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Environmental Regenration through Watershed Management Approach in Alwar District

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Abstract

India is one of the countries affected by serious environmental degradation. Watersheds are distinct units where biophysical processes (water flow, erosion, nutrient flows, vegetation regeneration, etc.) and socio-economic processes (traditional practices, life style, irrigation, grazing, nutrient management, etc.) interact in a specific geographic area. It is a holistic watershed management practice involving land, water and other natural resources management leading to sustainable development of water resources.

It involves integration of land, water and infrastructure development and inclusion of all stakeholders in a participatory process this makes the 'watershed' an appropriate unit for managing environmental regeneration. Regeneration of environment needs scientific planning with traditional wisdom.

About 70% population of India is still dependant on natural resources resulting an anthropogenic pressure on ecological regime which trigger for the processes of environment degradation.

The paper peeps to find out the inter-relationship between watershed management and environment regeneration in Alwar district. The study also tries to identify the constrains in the watershed management.

Keywords: Watershed Management, Environment Regeneration,Impact on Environment, Rise in Water Table, Rainwater Runoff Check, Increased Water Availability, Soil Erosion, Soil Moisture.

Introduction

The watershed development approach has emerged as the cornerstone strategy to protect and regenerate environment for sustainable development particularly in dry and semi arid regions of India. Watersheds are ecologically and socially complex geographical units characterized by interdependence between overlapping resources and resource users. Basically, environmental regeneration is to rehabilitate the environmentally damaged areas due to the increased human activities to result in degradation and changes of the land use and the environmental quality.

Alwar is the north-eastern and 19th largest district lies in semi-arid agro-climatic zone of the state, covering an area of 8291.500 Sq. Kms. which is 2.45% of the total geographical area of the state. The study area is covering an area about 8291.500 Sq. Kms. and nurtures 12 tehsils and 15 Panchayat Samities. It falls in Survey of India Degree Sheet No. 54 A, 53D and 53E between the latitudes 27^{0}04'N to 28^{0}04'N and longitudes 76^{0}07' to 77^{0}13' East. The district has severity of nature with scant and decreasing rainfall of an average 663 mm per annum and vast stretches of land dry and rainfed. The decreasing surface water and underground water put immense pressure on resource availability. Entire Alwar district is recently; declared as dark zone of the state. The district is confronted with intrinsic problem of degradation of land and water. Soil erosion is hilly and undulating terrain of the district not only degrades the landmasses but also leads to the problem of sedimentation and siltation of water bodies and reduces their storage capacity.

Objectives of the Study

The objective of this paper is to review a framework for impact assessment of watershed development project in Alwar district. In evaluating watershed projects the environmental regeneration aspect has

been also evaluated through questionnaires method with selected sampling technique in the district. The broad objectives are assessed as following:

1. To examine environmental regeneration through watershed approach, where the intervention of watershed management had very wide experience.
2. To study, evaluate and analyze the impact of micro-watershed on environmental aspect of the study area.
3. To identify and understand practical problems of watershed development and management and to suggest appropriate measures to overcome the major problems.

Methodolgy

This study based on primary as well as secondary data collected of the year 2018-19 of the five selected watershed by detailed household through stratified sampling method. Primary information through the set of questionnaire was gathered from the selected five watershed of Patta, Sanwatsar, Geeglana, Rampur and Bassai- kalan as sample village to represent Alwar district as the whole. The overall impact assessment has been merged into one chosen broad aspect of environmental regeneration. From each watershed area, 50 respondents were selected randomly. Altogether total 250 respondents from 05 micro-watersheds were getting the first hand information through prepared questionnaires. The secondary data were collected from various sources like reports prepared by district officials and other agencies. To ascertain the extent of groundwater recharging due to water harvesting and soil conservation structures as well as natural recharging the groundwater levels in the open wells and the water balance were used.

Table-1

Sample Size Of Watershed: Alwar District

Micro Watershed	Patta	Sanwatsar	Rampur	Geeglana	Bassai-kalan	Total
Sample Size	50	50	50	50	50	250

Interventions such as water harvesting and groundwater recharging structures(*check dam, percolation tank, farm pond, gully plug and earthen bund*) on water availability, resource conservation measures on reducing land degradation (*runoff, soil loss and groundwater*), natural resource development for biodiversity conservation, fuel and fodder availability afforestation, water land development and livestock improvement, which were implemented to regeneration of environment for sustainable development.

Review of Literature

In the past, several useful studies have been conducted to assess the impact of WSPs as well as to examine the environmental regeneration. That paved the ways for the common 'Guidelines for Watershed Development' issued by MoRE in 1994, which has up turned the top-down implementation approach into bottom-up participatory. A number of organization, researchers and academicians has monitored and evaluated watershed development projects adopting different methodologies suggested following paragraphs present overview of evaluation studies of focusing on watershed impact and findings.

National Status

Watershed development projects have been taken up under different programs launched by Government of India. The Drought Prone Area Program (DPAP) and the Desert Development Program (DPP) also adopted the watershed approach in 1987. The Integrated Wasteland Development Project scheme (IWDP) also aimed at developing wasteland on a watershed basis in 1989. The major program based on the watershed concept is the National Watershed Development Program in Rainfed Area (NWDPRA). [http://www.ised.9c.in/proj3.pdf] These programs were actually concentrated on the production of fuel, food and fodder whereas the loss of soil of the land and the lack of control of runoff rainwater variable were not given priority. Without controlling runoff, it is not possible to stabilize water region and it is difficult to rehabilitate degraded lands without introducing moisture conservation and water harvesting measures.

Research on the technology of rained farming began in the country in early thirties with the establishment of dry framing research stations at Sholapur (*1933*), Bijapur (*1933*), Hagri (*1934*), Raichur (*1934*) and Rohtak (*1935*). Early research on dry farming was mainly confined to the conservation of soil moisture through bunding and understanding the rainfall behavior in these regions. (*Deshpande and Thimmarah, 1999*). Y.P Bali's watershed management and concept (*1975*) put effects on watershed development at micro level to enhance economic development. Dr. Dharuv Narayan in his "watershed management" (1990) put emphasis on theories and important activities of watershed. In 1995, J.V.S. Murti complied his work on "Watershed Management Guideline for Indian Condition" put emphasis on fundamental elements of watershed management. Dr. Rajesh Rajoria (*2001*) in his "integrated watershed Field Manual for Equitable Productivity and Sustainable Development" describes the elements based on watershed management programme. The studies for water conservation in the state includes (*1995*) "Rajasthan ki Rajat Buiday – Kharay Hai Talab" describes traditional techniques of water conservation in a very effective and concise manner.

Sanjay Modi and S.C. Mahant in 1995 by writing "Watershed Approach in Improving in Socio Economic status of Tribal Area" put emphasis on revival of living tribal area by watershed development. Dr. Ram Kumar Gurjar (*1990*) in his "Irrigation Input on Desert Ecology" describes effects of watershed development on desert ecology. In 1991, J.V.S Murti in his "Management of water Resource in Rajasthan" describes about water resources and its impact of various community.

Jaiswal and Purandare (*1982*) evaluated implementation of DPAP in Sholapur district. They found that the planning of watersheds was not based on the analysis of resources, problems and priority needs of the population depending upon the watersheds due focus on sectoral activities rather

than watershed based. Deshpande and Reddy (*1991*) in their study revealed that (I) location-specificity is an extremely important components of watershed planning that enhance impacts; and (II) watershed treatments alter the income, stabilize income flow by avoiding overt fluctuations and have impact distribution. Mahnot (*1992*) in their evaluation study of WSO in village Tahkarda, (*Rajasthan*) found that the programme has favorable response in agriculture as well as dairy sector by increasing employment opportunity. Improved agronomic practices, which were a major part of the programme, led to 44.84 to 73.7 per cent increase in grass return form agriculture crops. The availability of more dry and green fodder from watershed area increased milk production from 31.0 to 99.0 thousand liters per annum, which gave grass return from 2.72 to 11.49 lakhs rupees.

Rajasekaran, N (*1997*), analyses the need of and significance of sustainable development programs of India's dry regions and the role of participation in sustaining the development process. The data show how increases in yield per hectare, reduction in farm income inequalities and improved environments have resulted in such areas. Datta SK.; Virgo, K. J (*1998*), reviews their experiences of the Doon Valley Integrated watershed management project in Uttar Pradesh, India, with emphasis on the evolution of a participatory process orientated' approach aimed at developing community capabilities to sustain the increased natural resource production systems introduced by Project activities. Ruedi and Luithi- Bourgeois, (*1994*) reported that intensification has occurred only in cases where the biophysical environment and market access are conductive and in fragile ecosystems the livestock sector productivity has not increased much despite the WDPs and the resulting changes. Deshpande and Narayanmoorthy (*1998*) reveals the results of studies on NWDPRA, Southern Plateau for the States of Andhra Pradesh, Tamilnadu, Karnataka that the benefits of watershed can be seen in physical terms like increase in water levels, yield, changes in income and employing more wage laborers when compared with the non-beneficiaries. Deshpande and Narayanmoorthy, (*1999*) reports the result of a study which was conducted to locate differential impact of watershed across agro-climatic zones in the three distinct agro-climatic regions of Maharashtra, i.e. Sholapur, Akola and Aurangabad districts. The study observed that there was a definite improvement in fodder, fuel and food availability in the program areas across agro-climatic zones.

Deshpande and Thimmaith (*1999*) studied NWDPRA in almost all the major of the country. They found the impacts of the programme are of mixed across the states due to several irregularities at policy and implementation. Hanumantha Rao (*2000*) in his review study found overall impact of the WSP positive and significant comparison to the previous programmers. According to him, there has been a marked improvement in the access to drinking water in the project area, crop yields have risen and there has been a substantial increase in area under cultivation in the Rabi season, leading to a rise in employment and in reduction in migration of labour. Availability of fodder for animals has also improved leading to arise in the yield to milk. Kolavalli and Kerr (*2000*) examine the implementation processes of watershed projects in a sample of 36 projects in Andhra Pradesh, Orissa and Rajasthan. They found that there was no shared understanding of the meaning of participation or the means of effectively operationalising it.

Dr. S.S.Negi (2001) Presents how integrated watershed management involves the judicious management and sustainable development of three basic resources namely soil (land), vegetation and water on a watershed basis. This approach improves ecological stability, enhances the productivity of the land, and brings about an increase in the socio-economic status of the communities living in the watershed. This book deals with the basic principles of participatory watershed management with special reference to Indian subcontinent.

Similar study was taken by the Programme Evaluation Organization (PEO) at the instance of the Prime Minister's secretariat to assess overall impact of the dry land agriculture programme adopting watershed development programme, its success and failure. The study had shown that soil, moisture conservation programme was sufficient, and additional area was brought under cultivation. [Search Bulletin, "Micro-watershed Development Monitoring & Impact Assessment, vol. XIII no. 1, Jan-March 1998"]Watershed Management: People Matter, the article published in the Hindu, Jan. 02, 2002 explored that soil erosion is contributing to degradation in about 45 percent of the cultivable area of the county.

Sharma (2003) demonstrated that watersheds, particularly in developing countries are undergoing degradation due o increasing pressure on forest pastureland agriculture lands following population growth under investment. Krishna Prasad Pouel (2003) Shows mountain watershed is the focal points of environmental management for sustainable development. Resources extraction and utilization behaviors of human beings on those watersheds are closely related with the broad spectrum of man-environmental interrelationship with respect to number, skill, knowledge and period. K.V. Seshagiri Rao (2003) has presented in the book how soil and water conservation, are very important aspects in watershed management. KantaPrasad (2003) gave that volume covers the whole gamut of issues related to sustainable development of water resources impinging on socio-economic, institutional and environmental aspects that would face the humanity in the coming decides.

K. Gopal Iyer & Upendra Nath Roy (2005) Watershed development has been conceived as a strategy for protecting the livelihood of the people inhabiting the fragile eco-system experiencing soil erosion and moisture stress. The aim has been to ensure the availability of drinking water, fuel wood and fodder and raise income and employment for farmers and landless labourers through improvement in agricultural production and productivity. During the last 30 years several thousand-watershed projects

has been launched in the country. These are spread throughout the country in different states. The key to success is o ensure people participation in watershed management.

Watershed management for sustainable development with reference to drought by A Ranga Reddy, (2005) in this book the significance of dryland development through watershed management had been realized in the study of Chittor district and has been attempted to harness the water resources for the sustainable development. The study concludes that watershed development and management is therefore in a significant aspect especially in dryland development.

In this book, K.V Dwivedi and Sreedevi T.K (2006) have discussed the assessing impact of integrated natural resource management technologies in watershed in India context (pp 38-58).

Selvin Jebaraj Norman, T. Narayanan Kutty, MC and Rajan, KC (2006) has discussed about the improvement on employment generation Palakked district of Kerala (watershed planning and employment generation).

In Glimpses of India agriculture Macro and Micro aspects (2008), R.S. Despande, M. J. Bhende and S. Erappa has studied the output and impact monitoring study of KAWAD Project. National Seminar on Emerging trends in watershed management (15 Jan 2009), New Delhi also focuses to adopt an approach to conserve and develop the natural resources. People's participation is the main strategy for its planning and implementation, which is the most important component in this approach. In climate change and food security in south Asia by RatanlaI, Khandarkar, R. Islam (2010 page-576) has discussed the impact of the Sujala watershed development project which has carried out and indicated very encouraging trends regarding average crop yields.

K.N. Rao, Narendra and Latha (Vol. 38/2 pp 255-267 June 2010) in Journal of Indian Society of Remote Sensing has explored the surface runoff estimation in an agricultural Mehadrigedda watershed of Eastern Ghats of Vishakhapatnam district. The study is based on resource SAT-I (IRS-P6) LISS-IV with 5.8 m high spatial resolution sensors. The study explored that watershed intervention has increased the watershed resulting the increase in the area of various cropping in semi-arid region. Secondly, geographical information technology can augment the conventional methods largely in rainfall runoff studies.

A. Kumar, Gosh and Dadhwal (J.I.S.R.S June 2010, 28 pp 239-245) have explored the importance of resource management for people to extract single land cover class as water. S.K. Goyal, Choudhary, Singh, Sethi and Thakur (J.I.S.R.S. June 2010/38 PP 355-365) has discussed the depth and variability analysis of ground water level on the basis of GIS for agriculture dominated Kaithal district of Haryana.

State Status

Ahluwalia, M (*1997*), focuses on a community-based watershed project in Rajasthan implemented by Seva Mandir. The tools of environmental entitlements analysis are applied in a project evaluation mode to explore the effects of social difference on project experience and impact. Pant and Sharma (*1995*) reported results of a study on role of livestock in farm economy in semiarid region of Rajasthan by conducting surveys of different groups of farmers. Further Krishna, Anirudh, (*2004*) study on watershed implementation in Rajasthan, suggests that instead of focusing their energies exclusively on developing newer and better programs and implanting these from the top down, development agencies ought to consider as well the capacities that emerge from the bottom-up that enable villagers to succeed in multiple development enterprises. Patel, Jashbai (*1987*) narrates the story of the rebirth of a small river Arvari in Alwar through traditional water harvesting structure called johads. Sharma, Abhishek (*2002*), reports that water harvesting has been a common agricultural practice in India since times immemorial. This paper takes a critical look at the phenomenon of water harvesting technology both from the points of view of supply as well as demand. The basis for the study is Tarun Bharat Singh's projects in the Alwar district of Rajasthan. This study uses the sustainable livelihoods approach to take a fresh look at the impact of land-livestock and watershed interaction on rural livelihoods. It focuses particularly on questions relating to the extent to which land-livestock and watershed interaction result in the creation of new livelihood opportunities and to extent to which these opportunities are both equitably distributed and sustainable. R.K. Gurjar & B.C. Jat (2008) presents a comprehensive, well-illustrated and documented accord of the issues concerning water resources, such as their worldwide, distribution and circulation through all spheres of earth. Water quality and its uses, irrigation, methods, floods, droughts, watershed management, traditional water harvesting techniques, water ethics etc. have been discussed. "Watershed development in arid Rajasthan"-By Sunil Ray & Sunil Pareek (2008) shows the development of micro watershed under desert conditions was certainly a step taken in right direction.

Raj Bala Beniwal (unpublished Ph.D. 2006, UOR Jaipur) also has studied the impact of watershed management on wasteland development of Alwar district. Ritu Arora (unpublished Ph.D 2008, UOR Jaipur) has discussed the evaluation of agricultural land resources development with reference to watershed management in Matsya Region in which she has explored the impact of watershed management on land and cropping pattern. Neeraj Karagwal (unpublished Ph.D. 2010, UOR Jaipur) has also explored the watershed impact on agriculture land use pattern for sustainable development in Bairath Region of Thanagazi tehsil. He has explored the watershed impact on crop ranking concentration, diversification as well crop combination. Simultaneously Ritesh Agrawal (unpublished Ph.D. 2015, UOR Jaipur) has evaluated the watershed impact on socio-economic condition of community in Alwar district of Rajasthan.

International Status

Cathryan Turton et. al. (*1988*) assesses the implementation of 1994 guidelines of MoRE in three

states.They are widely welcomed being adopted to local context and, for many areas, after unique prospects of enhancing livelihoods in an environmentally sustainable fashion. Mitchell (1993) validated the agricultural new point source (AGNPS) model by use of GIS for predicting runoff and sediment delivery from small watershed of mild topography. Robert J. Naiman (1994) find that watershed contains vitally important resources, which must be managed in coordinated fashion to achieve sustainability. Schultz (1994) reported on meso scale modeling of runoff and water balance using remote sensing and other GIS data. Neumonn (1990) discussed a GIS as database for distributed hydrological model and Wolfe (1992), presented a GIS assisted input data set development for a hydrograph model. Wolfe noted that input data set development procedure provide an efficient way for considering alternate land use and management scenario in Florida.

Schuler (1995) observed that depending on the degree of watershed impervious cove, the annual volume of storm water run of could increase by 16 times that for natural areas. E.M.Tideman (1996) this book is the result of Indo-Germanic Bilateral project on watershed management. This book brings together the technical and some of the socio-economic knowledge available for successfully implementing watershed management.

G.W. Kiti, E. Elleojs A. Dalton (1996) their hydrological model is an attempt to describe the natural processes, which convert precipitation into runoff. Kenneth N. Brooks, Peter F. Flolliott, Hans M. Gegerson, Leonard F. Debano (1998). Their book provides fundamental information and practical methodology necessary to solve hydrologic problem on watersheds and to understand and develop watershed management programmes. Abernethy, C.L. and Wiijayaratna C. M (*1998*) reports that watershed management projects especially in developing counties under pressure of rising populations, present challenges in design and evaluation.

A popular investment by development agencies and international donors has been the funding and establishment of participatory watershed research and management projects says Robert Rhodes (*1999*). According to Meyer, 1999 every parcel of land on the Earth's surface is unique in the cover it possesses. Land use and land cover are distinct yet closely linked characteristics of the Earth's surface. Xiaomei Y and Rong Qing L.Q.Y in 1999 noted that information about change is necessary for updating land cover maps and the management of natural resources. Adeniyi and Omojola, (1999) in their land use land cover change evaluation in Sokoto - Rima Basin of North - Western Nigeria based on Archival Remote Sensing and GIS techniques, used aerial photographs, Landsat MSS, SPOT XS/Panchromatic image Transparency and Topographic map sheets to study changes in the two dams (Sokoto and Guronyo) between 1962 and 1986.

Hinchcliffe, Fiona (*1999*) presents the findings of in depth research into the impacts of participatory watershed management in a range of agro ecological and socio-economic settings in Africa, Asia, Australia and Latin America. Baxter E.Vieux (2001) shows how Raster or TIN DEM's are the primary data structure used in the delineation of watershed boundaries. Daniel et al, 2002 in their comparison of land use land cover change detection methods, made use of 5 methods viz; traditional post - classification cross tabulation, cross correlation analysis, neural networks, knowledge - based expert systems, and image segmentation and object - oriented classification. Paul A. Debarry (2004) believe in integrated approach to watershed management – that is integrating the various disciples to develop comprehensive assessment and management of water resources in our watershed. They also said that each watershed has a unique personality that needs to be explored to develop a truly personalized management plan. Robber Laur France (2006) has discussed in the book entitles introduction to watershed development about serious impact on development, which has inflicted upon watershed functionality and health.

Arvind C. Pandy and M. S. Nathawat (2006) carried out a study on land use land cover mapping of Panchkula, Ambala and Yamunanger districts, Haryana State in India. H.M. Gregerson, P.F.Flolliott. K.N. Brooks (2007) Using a practical approach, based on both theories and examples from around the world, this book provides guide to the principles, institutional approaches and technologies involved in integrated watershed management.

Icumtara Lahiri-Dutt, Robert J. Wasson (2008) they review the policy for land resource management and then look into the evolution of watershed policy in India, starting from 0^{th} Century. Tammer Afifi, Jill Jager (2010) on the Environment, Forced Migration and Social Vulnerability has revealed that there were more male migrants in areas where no watershed development project were implemented. Jeroen Dijkman (2010) has revealed that livestock-environment interaction has created greater awareness among policy makers, planer, implementers for sustainable land and water management. Therefore the government of India for first time included "livestock and environment" as one of the working group theme in the proposal for the 11^{th} five year plan.

R.S. Bhalla, K.V. Devi Prasad, and Neil W. Pelkey (2013) Watershed development (WSD) is an important and expensive rural development initiative in India. As the criteria used can influence results we analyzed micro watersheds grouped by catchments, state ecological region and biogeographically zones for analysis. Thomas Pikkety (2014) has written a book entitled capital in Twenty First Century, which elaborates the investment in watershed development project and its role in promoting economic benefit to society.

Ibobel W. Health Cote (2014) in "Integrated Watershed Management: Principles and Practice" has elaborated that water is the next oil. A strong global consensus has began to develop that effective WSM must start at the watershed level and that water

management actions must be taken in the context of watersheds and the human communities in them. Beheim, E., Rajwar, G.S., Haigh, M., Krecek, J. (2014) in "Integrated Watershed Management: Perspective and Problems have been discussed and suggest had waters are fragile environment threatened by anthropogenic actions.

Shashank Shekhar (2018) in Regeneration of Catchments-Watershed Management: New & Traditional Practices Watershed management involves land, water and other natural resources management leading to sustainable development of water resources. Regeneration of degraded catchment needs scientific planning with traditional wisdom.

Mechler R (2019) in Loss and Damage from Climate Changes provide state of the art of research and policy linked to this discourse and articulating its multiple concepts, principles and methods. It identifies practical and evidence based policy options to inform the discourse and climate negations. Singh Ajay (2019) explore in Waste Water Reuse and Watershed Management regarding the demand for clean water and humans produces billions of tons of waste water every year which can be effectively recycle ,reclaim and reuse of water by watershed management. Yousuf A. Singh M. (2019) provides a comprehensive insight into Watershed and Modeling of the hydrological processes in the watersheds. The basic types, of soil erosion and its measurement and estimation of runoff and soil loss from the small and large watersheds are discussed. Recent advances in the watershed management like the application of remote sensing and GIS and hydrological models are a part of the book.

Dhyani.S. (2020) is his book Nature Based Solutions for Resilient Ecosystems and Societies introduces to researchers to the diagnosis and management of ecosystems and disaster risks using nature based solutions.

It is clear from the above review that most of the studies to a large extent focus on one or more aspects of WSP. Very rarely one finds studies that look into watershed development in an integrated or a holistic manner. Moreover, the bulk of them remained project specific and covered vary small area. Against this, the present study includes all the major aspects of integrated watershed development and management and their subsequent impacts in the large areas of the Aravalli-region.

Watershed Status in Alwar

Alwar district has well defined 108 macro-watershed and 665 micro watersheds, delineated and prioritized by the State Remote Sensing Application Centre, Jodhpur. This paper on environmental regeneration through watershed development approach has been undertaken of Alwar district by the union and state governments and multilateral agencies and various NGO's. Alwar district falls in the basis 2C of water resources region no.2. Yamuna Basin 2C has only one catchment covering full district into 2C5. This catchment is divided into four sub-catchments, which are 2C5C, 2C5D, 2C5E and 2c5F. These four sub-catchments are divided into 20 watersheds, 108 macro watersheds which are finally divided into 665 micro-watersheds.

As reported by the villagers among all structure including check dam was the most beneficial among the structure constructed under drainage line treatment as their water holding capacity is more and their upkeep and maintenance is minimum and their durability is more. It is observed that part from drainage line treatment; focus was also given on plot-level management. Farm bunds were taken up on almost all the plots which have resulted in the improved land productivity. It was observed that apart from drainage line treatment, focus was also given on plot-level management.

After 12-15 years of project completion most of the structures are almost damaged or run away by rains or flood which shows the high level of corruption and poor quality control in construction. In all several check dams have been constructed on the main seasonal rivers and streams of the watershed area in the district. Even after the reconstruction presently all structures are not in good condition. Although these check dams are having good storage area. At the time of visit, some of the dams were having stored water; water normally remains till the month of March. It is reported that small leakage is occurring from all the dams. Many gabions constructed in the watershed area in which gauge wire mesh was used for the Gabion however, are damaged due to rusting of the wire mesh. Damage was also caused due to improper size of the boulder. Structure has helped to control the gully formation, silt accumulated in the upstream, down side land protected from the soil erosion. Gully down side land protected from the soil erosion. Gully area to minimize the erosion siltation that was observed in these structures.

Environmental regeneration and impact of the watershed interventions is discussed in the following paragraph

Environmental Regeneration

Environmental aspects of the watershed the immediate objective of watershed development were to arrest soil erosion, improve moisture conservation and harvest rainwater. The environmental aspect is one of the significant facts of watershed development. The watershed approach boost the sustainable development with a single coherent strategy of involving local stakeholders and communities at multiple scales while addressing ecological and farming and natural resource aspects. For this, watershed development activities are prepared for all the lands [arable and non arable land] and drainage lines of the district. For environmental indicators, the study is focused on following variables viz; watershed interventions, run off check, water resource, soil moisture, soil erosion, ground water table etc. The regeneration of environment are addressed with respect to terrain characteristics, soil erosion check and its management, conservation of moisture contains, underground water situation, and benefits derived from the watershed projects.

The study contains the impact assessment on environment, which carried out in five selected micro watersheds, located in different geographical

areas of the district. The impact assessment is based on mainly primary data collected from individual farmers through questionnaires, checklist and in formal discussions and secondary data collected from project implementing agency, watershed project villages and village institutions. This study analyses, interprets and reflects the impact of the watershed programme in order to ensure sustainable integrated development. These have direct impact in expanding the irrigated area and increasing cropping intensity. On an average the irrigated area increased by about 17% while the cropping intensity increased by 21%. These benefits confirm that the watershed programme performed as a viable strategy to overcome several externalities arising due to occurring of drought and soil and water degradation.

Terrain Characteristics and Rainwater Run Off Check

The district has undulating terrain with moderate slope from 100 to 350. The some of the watersheds in hill area of Thanagazi have the steep slope, which is more than 750. The district topography ranges from undulating plains to hills. The soil texture of the watersheds is clay sandy and loam. The color of soil is yellow and brown. The depth of top soil is shallow to very shallow ranging from 25-50 cm to 01-25 cms.

Water harvesting structures (Johad, earthen dam, anicuts, contour bunding, minor check dam) were constructed in the selected watersheds at large. In this regards an attempt has been made to explore the rainwater run off check in the selected watersheds. The study reveals that about 64% respondents reported up to 20% rainwater runoff check through the construction of watershed interventions while, less one third of the respondents (28%) pointed out up to 40% rainwater runoff check through watershed interventions.

Since most of the watershed, treatment took place in drainage line areas and a large portion of the watershed area remained untreated in majority of the watersheds. It was observed during field visit that views of villagers differed within the same watershed. The villagers from the treated area have reported higher rum off check by watershed interventions than the villagers belonged to untreated area of the watershed. Furthermore, the project record reported comparatively higher rainwater runoff check up to 40% through rainwater harvesting structures because initially most of the watershed structures were in good condition whereas, later on the present condition of water harvesting structures were breached/ damaged in majority of the watersheds. Largely, it can be concluded that the watershed structures made for water conservation could succeed to check the rainwater run off to some extent due to poor maintenance of watershed structures or lack of maintenance and repair arrangements, further deposition of silt has decreased the capacity of rainwater harvesting structures for run off check and storing capacity.

Impact on Water Rersource

On water conservation, it was noted that additional water storage capacity is created in all watersheds. Augmenting water storage capacity contributed in reducing rate of runoff and increasing groundwater recharge. Construction of new percolation ponds and minor check dams and rejuvenation of existing ponds/ tanks has enhanced the storage capacity and groundwater recharge in the watershed area. The details on surface water and storage capacity for the study watersheds are given in Table.2. It is evidenced that additional surface water storage capacity created is worked out to 9299 M3 in Sanwatsar watershed (Thanagazi), comprising of 4245 M3 from renovation of tanks, 4924 M3 from new percolation pond and 130 M3 from construction of major and minor check dams. This additional storage capacity further help in improving groundwater recharge and water availability for livestock and other non-domestic uses in the village because of watershed treatment activities.

Table: 2

Increase of Surface Water Storage Capacity: Alwar District

Name of the watershed	Surface water storage capacity (M^3)				Total storage (M^3)	Addition capacity created (M^3)
	Renovation of tanks		New percolation Ponds	Major/minor check dams		
	Before	After				
Sanwatsar	4528	8773	4924	130	1827	9299
Geeglana	5094	7358	10471	208	18037	12943

It is evidenced that, in Geeglana watershed Neemrana, the additional water storage capacity created is worked out to 12943 M3. The rise in water level for the sample farm households was studied and presented in Table 5.2.

Based on the study it is found that the water level in the open dug wells has raised in the range of 2.5 to 3.5 meters in Thanagazi and 2.0 to 3.0 meters in Neemrana watersheds. This is mainly due to the construction of percolation ponds and major and minor check dams.

Table: 3 Rise in Water Level Due to Watershed Intervention

Particulars	Sanwatsar		Geeglana	
	Watershed village	Other village	Watershed village	Other village
Rise in water level	2.5-3.5		2.0-3.0	
Average water level rise	3.01		2.11	
Average water level in the wells	3.53	2.16	2.59	2.10
Percentage difference (%)	63.43		23.33	

The average water level of the study wells were collected both watersheds of villages for comparison. It is evidenced that the average water level in the watershed villages are higher than in wells in other villages. Information related to duration of pumping hours before well goes dry (or water level decreased to a certain level) and time it takes to recuperate to the same level were collected for the sample farmers across villages (Bhawanta Kalan & Jhiri).

This could be seen from the study that due to watershed treatment activities such as construction of percolation ponds check dams etc. The groundwater recuperation in the near by wells are increased.

It is also observed that the recharge to the wells decreases with distances of wells away from the percolation ponds and check dams and the distance could be generally observed up to a distance of 500 to 600 meters in the case of percolation ponds. The common water points particularly for drinking purpose have to be inalienable feature of watershed projects. It is pity that National Drinking Mission does not have well coordination with watershed wing of Department of Rural Development as well as Ministry of Agriculture to ensure this. It is evidenced that the average groundwater recuperation rate is significantly higher in watershed villages. Pernniality of wells i.e. duration of water availability across months in the wells was enquired during the survey. The pernniality of wells is found to be little higher in the case of watershed villages.

For instance, out of 25 wells four wells yield water for 12 months and none wells yield water 12 months respectively for watershed treated and other villages in Sanwatsar watershed. Similar trend is visualized in Geeglana watershed (Table 2). It is not surprising most of the wells in the study area yield water for three months or less across seasons is mainly due to being hard rock tract, the water table has gone down due to over exploitation.

Table: 4 Incresae of Water Availability in Wells Influenced by Percolation Ponds and Check Dams: Alwar District

Particulars	Sanwatsar		Geeglana	
	Watershed village	Other village	Watershed villages	Other villages
12 months	4	Nil	4	1
9 months	3	2	2	1
6 months	7	3	6	3
3 months`	11	20	13	20
Total no. of wells	25	25	25	25

Fluctuation of water table in a region gives the prevailing groundwater condition. Hence, measurement and monitoring of water level in wells is a basic task for proper assessments and management. By establishing a network of observation wells spread over the entire district, the fluctuation in groundwater level is being monitored periodically. The groundwater level lowers to the maximum during the pre monsoon period. After which it starts rising soon after the monsoon. The rise and fall in water levels depend upon the amount, duration and intensity of precipitation, climatic conditions, specific yield of the information, general slope of the terrain towards drainage channel and various other factors. The general view of the water level indicate that the water level tends to rise during the months of October to December/ January to reach the peak and starts receding from February onwards to the end of August/September.

Impact on Water Availability

Water availability has increased significantly, which is reflected from the increase in the net irrigated area. Seasonal Irrigation has increased from 20-25 % in pre watershed period to almost 70% at current. All the wells that used to be dry in summer season from February to March are having water even in the dry months also (Jhiri, Bhawanta kalan and Sanwatsar). Earlier the water availability was largely dependent on the availability of water in the percolation tank. At present in the low lying area pump can run from 10 to 60 minutes in peak summer season. Based on the discussion with villagers it is observed that average ground water level in the upper reaches has increased by 2 m. and in the lower region by 6 m. The increase in water level is also reflected from the selected wells, of nearby the watershed. During the course of this study an attempt was made to get the status of observation wells. The availability of water in the month of May both in the lower as well as upper region reflects that there is significant impact of water conservation efforts on the ground water. This not only reflects the impact of recharge measures but also shows that if favorable geological conditions are not available and over exploitation of ground water is taking place then even in the lower reaches also the availability of ground water will be affected. This trend substantiate the theory that prior to any watershed the geological feasibility study is essential in order to get optimal benefit of the water conservation measures as well as proper water budgeting may lead to the better water management practices

Now from tanker fed villages, these have assured drinking water facility. The quantity of supply reduces in the summer months. Though the water conservation interventions in the district the watershed area has increased the overall ground water potential however many new wells have been added and the water is pumped out through electric tube wells. In addition, this excessive pumping is causing adverse impact on the ground water regime.

Impact on Soil Moisture

The reduction in soil erosion and rainwater runoff, obliviously, facilitates retention of soil moisture for longer period is the watersheds. The study reveals that with increase in soil moisture due to water conservation structure made under the watershed project. More than 82% of the respondents pointed out that only 20% increase in soil moisture level have found in the district due to various watershed interventions made under the watershed project

whereas only 9.05% of the respondents reported upto 40% increase in moisture content in the soil, contrary to this 8.10% of the villagers mentioned no change with soil moisture level due to the watershed interventions.

Since most of the treatment, measures were under taken in the drainage line areas due to lack of appropriate villagers' lands in majority of watersheds. Due to low level of villagers' participation, a vast tract of agriculture and pasturelands were left untreated. Thus, the impact of the watershed interventions on the soil moisture level was very limited to some extent.

Impact on Soil Erosion

Soil erosion is a major watershed problem in India causing significant loss of soil fertility, loss of productivity and environmental degradation. Erosion from the watershed surface takes place in form of sheet erosion. . Erosion and sedimentation are critical problems in entire district of Aravalli region. The current level of degradation leading to erosion, sediment transport, and sedimentation are causing considerable loss of soil, deposition in rivers and reservoirs, and already has caused irreversible levels of degradation, loss of livelihood, and significant canal and reservoir sediment cleaning costs. Soil erosion control is essential in order to maintain soil fertility and thereby increase agriculture production in the Alwar district. In this context, various water-harvesting structures such as contour bounding, vegetative barrier, boulder check, and earthen dam were envisaged under the watershed project in order to control soil erosion.

This study is also conducted to determine the factors that affect adoption of watershed measures of Alwar district. A total of 250 families were interviewed using a structured questionnaire, and group discussions were held with the families.

Moreover, transects were walked the study showed that crop fields are affected by soil loss. Farmers are well aware of these erosion problems, and related the soil loss to steep slopes and a decline in soil fertility As it is observed that soil conservation and development was given less focus due to lack of sufficient villagers land. As a result, over 53.05% respondents reported that upto 20% for soil erosion control through watershed structures created in the drainages lines areas in the district. Soil erosion in seasonal nalas of the Alwar district has both negative impacts on upstream and downstream villages. The sediment discharged from the catchments reflects a loss of fertile topsoil that farmers depend upon for the production of crops and fodder. In addition, sediment loads in streams have a direct negative impact on water quality and the longevity of water storage structures, both of which have significant economic implications. The areas of Thanagazi and Neemrana particularly are heavily affected by soil erosion problems, caused by illegal mining, poor cultivation and land use practices, deforestation, and overgrazing, resulting in significant loss of soil fertility.

Only few watersheds such as Sanwatsar, Geeglana and Patta in the district, where field's bunds were promoted and carried out on private lands, resulting reduced the soil erosion significantly of the fields and increased soil moisture in these areas. The field observations and discussion with the villagers revealed that soil erosion and conservation activities were constrained due to various reasons.

This impacts evaluation studies play a key role in the policy planning for sustainable future. There is need to take up series of low cost structures, i.e. nala bunds, Small check dams, etc. at periodical interval. The percolation tanks nala bunds and check dams along with silt trap plants will reduce the amount of silt reaching downstream reservoirs. These structures can be ploughed back to agricultural fields. It is evident from the study that surface runoff and soil erosion were largely influenced by the watershed management practices. According to the observation during the study, soil loss was highest in agricultural land use type in upper watershed.. In this study, agricultural land use had notably high mean runoff second only to grazing land. High runoff in agricultural land use led to high soil losses. The major contributor of high soil loss in agricultural land was tillage, which detached a generous supply of loose aggregates and soil particles. The relatively low organic matter content of agricultural land use led to the detachability of soil particles and consequently high soil losses. Forested land use types (indigenous and plantation) are undoubtedly the best in terms of soil erosion control. These areas recorded the lowest soil losses. This was high organic matter and low bulk density especially for the indigenous forestland use type.

This study had identified agriculture, grazing and deforested land use types as the main cause of the erosion problem. From the results of this study, it can be argued that by maintaining and/or increasing the forest cover, surface runoff and soil erosion will reduce. Increasing the forest cover through afforestation and reforestation programmers should be a priority for the stakeholders in the watershed. It is obvious that micro watershed projects in the district have yielded multiple exemplary benefits particularly to raise farm productivity. Conserving soil means raising farm productivity and transferring good soil to the next generation.

Imapct on Plantation

Afforestation/ Plantation was done mainly on the total area of 665 hectare was taken up for the plantation activity. Almost 30-40% plants are survived. Plantation also was done along on barren land. Sapling planted were Acacias, lyrecedia, Awala, Neem, Karanj, Kashid etc. Survival rate of Akashia, Karanj, and Seesam seems to be quite good. Karanj has grown on their own has good survival rate and are providing alternate opportunity of income generation especially for the land less and marginal. Seesam, which was planted over the bunds, is having satisfactory survival rate. Bushes and shrubs have also developed under favorable conditions However; the rate of survival is poor. From the plantation, it appears that it has not contributed much in increasing the supply of fuel wood, fodder, fruit and smaller timber. The purpose of afforestation it appears is to arrest the runoff and increase the infiltration rate. Horticulture development activities are not taken up

as major activity however; two plots of Awala orchard have survived in the area. The survival rate of Awala plants is quite good. It is observed that farmers are having less inclination towards plantation activities as they have alternate and better source of income.

Mitigation of Drought

Rajasthan is known for as drought state. With this context, the watershed programme was envisaged to mitigate the ill effects of drought on the villagers and particularly on the village poor residing in the rainfed regions. Thus along with other environment indicators, the question on watershed regeneration on drought was asked. The study depicts that majority of the villagers (74.65%) reported very less [up to 20%)] impact on watershed interventions on drought mitigation in their watersheds. More than 15% respondents pointed out that the impacts of watershed interventions helped to some extent upto (40%) in drought proofing. In addition, very few respondents (0.94%) accounted a large impact of watershed interventions on drought mitigation in their respective watersheds. Thus, the impact of the watershed interventions in drought mitigation has largely been positive and varied from one place to place.

Summing Up

The General perception among the villagers is that watershed development had positive impact on environment. Although project impact was not very conspicuous quality, vegetation status and other environmental indicators such as ground waters status, land project activities played critical protective role on ground water depletion and degradation and with regard to impact of conservation measures on the ground water table farmer's perception was uncertain. Sharp fluctuations in annual rainfall and exhaustive pumping of ground water in watershed from surrounding area were the over-riding factors influencing ground water status. However, positive impact of the watershed interventions on ground water recharge is indicated by increased exploitations of ground water tables. There is about 35% to 65% has increase in the number of wells in the watershed areas. Irrigated areas increased and also irrigation requirements due to change in cropping pattern is has increased. Ground water is the only source of irrigation in the watershed area. With increasing populations, number of hand pumps has increased for meeting drinking water requirement. Water scarcity as well as fodder scarcity period reduced from 4-5 months to 2-3 months. The study reveals that the watershed performance in the district has not kept pace with the expectation. Reviewing this study, the watershed programme needs to be restructured significantly. Such restructuring must clearly embrace the livelihoods, productivity, sustainability, equity, decentralized governance as its central concern, and must be based on strategies that respond to the varying socio- ecological contexts and experiences in the implementations.

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