



# MICRO LEVEL WATERSHED MANAGEMENT USING REMOTE SENSING AND GIS A CASE STUDY FROM BALLARI DISTRICT KARNATAKA

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## ***Abstracts:***

*Participatory watershed management has emerged as a new paradigm for sustainable rural livelihoods and it occupied the central-stage of all rural development programmes including watershed programmes in the fragile and semi-arid environments of the developing nations. A study was carried out to evaluate the relative performance among the watersheds implemented by different organizations in terms of various participatory indicators. One watershed each implemented by Government organization (Lottinekere) and NGO (Kalvi) were selected from Bellary district of Karnataka State, India and data was collected from members of project implementing agencies and watershed development team using a well designed schedule. The results indicated that both Kalvi and Lottinekere watersheds have greater Participation Paradigm Index value for preparation of strategic action plan (86%) and structure of WDT (100%). Level of participation was higher in Kalvi watershed (87%) compared to Lottinekere watershed (47%). Both watersheds were poor in terms of monitoring activities and management of common property resources. Participatory Watershed Development Index for Kalvi and Lottinekere watersheds were 61% and 56% that indicates implementing agencies were able to fulfill 61% and 56% of possible components of participatory watershed development programmes.*

**Keywords:** *Participation paradigm index, Participatory watershed development index, Project implementing agency, Transparency, Watershed development team.*

## 1. INTRODUCTION

In India, watershed development projects are one of the massive and effective rural development programmes to conserve natural resources *i.e.* rainwater and top fertile soil and increase the productivity especially in rainfed areas on sustainable basis (Grewal *et al.*, 1995; Reddy, 2000, Reddy *et al.*, 2006 and Susma Sudhishri and Kumar, 2011). India's four decade old watershed management programme switched from top-down to bottom-up based on the recommendations of Hanumantha Rao Committee in 1995 (Dogra *et al.*, 2005). The "1994 Guidelines" (MoRD, 1994) and subsequent "2001 Revised Guidelines" (MoRD, 2001) envisaged a high degree of participation and local autonomy in designing and implementation of micro-watersheds. Though most of the past studies have made a cursory statement that peoples participation is a must for sustainable watershed development, a few have attempted to analyze and understand the management aspects of collective action, either theoretically or empirically. As a result, 'participation in watershed management' has remained cursory even in policy formulations and consequent low adoptions (Reddy, 2000).

Till recently, greater emphasis was on the techno- economic aspects rather than its social aspects. As per new guidelines, watershed development programmes emphasize active mobilization and participation of stakeholders in planning, implementation and subsequent management of programme activities. The success of watershed depends on project implementing agency (Central/State Government, NGO's and SAU's) and the process of its implementation at field level. Hence, the present study concentrated on evaluation of projects in terms of various participatory paradigms under different institutional set-up in Bellary district of Karnataka, India.

## 2. PROFILE OF STUDY AREA

Bellary district of Karnataka State was purposively selected for the present study due to its' distinctive physical locations and environment. In northern dry zone of Karnataka, nearly 85% of area is under black soils and 15% covers red soils. Rainfall in the region varies from 500 to 680 mm. Among the different districts of northern dry zone, Bellary has lower rainfall average varying from 500 to 620 mm. Yield of crops in general in this region are low and is attributed to low rainfall with poor distribution, lack of adoption of conservation measures and cultivation of traditional cultivars with lower application of nutrients. Hence, these situations offered a better opportunity to develop the region through watershed based interventions for conservation of natural resources, improving productivity and enhancing livelihoods in the region.

Karnataka, a separate Watershed Development Department has been constituted during 2001 headed implementation of watershed programmes assisted by a District Watershed Development Officer for multi-disciplinary head under the overall control/ supervision of Zilla Panchayat/District Rural Development implemented by a multi-disciplinary team of different Agency (DRDA). At watershed level, project is government department (GO) or an NGO. Hence, one project implemented under GO (Lottinekere watershed) and another by an NGO (Kalvi watershed) were selected for detailed investigation.

### 3. ANALYTICAL TOOLS

Relative weights of each of the 80 components ascertained by Dogra et al., (2005) from a team of 15 experts involved in implementing watershed activities were used directly for calculating consolidated scores. These 80 components were further grouped into ten individual categories based on the broad aspects of participatory watershed management for assessing the performance of a watershed development projects. Accordingly, average weights (assigned by the experts) of all 80 components were grouped by summing up and divided by number of components to estimate the weight of each categories. Based on the magnitude of weights, these categories were ranked from I to X and higher rank was assigned a modified weight of 10 and lower rank was assigned 1 in a descending order (Table 1). Based on the responses of field functionaries of a particular watershed development project, a score (1-Yes or 0-No) for each of 10 major components was estimated by summing up the positive response with respect to individual component. The obtained score was multiplied by estimated average weight and a maximum weighted score was also estimated for each of 10 major components. Participation Paradigm Index (PPDI) for each watershed was estimated for each major component as:

$$\text{Participation Paradigm Index (PPDI)} = \frac{\text{Weighted Score}}{\text{Maximum weighted score}} \times 100$$

**TABLE: 1 MAJOR CATEGORIES OF PARTICIPATORY PARADIGMS AND THEIR WEIGHT**

Major Components	Number of parameters	Summed weight*	Average weight	Rank	New weight
Participation	15	66	4.40	III	8
Transparency	15	49	3.27	VII	4
Watershed plan preparation	7	41	5.86	II	9
Watershed stakeholders institutions	9	36	4.00	IV	7
Watershed meetings & accounts records	10	29	2.90	VIII	3
Monitoring	6	23	3.83	VI	5
Common Property Resource management	9	22	2.44	IX	2
Project Implementing Agency	2	13	6.50	I	10
Watershed Development Team	3	12	4.00	V	6
Equity	4	9	2.25	X	1

For evaluation in terms of all 10 major components, a Participatory Watershed Development Index (PWDI) was also estimated as:

$$\text{Participation Watershed Development Index} = \frac{10 S \text{ Weighted Score}}{10 S \text{ Maximum weighted score}} \times 100$$

**TABLE: 2 RATING OF PARTICIPATION PARADIGM INDEX (PPDI) AND PARTICIPATORY WATERSHED DEVELOPMENT INDEX (PWDI)**

Following Dogra *et al.*, (2005), each of the categories of participatory paradigms were rated from “Excellent” to “Poor” (Table 2).

Category	PPDI/PWDI
Excellent	>90
Very Good	80-90
Good	50 - 80
Fair	20 - 50
Poor	< 20

#### 4. RESULTS AND DISCUSSION

Details of Selected Watersheds Details of the selected watersheds are described in Table 3. Both the watersheds were implemented under DDP-VI covering 500 ha area. Rainfed area constitutes around 75% of the treated area in Kalvi and 87% in Lottinekere watershed and rest of the smaller area is irrigated through bore wells. Both the watersheds comprises small hamlets (tandas) inhabited by 91% and 51% of SC/ST population. Sorghum, bajra, sunflower, groundnut, cotton and sesamum are major crops grown in the area with lower yields that ranges from  $0.8 \text{ t ha}^{-1}$  in case of cereals,  $0.6$  to  $0.8 \text{ t ha}^{-1}$  in sunflower and  $0.5 \text{ t ha}^{-1}$  in groundnut

#### 5. Participation Paradigm Indices

Participation Paradigm Index (PPDI) for each of the ten major components and Participatory Watershed Development Index (PWDI) for both watersheds are described in this section.

#### 6. Participation

The degree of participation by different stakeholders is major determinant of success or failure in watershed development programmes (Johnson *et al.*, 2001). In Kalvi watershed, index for participation (PPDI) was higher to the extent of 86.7% and it indicates higher participation as 13 out of 15 components were met in this project (Table 4). This was attributed to good rapport of NGO with watershed community and existing groups (SHGs). In Lottinekere watershed, only 7 out of 15 components were met resulting in comparatively lower rate of participation 46.7% (Table 5).

TABLE NO 3 DETAILS OF THE SELECTED WATERSHEDS

Particulars	Kalvi watershed	Lottinekere watershed
<i>General details</i>		
Implementing agency	SNEARDS (NGO), Hadagali	DWDO, Bellary
Duration	2000-01 to 2008-09	2001-02 to 2009-10
<i>Area details</i>		
Average annual rainfall (mm)	531	587.3
Treated area (ha)	500.0	500.0
Rainfed area (%)	74.96	86.54
Irrigated area (%)	18.60	6.46
Non-arable land (%)	4.56	5.90
Others (%)	1.88	1.10
<i>Demographic details</i>		
Villages covered	Kalvi; Bhanayana, Dungabati, and Beethana Tanda.	Lottinekere and Hyalya Hampapur.
Households	465	435
Population	2646	2640
SC/ST population (%)	90.75	50.57
<i>Crop details</i>		
Major rainfed crops	Sorghum, <i>bajra</i> , sunflower, and groundnut.	<i>Bajra</i> , redgram, groundnut, sesamum, and sorghum.
Major irrigated crops	Maize, hybrid cotton, <i>bajra</i> , sunflower, hybrid sorghum and vegetables	Maize, <i>bajra</i> , hybrid sorghum, sunflower and vegetables.

TABLE NO 4 PARTICIPATION PARADIGM INDICES (PPDI) FOR KALVI WATERSHED

Major Components	Maximum Weighted Scores	PPDI	Rating
Participation	120	86.7	Very Good
Transparency	60	66.7	
Watershed Plan Preparation	63	85.7	Very Good
Watershed Stakeholder Institutions	63	77.8	
Watershed Meetings & Accounts Records	30	70.0	Good
Monitoring	30	16.7	Poor Fair
Common Property Resource Management		22.2	
Project Implementing	18	50.0	
Agency Watershed Development	20	100.0	Good
Team Equity	18	50	Excellent
Watershed Meetings & Accounts Records	4		Good

## 7. Watershed Plan Preparation

In both watersheds, high priority was for watershed plan preparation and it resulted in higher PPDI (85.7%). In Kalvi watershed, implementing agency (PIA) was not technically sound with subject matter specialists, they had a better previous experience in watershed plan preparation and execution with better

social mobilization capability. In Lottinekere watershed, the PIA comprised of members from various government departments and were technically sound and capable of good plan preparation for solving problems prevailed in the area through watershed based interventions.

**TABLE NO 5 PARTICIPATION PARADIGM INDICES (PPDI) FOR LOTTINEKERE WATERSHED**

Major Components	Weight	Consolidated total Score	Number of components	Weighted Score	Maximum Score	Maximum weighted Score	PPdI	Rating
	a	b	c	$a \times b$		$a \times c \times 1$		
Participation	8	7	15	56	15	120	46.7	Fair
Transparency	4	10	15	40	15	60	66.7	Good
Watershed Plan Preparation	9	6	7	54	7	63	85.7	Very Good
Watershed Stakeholders Institutions	7		9	35	9	63	55.6	Good
Watershed Meetings & Accounts Records	3	4	10	12	10	30	40.0	Good
Monitoring	5	2	6	10	6	30	33.3	Fair
Common Property	2		9	6	9	18	33.3	Fair
Resource Management								
Project Implementing Agency	10	1	2	10	2	20	50.0	Good
Watershed Development Team	6	3	3	18	3	18	100.0	Excellent
Equity	1	1	4	1	4	4	25.0	Fair

## 8. Watershed Stakeholders Institutions

Kalvi watershed executed by an NGO and is capable of mobilizing people and integrates them into various activities of watershed development programmes. The number of various stakeholders' institutions was higher and it yielded higher PPdI in Kalvi (77.8%) compared to Lottinekere watershed (55.6%) (Tables 4 and 5). Watershed association was formed through Gram Sabha with adequate representation of various sections of society in both watersheds. However, people were unaware about by-laws of watershed association

## 9. Transparency and Watershed Meetings, Accounts and Records

The transparency in implementing different activities by both NGO and government departments were found to be good with fulfillment of 10 out of 15 components and scored 66.7% (Tables 4 and 5). In Kalvi watershed, number of meetings conducted with beneficiaries or among WDT was higher. All the activities of watershed programme were carried out with confidence of stakeholders and also the accounts/ records were maintained well resulting in higher PPdI (70%) (Table 4). In Lottinekere watershed, few meetings were conducted and almost all the watershed activities were implemented as per norms with less discussion among the watershed committee members. However, accounts were maintained correctly and they could meet 4 out of 10 components with a PPdI of 40% (Table 5).

## 10. Monitoring and Withdrawal Strategy

Both watershed projects initiated activities with standard action plan by adhering to the stipulated norms for different interventions, however, failed to include mid-term corrections in the action plan. The farmer's contribution collected was not utilized for watershed maintenance. These resulted in 'Poor' PPDI of 16.7% in Kalvi watershed and 'Fair' in Lottinekere watershed (33.3%) (Tables 4 and 5).

## 11. Common Property Resource Management

In semi-arid watersheds, sustainability of the programme crucially depends on the maintenance of common property resources. In both watersheds, permanent water harvesting structures were constructed, non-arable/community lands treated without clear-cut guidelines for distribution of benefits and/or maintenance of vegetation, common facilities, etc. These resulted in 'Poor' to 'Fair' PPDI in Kalvi (22.2%) and Lottinekere watershed (33.3%).

## 12. Watershed Development Team and Project Implementing Agency

In Kalvi and Lottinekere watersheds the watershed development teams were constituted comprising specialists from Engineering, Agronomy/Soil science, Horticulture and Social Sciences background and they received specialized training in the area of resource conservation and watershed development. The duration of both watersheds were 5 years and were implemented over a period of 8 to 10 years. The reasons for delay in implementation were attributed to timely non release of funds and other administrative/technical problems.

## 13. Equity

Equity is one of the major policy issue, with past watershed programmes often failed to reach the poor households and disproportionately benefiting the better-off sections of the community. The value of index related to equity was 50% for Kalvi watershed and it was only 25% for Lottinekere watershed (Tables 4 and 5). The lower values were attributed to non-allocation of usufruct rights to poor/women for development of common land and no leasing out of surplus land by rich farmers to poor/landless. Though equal wage opportunity for women/different sections of society prevails, no proper guidelines were observed to uphold livelihoods of the poor strata.

## 14. Participatory Watershed Development Index (PWDI).

By considering value of PPDI of all the major components discussed above, a composite index namely Participatory Watershed Development Index (PWDI) was prepared and calculated value of the index were found as 61.2% and 55.8%, respectively for Kalvi and Lottinekere watershed. These indicate that implementing agencies were able to fulfill around 61% and 56% of the possible components of participatory watershed development programmes.

## 15. CONCLUSIONS

It is widely accepted that the participation of different stakeholders in different watershed activities is critical to enhance the effectiveness in terms of efficiency, equity and sustainability in watershed management programmes. The present study revealed that both the selected watersheds rated “Good” in terms of overall index of different participatory paradigms of watershed development programmes. These values seem to be nearly similar for both watersheds, however, component wise value differs and it indicates the priority of the implementing agencies in executing the programme activities. The in-depth analysis of different components that met out by the implementing agencies/watershed institutions indicated the lacuna in important aspects of the programme like participation, monitoring, watershed institutions, etc. And it needs to be emphasized for all future programmes. For sustainability of watershed programmes, clear-cut guidelines need to be promulgated for maintaining common resources and priority should also be given to equity aspects for greater acceptability of the programme by the people.

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