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Methodological Issues in Assessing Impact of Watershed Programmes

Editors:
Sant Kumar • Alok K. Sikka • Suresh A.

भाकृअनुप
ICAR
National Centre for Agricultural Economics and Policy Research

सत्यमेव जयते
National Rainfed Area Authority

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Foreword

Watershed development programmes (WDPs) are undertaken across the globe to fulfill the needs of rural people by providing food, fuel, fodder, and timber since the majority of rural masses depend on the natural resources for livelihood. The Government of India has accorded high priority to the implementation of WDPs so as to provide sustainable livelihood to millions of people. Monitoring and evaluation of WDPs being necessary to realize the maximum intended impact, a comprehensive common approach is called upon.

The need for evolving some common methodologies to evaluate watershed programmes is being felt for a very long time. It is more so due to the inability of the present approaches to capture the overall impact of watershed programmes on the society at large. Further, funding agencies and policy planners are also concerned about the overall impact of watershed programmes on the target population and environment which is lacking at present due to use of different kinds of indicators for monitoring and evaluation of WDPs. The pooling of various indicators for evaluation of watershed programmes is a problem and it is difficult to derive logical conclusions based on them. Therefore, the National Rainfed Area Authority (NRAA), Planning Commission, Government of India, sponsored a National Workshop on '*Methodological Issues in Assessing Impact of Watershed Programmes*' which was organized by the National Centre for Agricultural Economics and Policy Research (NCAP) in New Delhi, on 6 August, 2010.

I am thankful to Prof. Ramesh Chand, Director, NCAP, for taking initiatives to organize the workshop and for providing necessary support and encouragement.

Apart from Dr Sant Kumar, Dr Alok K. Sikka and Dr Suresh A., who shouldered the onerous task of coordinating the workshop and compiling this volume, other staff members of NCAP and NRAA who have worked hard for making this workshop successful and bringing out the publication deserve appreciation.

I am sure that the recommendations of this workshop will be helpful in deriving a set of common minimum indicators to evaluate the watershed programmes across the country.

Dr J. S. Samra
Chief Executive Officer
National Rainfed Area Authority

Preface

The concept of watershed (or catchment) is an ideal planning unit for conservation of soil and water. The idea is quite simple and is perhaps as old as the history of farming. But, the benefits are manifold. It changes the entire landscape by making the land fertile, facilitating the growth of trees and checking the runoff and soil erosion.

The Government of India has accorded high priority to watershed development programmes (WDPs) during Five-Year Plans for the holistic and sustainable development of rainfed areas. A large number of watershed development programmes have been implemented through the support of Government of India and international agencies. These have led to the improvement in livelihood of millions of people. Quantification of the impact of these WDPs has been rather difficult due to the use of different methodologies for evaluating these programmes. This calls for building a consensus on some common indicators to evaluate the impact of watershed programmes.

The present volume is the outcome of a National Workshop on '*Methodological Issues in Assessing Impact of Watershed Programmes*' held at the National Agriculture Science Centre Complex, New Delhi, in August, 2010. In this workshop, a number of issues related to the monitoring and evaluation (M&E) of watershed programmes were discussed and efforts were made for arriving at a consensus in identifying common indicators. I hope this volume will be useful to planners, policymakers, scientists and managers engaged in watershed development programmes.

Prof. Ramesh Chand
Director, NCAP

October 2011
New Delhi

Acknowledgements

The need for common indicators to evaluate a watershed programme is being felt for a long time. Therefore, a national workshop on '*Methodological Issues in Assessing Impact of Watershed Programmes*' was organized by the National Centre for Agricultural Economics and Policy Research (NCAP), New Delhi, on 6 August, 2010.

We are grateful to Dr J. S. Samra, Chief Executive Officer, National Rainfed Area Authority (NRAA), Planning Commission, Government of India, New Delhi, for delivering the inaugural address, providing guidance, encouragement and support for organizing this workshop. We are thankful to Prof. Ramesh Chand, Director, NCAP, for his constant guidance and encouragement in organizing this activity and bringing out the proceedings. We express our special thanks to Technical Experts at NRAA, for the support in organizing this workshop.

We express our sincere thanks to Shri B. K. Sinha, Secretary, Ministry of Rural Development, Government of India, New Delhi, for consenting to be Chief Guest at National Workshop and for offering valuable remarks during the inaugural function. We sincerely thank Dr R. S. Deshpande, Director, Institute for Social and Economic Change, Bangalore, for providing deep insights during the deliberations.

Our sincere thanks to the Chairpersons and Rapporteurs of different sessions of the workshop. The role of participants in providing their useful inputs is highly appreciated. All the paper contributors also deserve special thanks for contributing their papers.

We do acknowledge the financial support received from the National Rainfed Area Authority for organizing the workshop and the National Centre for Agricultural Economics and Policy Research for bringing out this volume. We hope that this publication will help in arriving at common indicators for assessing impact of watershed programmes and will provide directions for future development. Dr B. S. Aggarwal deserves special thanks for his contribution in improving the language and presentation of the contents of this publication.

Editors

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List of Acronyms and Abbreviations

BCR	Benefit-cost Ratio
CAPART	Council for Advancement of People's Action and Rural Technology
CBO	Community-based Organization
CDI	Crop Diversification Index
CEP	Composite Entropy Index
CLUI	Cultivated Land Utilization Index
CPI	Crop Productivity Index
CPLRs	Common Property Land Resources
CPRs	Common Property Resources
CSWCR&TI	Central Soil and Water Conservation Research and Training Institute
DoLR	Department of Land Resources
DPAP	Drought Prone Area Programme
ESM	Economic Surplus Model
GoI	Government of India
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IRR	Internal Rate of Return
IWDP	Integrated Watershed Development Programmes
LLI	Land Levelling Index
M&E	Monitoring and Evaluation
MoE&F	Ministry of Environment and Forests
MoRD	Ministry of Rural Development
NABARD	National Bank for Agriculture and Rural Development
NARS	National Agricultural Research System
NGO	Non-Governmental Organization
NLBA	Non-land Based Activity
NPK	Nitrogen, Phosphorus and Potash
NPV	Net Present Value
NRM	Natural Resource Management
NWDPRA	National Watershed Development Project for Rainfed Areas

PRA	Participatory Rural Appriasal
RS-GIS	Remote Sensing-Geographic Information System
SHG	Self-Help Group
UGs	User Groups
WASSAN	Watershed Support Services and Activities Network
WDC	Watershed Development Committee
WDPs	Watershed Development Programmes
WSCUI	Water Storage Capacity Utilization Index

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Introduction

Sant Kumar, Alok K. Sikka and Suresh A.

1.1. Background

Any developmental intervention is considered justified only if it yields significant economic, environmental and sustainable impacts and has wider societal benefits. Watershed development approach is one such effort towards conservation of natural resources. The integrated watershed development approach implies a multi-dimensional or inter-sectoral concept that calls for simultaneous consideration of natural resources, and social, cultural, institutional, regulatory, economic and political issues. Several studies at the micro-level have been attempted in the past to document the impact of watershed development programmes using different methodologies. However, it is felt that the available methodological approaches do not capture the overall impact of watershed programmes on which about Rs 192.5 billion have been invested over different Five Year Plan periods. The funding agencies and policy planners are concerned about the overall impact of watershed programmes on the target population. Amalgamation of different indicators being used for impact evaluation has practical limitations and it is difficult to follow a common approach for watershed evaluation. Under this background, a national workshop on 'Methodological Issues in Assessing Impact of Watershed Programmes' was organized by the National Centre for Agricultural Economics and Policy Research, New Delhi, on behalf of the National Rainfed Area Authority, Planning Commission, Government of India, New Delhi with the aim of identifying minimum indicators and a methodologies for evaluation.

1.2. Objectives

The workshop was organized with the following objectives:

- Documentation of methodological issues in assessing the impact of a watershed programme,
- Suggesting suitable indicators, tools, analytical techniques and approaches for measuring the overall impact of a watershed at the micro, meso (district) and macro levels, and

- Finalization of a suitable methodological framework for monitoring and evaluation of a watershed programme.

1.3. Technical Sessions

The workshop was organized under the following two technical sessions, besides the inaugural session:

Session I: Methodological issues in assessing impact of a watershed programme

Session II: Discussions on common indicators and framework to evaluate impact of a watershed programme

1.4. Organizers and Venue

The national workshop was organized by the National Centre for Agricultural Economics and Policy Research (NCAP), a unit of ICAR, on behalf of the National Rainfed Area Authority (NRAA), Planning Commission, Government of India. The workshop was organized at the National Agricultural Science Centre (NASC) Complex, New Delhi, on 6 August, 2010.

1.5. Participants

The national workshop was attended by 80 professionals who are involved in research and development (R&D), management, evaluation and policy formulation of watershed development programmes in the country. The participants comprised R&D managers, policymakers and researchers in the government institutions, non-governmental organizations (NGOs), international organizations/ donors, Consultative Group on International Agricultural Research (CGIAR) system and other developmental organizations engaged in natural resource management.

1.6. Outlines of Proceedings

The proceeding has five chapters. The introduction of workshop is presented in Chapter 1, followed by workshop summary and recommendations in Chapter 2. Chapter 3 describes the methodologies being used in evaluation of watershed development programmes (WDPs). Technical indicators to evaluate WDPs in India have been presented in Chapter 4, and social, institutional and environmental indicators to evaluate WDPs have been discussed in Chapter 5. The programme of workshop and list of participants are also appended in this volume.

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Workshop Summary and Recommendations

Sant Kumar, Alok K. Sikka and Suresh A.

Building a consensus on selection of appropriate common minimum indicators to evaluate the performance of watershed development programmes (WDPs) implemented usually by the District Authorities, was main objective of this national workshop. After detailed discussions, the workshop suggested a set of common minimum indicators for monitoring and evaluation of watershed programmes. While suggesting these indicators, due care was taken that these should be easy to comprehend and comparable across different watersheds. Since the suggested indicators would form the basis for performance evaluation of WDPs, it was suggested to follow a practical approach and give proper weightage to different set of indicators while identifying them.

The workshop was organized in two sessions. In the first session, various speakers dealt upon the methodological issues and indicators to assess the impact of WDPs. In the second session, the participants were divided into two working groups to discuss issues like (i) common indicators and methodology for monitoring and evaluation of watershed programmes, and (ii) modalities for developing institutional mechanism for assessment of WDPs. The major suggestions that emerged from group discussions are summarized below under two broad heads:

Working Group I: Common Indicators and Methodology for Monitoring and Evaluation of Watershed Programmes

The first suggestion of this Group was that the variables/ indicators should be chosen under four broad components, viz. *bio-physica*l, *socio-economic*, *institutional* and *environmental.* The Group proposed a set of minimum indicators to be collected under each component, the methodology to be followed to record variables and suggested integration of variables into dimensionless (scale neutral) units (i.e. indices). The Group emphasized on the need of preparing the baseline information at the start of a project and a regular recording of common database so as to conduct the evaluations in

Table 2.1. Minimum indicators and suggested methodologies for evaluation of a watershed programme

Component	Minimum indicator	Methodology/ Data source	Output
Bio-physical	1. Groundwater level proxied by (a) well water level (b) number of months of water availability (c) pumping hours (d) increase in irrigated area	Comparison with baseline and using "*with and without*" approach. The data may be collected annually or half yearly basis; at least covering pre-& post-monsoon periods. The sample is to be collected from the upper, middle and lower reaches of the watershed.	Bio-physical indices
	2. Land use change including conversion of wastelands to productive use	Remote sensing data for a watershed and its comparison with baseline/ ground data collected through participatory rural appraisal (PRA) method.	
	3. Crop yield change	Comparison with baseline and using "*with and without*" approach. The sample surveys are to be carried out considering the seasons and locations. The data need to be generated considering the irrigability status. Use of PRA techniques may be considered for collection of data.	
Socioeconomic	1. Cropped area	Sample survey– stratified based on irrigability status	Socio-economic indices
	2. Crop diversification	Sample survey– stratified based on irrigability status	
	3. Income	Baseline and PRA	
	4. Distress migration	Baseline and PRA	
	5. Productivity	Baseline and PRA	
	6. Livestock population	Baseline and PRA	
	7. Equity (assets, income, and employment of marginalized people)	Baseline, PRA and sample survey	
	8. Credit/ indebtedness	Baseline and PRA	
Institutional	1. Status of community-based organization (CBO)	Focused group discussions and baseline	Institutional indices
	2. Inclusiveness	CBO documents	
Environmental	1. Tree cover	Remote sensing	Environmental indices
	2. Land use/ cover	Remote sensing, survey and baseline including PRA	

due course. The Group also explored the possibility of collecting the information at the field level by using space and communication technologies. The suggestions that emerged from this Group are presented in Table 2.0.

Overall, the Group emphasized on the importance of four major components viz. biophysical, socioeconomic, institutional and environmental and these are to be assessed with a mix of options including remote sensing. The Group also suggested the following guidelines for evaluation of a watershed programme:

1. In the case of implementation of several watersheds, the district level agency may decide the number of model watersheds in the ratio of 1:15 to 1:20 (within the availability in the district).
2. The weightage criterion may be followed for synthesizing each component /variable. The concerned agency may decide on the level of weightage to be given to each component.
3. The model watershed should be linked to some academic/ research organizations as a support institution for conducting regular and proper monitoring as well as impact assessment.
4. A comprehensive impact assessment model needs to be developed by including more detailed and other essential indicators for Model Benchmark Watersheds to be selected in each district.
5. The indicators not covered under the broad set of common indicators, may be incorporated for the intensive monitoring and evaluation of model watersheds.

Working Group II: Modalities for Developing Institutional Mechanisms

Impact assessment, collection of necessary data at the field level, its electronic recording, storage, transmission, analysis and supply of the results to the concerned authorities, and linking the entire process in line with the existing watershed framework is of utmost importance. This phase, therefore, needs the interaction across multiple agencies/ departments, who could be involved in generating the necessary data and its processing. The workshop deliberated upon these details and came out with the following suggestions:

1. An integrated watershed development programme needs to be evaluated in three phases:

- *Preparatory phase*,
- *Watershed work phase* and
- *Consolidation phase*.

2. There is a need to build a cadre of evaluators with proper expertise at the grassroot level as this is lacking at the project level. These evaluators should be selected following objectivity and quality criterion.
3. Manpower requirement for scientific monitoring and evaluation of WDPs should be addressed suitably. For this, a '*Post Graduate Diploma in Watershed Evaluation and Monitoring*' may be started by established institutions. The budgetary support for the programme can be made available by the Department of Land Resources (DoLR), Ministry of Rural Development, Government of India.
4. Monitoring and evaluation (M&E) mechanisms need to be developed, and evaluations may be got done through an outside agency or a third party.
5. The existing budgetary support for M&E is inadequate; it needs to be addressed adequately and promptly.
6. The watershed implementing agency should have freedom to design the framework of evaluation and time period, so as to address the concerns arising out of location-specific variations.
7. There is a need for updating capacity building of independent evaluation agencies as well as of watershed development team (WDT) for monitoring and evaluation of a watershed programme.

After the presentations of both the working groups, discussions were held and suggestions were sought from the participants. The following points emerged:

- The inadequacy of groundwater monitoring was expressed as one of the major issues. The groundwater level is one of the important variables for monitoring and evaluation. Network of groundwater wells, and use of measures for groundwater monitoring were suggested.
- It was suggested that DoLR may issue directives for the identification of some model watersheds, which could have detailed monitoring of some important variables like rainfall, groundwater table, soil loss, runoff, etc. It was suggested to identify measures for capacity enhancement for baseline survey and for preparing the detailed project report.

- Efficient and effective management of the data collection at various levels was identified as another major issue that needs greater attention. It was pointed out that identification and functioning of a Management Information System (MIS) with adequate number of data entry operators, MIS coordinators and data processors should be created within the system itself. Such a system was already in existence, though with many shortcomings. Strengthening of the existing institutional system in terms of infrastructure and capacity building would help accelerate the efficiency. The necessity of linkage between various agencies included in operationalization of the District as well as State Data Centres, Department of Agriculture and Cooperation (DoAC), DoLR, etc. was also expressed. However, the most important element would be the data management at the field level, which constitutes the basis for deriving the numbers at various scales and aggregates. Therefore, development of MIS at the watershed level, with proper infrastructure in terms of information technology will be necessary. The scope of this data can be augmented and supplemented with the data available through space technology and other secondary sources.
- The need was emphasized to ensure the quality of data collection at the field level and to fix the responsibility of data collection during discussion. Highlighting the issue of lack of expertise in this area, which also affects data collection and its quality, the emphasis was made on identification of data collection agencies and the training needed to upgrade their capabilities.
- The suggestions included utilization of the services of independent evaluators, evaluation by the implementing agency through methods like focused group discussions with the beneficiary group. The beneficiary groups can be trained by using the local resources like eco-clubs or through educational institutions, voluntary organizations, youth organizations, etc. The successful programmes implementation of such kind in some parts of the country was highlighted. It was felt that even though the sporadic incidences of such success stories are encouraging in information collection, evaluation and monitoring, non-institutionalization of the operational mechanism may lead

to inefficiency and non-sustainability of the system. Therefore, it would be important to institutionalize the mechanism wherever possible. More effective institutionalization can be brought forward through the intervention of the Panchayati Raj Institutions (PRIs), with the help of local bodies and community participation.

- At the end, the discussions converged towards developing an aggregate framework that could link the technical and institutional mechanisms for monitoring and evaluation. Such an effective linkage would also help in measuring the returns to investment at various levels for investment prioritization. The information collection and its management at field level and its transmission and processing at evaluation level may be made effective by utilizing the existing facilities through capacity enhancement and streamlining. The extensive networks of National Agricultural Research System (NARS), state agricultural universities (SAUs) and *Krishi Vigyan Kendras* (KVKs) can provide technical inputs and handholding services at least during the initial phase.
- The inertia of some agencies towards the ground level implementation of watersheds was also highlighted. The need to sensitize these institutions about the implementation and evaluation of watershed and ensuring their participation at the appropriate level was identified as the major factor in developing a workable model at the aggregate level. The need of indicators for post–project sustainability and convergence was also highlighted.
- Emphasis was laid on ensuring the involvement of beneficiaries, PRIs, information and communication technologies, government departments, NARS and watershed development and monitoring agencies to formulate the mechanism that could respond to management of budgetary allocations, information generation and processing, technological intervention and policy planning at the appropriate level with proper feedback. It was suggested that the points emerged during the deliberations should be synthesized and sent to the concerned ministries to come out with policy guidelines on developing the monitoring and evaluation processes and the institutional mechanisms to be put in place to implement them efficiently.

Recommendations

The major recommendations that emerged during the Workshop are:

- The common minimum indicators need to be indentified under four sets of broad parameters, viz., bio-physical, socio-economic, institutional and environmental indices. However, additional comprehensive indicators could also be used for monitoring model watersheds.
- A comprehensive impact assessment model may be developed by incorporating essential indicators, and the weightage criterion for synthesizing each component and variable into an aggregate indices. At least one Benchmark Model Watershed in each district may be undertaken for evaluation.
- The Model Watershed should be linked to some research institution or such other support organization for a regular monitoring of data, its analysis, assessment and implementation.
- An integrated watershed development programme (IWDP) should be evaluated in three phases, viz., preparatory phase, watershed work phase and consolidation phase by the subject matter experts. For this evaluation, some independent agencies may be empanelled and/or a cadre of evaluators may be built, following objective and quality criteria.
- Guidelines may be provided for monitoring weather, hydrological, sediment and other important parameters/ indicators for Model Watersheds.
- Manpower requirement for scientific monitoring and evaluation of a watershed should be addressed suitably. A 'Post Graduate Diploma in Watershed Monitoring and Evaluation' may be started by the established institutions. The budgetary support for this programme can be made available by the Department of Land Resources (DoLR), Ministry of Rural Development, Government of India.
- Monitoring and evaluation mechanisms may be developed, preferably by involving independent outside agencies. Also, the existing budgetary provision for monitoring and evaluation is inadequate and it needs to be addressed adequately.

Methodology in Evaluation of Watershed Programmes

K. Palanisami*[1], D. Suresh Kumar[2] and S. Nedumaran[3]

Abstract

Watershed programmes in India are contributing to water resources development, agricultural production and ecological balance. Conventional methods using financial measures attempt to quantify the impacts of watershed development in an isolated manner. In order to evaluate the impacts of watershed programmes in a holistic manner, the Economic Surplus (ES) approach has been applied using the data from a cluster of 10 watersheds in the Coimbatore district of Tamil Nadu. The distributional effects of watershed programmes have also been captured through the ES method. Hence, the possibilities of using this methodology in the future watershed evaluation programmes could be examined. The study has suggested that people's participation, involvement of Panchayati Raj Institutions, local user groups and NGOs alongside institutional support from different levels, viz. the central and state government, district and block levels should be ensured to make the programme more participatory, interactive and cost-effective.

Introduction

Watershed development in India is not a new concept and has travelled a long way as a simple soil and water conservation programme to the recent integrated rural development programme with more people participation. Both central and state governments and international donors have been implementing watershed development programmes across the country in different modes. The overall objectives of these development programmes, by and

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large, are three-fold, viz. promoting economic development of the rural area, employment generation, and restoring ecological balance (Department of Land Resources, 2006). The watershed development programmes assume importance in India where nearly two-thirds of the cropped area is under rainfed, characterized by low productivity, degraded natural resources and widespread poverty, particularly in the rural areas. Under such a situation, understanding the nature and extent of impact of these watershed development programmes on various domains in the rural economy is crucial for the development personnel/specialists, economists and policymakers. It would guarantee more food, fodder, fuel, and livelihood security for those who are on the bottom of the rural income level.

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 utilization of surface and subsurface water for crop production (Kerr *et al.,* 2000). Different ministries of Government of India like Ministry of Agriculture (MoA), Ministry of Rural Development (MoRD) and Ministry of Environment and Forests (MoEF) are involved in the implementation of watershed development programmes in the country.

Watershed development has been conceived basically as a strategy for protecting the livelihoods of the people inhabiting the fragile eco-systems, 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 resource development/ management (percolation pond, farm pond, and drip and sprinkler irrigation), crop demonstration, horticultural plantation and afforestation (Palanisami *et al.,* 2003). Training in watershed technologies and related skills is also given periodically 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, fuel wood and fodder and generate income and employment for farmers and landless labourers through improvement in agricultural production and productivity (Rao, 2000). Today watershed development has become the main intervention for natural resource management. Watershed development programmes not only protect and conserve the environment, but also contribute to livelihood security.

As an important development programme, watershed development has received much attention from the central and state governments. Up to the Tenth Plan (till March 2005), an area of 17.24 million hectares was treated with a total budget of Rs 9368.03 crore under Ministry of Agriculture, 27.52 million hectares with an outlay of Rs 6855.66 crore under Ministry of Rural Development and an area of 0.82 million hectares with an outlay of Rs 813.73 crore under Ministry of Environment and Forests. A total of 45.58 million hectares has been treated through various programmes with an investment of Rs 17,037 crore. The average expenditure per annum during the Tenth Plan comes to around Rs 2300 crore (Department of Land Resources, 2006). As millions of rupees are being spent on the watershed development programmes, it is essential that these programmes become successful.

With programmes so large and varied, it is important to understand how well they function overall and which aspects should be promoted and which be dropped. However, despite this importance, little work has been done to assess their impacts. This paper partially fills this gap by examining both social and environmental outcomes. In particular, it tries to answer the questions: (i) What impacts the watershed development activities have on rural areas? and (ii) How do watershed development activities impact on groundwater resources, soil and moisture conservation, agricultural production and socio-economic conditions?. It would help the policymakers in up-scaling and mainstreaming watershed development programmes in the country.

To implement the watershed development activities successfully, the Government of India has issued various guidelines. The GoI guidelines were first issued in 1995. In order to make more participation of people in the development and management of a watershed, the GoI guidelines were revised and issued in 2001. Subsequently, to involve Panchayati Raj Institutions more meaningfully in the implementation of watershed development activities, the popular Haryali guidelines were introduced in 2003. In addition to all these guidelines, the guidelines for NWDPRA watershed development programmes, CAPART, NABARD and NGO implemented watershed guidelines were released separately over the period. Though these guidelines have, by and large, been successful in the implementation of various watershed development activities, they have some lacunae, particularly in the context of institutional issues, post- project maintenance and sustainability and monitoring and evaluation of watershed development activities. Recently, the GoI has issued Common Guidelines 2008 for the effective implementation of watershed development programmes in the country.

In spite of guidelines, the implementation aspects normally deviate due to local demand. Several studies have indicated that the watershed structures are not maintained after completion and benefits may decline over the years (Palanisami and Suresh Kumar, 2006). Also, to push up the implementation of watersheds at other locations, the evaluation of the existing watersheds has been conducted positively. But, it is always mentioned that the benefits and costs are based on several assumptions. Impact analysis of an area-based programme like watershed development has inherent difficulties. Apart from the benefits accrued from different technologies, the impact of watershed development should be looked into three major dimensions, viz. scales (household level, farm level and watershed level), temporal, and spatial. The dimensions of impact of watershed technologies further complicate the impact assessment.

Different studies have developed a variety of indicators for impact assessment of a watershed. These indicators cover watershed development activities including soil erosion, groundwater recharge and water resources potential, agricultural production, socio-economic conditions and overall impact incorporating the extent of green cover. These indicators have been compared with before and after the watershed treatment activities with those of the control village where watershed treatment activities are not taken up. The other methodologies, such as Total Economic Valuation (Logesh, 2004) and bio-economic modelling (Nedumaran, 2009) have also been employed by the researchers. However, still the researchers face challenges in quantifying the impacts of watershed development activities.

The problem of impact assessment of watershed development project includes the following aspects: (i) Developing a framework to identify what impacts to assess, where to look for these impacts and selecting appropriate indicators to assess the impacts, and (ii) Developing a framework to incorporate the indicators together and assessing the overall impact of the project. The nature of watershed technologies and their impact on different sectors pose challenges to the project monitoring and evaluating agencies, economists, researchers and policymakers. More specifically, major challenges include (i) choice of methodologies, (ii) selection of indicators, (iii) choice of discount rate, (iv) quantifying benefits in upstream and downstream, (v) defining the zone of influence, and (vi) extent of natural and artificial recharge (Palanisami and Suresh Kumar, 2006).

Since the watershed development technologies benefit not only the participating farm households, but also non-participating farm and other rural households in the watershed village, the economic surplus method has been used in the present chapter to study the impact of watershed programmes using data from sample watersheds in the Coimbatore district of Tamil Nadu state applying the following three approaches:

- Before and after
- With and without
- Combination of with and without

(i) Before and After

A comparison of project parameters to the 'pre-project' situation provides the incremental benefits due to the project. But these increments in the parameters intrinsically include the changes due to state-of-art technology. This approach would be viable when the benchmark information is available. But in reality, most of the watershed development programmes are implemented without collecting full set of benchmark information. Thus sometimes, the benefits may be exaggerated.

(ii) With and Without

The is the use of a comparison between the 'project parameters' with 'non-project control region'. This method automatically incorporates the correction for the impact of technology in the absence of the project. But, this approach also has limitations. Though the watershed-treated and control regions fall within the same agro-climatic conditions, the differences in hydro-geological profile vary within a village/even across plots in the farm. Thus, this approach can be only used when we compare the villages having homogeneous agro-climatic conditions.

(iii) Combination of With and Without

When the time span is too long, economists adopt a combination of with and without approaches, where they compare pre- and post-project periods and with the control village as well so as to get a holistic picture on impact of watershed development activities.

Methodologies

1. Conventional Benefit Cost Analysis
2. Econometric Models (e.g. Economic Surplus Model)
3. Bio-economic Modelling
4. Meta Analysis

Alternative Methodological Approaches for Impact Assessment

The limitations and complexities associated with measuring, monitoring and valuing social costs and benefits associated with natural resource management (NRM) interventions require more innovative assessment methods. An important factor that needs to be considered in the selection of appropriate methods is the capacity for simultaneous integration of both economic and biophysical factors and ability to account for non-monetary impacts that NRM interventions generate in terms of changes in the flow of resources and environmental services that affect economic welfare, sustainability and ecosystem health. Hence, a mix of qualitative and quantitative methods is the optimal approach for capturing on-site and off-site economic welfare and sustainability impacts (Freeman *et al.*, 2005). The approaches that have been developed recently for evaluating the impacts of agricultural and NRM interventions are presented below.

(a) Conventional Benefit Cost Analysis

This primarily includes:

- Net Present Value (NPV)
- Benefit-Cost Ratio (BCR)
- Internal Rate of Return (IRR)

(b) Econometric Approach

Econometric approach is also used to link measures of output, costs and profits directly to the past watershed-development investments. The econometric approach uses regression models (like probit, logit, tobit, and two-stage least squares (2SLS) regressions) to explain the variations in socio-economic and agro-ecosystem services through changes in NRM pattern. This approach uses the changes in biophysical, economic and environmental indicators as proximate indicators of impact of the NRM technologies. The indicators include changes in land productivity; total factor productivity; reduction in costs (e.g., reduced use of fertilizers, pesticides); reduced risk and vulnerability to drought and flooding; improved net farm income and change in poverty levels (e.g., head count ratio). However, there are some limitations of this approach related to data availability and measurement errors, and problems in internalizing externalities and inter-temporal effects. For example, the time-varying nature of impacts of NRM practices require time-series data, ideally panel data with repeated observations from the same households and plots over a period of many years so that the dynamics of these impacts and their feedback effected on household endowments and subsequent NRM decisions are adequately assessed (Pender, 2005).

Unfortunately, household and plot-level panel data sets with information on both NRM practices and causal factors and outcomes are quite rarely available or collected. In the absence of such data, inferences about NRM impacts will remain limited to those possible based on available short-term experimental data and cross-sectional econometric studies. These can provide information on near-term impacts, for example, on current production, income and current rates of resource degradation or improvement, but do not reveal feedback effects such as how changes in income or resource conditions may lead to changes in future adoption, adaptation or non-adoption of NRM practices (Pender, 2005; Barrett *et al.*, 2002).

Assessment of the multiple and complex mechanisms by which NRM (and other factors) may affect outcomes is an important issue, and one that is more difficult to address when limited dependent variable models (such as the probit, ordered probit, and tobit models) or other non-linear models are estimated. In the linear system of structural equations, the total impacts of any variable on the outcomes may be determined by total differentiation of the system and by adding-up the partial effects (Fan *et al.*, 1999). But with limited dependent variable models or other non-linear models, this approach does not work. There will be no simple general relationship between the estimated coefficients of the structural model and the total impact, all these relationships depend on the level of each variable in non-linear models.

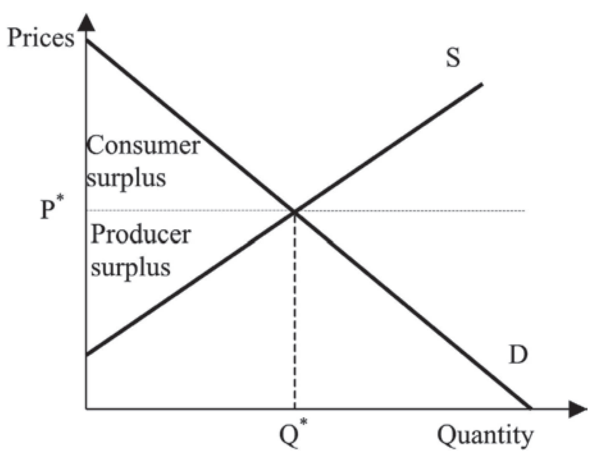
Pender (2005) has applied an alternative approach to estimate the total effects in non-linear models by using predictions from the estimated model to simulate both indirect and direct impacts of changes in the explanatory variables. Even though econometric models are useful in assessing the NRM impacts, they are not without problems and limitations. The most important are the problems of endogeneity of NRM practices and the omitted variable bias, which can be addressed through careful data collection and use of instrumental variable estimators.

Kerr and Chung (2001) have also applied the econometric approach to assess the impact of the watershed programme in the semi-arid tropics of India. In this study they have used instrumental variables approach for the evaluation because of inadequate data on baseline conditions and lack of hydrological data (such as groundwater level, runoff, soil erosion, etc.). The study has found that the more-participatory projects are more successful in protecting upper catchments to promote water harvesting. On the other hand, too often protection of upper catchments comes at the expense of landless people whose livelihood relies heavily on them.

Economic Surplus Model

The economic surplus model to impact assessment is rooted in the microeconomics of supply and demand (Bantilan *et al.*, 2005). The basic idea is simple and is illustrated in Figure 2.1. Consumer demand can be described by a downward sloping demand curve illustrating that some consumers are willing to pay more than others for the given commodity. At a market-clearing equilibrium price, P*, those consumers who were willing to pay more than p* realize benefits by getting the product for less money than they were willing to pay. Across all consumers, the area beneath the demand curve, D, and above the equilibrium price, P*, measures the total value of consumer surplus.

Producer supply can be described by an upward sloping curve that illustrates that some producers can supply a product for a lower price than others. At a market-clearing equilibrium price, P*, those producers who could supply the products at a lower price obtain extra benefits. The aggregate benefits described by the area above the supply curve, S, and below the equilibrium price, P*, measures the total producer surplus. Together, consumer surplus and producer surplus sum to the economic surplus.



P* is the equilibrium price; Q*, equilibrium quantity; S, supply curve; and D, demand curve

Figure 3.1: Economic surplus divided between consumer surplus and producer surplus

This is the most commonly used method for assessing the impact of agricultural research investment, particularly those related to crop improvements. This approach estimates the benefits of research in terms of changes in consumer surplus and producer surplus, resulting from a shift in the supply curve by introduction of a new technology. Thus, the economic surplus (sum of producer and consumer surplus) is taken as a measure of the gross benefit from research investment in a given year. The major challenge is to make a plausible link between changes in NRM practices and the supply of economic goods and services. The presence of non-marketed externalities further complicates the approach, although in theory, the social marginal cost of production could be used to internalize the externalities (Swinton, 2005). New methods (e.g., benefit transfer function) have been developed to extend the economic surplus approach for assessment of non-marketed social gains from improved NRM technologies. Bantilan *et al.* (2005) have used the economic surplus approach to estimate empirically the economic and environmental impacts of groundnut production technology in central India (Maharashtra).

(c) Bio-economic Modelling Approach

The individual impacts of various technologies are known but there is little information on their combined impact or on the role of policy and institutional arrangements in conditioning their outcomes (Okumu *et al.*, 2000). In addition, past studies have seldom included the biophysical factors (like soil erosion, nutrient depletion, water conservation, etc.) in their assessments, which have a direct effect on the productivity of numerous enterprises (like crop production, livestock production, forestry, pasture development). In the recent past, the methodologies that are capable of simultaneously addressing various dimensions of agriculture and NRM technology changes and the resulting tradeoffs among economic, sustainability and environmental objectives have been developed (e.g., Barbier, 1998; Barbier and Bergerson, 2001; Holden and Shiferaw, 2004; Holden *et al.* 2004). The main innovation in the development of such methodologies is the integration of biophysical and economic information into a single integrated bio-economic model. The bio-economic models link economic behavioural models with biophysical data to evaluate potential effects of new technologies, policies, and market incentives on human welfare and the sustainability of the environment or natural resources (Shiferaw and Freeman, 2003). Therefore, it helps the researchers in the selection of technologies that may improve the farmers' economic efficiency and welfare as well as the condition of the natural resource base over time.

The models can also be used to account for the externalities if the generation of externalities can be linked with NRM and economic factors (Shiferaw *et al.*, 2004). Bio-economic models have been applied at household (e.g. Holden and Shiferaw, 2004; Holden *et al.*, 2004; Holden *et al.*, 2005), village and watershed levels (e.g., Barbier, 1998; Barbier and Bergerson, 2001; Sankhayan and Hofstad, 2001; Okumu *et al.* 2002; Nedumaran, 2009) and for the agricultural sector (e.g., Schipper, 1996).

Advantages of Bio-economic Modelling in Impact Assessment Studies

Bio-economic models are used to incorporate changes in the biophysical conditions of natural resource use within the economic behavioural models with the purpose of exploring or understanding the two-way interaction (i.e., how changes in biophysical conditions affect welfare and vice versa?). Such models are useful to evaluate the potential effects of new agricultural and NRM technologies, policies and market incentives on human welfare as well as the quality of the resource base and the environment. Possibilities to address dynamic issues and linking changes in biophysical indicators with economic models are important advantages of this method (Shiferaw *et al.*, 2004). The integrated framework allows a consistent analysis of the technology impacts within a given socio-economic and policy setting.

According to Holden *et al.* (2005), the main advantages of using bio-economic models for NRM technologies and policy impact assessment are:

- They allow consistent treatment of complex biophysical and socio-economic variables, providing a suitable tool for interdisciplinary analysis
- They allow sequential and simultaneous interactions between biophysical and socio-economic variables
- They can be used to assess the potential impacts of new technologies and policies (*ex ante* impact assessment)
- They allow disturbing variation to be controlled (*ceteris paribus* conditions) for evaluation of impacts of certain interactions by isolating effects from other influences
- They can capture both direct and indirect effects (i.e., the total effect of technology or policy change can be estimated), and
- They can be used to carry out sensitivity analyses in relation to various types of uncertainties.

(d) Meta Analysis

Meta-analysis is effectively an analysis of analyses. It is a relatively new methodology and its main purpose is to collate research findings from the previous studies, and distil them for broad conclusions. Meta-analysis is helpful to policymakers, who may be confronted by numerous conflicting conclusions. Earlier, meta-analysis was applied to assess the returns on investment in education and understand the implications of certain medical treatments on offspring and the returns to research investment at the global level. The ordinary least square (OLS) approach was employed to estimate the regression Equation (1):

$$BCR = f\ (L, S, F, R, I, P, T, A, SL) \qquad \ldots(1)$$

where,

BCR = Benefit-cost ratio,
L = Geographical location of watershed,
S = Size of watershed,
F = Focus of watershed,
R = Rainfall in the watershed area,
I = Implementing agency of the watershed,
P = People's participation,
T = Time gap between project implementation and evaluation,
A = Various activities performed in the watershed area, and
SL = Type of soil in the watershed area as explanatory variables.

A comparison of different methods applied in estimating benefits from watershed programmes is given in Table 3.1.

Table 3.1: A comparison of methods for impact of watershed programmes

Methods	Major advantage	Major limitations
Conventional analysis	Quick to estimate	Sensitive to discount rate (i) and number of years of the project (n)
Econometric models (ES)	All sectors are included	Elasticity of demand (ed) & Elasticity of supply (es) sensitive
Bio-economic models	Whole system is included; optimization	Too much experimental details
Meta analysis	Provides a macro picture	Aggregation bias

Application of Economic Surplus Approach

The Economic Surplus (ES) method is widely followed for evaluating the impact of technology on the economic welfare of households (Moore *et al.*, 2000; Wander *et al.*, 2004; Maredia *et al.*, 2000; Swinton, 2002). The economic surplus method measures the aggregated social benefits of a research project. With this method it is possible to estimate the return to investments by calculating the variation in consumer surplus and producer surplus through a technological change originated by research. Afterwards, the economic surplus is utilized together with the research costs to calculate the net present value (NPV), internal rate of return (IRR), or benefit-cost ratio (BCR) (Maredia *et al.*, 2000). The model can be applied to the small/large open/closed economy within the target domain of production environment. The term 'surplus' is used in the economic literature for several related quantities. The 'consumer surplus' is the amount that consumers benefit by being able to purchase a product for a price that is less than they would be willing to pay. The 'producer surplus' is the amount that producers benefit by selling at a market price mechanism that is higher than they would be willing to sell for. In the case of watershed programmes, producers are mainly the farm households who produce the goods using the benefits of the watershed interventions such as soil and moisture conservation, watertable increase and livestock improvement activities and consumers are mainly the other stakeholders in the region, viz. non-farm households representing the labourers, business people and people employed in non-agricultural activities.

The micro economic theory defines consumer surplus (individual or aggregated) as the area under the (individual or aggregated) demand curve and above a horizontal line at the actual price (in the aggregated case: the equilibrium price). Following IEG, World Bank (2008), the demand curve is assumed to be log-linear with constant elasticity. Thus, the demand equation for this demand function can be written as Equation (2):

$$P = gQ^{\eta} \qquad \ldots(2)$$

where, h is the elasticity and g is a constant. Once, the parameters h and g are estimated, then consumer surplus can be estimated by Equation (3):

$$CS = \int_{Q_0}^{Q_1} gQ^{\eta} dQ - (Q_1 - Q_0)P_1 \qquad \ldots(3)$$

Combined, the consumer surplus and the producer surplus make up the total surplus.

Estimation of Benefits

Following the theory of demand and supply equilibrium, the economic surplus (benefits) as a result of watershed development intervention is measured by Equation (4):

$$B = K * P_0 * A_0 * Y_0 * (1 + 0.5\, Z * \varepsilon_d) \qquad \ldots(4)$$

where, K is the supply shift due to watershed intervention.

The supply shift due to watershed intervention can be mathematically represented by Equation (5):

$$K = \forall * \rho * \psi * \Omega \qquad \ldots(5)$$

where, K represents the vertical shift of supply due to intervention of watershed development technologies and is expressed as a proportion of initial price. $\forall$ is net cost change which is defined as the difference between reduction in marginal cost and reduction in unit cost. The reduction in marginal cost is defined as the ratio of relative change in yield to price elasticity of supply (ε_s). Reduction in unit cost is defined as the ratio of change in cost of inputs per hectare to (1+change in yield). ρ is the probability of success in watershed development implementation. ψ represents adoption rate of technologies and Ω is the depreciation rate of technologies.

If Z represents the change in price due to watershed interventions, mathematically, Z can be defined by Equation (6):

$$Z = K * \frac{\varepsilon_s}{(\varepsilon_d + \varepsilon_s)} \qquad \ldots(6)$$

where, P_0, A_0, and Y_0 represent prices of output, area and yield of different crops in the watershed before implementation of watershed development programme. If we use with and without approaches, then these represent area, yield and price of crops in control village.

Cost of Project

The analysis considered cost towards watershed development investment during the project period and maintenance expenditure incurred on the project. For watershed development projects with multiple technologies or crops, incremental benefits from each technology and crop were added to compile the total benefits. The worthiness of the watershed development projects was then evaluated at 10 per cent discount rate. Using the above estimates of returns and costs, net present value (NPV), benefit-cost ratio (BCR), and internal rate of return (IRR) were computed.

Study Area and Data Collection

The study was conducted in the Coimbatore district of Tamil Nadu, India. The predominant soil types in this area are red soil, laterite, clay loam, sandy clay loam, and black cotton soil. Differences in soil types have differential impact on the water resources and agricultural production and productivity. The success of the watershed development programmes critically depends on rainfall in the region. The major crops grown were: sorghum, cotton, sugarcane, maize, coconut and vegetables. Of the total cropped area, the area irrigated accounted for 56.82 per cent. The chief source of irrigation in the district was wells. Over the years, there has been a general decline in the water level in the whole of Coimbatore district, which is being attributed to indiscriminate pumping of groundwater. The groundwater resource degradation has in turn resulted in changes in crop patterns, well deepening, and increase in well investments, pumping costs, well failure, and abandonment and out migration of farmers (Palansami and Kumar, 2007). It is in this context that groundwater augmentation by artificial recharge through watershed development programmes gained momentum.

Data

The major data were derived from the recently completed study on Comprehensive Assessment (CA) of Watersheds Programmes in India, implemented by the ICRISAT team (Wani *et al.*, 2008). For the purpose of our study, the data were drawn from a cluster of 10 watersheds implemented in the Coimbatore district of Tamil Nadu. The details of all these watersheds with area treated are given in Table 3.2. A variety of indicators were developed and used for the impact assessment. The indicators of impact of watershed development activities covering soil erosion, groundwater recharge and water resources potential, agricultural production, socio-economic conditions and overall impact including the extent of green cover were developed. To make a comparative study, one control village where no watershed treatment activities were carried out, was selected for each watershed. The control villages were selected so as to have similar agro-climatic conditions. The select indicators were compared with before and after the watershed treatment activities and also

Table 3.2: Details of watersheds covered for study in Coimbatore district of Tamil Nadu

Name of block	Name of watershed	Area (ha)
Annur	Kattampatty I	460.0
	Kattampatty II	467.5
	Kuppepalayam	672.5
Avinashi	Naduvenchery	767.5
	Karumapalayam	752.5
	Chinneripalayam	524.8
Sulur	Arasur I	605.0
	Arasur II	590.0
	Rasipalayam	560.0
Palladam	Kodangipalayam I	455.0

with those of the control village. Thus, the data pertaining to 10 watershed villages and 10 control villages were gathered. The information on price elasticity of demand and supply of various farm products was obtained from the published sources.

Results and Findings

This section presents the key results and findings from the field experience of impact assessment of watershed programmes implemented under the Drought Prone Area Programme (DPAP) in the Coimbatore district of Tamil Nadu. The general characteristics of the sample farm households in the selected watershed were analyzed and have been presented in Table 3.3. It could be seen that the average size of holding was 1.28 ha and 1.75 ha, for watershed

Table 3.3: General characteristics of sample farm households

Particulars	Watershed village	Control village
Farm size (ha)	1.28	1.75
Household size (No.)	3.31	3.34
Land value (₹/ha)	230657	153452
No. of wells owned	1.35	1.20
Average area irrigated by wells (ha)	1.48	1.80
Value of household assets (₹)	261564*	184385
No. of persons in a household	4.07	4.2
Number of workers	2.5	2.1
Labour force participation (%)	61.48	50.79

Note: *indicates that value was significantly different at 10 per cent level from the corresponding values of control village and control villages, respectively. It is evident from the analysis that the average number of workers was 2.5 and 2.1 out of 4.07 and 4.2 persons in a household for watershed and control villages, respectively.

The labour force participation rate came out to be 61.48 per cent for watershed villages and 50.79 per cent for control villages. The higher labour force participation in watershed villages was due to better scope for agricultural production, livestock activities and other off-farm and non-farm economic activities. It is evidenced from the analysis that the labour force participation rate among farmers in watershed villages was higher, implying that the enhanced agricultural production was due to watershed treatment activities. Construction of new percolation ponds, major and minor check dams and rejuvenation of the existing ponds/tanks had enhanced the available storage capacity in the watersheds to store the run-off water for surface water use and groundwater recharge. The additional surface water storage capacity created in the watersheds ranged from 9299 m^3 to 12943 m^3. This additional storage capacity further helped in improving the groundwater recharge and water availability for livestock and other non-domestic uses in the village.

On the basis of the data collected from the sample farmers, it was found that the water level in the open-dug wells had risen in the range of 0.5 - 1.0 metre in watershed villages. The depth of water column in the few sample wells was recorded in both watershed and control villages for a comparison. The depth of water column in the wells was found to be higher in the watershed villages than in control villages. For instance, the depth of water column in the wells in Kattampatti watershed village was 3.53 m compared to 2.16 m in the control villages, leading to a difference of 63.43 per cent.

Information related to the duration of pumping hours before well went dry (or water level depressed to a certain level) and the time it took to recuperate to the same level was collected for the sample farmers across villages. Due to watershed treatment activities, groundwater recuperation in the nearby wells had increased. The increase in recuperation rate varied from 0.1 m^3/ hour to 0.3 m^3/ hour. It was also observed that the recharge to wells decreased with their distance from the percolation ponds and check dams and the maximum distance where the recharge to the wells had occurred was observed to be 500 - 600 m from the percolation ponds

The area irrigated in watershed villages registered a moderate increase after the watershed development activities in most of the watersheds, whereas in the control village it declined slightly over the period. The irrigation intensity was found higher in a watershed-treated village than in untreated village. This shows that watershed development activities had helped increase the water resource potential of a region through enhanced groundwater resources coupled with soil and moisture conservation activities. In the case of control villages, the water table in the wells had declined due to continuous pumping. It is one of the reasons why farmers in most of the villages demand watershed programmes in their villages.

The analysis has also revealed an increase in the net cropped area, gross cropped area and cropping intensity on sample farms in both the watersheds (Table 3.4). For example, the cropping intensity was found as 146.9 per cent in the watershed village, which is higher than that in the control village (133.3%). The composite entropy index (CEI) was used to compare diversification across situations having different and large number of activities. The CEI has two components, viz. distribution and number of crops or diversity. The value of crop diversification index (CDI) increases with the decrease in concentration and rises with the number of crops/activities. In general, CDI is higher in the case of watershed- treated villages than

Table 3.4: Cropped area, cropping intensity and crop diversification on sample farms

Particulars	Watershed villages		Control villages	
	Before	After	Before	After
Net area irrigated (ha)	1.08	1.10***	1.68	1.62
Gross area irrigated (ha)	1.25	1.35**	1.84	1.62
Irrigation intensity	115.74	122.73**	109.52	100.00
Net cropped area (ha)	1.15	1.28**	1.78	1.62
Gross cropped area (ha)	1.38	1.88**	2.43	2.16
Cropping intensity (%)	120.00	146.88	136.52	133.33
Crop Diversification Index (CDI)	1.0		0.97	

Note: ** and *** indicate that values were significantly different at 1 per cent and 5 per cent levels from the corresponding values of control village

Crop diversification index (CDI) was worked out by employing Composite Entropy Index (CEI) based on the proportion of different crops in the farm. The Composite Entropy Index for crop diversification was worked out as:

$$C.E.I = -\left(\sum_{i=1}^{N} P_i.\log_N P_i\right) * \{1-(1/N)\}$$

where,

CEI = Composite Entropy Index,

P_i = Acreage proportion of the i^{th} crop in total cropped area, and

N = Total number of crops.

Table 3.5: Livestock per household and per hectare of arable land

(Number)

Particulars	Watershed village	Control village
Per cent of households	46.67	93.33
Herd size	2.57	2.64
Per hectare of gross cropped area	2.01	1.63

control villages, confirming that watershed treatment activities help diversification in crop and farm activities.

The details regarding livestock per household and per hectare of arable land have been furnished in Table 3.5. The livestock income has been a reliable source of income for the livelihood of the resource-poor farmer households. Cattle, sheep and goats were maintained as important sources of manure and were the liquid capital resource. It could be seen that nearly 46.67 per cent and 93.33 per cent of the households in watershed and control villages maintained cattle. Access to grazing land and fodder had made the farm households in the watershed villages to maintain livestock in their farms to derive additional income. But, the analysis revealed that relatively more number of households in control villages also maintained livestock. It was mainly due to the fact that inadequate grazing land and poor resource-base for stall feeding persuaded them to feed their livestock with green leaves and fodder obtained from crops and crop residues. The farm households in control villages maintained mainly milch animals to derive additional income for their livelihood.

Application of Economic Surplus Method

The impact of watershed development activities on yield of crops and hence the cost was estimated and has been presented in Table 3.6. The change in yield due to watershed intervention across crops varied from 31 per cent in maize to 36 per cent in cotton. It was the maximum change in yield due to watershed intervention. Reduction in marginal cost due to supply shift ranged from 32.8 per cent in vegetables to 63.6 per cent in sorghum. The net cost change varied from 32 per cent in vegetables to 59.8 per cent in sorghum.

The change in total surplus due to watershed development activities was estimated and has been presented in Table 3.7. The change in total surplus was higher in sorghum and maize than crops like pulses and vegetables. Being the major rainfed-crops, these two crops were benefited more from the watershed interventions. The change in total surplus due to watershed intervention was

Table 3.6: Impact of watershed development intervention on yield and cost of crops

Crops/ Enterprises	Change in yield (%)	Reduction in marginal cost (%)	Reduction in unit cost (%)	Net cost change ΔC
Sorghum	33	63.6	3.76	59.8
Maize	31	39.9	2.29	37.6
Pulses	36	41.0	1.47	39.6
Vegetables	32	32.8	0.76	31.9
Milk	28	27.3	7.81	19.5

Note: The reduction in marginal cost was the ratio of relative change in yield to price elasticity of supply (ε_s). Reduction in unit cost was the ratio of change in cost of inputs per hectare to (1+change in yield). Ci was the input cost change per hectare. i.e., C_u = Ci/(1+Change in yield;. The net cost change ∀ was the difference between reduction in marginal cost and reduction in unit cost, i.e., ΔC = Cm–Cu.

Table 3.7: Impact of watershed development activities on the village economy

Crops/ enterprises	Total benefits due to watershed intervention (B)		
	Change in total surplus (ΔTS)	Change in consumer surplus (ΔCS)	Change in producer surplus (ΔPS)
Sorghum	293177.3 (100.00)	113636.3 (38.8)	179541.0 (61.2)
Maize	177774.2 (100.00)	85424.0 (48.1)	92350.2 (51.9)
Pulses	25777.5 (100..00)	12580.3 (48.8)	13197.2 (51.2)
Vegetables	29663.6 (100.00)	10627.5 (35.8)	19036.1 (64.2)
Milk	176878.5 (100.00)	105974.1 (59.9)	70904.4 (40.1)

Note: The figures within parentheses indicate the percentage in respective rows. The change in total surplus in the village economy due to watershed intervention was decomposed in to change in consumer surplus and change in producer surplus. The decomposition of total surplus was as follows:

$$\Delta TS = \Delta CS + \Delta PS = P_0 Q_0 K(1 + 0.5Z\eta)$$

$$\Delta CS = P_0 Q_0 Z(1 + 0.5Z\eta)$$

$$\Delta PS = P_0 Q_0 (K - Z)(1 + 0.5Z\eta)$$

Table 3.8: Results of economic analysis employing economic surplus method

Particulars	Economic surplus method	Conventional method
Benefit-cost ratio	1.93	1.23
Internal rate of return (%)	25	14
Net present value (₹)	2271021	567912

decomposed into change in consumer surplus and change in producer surplus. It was evident that the producer surplus was higher than the consumer surplus in all the crops. For instance, in sorghum, the producer surplus worked out to be 61.2 per cent, whereas the consumer surplus was only 38.8 per cent. Thus, watershed development activities benefited the agricultural producers more. It was interesting to note that unlike in the crop sector, the milk production had different impacts on the society. The decomposition analysis revealed that watershed development activities generated more consumer surplus in milk production.

The overall impact of different watershed treatment activities was assessed in terms of net present value (NPV), benefit-cost ratio (BCR) and internal rate of return (IRR). The NPV, BCR and IRR were worked out using the economic surplus methodology assuming 10 per cent discount rate and 15 years life period.

The BCR was found to be more than one, implying that the returns to public investment on activities like watershed development were feasible. Similarly, the IRR was worked out to be 25 per cent, which is higher than the long-term loan interest rate by commercial banks, indicating the worthiness of the government investment on watershed development. The NPV worked out to be Rs 567912 for the entire watershed. The NPV per hectare was computed as Rs 4542 (where the total area treated was 500 ha), which implied that the benefits from watershed development were higher than the cost of investment on the watershed development programmes of Rs 4000 /ha*.

*However, recently the watersheds in India have been allotted a budget of approximately Rs 6000/ha. Thus, a watershed with a total area of 500 hectares receives Rs 30 lakhs for a five-year period. The bulk of this money (80%) is meant for development/treatment and construction activities. According to the new Common Guidelines 2008, the budgetary allocation is of Rs 12000/ha.

Conclusions and Policy Recommendations

The study has concluded that the watershed impact assessment should be given due importance in the future planning and development programmes. It has demonstrated that the economic surplus method captures the impact of watershed development activities in a holistic manner and assesses the distributional effects, and therefore it would be a fairly good methodology to assess the impacts of watershed development in the country.

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

Watershed development activities have been found to alter crop pattern, increase crop yields and induce crop diversification and thereby could provide enhanced employment and farm income. Therefore, 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 may be introduced. Hence, appropriate water-saving technologies like drip could be introduced without affecting farmers' choice of crops. The creation and implementation of regulations in relation to depth of wells and spacing between them will reduce the well failure, which could be possible through Watershed Users Association. The existing NABARD norms such as 150 metres spacing between two wells should be strictly followed.

People's participation, involvement of Panchayati Raj Institutions, local user groups and NGOs alongside institutional support from different levels, viz. the central and state government, district and block levels should be ensured to make the programme more participatory, interactive and cost-effective.

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4

Technical Indicators to Evaluate Watershed Development Programmes

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Abstract

In the absence of suitable common minimum indicators, the effective monitoring and evaluation of a watershed programme is difficult and uncertain. In this chapter, a few technical indicators have been listed and used during pre-project and post-project periods to evaluate the overall impact of watershed development interventions in different agro-ecological regions. These indicators include land levelling index, crop productivity index, crop diversification index, cultivated land utilization index and induced watershed eco-index. In addition to these, some other indicators discussed are: water resource development indicators, runoff and soil loss, soil loss index, storage efficiency, utilization efficiency, water storage capacity utilization index, livestock composition index, carrying capacity improvement index, etc. The study has suggested that beside these, many more indicators need to be developed to analyze the impact of multi-sectoral activities of a watershed development project.

Introduction

Since 1960s many soil conservation and watershed development projects have been undertaken in the world under diverse agro-climatic conditions. These projects usually aimed at reducing soil erosion and preventing land degradation besides increasing crop and biomass productivity. However, while evaluating these projects, during and post-project periods, it was observed that no concrete conclusions could be drawn, mainly due to non-availability of tools and techniques for effective monitoring of project outcomes and impacts (de Graaff *et al.*, 2007).

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A huge knowledge gap exists with respect to the impact of soil and water conservation technologies in particular, such as the effectiveness of on-farm technologies in controlling soil erosion, their impact on human and natural resources, cost-benefit ratios, or the level of integration into prevailing farming systems (Liniger *et al.*, 2002). The reasons for this may be numerous. But development programmes generally seem to lay more emphasis on performance rather than impact. Another issue that prevents people from seriously dealing with impact monitoring is the fact that no one wants to admit negative effects when this could lead to a loss of funding (Herweg, 2007).

There is a need to monitor and evaluate the impact of soil conservation and watershed development projects that are multi-sectoral in essence from various points of view to achieve the objective of sustainable development. This means identifying the variables that the interventions are aiming to affect, indicators of those variables, and the people who are the intended beneficiaries. To be able to verify to what extent the activities contribute towards the objectives, clearly defined indicators need to be established for these objectives. Since objectives often relate to both physical factors, such as erosion and hydrological status, and socioeconomic and sustainability factors, including local institution development, capacity building, participation rates, financial performance and resource leveraging, a wide range of direct or proxy indicators need to be established. In this paper, bio-physical indicators to assess the impact of watershed interventions have been briefly discussed.

Technical/Bio-Physical Indicators for Watershed Projects

A number of bio-physical outputs are derived from the watershed development projects. Each can be classified into several sub-groups or sub-parametric areas. Assessing the changes brought about in these sub-groups would demand a large number of indicators. Thus, sub-parametric areas should be short-listed and then appropriate indicators should be chosen for each sub-parametric area (Das *et al.*, 2007).

The Central Soil and Water Conservation Research and Training Institute, Dehradun, Uttarakhand (India) has evolved several indicators for monitoring and evaluation of some bio-physical impacts of the watershed development projects in the country. These indicators relate only to the tangible impacts, though watershed management projects yield many intangible benefits, which are often difficult to quantify and assign monetary values to them. However, an attempt was made to evaluate the intangible benefits from a model watershed (Fakot, North-western mid-Himalayas), which revealed that intangible benefits very well outweigh the tangible benefits and are 4 to 5-times higher than the total cost of development of a watershed.

Technical/Bio-Physical Indicators Evolved and Tested

Participatory watershed management concept as enshrined in the guidelines of Govt. of India was successfully demonstrated through development of six model watersheds in different agro-ecological regions of the country, namely Eastern Ghats, Western Ghats (Nilgiris), Shivaliks (Himalayan foot-hills), Bundelkhand region, Western Coast Gujarat Plain and Chambal Ravines having diverse physiographic, climatic and socio-economic conditions. The watersheds were developed under Integrated Wastelands Development Programme (IWDP) of MoRD following guidelines of 1994. The morphological characteristics and socio-economic features of the six watersheds are presented in Table 4.1 (Sharda *et al.*, 2005). Need-based developmental interventions were undertaken in the watersheds as per the problems, needs and priorities of the watershed community and their technical feasibility. A mix of engineering and biological measures was adopted for the treatment of a watershed so as to make it cost-effective within the prescribed norms.

For the development of arable lands, mechanical measures like land shaping, levelling, terracing and bunding were undertaken in the watersheds. Construction/strengthening of contours, and graded and field bunds were also undertaken. Grasses were planted on bunds in the Kokriguda watershed to reduce the scouring velocity of runoff, and in the Aganpur-Bhagwasi watershed for stability and fodder production. To safely dispose off excess runoff from cultivated fields, several disposal structures were constructed in the Aganpur-Bhagwasi and Kokriguda watersheds. For the efficient management of precious water resource, drip irrigation was introduced in the Salaiyur watershed keeping in view the low irrigation efficiency, fast depleting groundwater resource and farmers' preference for irrigation-intensive crops like coconut, banana and sugarcane. In addition to these crops, this system was also adopted for mulberry, mango and tamarind plantations. Crop improvement was one of the major activities in all the six watershed development projects.

Table 4.1: Details of IWDP watersheds implemented by research centres of CSWCR&TI, Dehradun

Watershed	District & state	Agro-ecological region	Area (ha)	Elevation range (m) amsl	No. of families	Population	Average land-holding size (ha)	Average annual income (₹ / family)
Aganpur-Bhagwasi	Patiala (Punjab)	9	550	80-286	166	1150	1.72	30,523
Antisar	Kheda (Gujarat)	5	812	25-35	500	2104	3.12	16,247
Badakhera	Bundi (Rajasthan)	5	682.5	150-173	117	1117	3.23	25,811
Bajni	Datia (Madhya Pradesh)	4	532	263-284	176	993	1.10	18,597
Kokriguda	Koraput (Orissa)	12	317.5	880-1329	78	249	2.15	12,155
Salaiyur	Coimbatore (Tamil Nadu)	19	513	370-472	314	1314	1.98	19,837

For development of non-arable lands, drainage line treatment in the form of construction of checkdams and gully plugs was undertaken in the Badakhera, Aganpur-Bhagwasi, Antisar and Salaiyur watersheds for the protection of channels from further deepening, arresting their encroachment into agricultural fields and prevention of gully-head extension. Mechanical measures also included graded bunds and contour trenches, supported with vegetative measures. Vegetative barriers of recommended grasses were transplanted along field bunds and torrent banks, across gully beds, and near engineering structures for their stabilization in the Aganpur-Bhagwasi and Badakhera watersheds. Water resources development was undertaken in five watersheds through renovation/rejuvenation of the existing ponds and abandoned stone quarries, and repairing of earthen dams. Wherever feasible, water harvesting structures like percolation / sunken ponds and well recharge structures were constructed. Development of perennial horticulture/agro-forestry crops was accorded due importance in each watershed, e.g. plantation of poplar in Aganpur-Bhagwasi, and of mango, tamarind and coconut in Salaiyur. Afforestation and pasture development works were undertaken in the Antisar and Badakhera watersheds.

Monitoring and evaluation of various developmental interventions were carried out during the implementation phase to quantify their impact on productivity and ecology by evolving and employing appropriate indicators. The following indicators were evolved and used in the pre-project and post-project scenarios to evaluate the overall impact of the watershed development interventions in different agro-ecological regions:

- Land levelling index
- Crop productivity index
- Crop diversification index
- Cultivated land utilization index
- Induced watershed eco-index

Land Levelling Index

Land Levelling Index (LLI) is the ratio of recommended land slope to the existing or treated land slope. A higher value of LLI is a measure of better moderation in land slope. The LLI value ranged from 0.02 to 0.49 with weighted average of 0.37 for the six watersheds which improved to between 0.5 and 1.0, with weighted average of 0.65 after the land improvement interventions (Figure 4.1). This helped in the uniform distribution of rainwater and

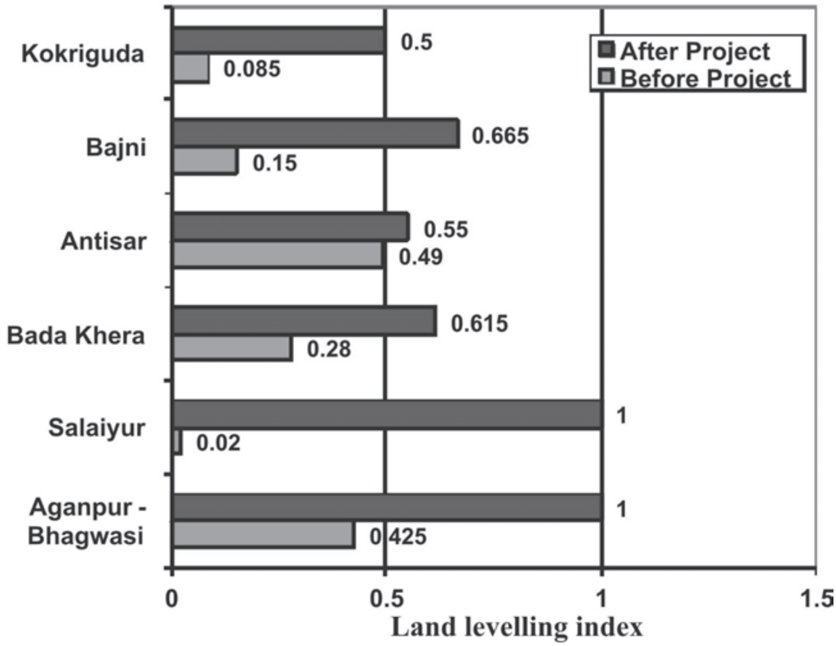

Figure 4.1: Improvement in the Land Levelling Index value on arable lands

availability of moisture in the soil profile, which in turn improved the crop yields.

Crop Productivity and Crop Diversification Indices

Various agronomical interventions in the six watersheds improved the yields of traditionally-grown crops from 9 per cent (ladyfinger, Salaiyur) to 256 per cent (tomato, Kokriguda). The overall crop productivity of the watersheds measured in terms of the Crop Productivity Index (CPI), which indicates the extent of crop productivity level in comparison to the normal yield of crops before and after the project, was found to increase by 12 to 45 per cent depending upon the location and type of crops (Table 4.2). Considering five watersheds together, CPI improved from 0.50 in the pre-project period to 0.64 after the project implementation (Figure 4.2). In the case of Antisar watershed, the maize equivalent yield (kg/ha) of all the crops increased by 37 per cent.

In addition to the introduction of high-yielding varieties (HYVs) of traditional crops, some new crops were also introduced in the watersheds for better economic returns through crop diversification. For assessing the changes in the cropping patterns/systems, Crop Diversification Index (CDI) was used, which increased by 6 per cent to 79 per cent in all the watersheds, except in the Badakhera

Table 4.2: Water resource development in the IWDP watersheds

Watershed	Water storage capacity created (ha-cm)	Wells influenced (%)	Increase in well recharge rate (%)	Irrigated area increase (%)
Aganpur-Bhagwasi	NA	NA	NA	NA
Antisar	1584	73	23	90
Bada Khera	256	20	6	65
Bajni	144	50	50	585
Kokriguda	121	NA	NA	583
Salaiyur	266	46	10 -15	84

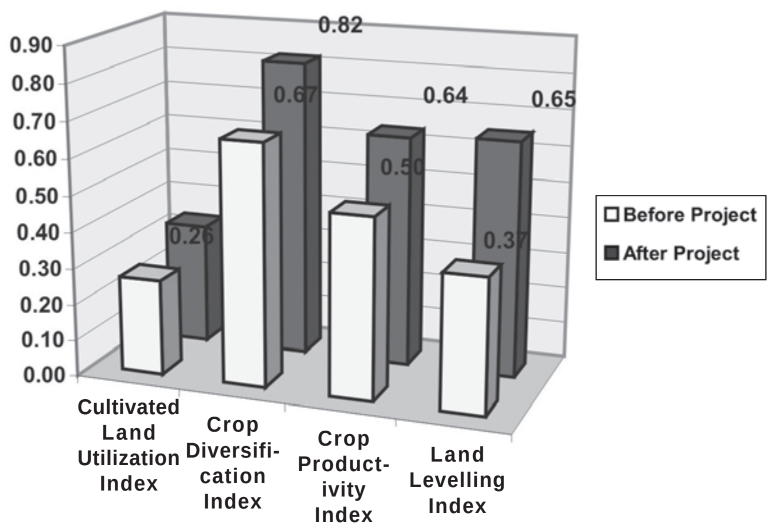

Figure 4.2: Improvement in various parameters as an indicator of overall watershed development

watershed where it declined by 32 per cent (Table 4.2). However, the overall diversification of crops considering all watersheds together improved from 0.67 during the pre-project period to 0.82 after the project implementation (Figure 4.2).

Cultivated Land Utilization Index

Cultivated Land Utilization Index (CLUI) indicates the impact of watershed interventions on changes in cultivable land area and duration of crop cultivation in pre-project and post-project periods. The index value estimated for each of the six watersheds under study showed that land utilization improved by 2 to 81 per cent.

Thus, more and more cultivated area was brought under cultivation for longer durations as a result of agronomical interventions. The overall utilization of cultivated land considering the six watersheds together showed that CLUI had increased from 0.26 before the project implementation to 0.33 in the post-project period (Figure 4.2).

Induced Watershed Eco-Index

Vegetative measures implemented in the arable and non-arable lands in conjunction with the mechanical measures helped in soil moisture conservation, which resulted in establishment and regeneration of vegetation and provided additional green biomass cover to the soil in all the watersheds. Induced Watershed Eco-Index (IWEI) calculated as the additional area made green through watershed interventions in proportion to the total watershed area varied from 0.042 to 0.28 with an average of 0.12 among the six watersheds, thereby indicating that additional 12 per cent watershed area was rehabilitated through green biomass cover.

Water Resource Development Indicators

Additional water storage capacity ranging from 121 ha-cm to 1,584 ha-cm with an average of 474 ha-cm was created in 5 watersheds as a result of various water resource development activities (Table 4.2). It helped in significantly augmenting the groundwater recharge, which was reflected through the increase in recharge rate of 20 per cent to 73 per cent wells located in the influence zone of the water harvesting structures by 6 per cent to 50 per cent in the four watersheds having open/bore wells for irrigation. The irrigated area increased in these watersheds ranging from 65 per cent to 585 per cent, with an average of 206 per cent, giving a tremendous boost to the crop yields/production and farmers' income. In the Kokriguda watershed, the increase in irrigated area is attributed to underground pipeline irrigation system that diverted water from a perennial stream. During the years of low rainfall, water from the wells provided life-saving irrigation to the crops thereby mitigating the effect of drought.

Runoff and Soil Loss

Various mechanical and biological measures including water resource development implemented with active participation of the watershed community helped in arresting the rainwater within the watersheds, which reduced runoff ranging from 9 per cent to 24 per

Table 4.3: Impact of interventions on surface runoff and soil loss in the IWDP watersheds

Watershed	Surface runoff (%)		Soil loss (t/ha/year)	
	Before Project	After Project	Before Project	After Project
Aganpur-Bhagwasi	48.5	24.0	12.6	2.8
Antisar	33.0	16.0	0.405	0.042
Bada Khera	30.0	10.0	40.0	10
Bajni	25.4	16.3	12.1	8.3
Kokriguda	36.8	12.4	38.2	6.6
Salaiyur	4.5–7.2	1.3	1.7–8.9	0.5–1.6

cent (Table 4.3). In the Salaiyur watershed, pre-project runoff which was already low was further reduced to 1.3 per cent. Consequently, soil loss from the watersheds also reduced drastically in the range of 0.042-10 t/ha/year, which is well within the permissible limits. In the case of Kokriguda and Badakhera watersheds, soil loss reduced by as much as 75 per cent to 82 per cent from initial rate of 38-40 t/ha/year.

In addition to the above indicators, some more biophysical indicators were also evolved subsequently, which need to be tested and evaluated in the on-going watershed development programmes.

Soil Loss Index

Soil Loss Index indicates the changes brought about in the soil loss occurring in a watershed in terms of ratio of soil loss tolerance limit to the prevailing soil loss in a watershed. The value of this index can vary from 0 to 1.

Storage Efficiency

Storage efficiency of water harvesting structures can be evaluated as a ratio of actual water stored to the designed storage in the live storage capacity. The efficiency can vary from 0 to 100 per cent.

Utilization Efficiency

Utilization efficiency of the stored water can be computed as a ratio of the total live storage excluding water lost through seepage, evapo-transpiration and the unutilized part, and the total actual water stored in live storage. The efficiency can vary from 0 per cent to 100 per cent.

Water Storage Capacity Utilization Index (WSCUI)

WSCUI evaluates jointly the twin aspects of water conservation, i.e. conservation of water available from all the potential resources within the watershed and its optimal utilization by assigning proper weights to the two aspects and then adding the products. The index can vary from 0 to 100.

Irrigability Index

Irrigability Index is the ratio of additional gross irrigated area and net incremental irrigated area. Gross irrigated area may be obtained by adding the net incremental irrigated area as many times as it was irrigated. The index can vary from 0 to infinity.

Conserved Water Productivity Index

Conserved Water Productivity Index helps in assessing the change in the form of ratio of sum of average equivalent yields per unit of utilized conserved water of crops that were irrigated in terms of targeted production. The value of the index can vary from 0 to 100.

Drought Resilience

For measuring the drought tolerance of a watershed, the ratio of sum of weighted equivalent yields of food, fodder and horticultural crops during drought and normal years can be utilized. The drought tolerance indicator can be estimated for rainfed, irrigated and watershed as a whole for the adopted watershed and non-adopted area outside the watershed. The value of the indicator can vary from 0 to 1.

Crop Fertilization Index

For assessing the fertilizer consumption, the ratio of actual consumption of NPK and as per recommended NPK doses is a useful indicator. The value of crop fertilization index varies from 0 to 1.

Livestock Composition Index

For measuring the change in livestock composition, the ratio of total livestock units of improved breeds of cows and buffaloes and total livestock units of local breeds of cows and buffaloes is a useful indicator. The ratio can vary from 0 to infinity.

Carrying Capacity Improvement Index

For assessing the carrying capacity of the watershed in terms of fodder supply for supporting its livestock population, the carrying capacity index is a suitable indicator. It is the ratio of the quantity of fodder available and required for the existing livestock population. The value of the index varies from 0 to 1.

In addition to the above indicators, many more need to be developed to analyze the impact of multi-sectoral activities of watershed development projects that have not been addressed in the present set of indicators. Once the appropriate indicators are evolved and tested, they need to be adopted on a large scale in the ongoing watershed development programmes in the country. It would facilitate periodic assessment of the projects in terms of watershed interventions and their impact on the biophysical attributes to justify economic viability over a period of time, besides many intangible benefits accrued from different activities. The indicators will then help in comparing the watershed development projects more systematically in a region, within a state as well as across the states.

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5

Social, Institutional and Environmental Impacts of Watershed Programmes: Some Conceptual and Methodological Issues

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Abstract

This chapter highlights the role of and importance of environmental, socioeconomic and institutional indicators to evaluate the impact of a watershed development programme (WDP). It has been emphasized that although these are closely inter-connected, the institutional aspect is a critical link that shapes and governs the inter-linkages among these three sets of indicators. It is pointed out that formulation and functioning of institutions like Watershed Development Committee (WDC), User Groups (UGs), and Self-help Groups (SHGs) are very critical for ascertaining the actual impacts of a WDP. The chapter has highlighted that socioeconomic indicators should cover aspects like improvement in access to drinking water, common property land resources (CPLRs) and fodder/ feed; food intake; change in cropping pattern and net income from crops, increased income from livestock, improved access to markets, credit, irrigation facilities, etc. The environmental indicators could include land use, vegetation cover, soil erosion, soil-moisture status, groundwater status, crop diversity, etc. Finally, some of the methodological issues involved in the impact assessment of WDPs have also been highlighted.

Context: The Larger Concerns

Watershed Development Programme (WDP) is more of an approach for development rather than merely a scheme for natural resource management (NRM). The broader developmental connotation of WDPs in India emanates from the multi-functionality

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of the programme that aims at simultaneously addressing the social, economic and environmental objectives with an ultimate goal of attaining sustainable development and livelihood promotion among rural communities including the poor and the vulnerable segments of the society.

The multi-functionality of a WDP as an approach to development entails five sets of larger concerns: (a) Stability in production, which may eventually lead to drought-mitigation in the long run; (b) Equity in benefit-sharing across space, class, caste, and gender; (c) Viability of economic returns; (d) Diversity and sustainability of resource use; and (e) Security of access to basic resources such as drinking water, food, fuel & fodder, and livelihood. Together these may culminate into significant and positive changes in terms of three sets of indicators viz., bio-physical (environmental), socio-economic, and institutional.

One of the important pre-conditions for attaining these multiple objectives is to evolve an integrated approach across natural resources (land, water, vegetation); livelihood activities (crops, livestock, forestry; and non-land based enterprise); and communities (landed, landless, women). Integration thus, constitutes a core concept in watershed-based development in India. Conversely, assessment of the impact of watershed development projects should also be seen through the lens of 'Integration'. The three sets of impact indicators, noted above, therefore should be seen in an inter-connected and integrated manner where the bio-physical aspects focus mainly on the technological interventions and selection of treatments for enhancing resource diversity and sustainability; the socio-economic impacts refer mainly to the economic viability and equity in benefits; and the institutional aspects refer to the norms and arrangements for ensuring sustainability, economic viability and equity in sharing of the benefits resulting from the progaramatic interventions.

It is the contention of this paper that although closely inter-connected, the institutional aspect is a critical link that shapes and governs the inter-linkages among the three sets of impacts of watershed development programmes.

Institutions — A Critical Link in WDPs

Figure 5.1 presents a simple outline of a framework, highlighting the central role that institutions may play in the attaining the bio-physical (environmental) and socio-economic impacts of watershed development in the Indian context.

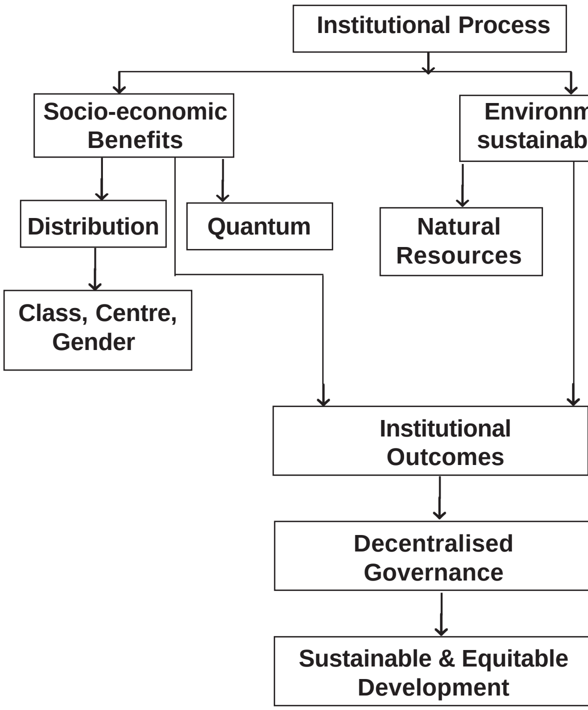

Figure 5.1: Role of institutions in watershed development — A framework

According to this framework, the nature and quality of institutional processes hold the key for determining the bio-physical/ environmental and socio-economic impacts of watershed projects in a given setting. More intense and broad-based the processes are, better would be the impacts (other things being equal) in terms of environmental sustainability, economic viability and equity.

In what follows we present a check list of important indicators for gauging the institutional processes, and also for assessing the socio-economic as well as environmental impacts of WDPs.

Environmental Indicators: Key Questions

Gauging the efficacy of institutional processes as well as outcomes is one of the least-explored areas in the literature on impact assessment of NRM-based projects in general and WDPs in particular. One of the most widely used frameworks in this context is that of the 'Stages of Participation' propagated by Aggarwal (2001). More recently, a non-governmental organization called Watershed Support Services and Activities Network (WASSAN) has developed and field-tested some of the process indicators for different stages of implementation of WDPs.

Though conceptually valid, the major difficulties arising in assessing the institutional process is the mismatch between the dynamic nature of the processes and the quantitative and one-time survey-based tools often used for gauging the effectiveness of the institutional processes. Another important constraint arises from the fact that much of the institutional assessment takes place after completion rather than during the period of the project implementation. Hence, instead of listing the final indicators, it would be useful to identify the key questions that one may have to investigate in order to gauge the institutional aspects of watershed projects. Some of these have been listed below:

Watershed Development Committee (WDC) and User Groups (UGs) are the core institutions created through a watershed project. Whereas the WDC takes up the responsibilities of decision making, execution and fund-management, the UGs have the mandate of managing the structures/assets created by the project. Self-help groups (SHGs) are established primarily for catering to the poorer segments, especially the landless and women, within the community. Though not directly linked to watershed development, SHGs are key institutions that may provide a potential link of the poor with the project.

Experience over a large number of micro watershed projects in India has shown that the nature and intensity of the processes adopted prior to the formation of WDC play a fairly deterministic role in explaining the actual functioning of WDC in terms of the decisions taken, efficacy of execution, and arrangement for post-project management of the assets created during the project phase.

Ideally, a WDC should have representation from different segments of the community; this has been also mandated through the project guidelines. The formation of a WDC should be through a Gram Sabha, which should elect/select the members of the WDC through processes of contestation and reconciliation. These initial processes are very critical for democratic functioning of a WDC, which eventually may help in taking care of the larger concerns like social equity, economic viability and environmental sustainability of the project. If not properly mediated, these processes have a tendency of getting hijacked by the elite capture that one observes in most of the institutional processes in a rural setting.

The reality, as obtained in a large number of cases, indicates that WDC-members are usually selected rather than elected. And, that the selection is often guided by the existing power structure within the community. The representatives from weaker sections such as SC/ST, women/landless, etc. are generally silent spectators in the decision-making processes. As a result, the key decisions like nature of the watershed treatments, their scale and location; deployment of local workers; norms for sharing of costs and benefits, etc. are generally taken by the powerful and the resourceful within the WDCs. Once these decisions are taken, the options and the spaces for the weaker sections to derive benefits from the projects, by and large, are foreclosed. For example, the key decisions are largely missed out on the poor's concerns like drinking water, CPLRs-management; access to fodder and fuel wood; share in the augmented water resources; norms for using the scarce water for irrigation; wage rates and payment to local labourers, timings of the labour work, etc. The weaker sections are left with very limited stakes and hence, interest in the functioning of the WDC. Similarly, if norms for accessing benefits from the watershed projects are not properly laid down right in the initial stage of processes, it is likely to be almost impossible for the beneficiaries to share part of their gains from the project with those who have been left out.

Together the realities depicted above imply that if not properly taken care of, the initial processes for setting up of a WDC could mar the rest of the processes during the stages of execution and also post-project management.

Some of the important indicators for gauging these institutional processes therefore could include the following:

Processes and Composition of WDC, UGs and SHGs

(a) Who are the members of the WDC and UGs and also SHGs?

(b) How are they selected/ elected?

(c) Who dominates the decision making processes? Is there any built-in mechanism for checks and balance within or outside the WDC?

(d) Whether the conflicting interests in the projects were brought to the surface and discussed while taking the key decisions by the WDC?

(e) What has been the process of reconciliation/conflict resolution? And what have been the outcomes with respect to the interests of the poor?

(f) How regular and frequent the meetings are held? Who participate? How convenient are the timings and the venue for the meetings? Is there any follow up for the absentee members?
(g) How well are the minutes of the meeting recorded and maintained? Are these records available to the members on request?
(h) What is the mechanism for sharing of the key decisions with the community at large?

Post-Project Sustenance of the Institutions

Whether the WDC survived after completion of the project?

(a) Was there any handing over process for future management of the project funds/assets and resource-use?
(b) Who takes care of the assets created under the project? Who pays for that? Is there any norm for sharing of costs or cross subsidization?
(c) Whether local communities were involved in labour work and supervision/quality checks?
(d) Are there set norms for the use of CPRs? Who laid out them? How were they communicated to the community?

The questions raised above, at best, provide a minimum checklist of the issues that need to be assessed while gauging the nature and intensity of institutional processes at different stages of the project. Ideally, each of these questions may require in-depth probing rather than merely gathering of information on these aspects.

A nuanced understanding on how the institutions were formulated and how did they function during the project is very critical for ascertaining the actual impacts on the other two sets of indicators, viz. bio-physical and socio-economic, and also help in explaining the reasons behind the observed impacts.

Given this context, we may now quickly go through some of the major indicators of bio-physical (environmental) and socio-economic impacts of watershed projects.

Socio-Economic and Environmental Indicators

The socio-economic indicators primarily focus on the two aspects of larger concerns, viz. equity (across class, caste/ethnicity, gender), and space, i.e. upper and lower reach). The central questions that need to be raised are: Who benefits? How much? and through what kind of interventions / investment? These questions need to be asked while examining some of the important indicators of socio-economic impacts of the watershed projects. This implies a matrix of checklist with the above key questions on the one axis and the specific socio-economic indicators on the other.

Socio-Economic Indicators: Who Benefits and How Much and at What Cost of Investment?

(a) Improved access to drinking water, CPLRs, fodder/fuel especially to the poor

(b) Economic benefits including increased cropped land and cropping intensity; water for irrigation; change in cropping pattern and net income from crops; increased income from livestock, inland fishery; promotion of non-land based activities (NLBA); improved access to inputs & output markets as well as credit; reduced cost of inputs including irrigation; and increase in employment opportunities over a sustained period of time.

c) Increased attainment of literacy among children; health care; and food intake

Environmental Indicators: Mapping the Changes

With the central thrust on soil-water conservation, bio-physical or environmental impacts constitute the core of watershed development. A number of indicators have been identified by the soil scientists, hydrologists, and forestry experts for mapping the changes in bio-physical features within the treated watersheds. We have not gone into the technical details of these indicators as this aspect has been covered elsewhere in this volume by technical experts on the theme. In what follows we have drawn out a list of indicators that need to be monitored and assessed with respect to the changes that have occurred due to various watershed treatments. The list includes the changes in:

- Land use
- Vegetative cover including CPLR
- Soil erosion at critical points that are prone to high erosion rate and damage to canopy in the upper reach, crop land, and water harvesting structures

- Status of soil-moisture and crop survival during extended dry period/droughts
- Number of water bodies and water table thereof during different seasons
- Groundwater recharge and water balance, and
- Diversity of crops, vegetation and farming system with special thrust on livestock.

While these are fairly simple lists of indicators for capturing socio-economic-environmental impacts of WDPs, ascertaining the impacts is a fairly complex phenomenon. A standard approach to capture the changes due to the project is to adopt a double-difference method by taking simultaneously before-after and with-without comparison. In reality, such information is difficult to obtain, thus making comparison a tricky proposition. It should be kept in mind that the above indicators need to be examined at different levels as noted below.

Levels of Enquiry

(a) **Institutional Impact**: Households (across social groups and spatial location with respect to upstream-downstream), Community-based Groups, including User Groups, Watershed Committee, Project Implementation Agency, Gram Sabha

(b) **Socio-Economic Impacts**: Households, Intra-households Differences, Treatment-specific Beneficiaries

(c) **Environmental Impacts**: Plots, Upper-Lower Reaches, Micro and Mini Watersheds

Combining Tools

The multi-layered assessment using multiple indicators would require combining of various tools such as ‘Surveys’ (households, institutions), ‘Focus Group Discussions’, ‘Physical Verification and Resource Mapping’, and RS-GIS data as well as techniques. Baseline surveys are critical for assessing the impacts, especially for the bio-physical (environmental) indicators.

Methodological Limitations and Way Forward

The list of impact indicators presented above, highlights the multifunctional nature of watershed projects, which in turn, makes the task fairly complex. Apart from the issues of measurement, quantification, and recall, there are serious issues of establishing causality thereby attribution. The problem of ascertaining the changes arise particularly in the light of the fact that WDPs take a fairly long time before unleashing the entire impact. Also, there are issues of attribution as similar interventions also come through farmer's own initiatives and/or other developmental schemes in the same area.

Some of the methodological issues involved in the impact assessment of WDPs are briefly noted as follows:

(a) Watershed development, as noted earlier, is an approach for NRM-based development; the impact assessment, however, gets bound by the project-specific interventions and initiatives.

(b) Baseline data are seldom collected and selection of control situations (without project like interventions) for a comparison is difficult to identify.

(c) The actual impacts take a fairly long time to realize, whereas impact assessments are generally undertaken immediately after completion of the project.

(d) Improvements in bio-physical indicators are not systematically linked with the expected changes in socio-economic impacts in the absence of proper mechanisms for linking these two.

(e) Assessments are usually linked to a micro watershed rather than at larger scales of watershed boundaries. As a result, downward impacts ofmicro (or milli) watersheds are missed out in the assessment.

(f) While increasing application of high-tech, high-cost methods, tools are important for improving accuracy and expanding the coverage of the assessment beyond micro watersheds, this may lead to neglect of participatory tools and low-cost methods available for impact assessment on a larger scale.

(g) The aggregate measures of economic/financial returns or reduced soil erosion and increased irrigation as well as crop productivity tend to mask the unequal and non-sustainable nature of the impacts.

Excessive emphasis on assessing or valuing the outcomes in monetary terms is likely to result into limited understanding of the socio-ecological processes through which resources get regenerated, technologies get adopted, and modified, conflicts get negotiated and resolved, and social norms get constructed. These processes are critical for addressing the larger concerns of a watershed based development.

Way Forward

(a) Resolving Practical Difficulties

The above limitations get juxtaposed by a number of practical difficulties that need to be addressed even when the basic limitations may not get completely resolved. The practical difficulties arise during both baseline as well as impact assessment studies. The specific aspects that need special attention are:

- **For Baseline Survey**: The issues for baseline survey are: lack of clarity on delineation of micro watershed boundaries; non-availability of data on rainfall below the district level; occurrence of multiple interventions simultaneously within the study area; installation of simple gadgets for monitoring of bio-physical parameters become difficult in the absence of a proper institutional arrangement in place, getting access to village level data and maps is also cumbersome.
- **For Post-Project Study**: Choice of the terminal and base year for comparison; segregating the project-impacts from that of other similar interventions/schemes in the village (i.e. the problem of attribution); difficulty in recall and records finding from WDC and other community-based institutions created during the project period; non-compatibility of information from different secondary sources; primary data getting influenced by the project functionaries (including the project implementing agency); scare of evaluation leading to reporting errors by the respondents.

(b) Need to Shift Towards

The efforts therefore should shift from the emphasis of impact assessment mainly from enquiring; 'whether the impacts have been realized or not and how much? To probing into 'how to make the impacts larger, equitable and more sustainable? An assessment such as may bring better insights and into the dynamic scenarios within which watershed-based development takes place on ground.

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Programme of National Workshop
on
Methodological Issues in Assessing Impact of Watershed Programmes

Venue: NASC Complex, Pusa, New Delhi

6 August 2010

09:00-09:30	Registration
09:30-10:30	Inaugural Session
	Welcome
	Prof. Ramesh Chand, Director, NCAP
	Background of the Workshop
	Dr A K Sikka, Advisor, NRAA
	Chief Guest Remarks
	Shri B K Sinha, Secretary (RD), Govt. of India
	Chairperson's Address
	Dr J S Samra, CEO & Chairman, NRAA
	Vote of Thanks
	Dr Sant Kumar, Senior Scientist, NCAP
10:30-11:00	Tea/coffee and group photograph
11.00-14.00	**Technical Session I: Methodological issues in assessing impact of watershed programmes**
	Chairperson: Prof. R.S. Deshpande, Director, ISEC, Bangalore
	Rapporteur: Dr P. Shinoj, Scientist, NCAP
11:00-11:40	Economic indicators and methodology for evaluating watershed programme *Dr K. Palanisami, Director, IWMI-TATA Programme & Dr Diwakar Parsi, ISRO*
11:40-12:00	Technical indicators to evaluate watershed development programmes *Dr V.N. Sharda, Director, CSWR&TI & Dr B.Venkatswarlu, Director, CRIDA, Hyderabad*

12:00-12:20	Social, institutional and environmental indicators *Dr Amita Shah, Director, GIDS*
12:20-12:40	Management and financial indicators *Sh Arvind G Risbud, Executive Director, MYRADA*
12:40-13:00	Sustainable livelihoods indicators *Sh Dharmendra, Sambodhi Research and Communications*
13:00-13:45	Open discussions and flagging of issues
13.45-14.00	Chairperson's remarks
14:00-15:00	Lunch
15.00- 16.00	**Technical Session II: Discussion on Common indicators and framework to evaluate impact of watershed programmes** **Working group I: Methodology for monitoring & evaluation mechanism** Convener : Dr K. Palanisami, Director, IWMI-TATA Programme, ICRISAT Co-Convener : Shri M. Crispino Lobo, Managing Trustee, WOT, Ahmednagar **Working group II: Policy and institutional issues** Convener : Dr Dinesh K. Marothia, Former Prof. IGAU, Raipur Co-Convener : Mr Surendra Kumar, DIG (WM), DoLR, GoI
16.00-16.15	Tea
16.15- 17.00	**Technical Session III: Discussions and Concluding Remarks** Chairperson : Dr A.K. Sikka, Technical Expert, NRAA, GoI Co-Chairperson : Additional Secretary, DoLR, GoI Rapporteur : Dr A. Suresh, Senior Scientist, NCAP
16:15-16:25	Chairpersons's opening remarks
16:25-16:35	Presentation by working group I
16:35-17:45	Presentation by working group II
16.45-16.55	Chairperson's concluding remarks
16.55-17.00	Vote of Thanks *Prof. Ramesh Chand, Director, NCAP*

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