Impact of Watershed Development Programs in Tamil Nadu

K. Palanisami and D. Suresh Kumar

Introduction

The concept of integrated and participatory watershed management has emerged as the cornerstone of rural development in the dry, semiarid and rain-fed regions of the world. Most watershed projects in India are implemented with the twin objectives of soil and water conservation and enhancing the livelihoods of the rural poor (Sharma and Scott 2005). A watershed is a geographical area that drains to a common point, which makes it an attractive unit for technical efforts to conserve soil and maximize the utilization of surface water and subsurface water for crop production (Kerr et al. 2000). Watershed development has been conceived basically as a strategy for protecting the livelihoods of the people inhabiting the fragile ecosystems experiencing soil erosion and moisture stress.

Different types of treatment activities are carried out in a watershed. They include soil and moisture conservation measures in agricultural lands (contour/field bunding and summer ploughing), drainage line treatment measures (loose boulder check dam, minor check dam, major check dam, and retaining walls), water resources development management (percolation pond, farm pond, and drip and sprinkler irrigation), crop demonstration, horticulture plantation and afforestation (Palanisami and Suresh Kumar 2005). Periodically, training in watershed technologies and related skills is also given to farmers in watersheds. In addition, members are also taken to other successful watershed models and research institutes for exposure. These efforts appear to be contributing to groundwater recharge. The aim has been to ensure the availability of drinking water, fuelwood and fodder and raise income of, and employment opportunities for, farmers and landless laborers through improvement in agricultural production and productivity (Rao 2000). Today, watershed development has become the main intervention for natural resource management. Watershed development programs not only protect and conserve the environment but also contribute to livelihood security.

As an important development program, watershed development received much attention from both the central and state governments. Up to the Tenth Plan (till March 2005), 17.24 million hectares (Mha) were treated with a total budget of Rs 93.6803 billion under the Ministry of Agriculture, 27.52 Mha with an outlay of Rs 68.5566 billion under the Ministry of Rural Development and 0.82 Mha with an outlay of Rs 8.1373 billion under the Ministry of Environment and Forest. Altogether, 45.58 Mha were treated through various programs with an investment of Rs 170.37 billion. Average expenditure per annum during the Tenth Plan was around Rs 23 billion (Department of Land Resources 2006). As millions of rupees

were spent on watershed development programs it is essential that the programs become successful.

With the programs so large and varied, it is important to understand how well they function overall and which aspects should be promoted and which dropped. Keeping these issues in view, the present paper examines the overall performance of watershed development programs in Tamil Nadu.

Watershed Development Programs - An Overview

Watershed development has emerged as a new paradigm for planning, development and management of land, water and biomass resources following a participatory bottom-up approach. Some important ongoing watershed development programs include Drought Prone Area Programme (DPAP), Desert Development Programme (DDP), River Valley Project (RVP), International programs of DANIDA, DFID (UK), SIDA, and state-funded watershed development programs, etc. In addition, based on experience, the Government of India recently created the Watershed Development Fund (WDF) in collaboration with NABARD. The objective of the fund is to create the necessary conditions to replicate and consolidate the isolated successful initiatives under different programs in the government, semi-government and NGO sectors. In addition, several initiatives of people's participation in resource management also took place. Prominent among them are the Chipko Movement, Save Narmada Movement, AVARD's Irrigation Scheme, Water Council (Pani Panchayat), Ralegan Siddhi, etc. The Ralegan Siddhi is one among the very successful models of people's participation.

Most watershed projects are implemented within a well-defined institutional framework. A state-level committee called the State Watershed Development Committee coordinates different departments and evaluates progress. The District Watershed Development Committee undertakes similar tasks at the district level. It advises the District Rural Development Agency in selecting a Project Implementation Agency and members of a Watershed Development Team (WDT). The Project Implementing Agency (PIA) is responsible for implementing watershed activities and supervises the various tasks undertaken by community-based organizations.[1] The Watershed Development Team is made up of multidisciplinary members who provide technical guidance to the PIA and to community organizations.

The community-based organizations (CBOs) involved in managing watersheds are the Watershed Association (WA), the Watershed Committee, User Groups, and Self-Help Groups. The WA is made up of members who are directly or indirectly dependent on the watershed area.[2] The President of the WA is the Chairman of the Watershed Committee, which carries out the day-to-day activities of watershed management.[3] Self-Help Groups are homogeneous groups whose members share a common identity such as agricultural laborers, landless households, women, shepherds and scheduled castes/tribes. These groups focus on micro-finance thrift groups, small shops, goat-rearing, etc.

[1]The PIA prepares development plans, undertakes community organization training, provides technical guidance, monitors and reviews implementation and sets up institutional arrangements for post-project operation.

[2]The WA is expected to be formally registered as a society.

[3]These activities include planning, resolving disputes, identifying procedures for the O&M of assets, and facilitating the creation of the Watershed Development Fund, ensuring accuracy of accounts and so on.

Generally, watersheds in India are allotted a budget of approximately Rs 6,000 per ha. Thus, a watershed with a total area of 500 ha receives Rs 3 million for a 5-year period. The bulk of this money (80%) is meant for development/treatment and construction activities.[4] The WC opens a bank account and directly uses these funds. To promote participation of local villagers in the implementation of watershed programs, guidelines for watershed development were first issued in 1995 and subsequently revised in 2001. These guidelines emphasized the formation of CBOs.

But, by and large, these community-based watershed management initiatives have not produced the desired results in terms of people's participation, particularly once the state withdraws its support (Rao 2000; Palanisami and Suresh Kumar 2002). This led to further revision of guidelines and the involvement of the *panchayat raj* (local government) institutions in the planning, implementation and management of watersheds. New guidelines called the Haryali guidelines were issued in April 2003. Under the new Haryali guidelines, the village panchayats take the role of the Watershed Committee and the higher-level Gram Sabha represents the WA. Realizing the lacuna of different guidelines, in 2008, the Government of India issued new guidelines called Common Guidelines for Watershed Development Projects.

Watershed Development in Tamil Nadu

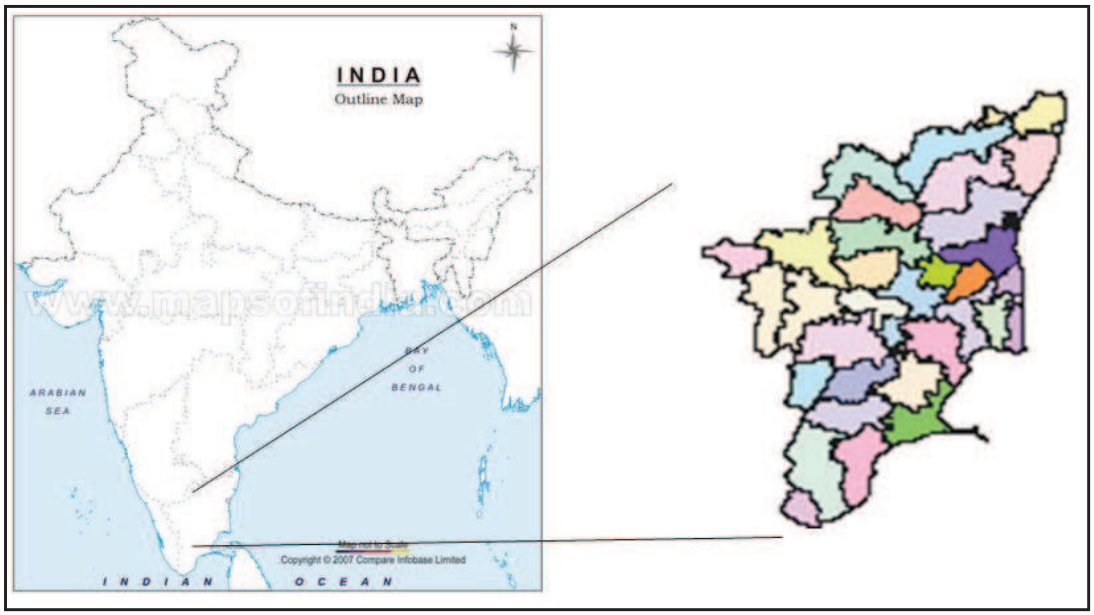
Profile of the State

Agriculture is the major occupation in the state as it provides livelihood support to 56% of the population. Incidentally, about 56% of the total cropped area of the state is under irrigated condition while around 44% of the area is under dryland farming. Land use pattern in the state has witnessed significant changes over the years. The net sown area has declined from 48% of the total geographical area during 1979-80 to 42.8% in 1999-2000 and further to 38.5% in 2005-06. Tamil Nadu agriculture is dominated by marginal and small farmers. The marginal farmers account for 74.3% of the total holdings operated only in about 30% of the total area while the semi-medium, medium and large farmers account for a small proportion of 10% of the holdings operated in a higher proportion of 46.1% of the total area. The number of marginal farmers has been increasing over the years.

Tamil Nadu (Figure 1) state which accounts for 7% of the population of the country is endowed with only 3% of water resources in India. The water potential of the state is 46,540 Mm^3. The groundwater potential available for future development was estimated at 3,142.27 Mm^3 as of January 2003.

[4]Funds are allotted for different activities as follows: Watershed treatment/development works -- 80%; CBOs including entry point activities -- 5%; training -- 5%; administrative overheads --10%. According to the new common guidelines of 2008, the budget allotment is Rs 12,000 per ha.

Figure 1. Map of the State of Tamil Nadu.



Also the development of groundwater has led to increased "drought proofing" of the state's agricultural economy. An analysis of the variance in growth rates of irrigated and unirrigated agriculture after the advent of new technology in the late 1960s revealed that the degree of instability in irrigated agriculture was less than half of that in unirrigated agriculture (World Bank 1998). Out of 385 blocks in Tamil Nadu, 180 blocks have almost exploited the potential and out of the 1.8 million wells in the state, about 12% are dried up or abandoned due to groundwater overexploitation (GoTN 2002). In some pockets of the state, the average well failure rate is 47% for open wells and 9% for bore wells (Palanisami et al. 2008). Being a hard-rock region, the externalities of groundwater depletion are felt in most parts of the state. The overexploitation of groundwater in many areas of the state has resulted in lowering of the water table below the economic pumping level. In this context, the watershed development assumes critical proportions in the state.

Watershed Development Programs

To increase the overall agricultural production and improve the living conditions of the farmers depending on the rain-fed lands, the watershed development programs are being widely implemented in the state. There are 19,331 micro-watersheds identified in the state of which, approximately 4,000 have already been treated. The details of number of watersheds in the state are given in the Annex. The important programs such as DPAP, National Watershed Development Project for Rain-fed Areas (NWDPRA) and Integrated Wasteland Development Programme (IWDP) are implemented through a watershed approach apart from the Comprehensive Watershed Development Projects implemented with assistance from DANIDA.

The DPAP is implemented with the prime objective of promoting the overall economic development of the watershed community through optimum utilization of natural resources, employment generation and restoring ecological balance. The program is implemented in 80

blocks of 16 districts which are Dharmapuri, Thoothukudi, Sivagangai, Ramanathapuram, Virudhunagar, Pudukottai, Tirunelveli, Salem, Namakkal, Coimbatore, Tiruvannamalai, Dindigul, Vellore, Tiruchirappalli, Perambalur and Karur. From 1999-2000 to 2006-07, the Government of India sanctioned 1,222 watersheds in seven batches at a total cost of Rs 3,367 million, for treating a total area of 0.61 Mha (GoTN2009).

The IWDP has been under implementation in Tamil Nadu since 1993-94 to develop non-forest wastelands on the principles of watershed development. This program is being implemented in 96 blocks of 24 districts, which are Coimbatore, Dharmapuri, Dindigul, Karur, Krishnagiri, Namakkal, Perambalur, Pudukkottai, Ramanathapuram, Salem, Sivagangai, Tiruvannamalai, Thoothukudi, Tiruchirappalli, Tirunelveli, Vellore, Erode, Theni, Madurai, Kancheepuram, Villupuram, Tiruvallur, Cuddalore and Virudhunagar. From 1999-2000 to 2006-07 the Government of India has sanctioned 910 watersheds at a total cost of Rs 2,622. 039 million, for treating a total area of 0.457 Mha (GoTN 2009).

The other important watershed development program is the NWDPRA. It is being implemented in the state from 1990-91. During the period from 2002-03 to 2007-08, a altogether 755 watersheds (0.290 Mha) with a total outlay of Rs 1,306.5 million have been treated.

In addition to these major watershed development programs, watershed programs assisted by the National Bank for Agriculture and Rural Development (NABARD) are being implemented. This covers 100 watersheds at a cost of Rs 600 million in 23 districts of the state.

Impacts

The watershed development programs involving the entire community and natural resources influence (i) productivity and production of crops, changes in land use and cropping pattern, adoption of modern technologies, increase in milk production, etc., (ii) attitude of the community towards project activities and their participation in different stages of the project, (iii) socioeconomic conditions of the people such as income, employment, assets, health, education and energy use, (iv) impact on environment, (v) use of land, water, human and livestock resources, (vi) development of institutions for implementation of watershed development activities, and (vii) ensuring sustainability of improvements. It is thus clear that watershed development is a key to sustainable production of food, fodder, fuelwood and meaningfully addressing the social, economical and cultural conditions of the rural community.

Recognizing the importance of watershed development program in the state, a large number of studies attempted to assess the impact of watershed development over a period of time. These studies vary in purpose, regions and domain of impacts. The impact studies vary from impact of specific water harvesting interventions such as percolation ponds to overall impacts of the watershed development program. The impact assessment studies focus mainly on the impact of different interventions, such as water resources development, soil and moisture conservation measures, drainage line treatments and afforestation, and assess the impacts on different aspects like increase in surface water and groundwater resources, cropping pattern changes, yield, environmental conditions, and socioeconomic conditions including the social capital and institution building as a result of watershed interventions.

Biophysical impacts. The watershed development activities have significant positive impacts on various biophysical aspects, such as investment on soil and water conservation measures, soil fertility status, soil and water erosion, expansion in cropped area, changes in cropping pattern, cropping intensity and production and productivity of crops.

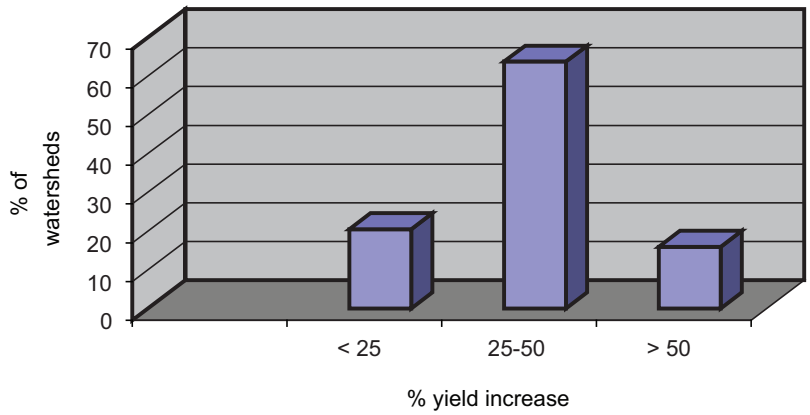
It is evident that the watershed treatment activities improved conservation of soil and moisture, improvement and maintenance of fertility status of the soil (Sikka et al. 2000; Ramaswamy and Palanisami 2002; Palanisami and Suresh Kumar 2002) and reduced soil and water erosion. The organic carbon increased by 37% due to watershed intervention (Sikka et al. 2000) and most studies revealed that there was a significant reduction in soil and water erosion.

An impact and evaluation study of the soil conservation scheme under DPAP indicates that only marginal impacts were realized in terms of land use pattern, crop pattern, yield rate, etc. (Evaluation and Applied Research Department 1981). Evidence shows that soil conservation appears to have had a positive impact on retention of moisture, reduced soil erosion, and change in land use pattern and yield. Soil loss reduced from 18,758 kg/ha to 6,764 kg/ha from 1988 to 1989. Between 1985-86 and 1989-90 the yield rate of all the crops had increased an annual compound growth rate (CGR) of 3.94% to 16.40% (Evaluation and Applied Research Department 1991).

Improvement in soil fertility coupled with increased water resources in the watershed area led to expansion in cropped area and cropping intensity, and increase in production and productivity of crops (Figure 2).

The cropping pattern changes have taken place both in additional area brought under well irrigation from the fallow lands and in the area under rain-fed cultivation. The area under high water-consuming crops increased by 25.3% in the first crop and by 29.4% in the second crop period (Evaluation and Applied Research Department 1991). Similarly, the evidence shows that the cropping intensity is increased from 120 to 146.88% in the Kattampatti watershed and 102.14 to 112.08% in the Kodangipalayam watershed (Palanisami and Suresh Kumar 2005). Increases in Crop Productivity Index, Fertilizer Application Index, and Crop Diversification Index were also observed (Sikka et al. 2000, 2001).

Figure 2. Percentage of watershed by increase in yield.



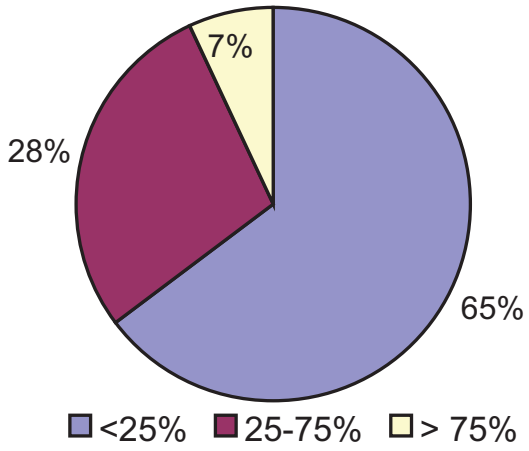
Environmental impacts. The watershed development activities generate significant positive externalities which have a bearing on improving agricultural production, productivity, and socioeconomic status of the people who directly or indirectly depend on the watershed for their livelihoods. The environmental indicators include water level in the wells, changes in irrigated area, duration of water availability, water table of wells, surface water storage capacity, differences in number of wells, number of wells recharged/defunct, differences in irrigation intensity and Watershed Eco Index (WEI).

The impact assessment studies conducted by different agencies and scientists across regions over a period of time imply that watershed development activities have generated significant positive impacts on the environment. One important objective of watershed development is in situ water and soil conservation and water resources development in the watershed village where the treatment activities helped in conservation and enhancement of water resources. Most of the studies report that water level in the wells increased leading to expansion in irrigated area in the watershed. Though many studies have not measured the actual increase in the water level in the wells, a few studies have made an attempt to do so. The increase in water level in the wells varied from 0.1 meter to 3.5 meters and this varied across seasons. Similarly, the expansion in irrigated area due to watershed development activities varied from 5.6 to 68% across regions and seasons. Experience shows that the increase in water level in the wells is observed to be less than 2 meters (57.22% of watersheds). About 30.48% of watersheds witnessed an increase of 2-5 meters and only 12.3% witnessed an increase of more than 5 meters in the water level in the wells.

The rainwater harvesting structures constructed in the watershed help enhance the surface water storage capacity. Structures like minor and major check dams, percolation and farm ponds, and renovation of irrigation tanks help in a big way to enhance the surface water storage capacity. Evidence shows that, on average, about 92 ha.cm additional capacity were created and varying from 63 ha.cm to 136 ha.cm. In addition to the fixed capacity, repeated storage will be available for different fillings once already stored water is percolated. A maximum additional storage capacity of 359 ha.cm was created in the Tiruppur block of the Coimbatore District of Tamil Nadu. The additional surface water storage created helped improve groundwater recharge and water availability for cattle and other nondomestic uses in the watershed villages. The duration of water availability in a year in the wells inspected during the sample survey was found to have improved as a result of watershed projects. The analysis of recuperation rate before and after watersheds indicates that the recharge rate had increased by 16 to 39%. It was also observed that recharge of wells decreased with their distance away from the percolation ponds and this influence could be generally observed up to a distance of about 500-600 meters (Palanisami and Suresh Kumar 2006; Sikka et al. 2000).

Impact of percolation ponds revealed an increase in water columns of wells from 1.2 to 1.8 meters. The gross irrigated area (GIA) increased by 13.6% by the pond intervention. Increase in GIA per well is 0.27 ha. The number of new wells in the zone of influence was 1-4 (Evaluation and Applied Research Department 1991). Palanisami et al. (2002) in their study in the Coimbatore District of Tamil Nadu used a combination of a with and without approach and a before and after approach to assess the impact of watershed development activities. It is evidenced that the additional surface water storage capacity created worked out to 9,299 m^3 in the Kattampatti watershed, comprising 4,245 m^3 from renovation of tanks, 4924 m^3 from percolation ponds, and 130 m^3 from construction of major and minor check dams. In the Kodangipalayam watershed, the additional water storage capacity created worked out to

Figure 3. Distribution of watershed by impact on irrigated area.



12,943 m^3. This additional storage capacity further helped improve groundwater recharge and water availability for livestock and other nondomestic uses in the village as a result of watershed treatment activities. The water level in the open dug wells has risen to 2.5 to 3.5 meters in Kattampatti and 2.0 to 3.0 meters in Kodangipalayam watersheds. The groundwater recuperation in the nearby wells was increased. The area irrigated increased and thus the irrigation intensity increased from 115.74 to 122.73% in the Kattampatti watershed and from 101.45 to 102.01% in the Kodangipalayam watershed.

Watershed development activities produced a significant positive impact on the water table, duration of water availability in the wells and pumping hours that resulted in an increased irrigated area and crop diversification (Sikka et al. 2000, 2001). Madhu et al. (2004) found that the conservation and water harvesting measures in the watershed helped improve the groundwater recharge, water availability for cattle and other domestic uses, increased duration of water availability in the streams, rise in water table in the wells, sediment trapping behind the conservation measures/structures and stabilization of the gully bed. The productivity of crops increased from 6.65 to 16.59% in the watershed village.

Planting trees in private farmlands and common lands is also being undertaken as part of the watershed development. This created additional green cover thus improving the environment. The Watershed Eco-Index which reflects the additional green cover created varied from 1.8 to 43% (Sikka et al. 2000, 2001; Palanisami and Suresh Kumar 2002; Ramaswamy and Palanisami 2002).

Thus it is lucid from the analysis that watershed development activities generate sufficient positive externalities and have significant impacts on the environment.

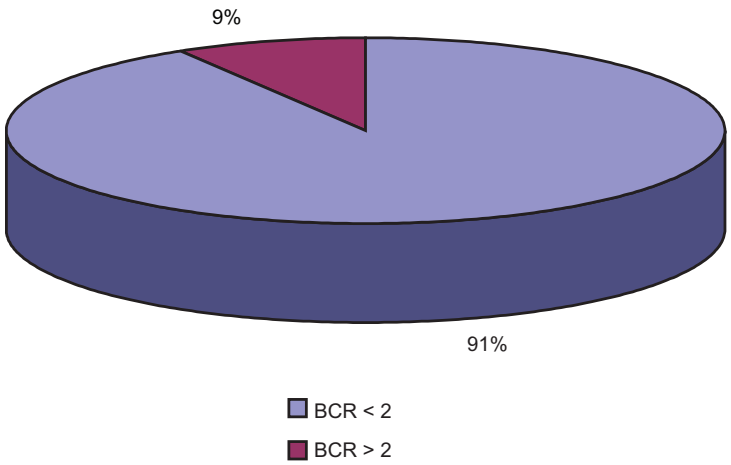
Socioeconomic impacts. The watershed development technologies aimed not only to conserve the natural resources but also to improve the socioeconomic conditions of the rural people who depended on them for their livelihoods. The impact of various watershed treatments is however widespread. The changes in various biophysical and environmental aspects will have significant impacts on the socioeconomic conditions of the people. Watershed development programs are designed to influence the biophysical and environmental aspects thereby bringing changes in the socioeconomic conditions (Deshpande and Rajasekaran 1997).

The socioeconomic indicators like changes in household income, per capita income and consumption expenditure, differences in employment, changes in lives of persons migrated, peoples' participation, household assets and wage rate at the village level were considered for the impact assessment.

The watershed intervention helped the rural farm and nonfarm households to enhance their income level. Evidence shows that the rural labor households in the treated villages derive Rs 28,732 when compared to Rs 22,320 in control villages, which is 28.73% higher in the Kattampatti watershed. Similarly, the per capita income is also relatively higher among households of watershed treated villages. The proportions of difference among households across villages worked out to 13.17% in the Kattampatti watershed and 70.44% in the Kodangipalayam watershed (Palanisami and Suresh Kumar 2005). In addition, increases in employment generation, social empowerment, and reduction in out-migration are also seen in many watersheds.

Overall economic impacts. Experience shows that watershed development activities have overall positive impacts on the village economy. It is essential to assess the impact of these watershed development activities using key indicators such as Net Present Value (NPV), Benefi Cost Ratio (BCR) and Internal Rate of Return (IRR). Though these indicators show the overall impact of watershed development activities, only a very few studies have quantified the benefits and arrived at the NPV, BCR and IRR. The reason for this is attributed to many, some of which are the following: (i) most of the evaluating agencies are not familiar with these techniques, (ii) inadequate data availability for quantifying benefits and costs, and (iii) non-familiarity with computer software. The overall impacts of watershed development activities in terms of NPV, BCR and IRR are discussed hereunder.

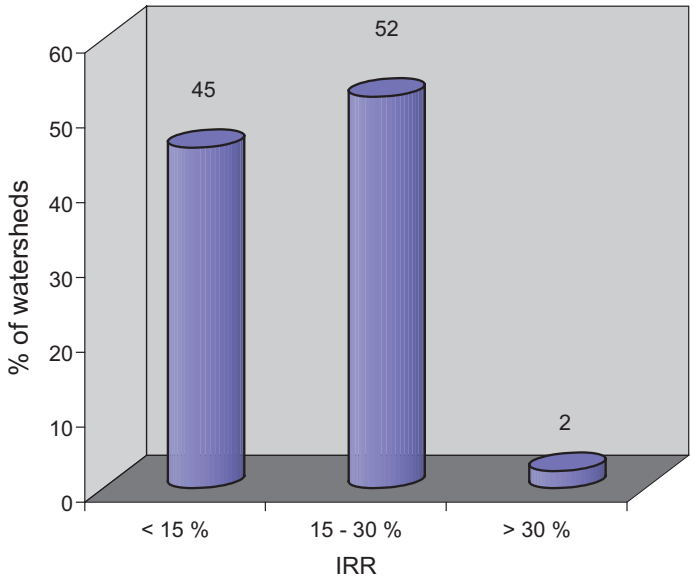
Figure 4. Distribution of watershed by BCR.



A few studies (Palanisami and Suresh Kumar 2005; Palanisami et al. 2002; Ramaswamy and Palanisami 2002; Palanisami et.al. 2002; Palanisami and Suresh Kumar 2006) have made an attempt to assess the overall impact of watershed development activities through BCR and NPV. The BCR which shows the return per rupee of investment ranged from 1.27 to 2.3.

The size of BCR also depends on the magnitude of benefits accrued due to the watershed development activities which in turn critically depend on the rainfall. The analysis also revealed that the BCR works out to more than 2 in around 9% of watersheds. About 91% of watersheds have a BCR less than 2. Similarly, about 45.45% of watersheds exhibit an IRR of less than 15%; 52.27% of watersheds have an IRR between 15 and 30% and only 2.27% of watersheds have an IRR higher than 30%.

Figure 5. Distribution of watershed by IRR.



It is evidenced that the BCR varies across regions and depends on the agroclimatic conditions. The financial analysis of the impact of watershed development indicates that the returns to public investment, such as watershed development activities, are feasible.

People's Participation in Watershed Management

Like all other development programs, the watershed development program is banking heavily on the participatory approach. Though the watershed development program envisages an integrated and comprehensive plan of action for the rural areas, people's participation at all levels of its implementation is very important. This is so because the watershed management approach requires that every piece of land located in the watershed be treated with appropriate soil and water conservation measures and used according to its physical capability. For this to happen, it is necessary that every farmer having land in the watershed accepts and implements the recommended watershed development plan. As the issue of sustainable natural resource management becomes more and more crucial, it has also become clear that sustainability is closely linked to the participation of the communities who are living in close association with these natural resources. This requires sustained effort in two important areas: (i) to inform and educate the rural community, demonstrate to them the benefits of watershed development and the fact that the project can be planned and implemented by the rural community with expert

help from government and nongovernment sources, and (ii) to critically analyze the various institutional and policy aspects of watershed development programs in relation to participatory watershed management.

Experience from the evaluation study of 15 DPAP watersheds conducted in the Coimbatore District of Tamil Nadu, India shows that the overall community participation was found to be 42%. The participation was found to be 55, 44 and 27%, respectively, at planning, implementation and maintenance stages. This suggests there should be more community participation in watershed development programs. Similarly, overall contribution for work on private land was found to be 14.71%. It varied from a low of 7% for fodder plots to a maximum of 22% for horticulture and farm ponds. However, contribution in terms of cash/ or kind towards development of structures at common lands such as percolation ponds, check dams, etc., was found to be nil. The level of adoption of various soil and moisture conservation measures and their maintenance indicate that there is a wide variation in the level of adoption, with a low of 2.4% in the farm pond, 30.40% in summer ploughing, 36.80% in land leveling, and 44% in contour bunding. Follow-up activities by farmers are also found to be poor in most of the technologies, which account for 5.23% in farm ponds, 21.58% for contour bunding, etc. (Sikka et al. 2000).

Experience from DPAP and IWDP Watersheds in the Coimbatore District

Active participation of the watershed community at every stage of the watershed development program, e.g., planning, implementation and maintenance and follow-up is a must for effective development and sustenance of the watershed activities. This also helps improve their capacity-building, sense of responsibility, etc.

People's participation index (PPI) for planning (pre-implementation), implementation and maintenance (post-implementation) stages of the watershed development program in DPAP watersheds revealed that overall community participation was found to be low with an overall PPI of 42% (Table1). The PPI is found to be 55, 44 and 27%, respectively, at planning, implementation and maintenance stages. This suggests medium, low and very low levels of community participation at planning, implementation and maintenance stages of the watershed development program. This could be attributed to the fact that those who are not benefited from the project directly might not have participated in implementation and maintenance.

Community Participation in Watershed Development Activities

Community participation can be judged based on their contribution/involvement in terms of giving their time to the project and their contribution in cash/or kind towards works, both on development and management of private and common property resources. It is evident that the community members of watersheds have contributed in cash and kind towards the works on private lands. Overall, their contribution for works on private land was found to be 14.71% (Table 2). It varied from a low of 7% for fodder plots to a high of 22% for horticulture and farm ponds. Overall, this can be considered good. However, contribution in terms of cash and/ or kind towards development of common property resources such as percolation ponds, check dams, etc., is found to be nil.

Table 1. People's, participation in the DPAP watersheds of the Coimbatore District of Tamil Nadu.

Level of participation	Peoples' participation (number)		
	Planning	Implementation	Maintenance
Low	45	79	98
	(36)	(63)	(78)
Medium	52	32	22
	(42)	(26)	(18)
High	28	14	5
	(22)	(11)	(4)
Total	125	125	125
Overall PPI (%)	55	44	27
Level of participation	Medium	Low	Very low

Note: Values in parentheses indicate percentage of the total.

Table 2. Community participation for watershed development activities in the DPAP watersheds of the Coimbatore District of Tamil Nadu.

	Contribution (%)		
Name of activity	Cash	Kind	Total
Contour bunding	10	3	13
Land leveling	10	3	13
Summer ploughing	10	4	14
Vetiver plantation	10	2	12
Farm pond	15	7	22
Horticulture plantation	12	10	22
Fodder plots	5	2	7
Total	12.57	4.44	14.71

Adoption of Soil and Moisture Conservation Measures

The level of adoption of various soil and moisture conservation measures and their follow-up activities by farmers can also be considered as a combined effect of awareness, involvement in the program and contribution. The result indicates that there is a wide variation in the level of adoption, with a low of 2.4% in farm pond, 44% in bunding, to a high of 92% for horticultural plantation (Table 3). Follow-up activities by farmers are also found to be maximum (98%) in horticultural plantations, followed by summer ploughing (66%) and minimum in farm ponds.

Table 3. Level of adoption of soil and moisture conservation measures in the DPAP watersheds of the Coimbatore District of Tamil Nadu.

Activity	Rate of adoption		Maintenance (%)
	Frequency (N=125)	Percentage	
Land leveling	46	36.80	52.12
Bunding	55	44.00	21.58
Summer ploughing	38	30.40	65.76
Crop demonstration	25	20.00	25.36
Farm pond	3	2.40	5.23

People's Participation in Training and Exposure Visits

Experience from the IWDP watershed implemented in the Coimbatore District reveals that the number of participants who attended the training program varied from 60 to 93%, while the number of respondents who did not attend the training program varied from 7 to 40%. In the majority of the watersheds the total number of participants who attended the training exceeded 80% indicating the interests shown by the beneficiaries in attending training sessions and gaining technical knowledge.

Table 4**.** Participation in training and exposure visits in the IWDP watersheds of the Coimbatore District.

Particulars	Attended	Not attended	Total
User group training	142	38	180
	(78.9)	(21.1)	(100.0)
Exposure visits	83	187	270
	(30.74)	(69.26)	(100.00)

Note: Values in parentheses indicate percentage of the total.

Of the total respondents, nearly 31% attended the exposure visits and gained knowledge. Among the members who attended the exposure visits nearly 94% found the visits to be very useful. Therefore, it is suggested that a larger number of exposure visits covering different

successful watershed models, community nurseries and research institutes involved in watershed development research may be organized. This will help gain knowledge regarding recent technical know-how and benefits of various watershed treatment activities among the members.

Factors Influencing People's Participation

A recent study indicates that the household contribution towards watershed development and maintenance is influenced by various household-level and supra-household-level factors (Suresh Kumar and Palanisami 2009). The factors such as number of workers in the farm family, number of wells owned by the farm households, distance between the farm and the rainwater harvesting structures are found to significantly influence the household contribution. Similarly, the supra-household-level factors such as the extent of social homogeneity as represented by caste at group level and the type of watershed technology positively and significantly influence household contribution.

Drivers of Success

Watershed development has been conceived basically as a strategy for protecting the livelihoods of the people inhabiting the fragile ecosystems experiencing soil erosion and moisture stress. The aim has been to ensure the availability of drinking water, fuelwood and fodder and raise income and employment for farmers and landless laborers through improvement in agricultural production and productivity (Rao 2000).

Most of the watershed development programs being implemented in the state aimed at (i) promotion of economic development of the village community which is directly or indirectly dependent on the watershed through optimum utilization of the natural resources of the watershed (land, water, vegetation) that will mitigate adverse effects of drought, (ii) employment generation and development of the human and economic resources of the watershed, and (iii) encouraging restoration of ecological balance in the watershed through sustained community action.

Experience from various impact assessment studies conducted in the state revealed that there is significant impact on soil and water erosion control, soil moisture conservation, water resources development, cropping pattern and increase in yield. The watershed development has also produced desired results in terms of improvement in socioeconomic conditions and the environment.

There are several reasons for the successful implementation of watershed development activities in the country. They include physical and agroclimatic conditions of the watershed villages like rainfall, soil type and hydrogeological features. In addition, some of the administrative and institutional issues such as guidelines for effective watershed development, role of different organizations like the state and central governments, line departments, and type of PIAs play a crucial role in implementing watershed development activities.

Future Directions

Watershed development programs not only protect and conserve the environment but also contribute to livelihood security. With the large investment of financial resources in the watershed program, it is important that the program becomes successful. For achieving the best

results, people should be sensitized, empowered and involved in the program. Local community leaders and stakeholders should be necessarily motivated about conjunctive use of water, prevention of soil erosion, etc., through various media. The stakeholders at different levels should be involved at various stages of project activities, planning and implementation with the ultimate objective of sustainability. In addition to the above, strengthening of community organizations within the watershed, implementation of the planned watershed management activities, encouraging linkages with other institutions and initiating groups towards formation of apex bodies will help motivate the people and make the watershed development program a people's movement.

Given the increasing demand for a watershed program by the community, it is difficult to provide adequate funding for all locations. Hence, the development and adoption of a Decision Support System (DSS) to promote the watershed investment is highly warranted.

As the impact assessment of watershed development has been felt crucial, a general framework has to be developed and personnel trained who are involved in the watershed development impact assessment. Experience shows that most of the impact evaluation studies depended on primary data collected from the stakeholders through participatory rural appraisal techniques and interviews, supported by secondary data. Developing a framework, selection of the right approach and methods of impact assessment, and identification and use of indicators will enable the process of impact assessment to be sophisticated. Establishing a proper institutional mechanism in a multidisciplinary approach will be a viable step in impact assessment. Panel databases should be created for the watersheds in different agroecological regions for proper evaluations.

Redefining the Quantification of Benefits due to Watershed Development Is Warranted at Present

Upstream and downstream conflicts. Being a common property resource, treatments in watersheds generate various positive externalities. Conflicts arise between downstream and upstream farmers in sharing benefits and making investments. Thus, care should be taken when quantifying the cost and benefits for impact assessment in watersheds.

Zone of influence. As the rainwater harvesting structures are the main structures which generate various positive externalities, quantifying benefits from these structures like percolation ponds, check dams and farm ponds assumes importance in impact assessment. When quantifying the benefits, determining the zone of influence is very crucial and a challenge to the evaluators. For instance, the zone of influence of a percolation pond varies from 300 meters to 400 meters downstream and 200 to 250 meters upstream. Similarly, the zone of influence of tanks as a groundwater recharge structure varies from 4 to 5 km downstream based on the size of the tank. Thus, one must be careful in determining the zone of influence when quantifying the benefits from the rainwater harvesting structures.

Natural and artificial recharge. The rainwater harvesting structures like percolation ponds, check dams, tanks and farm ponds are expected to increase the groundwater recharge in the wells located in the zone of influence. Enough care should be taken to segregate the natural and artificial recharge. Experience shows that the total groundwater recharge in wells due to various structures is found to be around 30% of total recharge. However, the natural recharge

without any rainwater harvesting structures is reported to be about 10%. Thus, the net recharge due to rainwater harvesting structures is only 20%. Thus, while evaluating the impact of recharge structures, care should be taken to account for the natural and artificial recharges (Palanisami and Suresh Kumar 2006).

Addressing all these issues will help achieve sustainability in watershed management in the state and elsewhere.

Conclusion and Policy Implications

Today, watershed development has become the main intervention for natural resource management and rural development. Watershed development programs not only protect and conserve the environment but also contribute to livelihood security. The importance of watershed development as a conservation program is being recognized, not only for rain-fed areas but also for high rainfall areas, coastal regions, and the catchments areas of dams. With the large investment of financial resources in the watershed program, it is important that the program becomes successful. Experience shows that the watershed development programs have produced desired results and there are differences in their impacts. Hence, the watershed impact assessment should be given due importance in the future planning and development programs.

Watershed development activities have a significant impact on groundwater recharge, access to groundwater and, hence, the expansion in irrigated area. Therefore, our policy focus must be the development of these water harvesting structures, particularly percolation ponds wherever feasible. In addition to these public investments, private investments through the construction of farm ponds may be encouraged as these structures help in a big way to harvest the available rainwater and, hence, groundwater recharge.

Watershed development activities have altered crop patterns, increased crop yields and crop diversification and thereby provided enhanced employment and farm income. Therefore, an alternative farming system combining agricultural crops, trees and livestock components with comparable profit should be evolved and demonstrated to the farmers. Once the groundwater is available, high water-intensive crops are introduced. Hence, appropriate water saving technologies like drip should be introduced without affecting farmers' choice of crops. The creation and implementation of regulations in relation to depth of wells and spacing between wells will reduce well failure, which could be possible through Watershed Associations. The existing NABARD norms such as 150 meters spacing between two wells should be strictly followed.

Therefore, the future strategy should be a movement towards a balanced approach of matching the supply-driven menu with a set of demand-driven activities. People's participation, involvement of panchayat raj institutions, local user groups and NGOs alongside institutional support from different levels, such as the Union Government, the State, the District and block levels should be ensured to make the program more participatory interactive and cost-effective. Convergence of various rural development programs in and around the watershed could be ensured to promote the holistic development of watersheds. For its continued success, the program should be economically efficient, financially viable, technically feasible and socially acceptable while ensuring equity. For sustainable development, regular and routine monitoring of environmental parameters is important as environmental enhancement increases the credibility and acceptability of the program.

Annex

Abstract of total number of watersheds in Tamil Nadu.

Name of district	No. of watersheds		No. of sub-water-sheds	No. of mini-water-sheds	No. of micro-watersheds			
	Full	Partial			Gr.I	Gr.II	Gr.III	Gr.IV
Kancheepuram	1	6	24	80	349	169	7	
Tiruvellor	3	3	11	47	107	165	170	116
Thiruvannamalai	2	10	27	86	302	409	213	8
Villupuram	2	6	34	74	367	273	156	
Cuddalore	2	6	35	126	441	274	73	15
Vellore	5	10	22	85	82	257	95	34
Dharmapuri	7	6	21	115	330	462	400	257
Coimbatore	2	4	22	28	127	638	436	84
Nilgiris	5	1	34	153	258	297	37	2
Erode	5	10	13	41	131	149	82	19
Salem	2	10	21	104	411	410		
Namakkal		7	12	37	105	202	144	113
Tiruchy	1	9	39	99	184	206	195	75
Perambalur		6	20	44	122	195	229	129
Karur	2	4	15	36	97	152	97	43
Tanjavur		5	28	15	28	93	413	182
Tiruvarur		4	9	49	328	104	0	
Nagapattinam		5	16	93	245	171	15	
Pudukkottai	2	7	19	70	216	161	41	13
Ramanathapuram	1	6	8	73	288			
Sivagangai	1	10	20	68	233	214	90	15
Madurai	2	4	14	123	424	358	92	
Virudhunagar		3	5	73	151	52		
Theni	2	1	7	229	547	295	53	
Dindigul	1	6	21	264	589	632	135	5
Tuticorin	3	4	37	103	676	279		
Tirunelveli	4	6	14	39	167	299	167	35
Kanyakumari	2	1	6	9	77	200	318	30
Total					7,382	7,116	3,658	1,175
Micro-watersheds								19,331

Source: GoTN 2002.

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