sastry and Samra (2002) reported that the integrated watershed management programmes without village level institutions like, watershed association, watershed committee, user groups and self help groups cannot sustain for long in an efficient and effective manner nor the natural resources can be managed. The PIA/WDT members will act as facilitators to these institutions. Further, it is also suggested that Gram Panchayat itself may not be considered as watershed association to avoid any political interference and ensure more people’s participation as a separate body particularly for conservation of natural resources on sustainable basis.

Pathak et al. (2002) studied the effect of water harvesting structures in the contribution of seasonal rainfall received during normal year to groundwater in various watersheds in India. The various water harvesting structures (WHS) resulted in the average contribution of seasonal rainfall during normal rainfall year to groundwater ranged from 27 to 34 per cent. The contribution to groundwater was 27% in Adarsha watershed Kothapally, Andhra Pradesh, 29% in Lalatora watershed, Madhya Pradesh and Rajsamadhiayala watershed, Gujrath was 34%.

Wani et al. (2003) stated that the integrated watershed development is the strategy adopted in the country for sustainable development of dry land areas. A recent comprehensive assessment of watershed development programmes in India was undertaken by ICRISAT led consortium revealed that integrated watershed can become the growth engine for sustainable development of dry land areas by improving the performance of $2/3^{rd}$ watershed in the country. In most of the developed watersheds with concerted efforts to manage rainwater, the groundwater availability is improved not only in the watershed, but the downstream areas also benefited with increased groundwater recharge. It was also observed that in Lalatora watershed in Madhya Pradesh, the groundwater level in treated area registered an average rise of 7.3 m, at Bundi watershed in Rajasthan 5.7 m increase was observed and at the Adarsha watershed Kothapally in Andhra Pradesh 4.2 m rise in ground water was recorded.

Joshi et al. (2004) the important reason for the success of Fakot watershed was continuous flow of new information and improved technologies by CSWCRTI. The institute is regularly monitoring technical, hydrological and socio-economic changes by posting two regular technical personnel in the village. These also act as extension agents and disseminate improved technologies. Water is a binding force for the farmers to work together for regular maintenance of the check dams. Market opportunities induced to cultivate high value crops which require regular water for irrigation.

Sastry et al. (2004) carried out an extensive survey to assess the impact of watershed management practices on sustainability of land productivity and socio-economic status of 37 watershed locations developed under the National Watershed Development Programme for Rainfed Areas. The rise in water table was examined under arid, semi arid and humid agro- climatic conditions over the 37 watersheds. It was found that the groundwater rise was 1.36 m in heavy soil areas as compared to 1.72 m in light soils. It was observed that on an average the water table was raised by 1.05 m, 1.57 m and 1.38 m in arid, semi-arid and humid agro climatic conditions respectively. The rise in groundwater was high in semiarid region. It was relatively less in the humid region. This could be due to high and variable slopes in the humid region. The surface water resources were developed to the tune of 9%, 18% and 20.5% in` arid, semi-arid and humid agro climatic conditions respectively.

Sethi and Jena (2004) studied the impact of watershed management on groundwater availability in various regions of the Country. It was found that the impact varies in different agro-ecological regions. In Aravali hills of Rajasthan, the groundwater table raised by an average of 7.97 m after six years of watershed development programme. Due to increased availability of water for irrigation, there was an increase of 83 per cent in post monsoon cropped area. In Yamuna ravine of Uttar Pradesh, the watershed management measures resulted in rise of ground water table ranging from 1.53 to 6.05 m depending upon monsoon rainfall. In Malwa region of Madhya Pradesh, the average annual post monsoon increase in groundwater was 6.79 m due to implementation of watershed management measures compared to just 1.5 to 2.0 m in pre-project era.

Palanisami and Kumar (2005) examined the overall performance of watershed development programme in the State of Tamil Nadu. They reported that due to the soil and water conservation interventions carried out in the watershed, the water level in the open dug wells increased from 2.5 m to 3.5 m in Kattampatti watershed and 2.0 m to 3.0 m in Kodangipalayam watershed. Groundwater recuperation in the nearby wells was observed to be increased, also the irrigated area and the irrigation intensity in the study area was found increased. The most important notable feature of the watershed development programme is that seven out of nine dug wells of the respondents during the household survey which were totally dry got recharged and became fully functional.

Sreedevi et al. (2006) conducted a detailed study of groundwater scenario in the Rajsamadhiayala watershed, Gujarat. During pre and post watershed interventions, it was revealed that the mean total groundwater recharge has increased by three folds in different rainfall situations and the water requirement has doubled after the watershed interventions due to increased cropped area, cropping intensity and change in the cropping pattern. The average water column was increased from 5.9 m in 1995 to 10.4 m in 2004. Not only increase in the water column is observed, significant improvement in the water yield in wells were also reported based upon the duration of pumping hours per day for irrigation. The average pumping duration of 5.25 hr per day in 1995 increased to 10.4 hr per day in 2004, which means that there is a net increase of 5.2 hr per day of pumping duration.

Mekonen and Tesfahunegn (2011) assessed the impact of various physical and biological soil and water conservation (SWC) measures implemented during the past 2_ 3 decades in combating land degradation caused by soil erosion in the Medego watershed, northern Ethiopia. Such evaluation is essential to understanding the success or failure of previous conservation measures and readjusting accordingly in the future planning. Data collected through semi-structured interviews, transect walks, field observation and field measurements demonstrated that terraces and check dams were filled with soil up to 1.5 m deep, gullies started to stabilise, irrigation and other water supplies increased many folds, the seedling survival rate rose to over 45%, and the vegetation composition and coverage density improved by more than 30%. Water levels increased in hand-dug wells by up to 2 m, and in a number of springs and shallow wells by more than 100 times as a result of the positive impact of SWC measures implemented in this watershed. Existing SWC measures should be improved for continued maintenance and also expanded further to restore critically degraded areas to their full potential through integrated intervention.

Osman et al. (2013) reported a significant improvement in groundwater level in the watershed area resulting in increased area and number of irrigations per crop compared to baseline period (before WDP) leading to crop diversification. The average depth of groundwater level over a period of ten years in open dug wells from ground level before WDP was 9.5 m which got reduced to 6.1 m after WDP indicating a rise in water table of 3.4 m. The availability of groundwater also improved to 3.9 m even during summer which was earlier just 0.5 m prior to watershed development.

Dagnew et al. (2015) conducted four year study in the 95 ha Debre Mawi watershed in Ethiopia where under the government led conservation works, mainly terraces with infiltration furrows were installed halfway in the period of observation. The results show that runoff volume decreased significantly after installation of the soil and water conservation practices but sediment concentration decreased only marginally. Sediment loads were reduced mainly because of the reduced runoff. Infiltration furrows were effective on the hillsides where rain water could infiltrate, but on the flat bottom lands that become saturated with the progress of the monsoon rain, infiltration was restricted and conservation practices became conduits for carrying excess rainfall. This caused the initiation of gullies in several occasions in the saturated bottomlands. Sediment concentration at the outlet barely decreased due to entrainment of loose soil from unstable banks of gullies in the periodically saturated bottom areas. Since most uphill drainage were already half filled up with sediments after two years, long term benefits of reducing runoff can only be sustained with continuous maintenance of uphill infiltration furrows.

Negusse et al. (2013) studied impact of integrated soil and water conservation measures on water availability in Mendae catchment (10.37 km2), which is located in the North Eastern Tigray. Historical background of the catchment with respect to its land use was obtained from the local Bureau of Agriculture and Rural Development office. The hydrology of the area was characterized based on its land use, soil, slope, rainfall, temperature, evapotranspiration, and runoff. Thornthwaite method and Thornthwaite soil-water balance model were used to determine potential and actual evapotranspiration, respectively. The mean annual runoff from the catchment was computed using runoff coefficient method. Before the intervention, the area was severely degraded and known with scarcity of water. Integrated soil and water conservation (physical and biological measures) was introduced to the area since 1993. The catchment is characterized by two rainy season and three dry seasons during the year. The rainy seasons in total have four months whereas the dry seasons comprises of eight months. The mean annual rainfall of the catchment is 565.8 mm, out of which rainy season accounts for 86.13% and the dry season for 13.87%. The rain that occurs with a very high concentration accounts 73.20 % of the mean annual rainfall of the catchment and this occur only in two months (July and August).The mean annual potential and actual evapotranspiration was found to be 832.67 mm and 405.61mm, respectively. The volume of runoff before and after the intervention was found to be 26.88 % and 17.19 % of the mean annual rainfall of the catchment, respectively. The groundwater recharge before and after the intervention was found to be 1.43 % and 19.04% of the mean annual rainfall of the catchment, respectively. The availability of groundwater has increased more than 10 times since 1993. Though the groundwater is being used for both complimentary and supplementary irrigation during the dry and rainy season, respectively, construction of additional physical conservation structures is suggested to further improve the groundwater availability in the area.

Bamane et al. (2014) conducted a study on selection of suitable site for water harvesting structures in Narli nala watershed, Gangapur, Aurangabad using Remote Sensing and Geographical Information System (RS & GIS). Delineation of catchment area is carried out using Survey of India topo sheet after geo referencing them. The IRS-P6 LISS-III satellite imagery of Gangapur is used and land use / land cover classes have been derived from it. A soil map of 1:50000 scales is obtained from National Bureau of Soil Survey and Land use Planning, Nagpur and surface drainage map is prepared. To indicate the rate of infiltration, soil and surface drainage are classified into Hydrologic Soil group. The various thematic maps such as land use map, group map, hydrological soil slope map and drainage map are laid over each other and five check dams are proposed for construction according to guidelines for selecting suitable site for construction of water harvesting structure as per Integrated Mission for Sustainable Development (IMSD). Geographical Information System is the technique which is used for preparation of thematic maps and combining all the layers and performance analysis.

Bilal et al. (2015) Geographical Information System is the technique which is used for preparation of thematic maps and combining all the layers and performance analysis. In the present study, an attempt has been made for identification of suitable site for water conservation structures in a watershed GV53 and GV54 of Aurangabad district of Maharashtra using Remote Sensing and Geographical Information System. Data such as toposheets, Landsat 8 satellite imagery, and soil map were used .The various thematic maps such as land use map, soil map, slope map and drainage map are integrated. Fourteen check dams and seven percolation tanks are proposed for construction according to guidelines for selecting suitable site for construction of water conservation structure as per Integrated Mission for Sustainable Development.

Pimpale (2015) conducted a study on, 'Impact assessment of watershed development programme at Raikheda, district Parbhani' was carried out during 2014-15. Six open wells located at downstream side of water harvesting structures like earthen nala bunds and cement nala bunds situated in treated area of watershed were selected for water table monitoring and to study the effect of these water harvesting structures on ground water recharge. The study revealed an average increase in water table depth of the area influencing in the zone of ENB and CNB was found to be 1.93 m and 1.80m respectively at post development stage of the watershed. Also the area under irrigation was found to be increased from 79.50 ha to 139.58 ha at post development stage in the year 2014-15. Due to increase in irrigation facility, productivity of kharif crops like, jowar, soybean, cotton, green gram, black gram, pigeon pea, rabi crops like, wheat, rabi jowar, red gram and summer crops was increased at post development stage of watershed in the year 2014-15.

Tapre (2016) conducted a study on evaluation of different soil and water conservation structures at Raholi watershed Dist. Hingoli during 2015-2016 which was developed by Department of Agriculture, Government of Maharashtra in the year 2010-11. An average increase in water table depth of the wells situated below the water harvesting structures like ENB and CNBs was found to be 1.64m and 1.70 m respectively at post development stage of the watershed. Also crop productivity index of Raholi watershed was increased from 0.83 to 0.86 at post development stage of the watershed.

Ullewad (2018) conducted a study on; "Impact of Soil and Water Conservation Works of Jalyukt Shivar Abhiyan at Mandakhali, Dist. Parbhani on Water Availability and Crop Productivity" during 2017-18. The Soil and Water Conservation Works at Mandakhali, were undertaken by Department of

Agriculture, Maharashtra Government under 'Jalyukt Shivar Abhiyan in the year 2014-15. Representative soil and water conservation structures were selected to study their effect on increase in ground water recharge of the area. Five open wells located in the zone of influence of the soil and water conservation structures were selected for ground water level monitoring. Open wells located at both side of water harvesting structures like cement nala bunds situated in treated area of Mandakhali village were selected for water table monitoring and to study the effect of these water harvesting structures on ground water recharge. Impact of soil and water conservation programme on crop productivity and irrigation potential of the study area was assessed by personal interview with the beneficiaries of this scheme using questionnaire. The study revealed an average increase in water table depth of area influencing in the zone of CNB at downstream side by 1.103 m and on upstream side by 1.487 m at during 2017-18. The area under irrigation was found to be increased from 36.50 ha to 61.38 ha i.e. 68.16 per cent increase in irrigated area in the year 2017-18. Productivity of kharif crops like cotton, soybean, green gram, pigeon pea, black gram, sorghum, turmeric, rabi crops like wheat, rabi jowar, gram, safflower and summer crops like vegetables, fodder crops was also found to be increased in the year 2017-18 due to increase in ground water availability for irrigation purpose.

CONCLUSION

The above studies demonstrates impact of soil and water conservation measures undertaken in watersheds on ground water recharge and irrigation potential of the area.

LITERATURE CITED:

[1] Bamne, Yogesh, K. A. Patil, S. D. Vikhe.2014.Selection of Appropriate Sites for Structures of Water Harvesting in a Watershed using Remote Sensing and Geographical Information System. International Journal of Emerging Technology and Advanced Engineering. Volume 4, Issue 11, November 2014:270-275

[2] Bilal Haji, K. A. Patil, S. D. Vikhe. 2015. Identification of Suitable Sites for Water Conservation Structures in a Watershed using RS and GIS Approach. International Journal for Scientific Research & Development| Vol. 3, Issue 09, 2015 | ISSN (online): 2321-0613

[3] Dessalegn C. Dagnew , Christian D. Guzman , Assefa D. Zegeye , Tigist Y. Tibebu , Menelik Getaneh , Solomon Abate , Fasikaw A. Zemale , Essayas K. Ayana , Seifu A. Tilahun , Tammo S. Steenhuis.2015.Impact of conservation practices on runoff and soil loss in the sub-humid Ethiopian Highlands: The Debre Mawi watershed. J. Hydrol. Hydromech., 63, 2015, 3, 210–219.

[4] Drasana, A. (2002). Impacts of Wtershed Management Projects in Madagasca: Case of Tsiazompaniry Area". http://www.rinya.maff.go.jp/, accessed March 2007.

[5] Gore, K.P., Mal, B.C., Pawde, M.N. and Pendke, M.S. (1998). Effect of Conservation measures on runoff, soil loss, ground water recharge and crop productivity in watershed. Journal of soil and water conservation. Vol. 42(1&2): pp68-79.

[6] Joshi, P. K. Jha, A. K. Wani, S. P. Sreedevi, T. K. and Shaheen, F. A. (2004). "Impact of Watershed Program and Condi- tions for Success: A Meta-Analysis Approach," Global Theme on Agro Ecosystems Report No.46, ICRISAT, Patancheru A.P. 2008, P. 24.

[7] Kerr J. Pangare G, Pangare V and George PJ. (2000). An evaluation of dryland watershed development in India. EPTD Discussion Paper 68. International Food Policy Research Institute. Washington, DC, USA.

[8] Khepar, S.D., Sandhi, S.K., Chawla, J.K. and Singh, M. (2001). Impact of soil and water conservation works on ground water regime in Kandi area of Punjab. Journal of Soil and Water Conservation, India .pp: 41-45.

[9] Osman, M., Sonune, S.V., Ravi Shankar, K., Ravi Dupdal and Pandit Wasare (2013). "Impact Evaluation of Kadwanchi Watershed in Maharashtra: Lessons for PostProject Sustainability". Indian Journal of agricultural Research and Development 2013. Volume 28, No. 2: pp 9-15.

[10] Negusse, Eyasu Yazew and Nata Tadesse.2013.Quantification of the Impact of Integrated Soil and Water Conservation Measures on Groundwater Availability in Mendae Catchment, Abraha We-Atsebaha, eastern Tigray, Ethiopia Tireza. Momona Ethiopian Journal of Science (MEJS), V5(2):117-136.

[11] Palanisami K. and Suresh Kumar D. (2005). Leapfrogging the Watershed Mission: Building capacities of farmers, professionals and institutions, In: Watershed management challenges: Improving productivity, resource and livelihoods, (BR 204 Sharma, JS Samra, CA Scott and SP Wani Eds.), International Water Management Institute and ICRISAT publication, Malhotra Publishing House, New Delhi. pp: 245-257.

[12] Pimpale, S.V. 2015. IMPACT ASSESSMENT OF WATERSHED DEVELOPMENT PROGRAMME AT RAIKHEDA, DIST. PARBHANI. M.Tech. thesis submitted to VNMKV Parbhani(Un pub.)

[13] Sastry, G., Venkateshwarlu, J., Reddy, Y.V.R., Om Prakashm and Vittal, K.P.R., (2004). Evaluation of Watersheds in India. (Ed. Somani, L.L.), 2004. Scientific Publishers, Jodhpur. pp: 231.

[14] Sethi, R.R. and Jena, S.K. (2004). Impact of watershed management on ground water recharge – few case studies. Training Manual on Artificial Recharge to Groundwater and Rainwater Harvesting, August (2004), Water Technology Centre for Eastern Region (Indian Council of Agricultural Research), Chandrasekharpur, Bhubaneswar, Orissa, 751 023, India.

[15] Sreedevi, T.K., Wani, S.P., Sudi, R., Patel, M.S., Jayesh, T., Singh. S.N. and Tushaar Shah. (2006). On-site and off-site impact of watershed development: A case study of Rajsamadhiyala, Gujarat, India. Global Theme on Agro-ecosystems Report No. 20. Patancheru 502324, Andhra Pradesh, India: ICRISAT. 48pp.

[16] Tapre, P.A.2016.Impact Evaluation of Raholi Watershed Development Programme in Hingoli District of Maharashtra. M.Tech. thesis submitted to VNMKV Parbhani(Un pub.)

[17] Ullewad, S.R. 2018.IMPACT OF SOIL AND WATER CONSERVATION WORKS OF JALYUKT SHIVAR ABHIYAN AT MANDAKHALI, DIST. PARBHANI ON WATER AVAILABILITY AND CROP PRODUCTIVITY. M.Tech. thesis submitted to VNMKV Parbhani(Un pub.)

[18] Wani, S.P., T.K. Sreedevi, H.P. Singh, T.J. Rego, P. Pathak and Piara Singh (2003). A consortium approach for sustainable management of natural resources in watershed. Paper presented at Integrated Watershed Management for Land and Water Conservation and Sustainable Agricultural Production in Asia, ADB-ICRISAT annual meeting and 6th MSEC Assembly, Hanoi, Vietnam, 10-14 December 2001, pp.: 218-225.