Appendix I
An Appeal

Sir/Madam!

This research study about “Watershed Management in Kancheepuram District” is being undertaken for the purpose of Ph.D. Degree of the University of Madras. Data collected through this schedule would be used only for research purpose. Complete anonymity would be maintained in the analysis and in the interpretation of data. I request you to cooperate and commit your valuable time.

Thank you for your cooperation.

Dr. M Kennedy Stephenson
Vaseekaran
Assistant Professor,
Supervisor and Guide
Dept of Politics &Public Administration,
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Chennai-600 005

S V Murugan
Ph.D Research Scholor (Part Time)
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Chennai- 600 005
### PART – I

**Questionnaire for Beneficiaries**

1.1 Name of the Watershed:  

1.2 Name of the Village / Hamlet:  

1.3 Respondent details:  

<table>
<thead>
<tr>
<th>Name &amp; Address of the Respondent</th>
<th>Male (1) / Female(2)</th>
<th>Age</th>
<th>Literate Educational Qualification</th>
<th>Illiterate</th>
<th>Community OC(1), BC(2), MBC(3), SC(4), ST(5)</th>
<th>Landholding in ha</th>
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<tbody>
<tr>
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<td>1-5 (2),6-8(3)</td>
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<td>9-10(4),11-12(5)</td>
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<td>UG(6), PG(7)</td>
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<td></td>
<td>Other(8)</td>
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</tr>
</tbody>
</table>

1.4 Occupation: Farmers (1), Agriculture Labor (2), NAL (3), Others(4)  

1.5 Years of Experience:  

1.6 Project Under: WDF(1), IWMP(2)  

1.7 River Basin: Palar(1), Oongur(2)  

### 2.0 AWARENESS

2.1 Are you aware of the implementation of Watershed development program in your village: Yes(1), No(2)  

2.2 If yes, how do you come to know about it (Please tick): Public Display (1), Implementation Officials (2), Farmers (3), Panchayat (4), Relatives (5), Friends (6)  

2.3.0. Are you aware of how the program is executed by: People (1), Others (2), None (3)  

2.3.1. Payment made through: VWC (1), UG (2), Others (3), None (4)  

### 3.0 TRAINING

3.1 Have you attended any training program? If yes, : Yes (1), No (2)  

3.2 Do you think that the training is really useful? : Yes (1), No (2)  

3.3 Have you participated in any exposure visit? If yes,  

   a) Place of visit  
   b) Duration of visit
3.4 Understanding of Watershed concepts  : Yes (1), No (2)

3.5 Training Attended
  ✓ Orientation Training  : Yes(1), No (2)
  ✓ Planning and Management Training: Yes(1), No (2)
  ✓ Technical Training : Yes(1), No (2)
  ✓ Capacity of taking responsibility  : Yes(1), No(2)

4.0 People’s Participation

4.1 Did you participate in PRA exercise Conducted in the village : Yes (1), No (2)

4.2 Did you participate in meeting conducted by USER / SHG for selection of works : Yes (1), No (2)

4.3 Name the group you represent and total Members belongs to the group : USER (1), SHG (2), None (3)

4.4.1. What kind of activity your group has been Associated : Farm (1), Non –Farm (2), None (3)

4.4.2. Whether work has been executed : Yes (1), No (2)

4.5 Owner of Watershed Project and Assets : VWC (1), WDT (2), PFA (3), None (4)

4.6 Attended any awareness meeting : Yes (1), No (2)

4.7 Maintaining of Assets by : VWC (1), WDT (2), PFA (3), None (4)

4.8 Distribution of Authority to sub groups : VWC (1), UG (2), SHG (3), None (4)

5.0 SHG – HELP GROUP (SHG)

5.1 Are you a member of SHG?  : Yes (1), No (2)

5.2 How many members are there in your group? : 

5.3 Please indicate the purpose for which your SHG is formed. Whether any credit and thrifts Activity commended. If yes, give Details : Savings (1), Business (2), None(3)

5.4.0. Whether any special training attended : Yes (1), No (2)

5.4.1. Training skill up gradation : Farm (1), Non –Farm (2), None (3)

5.4.2. Training duration (No of days) : 0 1 2 3 4 5 6 7

5.5 What is the loan amount received by you. (Indicate the date) : 

5.6 Indicate Mode of Repayment of the loan : Monthly (1), Qty(2), Half(3), Yearly(4), None (5)

5.7 Do you think that the amount has helped you to : Stabilize (1), Organize (2), The trade (3), Business (4), None (5)
5.8 Involvement of sub groups : Yes (1), No (2)

5.9 Income & Other Bank transaction by : SHG (1), UG (2), VWC (3), WDT (4), PFA (5), None (6)

5.10 Major source of corpus fund by : SHG (1), UG (2), VWC (3), None (4)

6.0 WORKS

6.1. What kind of works executed in your land :
   6.1.1. Land Leveling (1), None (2)
   6.1.2. Deep Ploughing (1), None (2)
   6.1.3. Summer Ploughing (1), None (2)
   6.1.4. Bund (1), None (2)
   6.1.5. Farm Pond (1), None (2)
   6.1.6. Fruit Plantation / Agri – Forestry (1), None (2)
   6.1.7. Crop Demonstration / Bio Fertilizer (1), None (2)
   6.1.8. Others (1), None (2)

6.2 Do you get any benefit out of the community works executed in and around your land
   6.2.1. Gully Control (1) None (2)
   6.2.2. Check Dams Percolated pond (1) None (2)
   6.2.3. Percolated pond (1) None (2)
   6.2.4. Drainage line treatment (1) None (2)
   6.2.5. Supply Channel (1) None (2)
   6.2.6. Community Well (1) None (2)
   6.2.7. Tube Shallow well Improvement to the (1) None (2)
   6.2.8 Existing water bodies (1) None (2)
   6.2.9 Please indicate the nature of such works(1), None (2)

Planning / Execution:

6.3 Activities proposed by : Farmers (1), VWC (2), WDT (3), None (4)

6.4 Activities finalized by : VWC (1), WDT (2), Stake Holders (3), None (4)

6.5 Work Execution by : Farmers (1), VWC (2), WDT (3), PFA (4), None(4)

6.6 Treatment as per Farmers willingness : Yes(1), No(2), None (3)

6.7 Finance on execution : Farmers (1), VWC (2), WDT (3), PFA (4), None(4)

6.8 Contribution : Willingly (1), Compulsions (2)

6.9 Contribution Percentage : 5-10 (1), 10-15 (2), 15-20 (3), above 20 (4), None (5)

7.0 AGRICULTURE:

7.1 Whether due to improvement in your land, have you resorted to alternate cropping, If so indicate the change? : Yes (1), No (2)

7.2 How much additional area has been brought into Cultivation? : Area (in acres)
7.3 Is there any significant improvement in the yield rate? : Yes (1), No (2)

7.4 If you realized any improvement after WSM programme? (Per ac) (Please indicate quantity crop – wise) : Yes (1), No (2)

7.5 Do you rear any livestock, if so, give details : Yes (1), No (2)

8.0 WATERSHED:

8.1.1. Whether Ground water level in your well : Summer Ht. (ft)
8.1.2. Increased? If so, indicate the quantum of rise : Rainy season Ht. (ft)

8.2 What extent of area has been changed from single to double crop : Yes (1), No (2)

8.3 If yes, please specify the change and area covered

9.0 INCOME LEVEL:

9.1 Would you specify the incremental income accrued due to the improvement in the yield level? : Yes (1), No (2)

9.2 What is your opinion with regard to selection of works and the execution of works : V. Good (1), Good (2), Normal (3), Poor (4), None (5)

9.3.1. Income: Annual income through Watershed : Rs.
9.3.2. Annual income from other sources : Rs.
9.3.3. Total : Rs.

10.0 Result / Outcome

10.1.1. Realized development Yes / No

Please Tick appropriate column

10.1.2. Water Level (1), None (2)
10.1.3. Afforestation and % of survival (1), None (2)
10.1.4. New area under cultivation (1), None (2)
10.1.5. Any increase in cropping intensity (1), None (2)
10.1.6. Any increase in Production / Productivity (1), None (2)
10.1.7. Increase on per capita of landless family (1), None (2)
10.1.8. Increase of labour Employment (1), None (2)

Sub groups / VWC / WDT / PFA / Stake Holders

10.1.9. Respondent affiliation : Sub groups (1), VWC (2), WDT (3), PFA (4), Stake Holders (5), None (6)
Department of Politics and Public Administration

University of Madras
Chennai  600 005

“A STUDY ABOUT THE IMPACT OF WATERSHED MANAGEMENT ON THE LIVES OF FARMERS- WITH SPECIAL REFERENCE TO KANCHEEPURAM DISTRICT”

An Appeal

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This research study about “Watershed Management in Kancheepuram District” is being undertaken for the purpose of Ph.D. Degree of the University of Madras. Data collected through this schedule would be used only for research purpose. Complete anonymity would be maintained in the analysis and in the interpretation of data. I request you to cooperate and commit your valuable time.

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S V Murugan
Ph.D Research Scholor (Part Time)
Dept.of Politics & Public Administration University of Madras
Chennai- 600 005
PART – II

Questionnaire for Project Facilitating Agencies Implementing Watershed Program

1.1 Name of the Watershed : 

1.2 Name of the Village / Hamlet : 

1.3 Field / Area of work : 

1.4 Respondent details :

<table>
<thead>
<tr>
<th>Name of the Respondent</th>
<th>Response held on</th>
<th>Male (1) / Female(2)</th>
<th>Age</th>
<th>Educational Qualification</th>
<th>Community OC(1), BC(2), MBC(3), SC(4), ST(5)</th>
<th>Experience</th>
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<tbody>
<tr>
<td></td>
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<td>1-5 (2),6-8(3)</td>
<td>9-10(4),11-12(5)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>UG(6), PG(7)</td>
<td>Other(8)</td>
<td></td>
</tr>
</tbody>
</table>

2.0 Training

2.1 Have you attended any orientation / training Program on Watershed project : Yes (1), No (2)

2.2.1. If yes specify; a) Nature of training : Yes (1), No (2)

2.2.2. b) Duration of training : Yes (1), No (2)

2.3.0. Have you participated in any exposure visit : Yes (1), No (2)

2.3.1. If yes, place of visit, duration of visit : Yes (1), No (2)

2.3.2. At what stage, have got exposed : Beginning (1), Middle (2), Both (3), None (4)

2.4 Do the exposure training is of any help in Project implementation in your watershed : Yes (1), No (2)

2.5 Are you aware any of watershed guidelines given below?

- 2.5.1. Common guidelines 2008 : Yes (1), No (2)
- 2.5.2. IWMP Salient features : Yes (1), No (2)
- 2.5.3. WDF Salient features : Yes (1), No (2)
3. Do you accept that the watershed management is essential for soil, water, agricultural, development, and related benefits?
   - 3.1 Do you agree with the above statement? : Yes (1), No (2)
   - 3.2 If yes, specify. : Yes (1), No (2)
   - 3.3 Is there any changes in cropping pattern. : Yes (1), No (2)
   - 3.4 If yes, please specify : Yes (1), No (2)
   - 3.5 Is there any improvement in ground water level Due to watershed implementation : Yes (1), No (2)

3.6 If yes, quantify in meter : 1 2 3 4 5 / None (0)

3.7 Is there any benefits realized other than Agriculture and allied sector? : Yes (1), No (2)
If yes, please specify;

3.8.0. Is there generation of Employment guaranteed for landless people in the watershed area? : Yes (1), No (2)

3.8.1. If yes; specify number of days : 25-50 (1), 51-100 (2), 101-150(3), 150-200(4), None (0)

3.9 What is your opinion about the Overall benefits to the watershed through this program? : Average (1), Good (2), Better (3), Excellent (4),

4.0 Differences in approach to watershed management by different agencies at field level

4.1. Do you think that there are differences in the manner and method of project implementation by Different agencies at field level? : Yes (1), No (2)

4.2. If yes, please specify; : Yes (1), No (2)
4.3 What is your opinion on the Common guidelines 2008/ Yes (1), No (2), None (3)

4.4 The differential approach is due to : Field conditions (1), Policies of stakeholders (2), None (3)

Please specify:

4.5 Do you feel that there is no deviation in the course of implementing watershed program? : Yes (1), No (2)

5.0 Do you think that Watershed committee plays an important role in Watershed management : Yes (1), No (2)

5.1 Which leadership is better in resolving issues in Watershed projects?
   a. Leadership from Panchayats (1),
   b. Leaders not connected with PRI institutions (2)

Please specify:

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Leaders of PRIs</th>
<th>Leaders not connected with PRI institutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leadership quality</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Representing problems</td>
<td></td>
<td></td>
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<tr>
<td>Financial devolution for WSC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resolving problems with other government institutions</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5.2 Do you feel that is there any bias in the selection of beneficiaries and treatments : Yes (1), No (2)

5.3 Do you feel that Panchayat Raj Institutions involvement is required for the watershed project success? : Yes (1), No (2)

5.4 Do the projects are implemented as per time schedule prescribed? : Yes (1), No (2)

6.0 Differences in costing and estimates:
6.1 Do you feel that there is difference in cost estimates based on the nature of terrain? (Plain or Hilly region)

Yes (1), No (2)

6.2 Whether the progress of the projects is affected because of the delay in the releasing of funds?

Yes (1), No (2)

6.3 Is there any difference in the outcome of the WSPs because of the difference in the project components of IWMP and NABARD schemes?

Yes (1), No (2)

6.4. Sustenance of the project after the completion of the project period: Yes (1), No (2)

6.5 What are the differences between IWMP and WDF with respect to the following?

1. Area Treatment (1), None (2)
2. Drainage line (1), None (2)
3. Renovation of Traditional Water Harvesting Structures (1), None (2)
4. Training & Capacity Building (1), None (2)
5. Livelihood (1), None (2)
6. Employment Opportunities (1), None (2)

7.0 Quality aspects of watershed program executed

7.1 Peoples participation while implementation of watershed program is

Average (1), Good (2), Better (3), Excellent (4)

7.2 Which among the two projects, generate more Employment

IWMP (1), WDF (2)

Thank you for your cooperation.
Appendix II
ARTICLE INFO

The global water scarcity analysis shows that a large share of world population up to two thirds will be affected over next several decades in Asia and other region. The major reason for such situation is due to neglect of river basin approach and watershed management initiatives over a period of time. The macro level initiative of river basin includes micro molecules of watershed management. In India, watershed programs are implemented across many river basins for over three decades. However, most of the watershed management projects carried out till date have not addressed the “basin perspective” but implemented in isolated manner by different agencies. This paper focuses on impact of watershed program on river basin perspective. The Palar and Ongur river basins 33 watershed have been studied out of 40 watersheds implemented at Kancheepuram District of Tamilnadu state in India. The results show that the Palar basin is better than Ongur in Total factor productivity. The people in Palar basin are adopting technology as well as deriving benefits from watershed leading to benefiting the community at large. However this study has to be done with all river basins in order to maximize the benefits to the people living in the planet earth. The better connectivity between river basin and watershed will be the likely solution for solving water scarcity in the near future.

ABSTRACT

RESEARCH ARTICLE

WATERSHED MANAGEMENT FROM THE RIVER BASIN PERSPECTIVE: A STUDY ON PALAR AND ONGUR RIVER BASIN WATERSHEDS OF TAMILNADU STATE

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3Department of Politics and Public Administration, University of Madras, Chennai-600005, Tamilnadu, India

INTRODUCTION

The need of water for India’s rapid development is growing day by day. Despite adequate average annual rainfall in India, still there is large area under the less water availability condition/drought prone. There are many places, where the quality of groundwater is not up to the acceptable standards. Another issue is the interstate nature of distribution of river water. Nearly 90 per cent of India’s river water irrigated areas are served by inter-state rivers. As a result, there is growing number of conflicts across the states and to the whole country on sharing river water. Some of the major reasons behind water scarcity are: Population growth and food production (Agriculture), Increasing construction/ infrastructure development activities, massive urbanization and industrialization throughout the country, climatic change and variability- Depletion of natural resources due to changing climate condition (Deforestation etc.) and Lack of implementation of effective water management system. It is estimated that by the year 2030, the mankind has to face many challenges on the water front globally including, Competition for scarce water from multiple uses within a river basin; the role of agriculture for food, feed, fiber and bio energy as a key demand driver for water; the inter link between water and energy, and the role of urbanization in water resource management and Sustainable growth in arid and semi-arid regions By the same token, in 2030, demand for water in India also will grow to almost 1.5 trillion m³ from the current level of 740 billion cubic meters, driven by domestic demand for rice, wheat, and sugar for a growing population, a large proportion of which is moving towards a middle-class diet. As a result, most of India’s river basins could face severe deficit by 2030. Unless concerted action is taken, with some of the most populous—including the Ganga, the Krishna, and the Indian portion of the Indus would be facing the biggest absolute gap. Efficient use of water resources is the need of the hour and cannot be procrastinated as water scarcity is a very real possibility for India. Per capita availability of water in India has reduced to about 33 percent of the level since 1947. However, so far live water storage capacity of about 253 billion cubic meter (BCM) has been created in the country. India is endowed with many rivers of which, twelve are classified as major rivers. The total catchment area is 252.8 million hectare (M.Ha.). Of the major rivers, the Ganga - Brahmaputra Meghna system is the biggest with catchment area of about 110 M.Ha which is more than 43 percent of the catchment area of all the major rivers in the country. The other major rivers with catchment area more than 10 M.Ha are Indus (32.1 M.Ha.), Godavari (31.3 M.Ha.), Krishna, (25.9 M.Ha.) and Mahanadi (14.2 M.Ha.). The catchment area of medium
rivers is about 25 M.Ha and Subernarekha with 1.9 M.Ha. Catchment area is the largest river among the medium rivers in the country. River basins are the major source of agricultural production to feed the increasing population. Several basins are facing the problem of reduced surface and groundwater supplies due to change in rainfall intensity, poor catchment management, and poor water distribution practices and increasing inter-sectoral water demand. In order to meet the future water demand, the available supplies should be efficiently used and a way to achieve this will be increasing the efficiency of the river basins.

**River Basin and Watershed**

The river basin and watershed are two extremes of Infrastructure need of the country at macro level and micro level respectively. More often the watershed programs are implemented by different agencies in isolated manner in different upstream and downstream of river basin. Thus holistic nature of water resource management is not happening in our country. Though this approach creates an impact at the micro level, the combined benefits of all watersheds are not reflected at river basin level thereby losing its sheen on the sustainability of groundwater management. Hence the watershed approach with river basin perspective has to be studied in detail across the country to bring in the necessary policy changes at country level in order to benefit all the end users. With this at the backdrop, the present study was undertaken with the following objectives:

1. To study the Role of watershed in two river basins
2. To study the outcome of watersheds in river basin perspective;

**River basin perspective**

While it has long been argued that management of land and water resources requires a basin perspective, examples of integrated river basin management are rare (Barrow et al., 2000). Although there may not be a central basin manager, this does not mean that river basins are not managed (Schlager and Blomquist, 2000). There are two main trends in basin governance. One trend concerns watersheds, or Sub basins, of a limited size (typically from tens of square kilometers to 1,000 square kilometers), where local stakeholders and agencies attempt to solve their land- and water- related problems. The other trend consists of major river basin and regions involving trans boundary operations where the decision making is carried out by many countries. The concept of watershed management has evolved over the past 40 years in response to implementing experience and changing policies and development paradigms on land husbandry, good governance, and poverty alleviation. Generalizing, the projects of the 1970s and 1980s may be characterized as top-down watershed protection projects aimed at arresting land degradation and securing downstream water supply, using a soil and water conservation engineering approach driven by physical targets. The impact of most of these projects was small and limited to the project period. A lack of people’s participation and a technical focus on conservation were broadly identified as major causes of failure (Kerr et al., 2002). A new generation of projects, generally referred to as participatory watershed management projects, emerged in the 1990s with a more complex mix of strategic concerns: poverty alleviation, local participation and ownership, collective action and institution building, production system and land husbandry, cost sharing, programmatic approaches with policy linkages, and sustainability (Farrington et al., 1999). These projects are generally considered likely to be more successful and are being further developed within the context of political and administrative decentralization, privatization, and the wider perspective of sustainable rural livelihoods to enhance equity, institutional sustainability, and replicability. This evolution parallels that on river basins - the second trend in basin governance - and reflects an adaptation of the watershed management concept from a narrow focus on hydrological linkages to a wider recognition of the human element and interconnectedness of ecosystems. A major lesson, relevant to all scales (field, farm, village, watershed, and basin), is that conservation or environmental objectives can be achieved only in combination with an upstream-oriented development objective: conservation through use (Badenoch, 2002). Watershed initiatives also signal a type of fragmentation of river basin management, and the links between these scattered initiatives and the larger basin remain a crucial question (Fang et al., 2007). According to (Palanisami et al., 2011), In Tamilnadu Creation of strong database at basin level is advocated to incorporate the supply and demand details of water, crop, and livestock. Investment made, returns to investment in various activities in the basin should be documented and analyzed periodically for making future projects based on basins current and future potential. He also opined that Climate change will affect the water supplies and it is important to identify and implement the various adaptation measures at both micro (farm) level and macro (basin) level. This will help to improve the overall basin performance.

**A profile of the study area**

The study area located in Tamilnadu, south India, there are 17 major river basin groups with 34 major river basins which include 127 sub basins spread across the state. Out of the 34 river basins, two sub basins that run through Kancheepuram District viz., LB Palar and Ongur sub basins which are part of Palar and Varahanadhi river basins respectively were selected.

**Table 1. Salient Features of Varahanadhi Basin**

<table>
<thead>
<tr>
<th>Name of the district</th>
<th>Area falling in the basin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chengalpattu</td>
<td>770</td>
</tr>
<tr>
<td>Thiruvannamalai (Thiruvannamalai-Sambuvayaray)</td>
<td>306</td>
</tr>
<tr>
<td>South Arcot</td>
<td>3138</td>
</tr>
<tr>
<td>Total</td>
<td>4214</td>
</tr>
</tbody>
</table>

Source: River basins in Tamilnadu report to state planning commission by TNAU 2011

**Table 2. Salient Features of Palar Basin**

<table>
<thead>
<tr>
<th>Name of the district</th>
<th>Area falling in the basin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vellore (North Arcot-Ambedkar)</td>
<td>4710.58</td>
</tr>
<tr>
<td>Thiruvannamalai (Thiruvannamalai-sambuvayaray)</td>
<td>4012.19</td>
</tr>
<tr>
<td>Kancheepuram (Chengai MGR)</td>
<td>2187.90</td>
</tr>
<tr>
<td>Total</td>
<td>10910.67</td>
</tr>
</tbody>
</table>

Source: River basins in Tamilnadu report to state planning commission by TNAU 2011
Location of the basin

The Palar basin is located in the mid of Kancheepuram district with the cascade drainage to Bay of Bengal and it is close to Chennai metropolitan. The Ongur basin is located near to Pondicherry. It is in the tail end of Kancheepuram and Vilupuram districts.

METHOD OF ENQUIRY

Data sources for the present study include bibliographic research, secondary data sources, analysis of reports, field level observations and stakeholder survey. The survey was conducted in two adjacent sub basins namely Palar and Ongur river basin. The number of watershed studied were 33 of which Under Ongur sub basin 18 (54.5%) watershed and Palar sub basin 15 (45.5%). Totally 380 respondents were selected by simple random sampling method and interviewed using a well structured interview schedule. Out of which 203 and 177 representatives of various peoples Institution like Village watershed committees and user groups of Palar and Ongur river basin respectively.

DISCUSSION

Role of watershed under river basin perspective

Educational status

Totally 380 respondents were interviewed from the two basins. Out of 380 respondents, 203 beneficiaries are from Palar and 177 from Ongur basin respectively. The distribution of respondents based on their educational status in two river basins is presented in Table below:

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Palar (%)</th>
<th>Ongur (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illiterate</td>
<td>16.3</td>
<td>25.4</td>
</tr>
<tr>
<td>Primary</td>
<td>14.8</td>
<td>15.8</td>
</tr>
<tr>
<td>Middle</td>
<td>17.2</td>
<td>22.6</td>
</tr>
<tr>
<td>High School</td>
<td>32</td>
<td>25.5</td>
</tr>
<tr>
<td>HSC and above</td>
<td>19.7</td>
<td>10.7</td>
</tr>
<tr>
<td>Total</td>
<td>203</td>
<td>177</td>
</tr>
</tbody>
</table>

Source: Personnel survey By Author 2013

It could be inferred from the above table shows that watershed beneficiaries under Ongur river basin have poor literacy rate than Palar. Similar trend prevailed in different educational categories of primary, high school and higher secondary education wherein Palar river basin beneficiaries had better literacy status than their Ongur counterparts.

Landholding pattern

The following Table presents that land holding pattern of the respondents spread over both the river basins.

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Palar (%)</th>
<th>Ongur (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural labourers</td>
<td>53 (26.10%)</td>
<td>71 (40.10%)</td>
</tr>
<tr>
<td>Small farmers</td>
<td>82 (40.40%)</td>
<td>57 (32.20%)</td>
</tr>
<tr>
<td>Marginal farmers</td>
<td>41 (20.20%)</td>
<td>31 (17.50%)</td>
</tr>
<tr>
<td>Medium farmers</td>
<td>18 (8.90%)</td>
<td>13 (7.30%)</td>
</tr>
<tr>
<td>Large farmers</td>
<td>9 (4.40%)</td>
<td>5 (2.80%)</td>
</tr>
</tbody>
</table>

Source: Personnel survey By Author 2013

Awareness

The following picture shows the level of awareness of the respondents about the watershed activities with respect to river basin perspective.
Since watersheds are people participation oriented, the level of awareness of respondents on the importance of watershed program play an important role in rejuvenation of river basin. The level of awareness of respondents with respect to its importance was significantly higher than Ongur river basin. This might be due to the higher literacy levels and land holding pattern of respondents of Palar basin.

Training

It could be inferred from the above discussions that the characteristics like educational status, awareness levels, land holding pattern and training attended by the respondents significantly influenced the efficiency of watershed projects. It could also be inferred that watershed projects in both the river basins were of poor efficiency due to poor level of these characteristics. However, among the river basins, these characteristics were better placed in Palar river basin than the Ongur basin which is reflected by relatively better performance of Palar river basin.

Table 5. Watershed Training Participation of Beneficiaries

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Palar</th>
<th>Ongur</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training attended</td>
<td>108</td>
<td>111</td>
</tr>
<tr>
<td></td>
<td>(53.20%)</td>
<td>(62.70%)</td>
</tr>
<tr>
<td>Training not attended</td>
<td>95</td>
<td>66</td>
</tr>
<tr>
<td></td>
<td>(46.80%)</td>
<td>(37.30%)</td>
</tr>
</tbody>
</table>

Source: Personnel survey By Author 2013

Outcome of watershed under river basin perspective

Improvement in quality of life of respondents after watershed program

The following table presents the response on the improvement realized under watershed program by the respondents.

Table 6. Improvement of quality of life of Beneficiaries

<table>
<thead>
<tr>
<th>Improvement after WSM programme</th>
<th>River Basin</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Palar</td>
<td>Ongur</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>55</td>
<td>31</td>
<td>86</td>
</tr>
<tr>
<td>No</td>
<td>148</td>
<td>146</td>
<td>294</td>
</tr>
<tr>
<td>Total</td>
<td>203</td>
<td>177</td>
<td>380</td>
</tr>
</tbody>
</table>

Source: Personnel survey By Author 2013

It could be noted from the table above that only 22.6per cent of the respondents have realized the improvement from watershed management program whereas about 77.4per cent of the respondents have not even realized the improvement due to watershed program. However, among those who had realized the improvement, 64 per cent of respondents belong to Palar river basin whereas only 36 per cent of the respondents belong to Ongur basin. It may due to the fact that better literacy rate is the main reason for realizing the benefits of watershed program under Palar river basin.

Ground water level improvement

The following table presents the response of the interviewees on the level of improvement in ground water status.

Table 7. Ground Water Level in Watersheds

<table>
<thead>
<tr>
<th>Ground water level improvement</th>
<th>Palar</th>
<th>Ongur</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>104</td>
<td>69</td>
<td>173</td>
</tr>
<tr>
<td></td>
<td>(60.1%)</td>
<td>(39.9%)</td>
<td>(45.5%)</td>
</tr>
<tr>
<td>No</td>
<td>99</td>
<td>108</td>
<td>207</td>
</tr>
<tr>
<td></td>
<td>(47.8%)</td>
<td>(52.2%)</td>
<td>(54.5%)</td>
</tr>
<tr>
<td>Total</td>
<td>203</td>
<td>177</td>
<td>380</td>
</tr>
</tbody>
</table>

Source: Personnel survey By Author 2013

It could be noted from the table above that 45.5% of the respondents have expressed that ground water level has improved out of watershed program. Among the river basins, majority (60.1%) of the respondents who had expressed ground water level improvement belonged to Palar river basin.

Increase in cropping intensity

The following table presents the details about distribution of respondents based on their level of understanding of increase in cropping intensity from watershed program. Out of the 256 respondents who have landholdings, 33.6% of them expressed that there has been improvement in cropping intensity from 100% to 200% whereas 66.4% of the total respondents did not see any significant increase in cropping intensity. However, among the river basins, palar river basin has significant proportion of respondents (72.1%) who had realized an increase in cropping intensity over their counterparts of Ongur river basin.

Table 8. Cropping Intensity improvement in watershed

<table>
<thead>
<tr>
<th>Watershed management has increased the cropping intensity</th>
<th>River Basin</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>62</td>
<td>86</td>
</tr>
<tr>
<td></td>
<td>(72.1%)</td>
<td>(33.6%)</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>(27.9%)</td>
<td>(66.4%)</td>
</tr>
<tr>
<td>No</td>
<td>88</td>
<td>106</td>
</tr>
<tr>
<td></td>
<td>(51.8%)</td>
<td>(33.6%)</td>
</tr>
<tr>
<td></td>
<td>82</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td>(48.2%)</td>
<td>(66.4%)</td>
</tr>
<tr>
<td>Total</td>
<td>150</td>
<td>256</td>
</tr>
</tbody>
</table>

Source: Personnel survey By Author 2013

Summary and Conclusion

Based on the above discussion, the following could be inferred

1. Watershed management programs are not approached under river basin perspective. This has resulted in poor impact on river basin rejuvenation for the investments made and have underperformed.
2. Among the river basin, Palar basin had better watershed impact than Ongur river basin.
3. The factors like educational status of the respondents, their awareness level, land holding pattern and occupational status and the training programs attended by them played a significant role in determining the efficiency of watershed.
4. The significantly higher levels of characteristics like educational status of the respondents, their awareness level, land holding pattern and occupational status as well as the training programs attended by them had positively influenced the performance of watersheds in Palar river basin than the Ongur river basin.
5. The outcome of watershed programs were significantly
and positively experienced under Palar river basins by increased cropping intensity, improvement in ground water level improvement as well as improvement in quality of life of the participating community.

REFERENCES


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Water Management Policies in India: Current Trends and Future Policy Options

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Abstract

Water is an important resource in the context of socio-economic empowerment of people. In India, more than water shortage, water wastage is a phenomenon in all sectors especially in Agriculture. To address water wastage, water use efficiency measures are advocated and for water shortage, the infrastructure gap through watershed approach has been carried out. Since 1970s, the soil and water conservation measures have been initiated by Government of India (GoI). After 1990s and 2000 significant changes in the policies have been brought out by both center and state governments. At this backdrop, the new watershed common guidelines was released in 2008 and revised in 2011 is taken for applied research study in 40 watersheds of Kancheepuram District, Tamil Nadu. The study revealed that people are accepting this initiative as need of the hour which is required to sustain agriculture and water requirement of various segments. This study also provides policy recommendations for the future watershed management in India.

Keywords: Watershed management, agriculture, watershed policies, watershed guidelines, people’s participation.

Introduction

Water is the basis of existence of living beings, in terms of drinking purposes, food production and also in industrial uses in varying proportions. In fact, water is used primarily for irrigation (75-80%), Industry (10%) and drinking and miscellaneous purposes (10-15%). India accounts for 15% of the world population and 4% of the world’s water resources. In the entire world, India faces a major crisis of water during recent times. This crisis threatens the basic right of drinking water of citizens; it also put the livelihoods of millions at risk. The demand of a rapidly industrializing economy and fast urbanizing society like India come at a time when groundwater table falling and water quality issue also has increasingly come to the fore. As far as excess water management is concerned, flood management strategies in India, no longer seem to provide an adequate answer to growing flood frequency and intensity. As mentioned earlier, 75-80% of India’s water is used for irrigation. The two main sources of irrigation are canals and groundwater. The relative contribution of canal irrigation has been steadily declining over time while groundwater especially that extracted through tube wells has rapidly grown in significance over the last 30 years. But the fact is that both these sources of water are now begun to dwindle. Considering the above, it is no wonder that conflict across competing uses and users of water are growing by the day. According to Sreedevi et al. (2006) integrated water resource management approach should be adopted in watersheds by discarding the artificial divide between rain fed and irrigated agriculture. There is an urgent need to have sustainable water use policies to irrigated sustainable development.

According to Wani et al. (2008), there is a need to improve monitoring and evaluation and the feedback of information to constantly improve performance. At one or two watersheds in each district, a broad range of technical and socio-economic parameters should be measured to provide a scientific benchmark and a better economic evaluation of impact. Since, Indian economy is agrarian in nature supporting nearly 65% of its population and agriculture sector supplying raw materials to various industries like sugar, textiles, edible oils etc. and engaging 15% of Indian workforce, scarcity for water will lead to serious socio-economic implications in the country. Various measures have been attempted by multiple stakeholders to address the issue of water management. Watershed management has been the foremost approach to conservation and management of water in India since time immemorial. However, with the advent of tapping the groundwater, watershed management was not given adequate attention in the recent past and the impact of negligence in this regard has already been realized. These issues have already started affecting both the Government and community at large, thus leading to various policy changes in the Government considering the long term accrued benefits and sustainability of water management system in India. As far as watershed management is concerned, several agencies are involved in conceptualization, financing and implementation of the same, prime being the National Bank for Agriculture (NABARD) and Ministry of Rural Development (MoRD), Government of India (GoI) with respective State Governments participation.
Till recently, these watershed management projects were implemented with different policy guidelines for different agencies. However, realizing the potential conflicts arising out of differential guidelines, the GoI had recently devised a set of common policy guidelines within which, various agencies operating watersheds across the country could operate. The present study discusses the impact of common policy guidelines on the performance of watershed implemented by Water shed Development Fund (WDF) of NABARD and Integrated Watershed Management Program (IWMP) of MoRD, GoI. In the year 2003, the GoI brought about a new set of guidelines called “Hariyali Guidelines” which sought to empower the Panchayat Raj Institutions (PRIs), both administratively and financially, in the implementation of the Watershed Development Programme of the MoRD as a new initiative through Department of Land Resources. These guidelines were applicable to new projects under Integrated Waste Lands Development Programme (IWDP), Drought Prone Area Development Programme (DPDP) and Desert Development Programme (DDP). Projects sanctioned after 1.4.2003 were brought under the Hariyali Guidelines.

Government of India in its budget for 1999-2000 had announced the creation of a Watershed Development Fund (WDF) with the National Bank for Agriculture and Rural Development (NABARD), with the broad objective of unification of multiplicity of watershed development programmes into a single national initiative through involvement of village level institutional and NGOs. In continuation of the same, WDF was created in NABARD with a contribution of Rs.100 crores each by NABARD and GoI. The objective of the fund was to encourage participatory watershed development. The fund was intended to be utilized to create the necessary conditions to replicate and consolidate the isolated successful initiatives under different programmes in the government, semi-government and NGO sectors, thereby all the actors are involved in watershed community, Central and State Government departments, Banks, Agriculture Research Institutions, NGOs and NABARD could act in tandem to make a breakthrough in participatory watershed development. The WDF was to be operationalized in close coordination with the Central and State Ministries as a continuum of their efforts but with a distinct identity. The GoI launched National Watershed Development Project for Rain fed Areas (NWDPA) under Ministry of Agriculture during eighth five year plan period and the guidelines were restructured in order to remove the difficulties faced by the implementing agencies and help them to undertake the works with the involvement of the local people. The restructured WARASA Guidelines were published in 2000 to govern the procedure for revised NWDPA programme. The CAPART-Watershed Conservation and Development Programme was conceived to achieve conservation and development of watershed to improve its ecological well being and thereby enhance its productivity and life supporting systems for the betterment of the people and their environment. Watershed Conservation Programmes implemented by CAPART engaged the assistance to voluntary organizations (VOs). VOs would try and implement watershed conservation over a total area of 1000 to 1500 ha, preferably in contiguous watersheds. The village however, was identified as the basic management unit for watershed conservation and would have priority over the geographical entities in this regard. Watershed treatments were undertaken with a “bottom up” approach. While reviewing different guidelines, it was observed that although there were variations in certain components, the following areas were common for all the four programmes.

- Appointing and engaging a separate Watershed Development Team (WDT).
- In order to build the ownership of watersheds, contributions from people for treatment on private and public lands were encouraged.
- Networking and streamlining the Institutional arrangement for the people at different levels in a watershed.
- Creation of Corpus fund for long term sustenance.
- Development activities and livelihood promotion.

Considering the special features and potential drawbacks of the above guidelines, GoI realized the need for unifying all the guidelines under a set of common policy guidelines encompassing the above features and enacted the same in the year 2008 and revised in 2011. These guidelines were applicable to all agencies with modifications suiting to the mandate of the respective agencies. With this, watershed management projects implemented by Ministry of Rural Development under Integrated Watershed Management Program (IWMP) and watershed projects implemented by NABARD under WDF became key players in watershed management in India. Though common guidelines were formulated, it allowed certain degree of flexibility in the approach to delivery of watershed and left it to the discretion of the agency. It is at this backdrop, an attempt was made to study whether differential approaches to common guidelines had any significant impact on usefulness and efficiency of watershed by different agencies. In this context there are many questions that arise: How far the watersheds are useful?; how far the guidelines given by the government time to time are flexible at the field level?; how far the leadership responsible for the watershed management at the field level are capable of sustaining the programme?; how far the people participation is essential for watershed management?; and how far other citizen action groups such as Self Help Groups (SHG) are involved in the implementation of watershed management.

Materials and methods

Experimental design: In order to study the objectives of the study, a well structured interview schedule was prepared.

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The schedule consisted of two parts which included individual characteristics of the respondents as well as their responses to specific questions pertaining to the objectives. There are 40 watersheds implemented in Kancheepuram District, out of which 33 watersheds were studied in which 31 IWMP and 14 WDF watershed officials were interviewed. The reasons for selection of study area was based on the fact that Kancheepuram District is considered to be the district of lakes with lot of watershed activities as well as the familiarity of the researcher in the study area. The respondents were selected by simple random survey from the WDT and Village Watershed committees (VWC) and Water User Association (WUA). Kancheepuram District is located north side of Tamil Nadu between 12.13-13.1E and 79.32-80.15N. It comprises 13 blocks of which 6 blocks were Both IWMP and WDF programs implemented. The IWMP program are implemented in cluster approach where as WDF are implemented in isolated manner.

Results and discussion

Study on level of awareness of the community and project implementing agencies on usefulness of watershed: Table 1 indicate that all the respondents were fully aware that watershed management projects are useful in terms of soil and water conservation, agriculture development and other accrued benefits. There is no difference in response between WDF and IWMP watersheds in terms of usefulness of projects.

### Table 1. Response of people based on their knowledge on usefulness of watershed (n=45).

<table>
<thead>
<tr>
<th>Response</th>
<th>WDF %</th>
<th>IWMP %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Useful</td>
<td>14</td>
<td>31</td>
</tr>
<tr>
<td>Not useful</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>14</td>
<td>31</td>
</tr>
</tbody>
</table>

*Source: Personnel survey, 2013.*

Studies on influence of flexibility in watershed approach and the impact created on watershed: While delineating the watershed area, IWMP addresses area coverage of 5000 ha under one watershed unit whereas, WDF offers flexibility in delineation even up to 500 ha. However, IWMP did not emphasize on the nature of area to be covered, WDF insists that priority should be given to dry and drought prone villages. In any case, the proportion of irrigated area may not exceed the average for the state or 30% whichever is lower. Villages with noticeable soil erosion, land degradation, resource depletion or water scarcity problems and villages in the upper part of drainage systems were accorded priority. The data presented in Table 2 gives the responses of the officials of project implementing units of both IWMP and WDF. Table 2 indicate that about 85.7% of the respondents had expressed that the impact of watershed program has been above average under WDF whereas only 16.1% of the respondents expressed that the impact of watershed has been above average under IWMP.

### Table 2. Implementation performance of watershed.

<table>
<thead>
<tr>
<th>Rating</th>
<th>WDF %</th>
<th>IWMP %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below average</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Average</td>
<td>2</td>
<td>14.3</td>
</tr>
<tr>
<td>Above Average</td>
<td>12</td>
<td>85.7</td>
</tr>
<tr>
<td>Total</td>
<td>14</td>
<td>100.0</td>
</tr>
</tbody>
</table>

*Source: Personnel survey, 2013.*

This clearly indicate that need based and location specific approach followed by WDF with flexibility in its policy on selection criteria plays a significant role in enhancing the efficiency and usefulness of watershed whereas the rigid policy of IWMP tends to affect the efficacy of the watershed.

Studies on the capabilities of leadership of watershed committees in solving field level problems: While implementing watershed projects at village level, the village watershed committees are formed. These committees play a key role in decision making by the community and the role of office bearers assumes significance. While office bearers are elected democratically by the village community, these office bearers tend to have allegiance towards political parties. However, there are also non-political leaders who are office bearers in watershed communities. The survey captured data on the ability of these office bearers and leadership with respect to decision making based on their allegiance to political party and the responses are given in Table 3. Table 3 presents the response of the respondents on their opinion about the leadership qualities of watershed committees on problem solving in watershed. Among the respondents under WDF, an overwhelming majority of 85.8% of the respondents agreed that non-political leadership were able to solve field level problems well than those with political allegiance. IWMP officials also expressed similar views (67.8%) that the watershed committees with leaders and office bearers not having political allegiance were able to solve the field level problems than the leaders with political allegiance. It could be inferred from the above that both IWMP and WDF watersheds have similar pattern of response on leadership qualities of watershed committees. It should be noted here that though the guidelines say that leaders should not owe allegiance to political parties, in reality, it is not adhered fully. A suitable mechanism should be worked out in the policy guidelines so that political interferences in watershed committees could be avoided to improve the efficiency of performance of watersheds.

### Table 3. Decision making trend in watersheds (n=45).

<table>
<thead>
<tr>
<th>Response</th>
<th>WDF %</th>
<th>IWMP %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-political leadership solves problem better</td>
<td>12</td>
<td>85.8</td>
</tr>
<tr>
<td>Political leadership solves problem better</td>
<td>2</td>
<td>14.2</td>
</tr>
<tr>
<td>Total</td>
<td>14</td>
<td>100.0</td>
</tr>
</tbody>
</table>

*Source: Personnel survey, 2013.*
Studies on the necessity of people participation in watershed implementation: One of the foremost criteria in the sustainability of watershed projects is the level of participation of the community as well as ownership of community assets. In the policy guidelines, it is strongly emphasized that the people’s participation from project and plan preparation is very essential. PRA is an important and scientifically proven tool to evaluate the natural resources of the project area and capacity building to the beneficiaries. It was in this context, a study was made to find out the importance of community participation in watershed projects. Table 4 presents the response from the beneficiaries of watershed on their opinion on people participation. Out of 380 respondents, a vast majority of (70%) respondents expressed that people participation in PRA exercises, training, project planning and implementation has benefited the watershed as well as the community as a whole whereas only 30% of the respondents had expressed that people participation did not play any significant role in watershed efficiency. Among the watersheds, an overwhelming proportion of beneficiaries (97.2%) from WDF expressed that people participation is very much essential and have opined that participation of the community has improved the visibility of the project and understanding the need to maintain the assets for long term sustainability of watershed projects. This kind of visibility is missing from the IWMP watersheds which are evident from the data that a little over half of the respondents (59.1%) had realized the importance of people participation. It could be inferred that a prudent people participation system should be in place to enhance the efficiency in the IWMP projects.

Studies on participation of SHGs in watershed project implementation: Self Help Groups (SHGs) are prominent community based organizations at the grass root level. Moreover, SHGs are predominantly women centric and their involvement enhances the participation of women thereby ensuring gender equity. It is at this backdrop, the study attempted to capture the participation levels of women SHGs in watershed projects.

Table 4. People participation in watershed (n=380).

<table>
<thead>
<tr>
<th>Response</th>
<th>WDF</th>
<th>%</th>
<th>IWMP</th>
<th>%</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>People participation plays a significant role in watershed project</td>
<td>105</td>
<td>97.2</td>
<td>161</td>
<td>59.1</td>
<td>266</td>
<td>70</td>
</tr>
<tr>
<td>People participation does not play a role in watershed projects</td>
<td>3</td>
<td>2.8</td>
<td>111</td>
<td>40.9</td>
<td>114</td>
<td>30</td>
</tr>
<tr>
<td>Total</td>
<td>108</td>
<td>100.0</td>
<td>272</td>
<td>100.0</td>
<td>380</td>
<td>100.0</td>
</tr>
</tbody>
</table>


Table 5. Role of SHGs in watershed (n=380).

<table>
<thead>
<tr>
<th>Study parameter</th>
<th>WDF</th>
<th>%</th>
<th>IWMP</th>
<th>%</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHGs play a key role in watershed projects and involvement of SHGs is important</td>
<td>35</td>
<td>32.4</td>
<td>179</td>
<td>65.8</td>
<td>214</td>
<td>56.3</td>
</tr>
<tr>
<td>SHGs do not have significant role in watershed projects</td>
<td>73</td>
<td>67.6</td>
<td>93</td>
<td>34.2</td>
<td>166</td>
<td>43.7</td>
</tr>
<tr>
<td>Total</td>
<td>108</td>
<td>100.0</td>
<td>272</td>
<td>100.0</td>
<td>380</td>
<td>100.0</td>
</tr>
</tbody>
</table>


It could be noted from Table 5 that 56.3% of the respondents have stressed the important role played by SHGs in watershed implementation whereas about 43.7% of respondents have downplayed the role of SHGs in watershed projects. It could be inferred from the above that SHGs do play a significant role in watershed projects. However, between WDF and IWMP, only IWMP significantly involves the SHGs which are evident from the fact that 65.8% of respondents appreciated the role of SHGs whereas only 32.4% of respondents have recognized the role of SHGs. Hence, it is clear that WDF watersheds should more actively involve SHGs while implementing watershed projects

Conclusion
It is evident from the study that the project implementation team as well as community members of both WDF and IWMP watersheds are fully aware of and appreciate the benefits of watershed in terms of soil and water conservation, agriculture improvement and other related socio-economic benefits. Inference could also be drawn that flexibility in approach to common guidelines while implementing watershed projects provide desired results rather than following common guidelines rigidly. This can be incorporated as a policy in guidelines which will enable watershed practitioner’s county wide in India. Non-political leadership of the watershed community organizations has a significant impact on decision making and problem solving rather than political leadership which tend to impede the timely and effective implementation of watershed projects. This inference has to be tested at large to bring in necessary policy formulations for the future. The study also implies that the active participation of people involved and community right from project planning with a bottom up approach enhances the efficiency of watershed. In order to efficiently leverage the strengths of the community, training and PRA are important and role of SHGs in enhancing gender equity in watershed projects significantly contribute to sustainability of watershed projects.
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References