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COMMUNITY WATERSHED MANAGEMENT IN SEMI-ARID INDIA

The State of Collective Action and its Effects on Natural Resources and Rural Livelihoods

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ABSTRACT

Spatial and temporal attributes of watersheds and the associated market failures that accelerate degradation of agricultural and environmental resources require innovative institutional arrangements for coordinating use and management of resources. Effective collective action (CA) allows smallholder farmers to jointly invest in management practices that provide collective benefits in terms of economic and sustainability gains. The Government of India takes integrated watershed management (IWM) as a key strategy for improving productivity and livelihoods in the rain-fed and drought-prone regions. This study investigates the institutional and policy issues that limit effective participation of people in community watershed programs and identifies key determinants for the degree of CA and its effectiveness in achieving economic and environmental outcomes. We use empirical data from a survey of 87 watershed communities in semi-arid Indian villages to identify a set of indicators of CA and its performance in attaining desired outcomes. Factor analysis is used to develop aggregate indices of CA and its effectiveness. Regression methods are then employed to test the effects of certain policy relevant variables and to determine the potential effects of CA in achieving desired poverty reduction and resource improvement outcomes. We find a positive and highly significant effect of CA on natural resource investments, but no evidence of its effects on household assets and poverty reduction outcomes. This may be attributable to longer gestation periods for realizing indirect effects from collective natural resource investments and the lack of institutional mechanisms to ensure equitable distribution of such gains across the community, including the landless and marginal farmers.

Keywords: collective action, institutions, property rights, watershed management, poverty, environmental impacts.

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1. INTRODUCTION

Watershed management is a landscape-based strategy that aims to implement improved natural resource management systems for improving livelihoods and promoting beneficial conservation, sustainable use, and management of natural resources. Integrated watershed management (IWM) has been promoted in many countries as a suitable strategy for improving productivity and sustainable intensification of agriculture. The government of India, in particular, accords high priority to watershed programs as a strategy for integrated development of rural communities, especially in rain-fed and drought-prone areas. It goes beyond conservation technologies and emphasizes the importance of the human dimension and the need to integrate technological tools with broad-ranging social, political, and economic changes. Instead of focusing exclusively on biophysical processes that improve resource conditions, IWM includes multiple crop and livestock-based income strategies that support and diversify livelihood opportunities for the poor, and create synergies between targeted technologies, policies, and institutions to improve productivity, resource use sustainability, and market access (Kerr, 2001; Reddy et al., 2004a; Shiferaw et al., 2006).

Investment in IWM requires active cooperation among stakeholders at different levels. Collective action occurs when individuals voluntarily cooperate as a group to coordinate their behavior to solve a shared problem. Collective action may be broadly defined as action taken by a group (either directly or on its behalf through an organization) in pursuit of members' perceived shared interests (Marshall, 1998). Effective collective action often requires formulating and enforcing rules that govern and condition the members' expectations to achieve their common goal. This indicates that several resource management and livelihood activities in rural areas manifest attributes of non-exclusion and require coordination of resource users' efforts through collective action. The need for collective action depends on the resource type, the degree of spatial integration, and the time required for attaining the desired outcomes.

Collective action tends to be more important in the context of many developing countries where formal institutions are missing or not functioning properly for the management of natural resources up on which the livelihoods of many poor depend. Successful communities in terms of sustainable management of

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common pool resources are usually characterized by exhibiting well defined rules, the ability to monitor behavior and punish violators, the existence of mechanisms for conflict resolution, and forum for negotiating future courses of action (Wade, 1988; Ostrom, 1990; Tang, 1994; Baland and Platteau, 1996; Lam, 1998). The ability of communities to initiate, develop, and sustain collective action often depends on the internal socioeconomic characteristics of the communities and the biophysical and socioeconomic setting. There is evidence based on comparison of communities for collective action in natural resource management that demographic characteristics and institutional and organizational structures of the community are related to cooperative and implementation capacity (McCarthy et al., 2004). Heterogeneity along the lines of ethnicity, religion, and social class is found to have a negative effect on cooperation. The effect of inequality in wealth and community size is less clear cut, although community size and inequality seem to reduce cooperation. Despite the increasing information on factors that deter or facilitate management of common property resources, there is lack of knowledge and information on factors that influence the level and effectiveness of collective action within the context of community watershed programs. This is despite the increased policy support for decentralized management of natural resources and the significant amount of investment that both governments and communities undertake to enhance the poverty and environmental impacts of watershed programs.

In order to address some of these policy relevant issues, this study uses socioeconomic data from 87 watershed villages in six districts of Andhra Pradesh, India, develops indicators for the degree of collective action, and examines its potential determinants. This is followed by the analyses of key indicators for the effectiveness of collective action in attaining desired economic and environmental outcomes of watershed management. The study provides useful insights on how community institutions determine the level of collective action in watershed management and how such collective action is related to the overall performance and effectiveness of watershed interventions. The study concludes that collective action is strongly correlated with improvements in natural resource conditions, but there is limited evidence to link it with impacts on poverty.

The rest of the paper is organized as follows. Section two outlines the theoretical issues that necessitate collective action in watershed management. Section three presents the data and empirical methods used in the analyses of the survey data. Section four discusses the major findings, and the final section concludes by highlighting the key findings and policy implications.

2. COLLECTIVE ACTION IN WATERSHED MANAGEMENT

A watershed is a catchments area from which all water drains into a common point, making it suitable for technical efforts to manage water and soil resources. It is a spatially defined unit that includes diverse natural resources that are unevenly distributed within a given geographical area. Due to this spatial aspect of the watersheds, resources as well as resource users become interdependent over time and space. Watersheds connect different communities that are spatially separated, exploiting watershed resources depending on their specific position within the catchments. This creates interdependence in both the watershed resources and user communities (for example, between those on the upper, middle, and lower reaches) where the actions of one group will influence the production and investment decisions of others (Swallow et al., 2002**)**. The actual size of the watershed depends on topographic and agro-climatic conditions and may range from few hundred to several thousand hectares. Thus, the effectiveness of watershed interventions depends on the ability to treat the entire hydrological landscape, not just a portion of it (Knox and Gupta, 2000; Johnson et al., 2002).

Some of the investment activities of watershed management include construction of check-dams for infiltrating surface water, terraces for soil and water conservation, and tree planting. The return to such investments is not often realized in a short period of time. The costs are incurred at the time of the investment while economic returns are often delayed and accrue in small quantities over a long period of time. Hence, the resource improving watershed interventions require a relatively larger planning horizon compared to short duration agricultural technologies like new varieties. Because of the problems of exclusion and the high initial costs, such projects that generate long term positive externalities are less likely to be undertaken by individual households, indicating the need for collective decisions among potential beneficiaries.

Watershed management also potentially provides livelihood support for socially complex and diverse groups with differing entitlements and rights of access and use of resources. Sustainable management of such resources requires institutional mechanisms for fostering cooperation and coordination of the resource use and investment decisions among diverse stakeholders in the community. Effective collective management depends on the level of existing community organizations and social capital to ensure equitable access and utilization of watershed resources.

For this study, we define collective action as decisions taken by a group to internalize negative externalities and/or to generate positive externalities in the use and management of watershed resources. We identify two main components of collective action needed for the effectiveness of watershed management interventions:

- *Enabling institutions:* This requires the development of rules and regulations for operation and management of the various common assets and structures including grazing lands, check-dams, agro-forestry, and soil and water conservation practices. These rules will also include establishment of mechanisms for conflict resolution, regulation of behavior, and agreed norms for sharing costs and benefits.
- *Organizational performance:* This involves the design and establishment of local mechanisms for coordination and implementation of watershed activities. This often calls for establishment of user groups, watershed committees and watershed associations, wherein the objectives and basic structure of authority and decision making are determined.

These institutional and organizational structures of the community are critical for conceptualizing the need for collective behavior and facilitating the proper planning, designing, and execution of specific actions taken by the community groups at various stages of implementing the watershed project, including mobilization and management of local and other resources, implementation of watershed activities, conflict resolutions, and maintenance of such investments. [2]

Setting up these arrangements is not without cost and may often require sensitizing and organizing widely dispersed resource users with diverging interests. However, these group activities can be used to capture the level of collective action in the community while the specific watershed outcomes can be measured using objectively verifiable investments like the number of check-dams, tube wells, tanks, and the like built or jointly maintained by the watershed communities. This can be complemented by other qualitative measures to characterize non-quantifiable economic and environmental benefits to the community attributable to the watershed development activities.

The level of collective action therefore defines the ability of the community to create operational frameworks to achieve the goals pursued by the community. Our empirical analyses focus on measuring the level of collective action in the community, using multiple indicators consistent with the different facets of collective action in watershed management. The selected indicators for the degree of collective action will have several dimensions spanning the two types of group actions described above. Hence, the different indicators are aggregated using statistical methods to develop indices for the level of collective action. Our dataset enables us to capture the critical elements of collective action in terms of the two categories: (a) enabling institutions and (b) participation and organizational performance. The selected indicators for each of the two categories representing the degree of collective action are discussed later.

Along with other factors hypothesized to influence the success of collective action, we investigate how the various facets of collective action determine the outcomes of collective action. An important initial outcome of collective action in watershed management is an improvement in the condition of soil, water, and other natural resources on both private and common lands. This first stage effect is captured by constructing an aggregate performance index for diverse outcomes defining changes in resource conditions and benefits derived from watershed management activities. In the second stage, collective action in watershed management is expected to improve the well-being of the community and the participants. This is the key driver of participation and private and community investments in watershed activities. In order to measure this effect, we use information solicited from communities on various indicators of poverty and welfare changes within the watershed. These changes are those that respondents consider to be primarily attributable or driven by the IWM interventions. We then test whether the level of collective action in fact is associated with these positive welfare changes within the community. The different indicators and indices are discussed in the next section.

[2] Whereas the underlying ability of the community to establish formal and informal institutions and organizational arrangements for achieving the goals of collective action would depend on the regional and national policy framework, our empirical analysis focuses on local level factors that affect the level and effectiveness of collective action in watershed management.

3. DATA AND EMPIRICAL METHODS

Data

This study is based on a large survey carried out in 87 watershed villages from a stratified sample of six districts of Andhra Pradesh, India. Meta analysis of watershed impact in India identified water availability (using rainfall as a proxy) as a major determinant of the success of community watershed programs (Joshi et al., 2004a). In order to capture this effect, community watersheds were stratified into three categories on the basis of historical average rainfall: low rainfall (less than 600 mm), medium rainfall (600-900 mm), and high rainfall (more than 900 mm). Two districts were selected from each agro-climatic zone. A proportional random sample of 87 community watershed villages was selected from the six districts of the survey. In order to assess the degree of collective action and its effects on poverty and natural resource conditions, watersheds were sampled from a list of mature watersheds where major institutional arrangements for collective action and community development activities have been completed. This does not, however, preclude the fact that communities may continue to maintain or upgrade the joint investments made during the project phase.

Data were collected using standard data collection instruments at the community level from leaders, user groups, and key informants. The number of respondents in each watershed representing group leaders and selected ordinary members varied from 5-8 local residents (including at least one woman) as key informants.[3] The group interviews were conducted in a transparent but informal setting that allowed all respondents to express views as freely as possible and reach consensus on many debatable issues. The key informants often knew the troubled user groups and self-help groups, and this was further verified during discussions with user and self-help groups and their members. Since the survey was conducted after the projects have been completed, there was no cash at stake, making it easier for groups to be more open in expressing their governance and management problems. Data collected included a range of issues that characterized the village and the watershed groups including demographic data (number of households by ethnicity, land ownership), market access, commodity and resource prices, social services and investment in natural resource management, process and evolution of collective action, and various indicators of the level and effectiveness of collective action including distribution of economic and environmental benefits from watershed management activities. The summary statistics of selected variables is given in Table 1.

[3] The ordinary members as key informants were often suggested by a council of village elders based on their overall neutrality and knowledge of diverse local issues for watershed management.

Table 1. Summary statistics of selected variables in the sample (n=87 watersheds)

Variables	Mean	Std. Dev.	Min	Max
Household (hh) and social characteristics				
Total number of households	380.89	270.18	76.00	1280.00
Number of castes in village	10.41	5.01	1.00	22.00
Social (caste) diversity index	0.49	0.17	0.00	0.73
Share of forward caste	0.15	0.18	0.0	0.87
Share of backward caste	0.44	0.26	0.0	1
Share of scheduled caste	0.25	0.18	0.0	1
Share of scheduled tribe	0.16	0.28	0.0	1
Number of seasonal migrants before project	13.51	17.06	0.00	75.00
Number of permanent migrants before project	4.38	7.31	0.00	52.00
Share of marginal and landless	0.32	0.20	0.00	0.97
Watershed project characteristics				
Age of watershed project	5.19	1.02	3.00	8.00
Area of watershed village (acre)	2603.38	1815.78	990.0	10380.0
Project implementing agency (NGO=1)	0.48	0.50	0.00	1.00
Assets				
Percentage of hhs owning open wells before project	22.16	27.66	0.00	170
Percentage of hhs owning open wells after project	20.05	25.75	0.00	170
Percentage of hhs owning tube wells before project	14.81	19.98	0.00	83.00
Percentage of hhs owning tube wells after project	21.72	22.88	0.00	95.00
Cattle owner households before project (%)	55.00	18.01	20.00	100.00
Infrastructure and markets				
Distance to nearest market (km)	14.83	11.81	3.00	70.00
Distance to mandal (km)	10.83	8.78	1.00	71.00
Distance to Hyderabad (km)	225.67	119.08	30.00	422.00
Quality of road to village (1=poor to 4=very good)	2.95	0.43	1.00	4.00
Highest school standard in village	6.62	2.23	0.00	10.00
Number of schools in village	1.49	0.93	1.00	5.00
Number of clinics	0.44	0.80	0.00	4.00
Number of phones per hh before project	0.02	0.03	0.00	0.18
Number of phones per hh after project	0.07	0.09	0.00	0.59
Percentage of hhs with electricity before project	54.06	29.92	7.15	100.00
Percentage of hhs with electricity after project	65.86	35.54	8.16	100.00
Biophysical conditions				
Medium rainfall zone (dummy)	0.36	0.48	0.00	1.00

High rainfall zone (dummy)	0.32	0.47	0.00	1.00
Share of cultivated area rain-fed	0.89	0.13	0.35	1.00
Share of total area degraded	0.01	0.01	0.00	0.06
Share of CPR and forest area	0.10	0.14	0.00	0.67
Leadership and conflict management				
Acceptability of leader (yes=1)	0.90	0.31	0.00	1.00
Popularity of leader (1=low to 3=high)	2.07	0.33	1.00	3.00
Leadership problem (1= low to 5=high)	1.91	0.39	1.00	3.00
Problems in transparency of using funds (5=high)	2.44	0.60	1.00	4.00
Problems in conflict management (1= low to 5=high)	2.43	0.74	1.00	5.00
Read previous minutes at each meeting (yes=1)	0.61	0.49	0.00	1.00
Share information widely (yes=1)	0.25	0.44	0.00	1.00
Preferred employment for women (yes=1)	0.03	0.18	0.00	1.00

Empirical methods

Several variables are identified to capture the degree and success of collective action in watershed management. However, the large number of indicators for the level and success of collective action can be reduced, using statistical data reduction methods, to a few indices that capture most of the information in these variables. We employ factor analysis to develop an aggregate index of the degree and success of collective action specific to each watershed community and to identify the relative importance of the selected indicators. Factor analysis allows clustering of variables on the basis of mutual correlations and a grouping of variables based on their similarities. The higher the loading of a variable, the more influence it has on the formation of the factor scores and vice versa. This is followed by regression analyses to identify the determinants of level and success of collective action in watershed management. The advantage of using factor score is that the new variables are not correlated and the problem of multicollinearity is avoided (Sharma, 1996:79-81). The resulting factor structure represents a distinct construct that can be meaningfully interpreted (Sharma, 1996:119). The ability to interpret and assign some meaning to the factors acts as an extremely important criterion in determining the final number of factors to extract (Frankfort-Nachmias and Nachmias, 1996).

Level of collective action

We consider two sets of variables that capture the level of collective action in watershed management activities: (a) enabling institutions and (b) participation and organizational performance. Development of institutions for defining and regulating individual behavior and shaping expectations is a critical first step and enabling condition for community watershed management. This is an important indicator of collective action in terms of creating the enabling conditions for community management. We use several proxy variables to capture the level of collective action in terms of establishing the ground rules for co-operation, including rules designed and adopted by the watershed community to address the different dimensions of collective natural resource management, the percentage of watershed association (WA) members respecting rules for cash contribution, and the percentage of WA members respecting rules for labor contribution. Participation of households in various joint community activities including attendance of meetings and fund-raising events is also decisive for the level of collective action. Community members show their commitment to collective principles through their labor and cash contributions, which can be considered as key indicators for the degree of collective action in a given community. In this category we included average amount of cash contributions per household, community's share of cash contribution, labor contributions, average amount of maintenance funds contributed per household and the number of households contributing to the maintenance fund. To indicate organizational performance, we use the proportion of smoothly running user groups (UGs), proportion of smoothly running self help groups (SHGs), number of watershed committee (WC) meetings per year, percentage of members attending WC meetings, and watershed association (WA) meetings per year. These variables capture the broader dimensions of the level or degree of collective action in community watershed management.

Success of collective action

We use a mix of quantitative and qualitative indicators to measure the effectiveness or success of collective action in watershed management in terms of achieving various community objectives. In the first instance, we capture the outcomes of collective action in undertaking natural resource improving investments. We identify eight different variables as indicators for the community's achievements in improving the natural resource base in the watershed. These include the total number of improved or well-managed communal tube (drill) wells, open wells, check-dams, ponds, tanks, area of community forests, and share of communal and private land treated with collective conservation practices. In the second level of the analysis, we identify certain indicators that measure the changes in the level of asset endowments or poverty profiles in the surveyed communities. We use seven indicators to capture these changes including increases in the number of households owning livestock and land, self-sufficient in food staples, overall food security, income growth to escape poverty as well as the reduction in the number of households involved in seasonal and permanent out-migration.

Econometric estimation

In both cases, the indices that are obtained from the factor analyses are investigated further to identify their key determinants using regression analyses. The first set of equations estimated examines the likely determinants of the variation in the degree of collective action across the surveyed watershed communities. The parameters for the determinants of the levels of collective action are estimated using ordinary least squares (OLS). The following general equation is estimated.

$$(1) \qquad CA - Index = \beta' X + \varepsilon$$

where CA-Index is a measure of the level of collective action, X is a vector of exogenous explanatory variables, β is parameters to be estimated, and ε is an error term that is normally distributed with zero mean and variance σ^2.

The second set of equations estimated attempts to identify the variables that affect the performance or effectiveness of watershed activities. Along with several community characteristics and biophysical and socioeconomic factors, we particularly test whether the indices measuring the degree of collective action identified above will have any effect on the two indices measuring the success or effectiveness of community watershed investments. This helps to assess whether collective action expressed through joint watershed investments has generated joint public goods that offer benefits and create incentives for conservation of community watersheds. The following generic equation is used for estimation of the performance of collective action:

(2) $Perf - index = \beta_1' X_1 + \beta_2 X_2 + \varepsilon$

where Perf-index is the dependent variable measuring the index of the performance of collective action, X_1 is a vector of exogenous regressors, X_2 is a vector of indices of collective action used to capture the enabling institutions and organizational performance, βs are estimated parameters, and ε is an error term that is normally distributed with zero mean and variance σ^2.

Using OLS for estimation of the performance of collective action may, however, lead to inconsistent estimates if unobserved variables affect both the level of collective action and the performance of collective action, leading to endogeneity bias (Wooldridge, 2002). In order to test this effect, we first estimate the full regression model for the performance equations and test for joint significance of selected variables. Those variables that were found to be jointly insignificant were then excluded from the performance regressions, and some of them are used as instruments for estimating the potentially endogenous variables (indices of the level of collective action). We also test for the validity of the instruments using standard tests for over-identifying restrictions (Baum et al., 2003) and use the Hausman test (Hausman, 1978) to evaluate the consistency of OLS compared to the two-stage instrumental variables approach. The analysis is undertaken using the IVREG2 procedure in STATA Version 10 (Baum et al., 2007).

4. RESULTS AND DISCUSSION

Socioeconomic characteristics of communities

Socioeconomic characteristics of the 87 sample watershed communities are given in Table 1 to facilitate a better understanding of the context. As indicated earlier, the watershed communities are chosen to represent the three rainfall zones: low, medium, and high. The sample watersheds are chosen from these three zones and evenly distributed among the zones. About 48 percent of the watersheds are implemented by various non-governmental organizations (NGOs) working with the communities. While previous studies indicate that projects implemented by NGOs were generally more successful (Kerr, 2001), the second-generation watershed programs implemented by government agencies also pursued participatory approaches. Some NGOs also lack capacity and/or reputation for mobilizing local communities and managing available project funds. The implementing agency (PIA) is not therefore expected to have any significant effect on the effectiveness of watershed projects included in this study. The important roles of the PIA are to facilitate community organization and training, motivate the formulation of local rules for collective action and resource mobilization, and design and facilitate implementation of development plans for the watershed. The projects were funded by various governmental (e.g., Drought Prone Area Program (DPAP), Desert Development Program (DDP), Integrated Watershed Development Projects (IWDP)) facilitated through national and state governments and non-governmental organizations.

Since the survey included only completed watersheds, the average duration of watershed projects is about 5.16 years. The average size of the communities varied both in terms of the size of the community members and the geographical areas covered. The average size of the groups is about 380 households but varied between 76 and 1280 households. The average size of the watershed villages is about 2600 acres (1054 hectares), but this ranged between 400 and 4200 ha showing wide disparities in the geographical areas covered by the projects. As is typical of rural India, the communities are composed of diverse social groups representing different castes. The number of social groups varied between 5 and 22 castes with an average number of 10 castes. Using the conventional caste classification systems used in India, about 15 percent of the villagers belonged to the forward, 44 percent to the backward, 25 percent to the scheduled castes, and the remaining 16 percent to the scheduled tribes.

The communities also varied in terms of infrastructure and market access variables. The distance to the nearest market varied between 3 and 70 km with an average of about 15 km. The distance to the State capital, Hyderabad, varied from 30 to over 420 km, with an average of 119 km. Similarly, the quality of the roads to the village varied significantly from good to very bad condition. The proportion of households owning certain assets like tube wells, livestock, etc and having access to electricity and telephones also varied among the surveyed villages. On average, there are 1.5 schools and 0.44 clinics in these watershed communities. About 55 percent of the households own cattle. Data was also collected on how asset ownership and access to social infrastructure varied before and after the project. For example, ownership of tube wells increased from about 15 percent before the project to about 22 percent after the project. However, the number of phones per household changed from 0.02 to 0.07, and the share of households with access to electricity grew from 54 percent to about 66 percent. These factors are taken into account in evaluating the likely determinants and impacts of collective action on watershed management.

Indicators for level of collective action

In this section, we discuss the results from analyses of indicators for collective action. As a preliminary validation step for the selected indicators, a simple pair-wise correlation between the 13 indicators is conducted (Table 2). The pair-wise correlations are significant at 10 percent for most of the variables and hence validate the use of factor analysis. The result of the factor analysis gives two useful factors with Eigen values greater than one, and we present the scoring coefficients for these factors in Table 3.

Table 2. Correlation matrix between 13 indicators of level of collective action

	1	2	3	4	5	6	7	8	9	10	11	12	13
1													
2	+												
3	+	+											
4		+	-										
5		+		+									
6		+											
7		-			-	-							
8	+		+		+								
9			-										
10						+		-	+				
11	-		-	+		+	-	-	+	+			
12			-	+		+	-			+	+		
13				+	+	+	-		+	+	+	+	

1– Community's share of total watershed development investment
2 – Average household cash contribution toward investment fund
3 – Average household contributions towards maintenance funds
4 – Households contributing to maintenance fund
5 – Labor contribution per household
6 – Percentage of smoothly running UGs
7 – Percentage of smoothly running SHGs
8 – WA meetings per year
9 – WC meetings per year
10 – Percentage of members attending WC meetings
11 – Percentage of WA members respecting rules for cash contribution
12 – Percentage of WA members respecting rules for labor contribution
13 – The dimension of NRM covered by rules (bylaws)

The scoring coefficients for the first factor are relatively high for variables related to local institutions (rules and bylaws) defining the rules of the game and shaping expectations of the participants. The scoring coefficients are particularly higher for the bylaws developed to strengthen local institutions of collective action, to address the specific uses and management of diverse resource types (community woodlots, check-dams, grazing, and so on) in the watershed, and the share of community members respecting the different rules, especially those related to cash and labor contributions. The first factor therefore is considered to capture the effect of 'enabling institutions' for community collective action and participation. We call this the internal institutional capacity (IIC—see Figure 1) of the community. The second factor gets most of its loadings from variables that show the degree of household participation in collective activities and their contributions towards watershed activities. These include both cash and labor contributions for project activities and for sustainability of project investments during the post-project period. Accordingly, we consider this factor to capture mainly the effect of participation and organizational performance that may be called internal mobilization capacity (IMC—see Figure 2) of the community.

Table 3. Scoring coefficients for two retained factors for level of collective action

Variables	Institutional Capacity	Mobilization Capacity
Community's share of cash contribution	-0.02951	0.10651
Per capita cash contribution	0.11568	0.46995
Cash contributions per household towards post-project sustainability	-0.08321	0.14667
Households contributing to investment maintenance fund	0.13313	0.13412
Labor contribution per household	0.02274	0.21983
Percentage of smoothly running UGs	0.14548	-0.03217
Percentage of smoothly running SHGs	-0.06003	-0.07277
WA meetings per year	-0.01354	0.17142
WC meetings per year	0.03762	-0.04319
Percentage of members attending WC meetings	0.11389	-0.12508
Percentage of WA members respecting rules for cash contribution	0.22828	-0.14813
Percentage of WA members respecting rules for labor contribution	0.24391	-0.03521
Dimension of institutions and NRM covered by bylaws	0.27820	0.04326
Eigen values	2.85	1.46

The factor analysis therefore provides two indices, capturing internal institutional capacity and internal mobilization capacity. In order to see the degree of variation across watershed communities in terms of these two measures of collective action, we plot these indices in Figures 1 and 2. These results show that watersheds vary significantly in terms of the degree of observed collective action, but the distributions for the two indices are quite different. Whereas the IIC shows that about 55 percent have values above zero (skewed to the right), the scores for IMC show that more than 60 percent of the watersheds have values below zero (skewed to the left). While the individual scores are difficult to interpret on their own, their relative values can shed light on the relative position of any given watershed community on the scale of the degree of collective action. Both indices show that watersheds with significantly higher scores (e.g., >1.0) are relatively fewer. The majority of the watersheds (about 60 percent) have values close to zero or slightly higher (± 0.5). About 8-10 percent of the sample watersheds have higher scores on both indices (>1.0). This clearly indicates that the level of active collective action in terms of establishing and enforcing collective rules and mobilizing community resources for joint investments is generally low in many of the watersheds. This is consistent with similar findings of low levels of effective community participation in watershed programs across India (Joshi et al., 2004b; Reddy et al., 2004a).

Figure 1. Percentage distribution of index of institutional capacity (IIC)

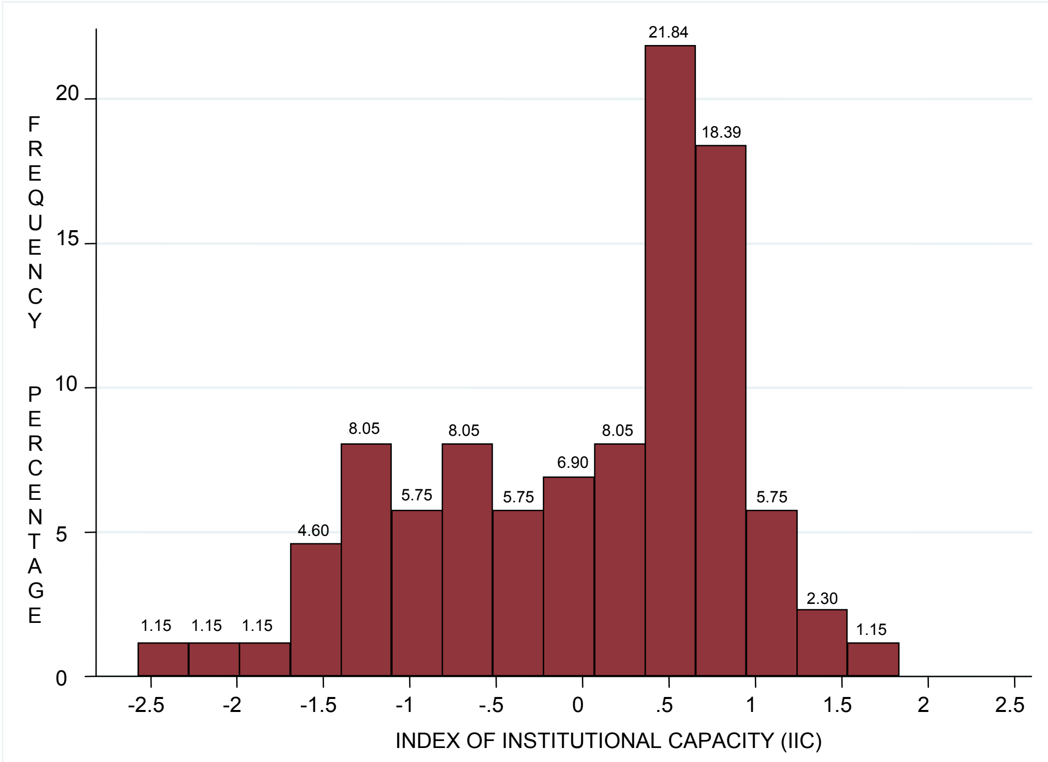

Figure 2. Percentage distribution of index of mobilization capacity (IMC)

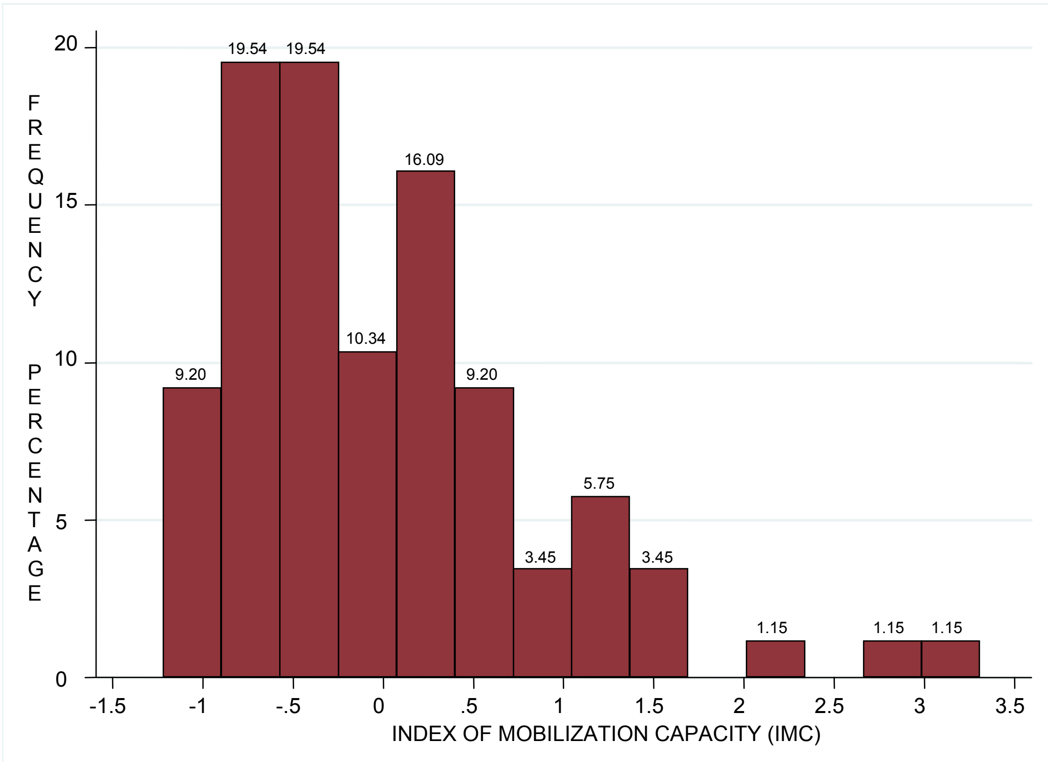

Table 4. Regression results for index of institutional capacity (IIC)[4]

Variables	Coefficients	Std. Err.	t-statistics	P-Value
Project implementing agency (NGO=1)	0.005	0.217	0.02	0.983
Age of watershed	-0.082	0.110	-0.74	0.460
Village area (acre)	-0.001	0.001	-2.17**	0.034
Medium rainfall dummy	0.483	0.477	1.01	0.315
High rainfall zone dummy	0.720	0.285	2.53**	0.014
Distance to Hyderabad	0.002	0.002	1.07	0.287
Distance to mandal	-0.020	0.011	-1.83*	0.072
Distance to market	0.025	0.008	2.97***	0.004
Number of households	-0.005	0.002	-3.03***	0.004
Square of number of households	0.001	0.001	3.05***	0.003
Number of castes	0.092	0.033	2.79***	0.007
Caste heterogeneity index	-0.557	0.623	-0.89	0.375
Proportion of marginal & landless households[a]	-0.105	0.562	-0.19	0.852
Number of seasonally migrating households[a]	0.004	0.006	0.66	0.514
Number of permanently migrating households[a]	-0.016	0.013	-1.22	0.226
Highest school standard	-0.044	0.058	-0.75	0.456
Number of schools	-0.189	0.143	-1.32	0.191
Households with phones[a]	0.010	0.006	1.69*	0.096
Households with electricity[a]	-0.002	0.001	-2.03**	0.047
Transparency of funding	0.198	0.174	1.14	0.258
Leader's acceptability	0.572	0.375	1.53	0.132
Information dissemination	0.219	0.255	0.86	0.394
Preference for female employment	0.897	0.463	1.94*	0.058
Proportion of waste land	-36.491	21.369	-1.71*	0.093
Proportion of rain-fed land	-0.265	0.873	-0.3	0.762
Proportion of CPR and forest	-0.824	0.753	-1.1	0.278
Constant	0.609	1.723	0.35	0.725
Number of observations	84			
R^2	0.60			

[4] *, **, *** signify significance at 10 percent, 5 percent and 1 percent level, respectively.

[a] Refers to before project conditions.

Determinants of the level of collective action

In this section we discuss results from the analyses of the determinants of indices of the degree of collective action. In order to identify the key variables associated with higher levels of community collective action, we included several variables that capture the:

- biophysical conditions (rainfall zone, village area, share of rain-fed farmland, share of degraded land, community forest, and other commons, and so on);
- socio-economic profile of the village (distance to markets and local administration, number of schools, ownership of selected assets like phones and wells);
- type of implementing agency (NGO or government);
- socio-economic characteristics of the groups (size, number of castes, and diversity of social groups);
- leadership and organizational attributes of the groups (transparency in management of finances, quality of leadership, role of women, and so on).

Table 5. Regression result for index of mobilization capacity (IMC)[5]

Variables	Coefficients	Std. Err.	t-statistics	P-Value
Project implementing agency (NGO=1)	0.086	0.160	0.54	0.594
Age of watershed	0.053	0.081	0.65	0.519
Village area (acre)	0.000	0.000	2.49**	0.016
Medium rainfall dummy	-0.772	0.352	-2.19**	0.032
High rainfall zone dummy	-0.859	0.210	-4.1***	0.000
Distance to Hyderabad	-0.002	0.001	-1.51	0.137
Distance to mandal	-0.028	0.008	-3.4***	0.001
Distance to market	0.009	0.006	1.4	0.167
Number of households	-0.006	0.001	-5.26***	0.000
Square of number of households	0.000	0.000	2.88***	0.006
Number of castes	-0.022	0.024	-0.91	0.369
Caste heterogeneity index	0.050	0.459	0.11	0.913
Proportion of marginal & landless households[a]	0.320	0.414	0.77	0.443
Number of seasonally migrating households[a]	-0.009	0.004	-2.1**	0.040
Number of permanently migrating households[a]	0.006	0.010	0.64	0.525
Highest school standard	0.075	0.043	1.73*	0.089
Number of schools	0.093	0.105	0.88	0.383
Households with phones[a]	-0.001	0.004	-0.19	0.850
Households with electricity[a]	0.000	0.001	-0.38	0.706
Transparency of funding	-0.001	0.128	-0.01	0.994

[5] *, **, *** signify significance at 10 percent, 5 percent and 1 percent level, respectively.

Leader's acceptability	-0.289	0.276	-1.05	0.300
Information dissemination	0.419	0.188	2.22**	0.030
Preference for female employment	1.024	0.341	3.00***	0.004
Proportion of waste land	23.358	15.754	1.48	0.144
Proportion of rain-fed land	-0.717	0.644	-1.11	0.270
Proportion of CPR and forest	1.170	0.555	2.11**	0.039
Constant	2.254	1.270	1.77*	0.081
Number of Observations	84			
R^2	0.742			

[a] Refers to before project conditions.

The regression results for the two indices are presented in Tables 4 and 5. The major positive correlates with institutional capacity include high rainfall, distance to the nearest main market, number of castes, number of phones, and agreed preferences for offering priority for female employment in watershed works in the community. The negative correlates with institutional capacity include the geographical size of the village, the number of households, distance to *mandal* (local administration), the proportion of households with electricity, and the proportion of degraded land in the community. The positive effect of distance to markets and the negative effect of access to electricity seem to indicate that the internal institutional capacity somehow decreases with market access and urbanization. Better market access seems to stimulate more integration with the economy outside the village, and so people may be more focused on that and less interested in participating in village institutions. On the other hand, better water management and access to irrigation resulting from collective watershed management may also strengthen market orientation through production of high value irrigated crops such as vegetables. The exact influence of these factors on collective action is not immediately clear and may warrant more investigations in the future. The negative effect of size of the village and number of households indicate the transaction costs and coordination problems associated with large groups. However, the second term for group size was positive, indicating a relationship that differs from the common inverted U type of response for this variable. But these results are consistent with findings in the West African Sahel (McCarthy et al., 2004). The negative effect of the proportion of degraded land on institutional capacity shows that villages with a higher proportion of village land under degraded categories may find it difficult to establish rules and bylaws for proper management of these resources.

With regard to the determinants of the second index for level of collective action, the positive correlates with the internal mobilization capacity include the size of the village, the level of education in the village (proxied through the highest school standard), the level of information flow about community activities (proxied through communication of work plans and decisions using the village notice board), the proportion of common lands and community forests in the village area, and the preference for female employment in watershed works. The negative correlates include the location of the village within the medium and higher rainfall zones in the semi-arid region, the size of the group (number of households), distance to the local administration (*mandal*), and number of seasonal migrants from the village.

Except for the two variables - rainfall and village area - most of the other variables have similar effects for the two indices of collective action (see Table 5). While institutional capacity seemed to be higher in the medium and high rainfall areas, mobilization capacity of the communities seems to be lower in these same areas, indicating that the overall effect of rainfall may depend on the relative magnitude of these seemingly opposing effects. Similarly, the share of village degraded land seemed to have a positive (but not significant) effect on mobilization capacity, indicating that if communities are able to evolve the fundamental rules of the game (institutions), the capacity for mobilizing local resources for collective action is likely to be higher in villages where the perception of land degradation is high. The effect of these indices on the selected poverty and natural resource outcomes of collective action will be investigated in the following sections.

Indicators for success of collective action

In this section we discuss the results from analyses of indicators for effectiveness or success of collective action. We present findings for changes in natural resource conditions and various quantitative indicators of performance defining changes in poverty and welfare conditions of the community. Using the rule of thumb of Eigen values>1, only one factor is retained. The factor loadings for this factor on the eight indicators capturing the outcomes related to improvements in natural resource conditions are presented in Table 6. The factor loadings are strongest for the community tube wells and open wells maintained in good condition through watershed investments. In the next stage we use factor analyses to develop an aggregate index for these indicators. The aggregate index (Perf-index-I) of the improvements in the condition of natural resources assets of the community is depicted in Figure 3. The plot for the performance scores of the watershed communities shows that the level of success in terms of these indicators is generally low. The distribution is generally concentrated around zero (but skewed to the left) indicating that most of the watersheds did not perform well on this index. Those with a score index greater than or equal to 1 are about 10 percent. These are those who are the best performing watersheds using this index.

Figure 3. Percentage distribution of performance index I: NRM indicators

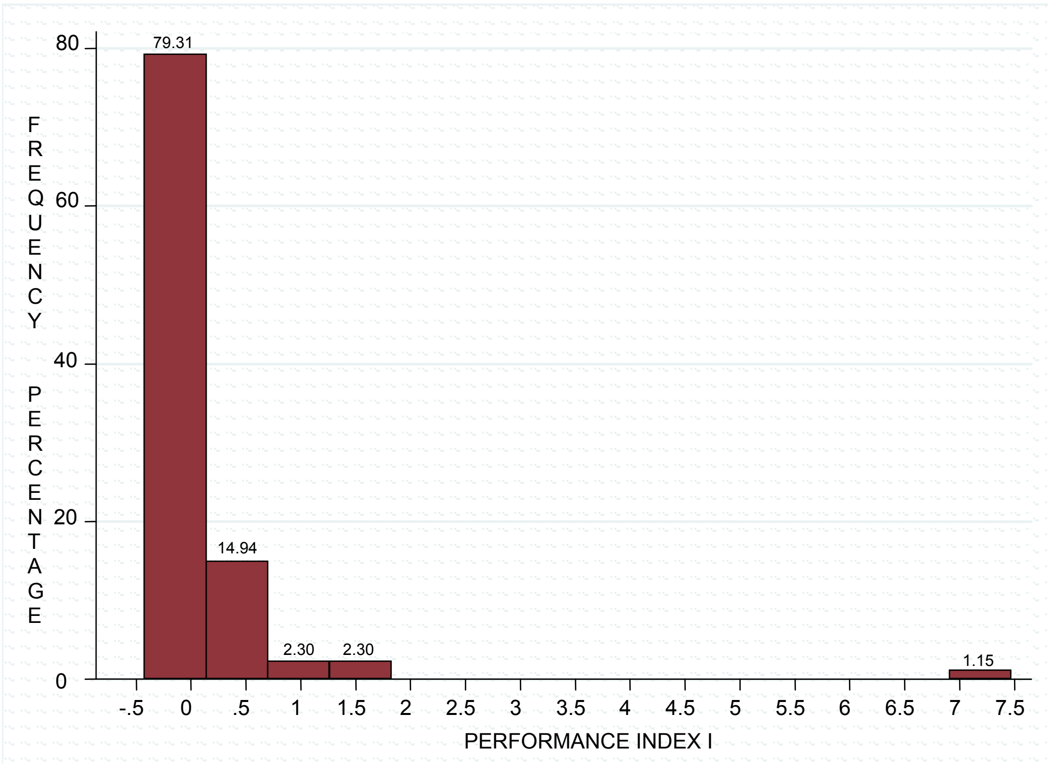

Table 6. Scoring coefficients for indicator of improved management of natural resources

Variable	Scoring coefficient
Communal tube wells in good condition	0.48505
Communal open wells in good condition	0.45743
Communal check-dams in good condition	0.03230
Communal ponds in good condition	-0.02063
Communal tanks in good condition	-0.02016
Plantation and managed forest (established through collective action)	-0.00528
Treated communal land (%)	-0.00423
Treated private land (%)	-0.00703
Eigen value	1.47

In addition to improvements in community natural resources, we also identified seven indicators measuring the changes in asset ownership and poverty conditions in the community. These are changes between conditions before and after the implementation of the watershed project that the key informants consider to be closely related to or attributable to the watershed project itself. As in the previous case, only one factor had Eigen values>1. The factor loadings for the selected indicators are presented in Table 7. Almost all the indicators have higher factor loadings towards an aggregate index (Perf-index-II) measuring the potential impact of collective action in improving asset endowments and welfare conditions in the community. The distribution of watershed villages using this index is presented in Figure 4. Unlike the previous performance index (Perf-index-I), this index is skewed towards the right, indicating that some watersheds have done generally well in improving the welfare and poverty conditions in the villages. However, similar to Perf-index-I, there are only very few communities with high levels of performance. About 10 percent of the watershed communities had performance scores greater than or equal to one.[6] This is also consistent with our findings (see above) on the level of collective action. The next question is to examine whether these changes in natural resource and livelihood conditions in the community are actually correlated with the levels of collective action assessed earlier.

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[6] There are two watersheds that seem to be outliers in their performance index. In Figure 3, the outlier in terms of improved natural resources is Kothapally—a more successful watershed village in Rangareddy district. In Figure 4, this was Bandarlapally watershed in Ananthapur district, a much less successful watershed in terms of poverty impacts. However, the performance scores for these watersheds do not show unique patterns if one uses the collective action indices (Figure 1 and 2).

Figure 4. Percentage distribution of performance index II: poverty and asset indicators

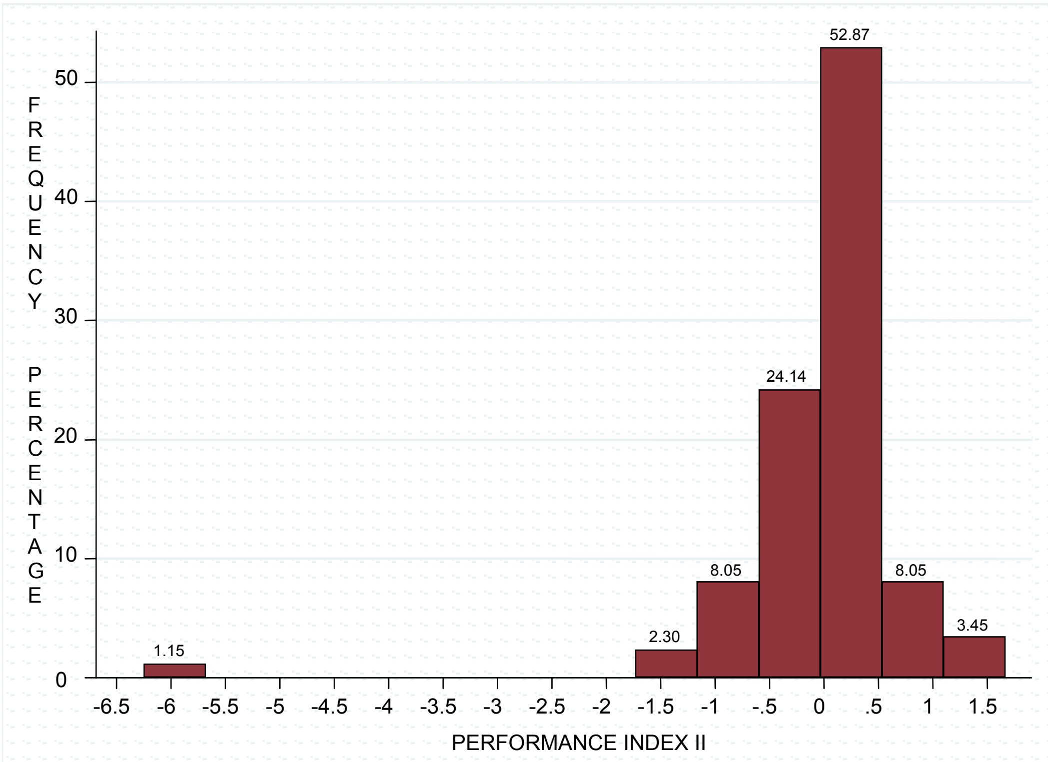

Table 7. Scoring coefficients for index of changes in asset ownership and poverty

Variables	**Factor 1oadings**
Increase in livestock ownership	0.52130
Decrease in landlessness	-0.16005
Increase in staple food self-sufficiency	0.40280
Reduction in poverty	0.54610
Improvement in food security	0.19959
Reduction in seasonal migration	0.70309
Reduction in permanent out-migration	0.69029
Eigen value	1.77

Determinants of success of collective action

In this section we discuss the results from analyses of the determinants of effectiveness or success of collective action. One of the major tests conducted in this analysis is the effect of the index of collective action on the measures of the effectiveness of community efforts. The analysis aims to show the potential association between good levels of collective action and the outcomes measuring the effectiveness of community action in attaining its ultimate goals (in terms of improvements in poverty and environmental conditions in the watershed). Notwithstanding the measurement and valuation problems, if such relationships cannot be established empirically, there will be limited justification for individual households to participate in collective action in watershed programs. Along with the indices measuring the degree of collective action in each community, we included several variables that were hypothesized to capture observed differences within the watershed communities and influence the performance of community watershed activities. However, there was some concern whether unobserved factors that determine the index of institutional capacity and index of mobilization capacity also affect the measures of success of collective action. This would imply that IMC and IIC variables will be correlated with the error terms in the performance regressions, making OLS parameter estimates inconsistent. In order to test this potential effect of endogeneity bias, we used an instrumental variables approach to see whether appropriate instruments can be identified. The validity of this approach, however, depends on whether suitable instrumental variables—exogenous variables that are good predictors of the IIC and IMC variables but that are valid to exclude from the second stage regressions for success of collective action—can be identified. We started with a full OLS regression to isolate some variables that may be jointly insignificant in the separate performance regressions for both Perf-index-I and II. This has allowed us identify some instrumental variables that could be safely excluded from the performance regressions but could be used for predicting the potentially endogenous IMC and IIC variables. [7] We also test for over-identifying restrictions to examine the overall relevance of these instruments in the two-stage estimation process. The results are presented below.

Effects on watershed natural resource conditions

The determinants of the success of collective action measured in terms of improvements on natural resource base estimated using both OLS and instrumental variables methods are presented in Table 8. First, it is important to note that the Hausman test indicates that the null hypothesis of consistent OLS parameters cannot be rejected (Chi2 (3) = 2.51; P-value = 0.473). The identified instruments also passed the test for over-identifying restrictions (Sargan statistic: Chi-sq (4) = 6.500; P-value = 0.165), indicating that the instruments are valid and are not correlated with the model error term. In order to check further as to why OLS remains consistent, we tested for endogeneity of IMC and IIC variables. The Wu-Hausman endogeneity test (F(2,56) = 0.529; P-value = 0.592) indicated that the null hypothesis that the two indices are exogenous cannot be rejected. Based on these results, the OLS estimates are used in the subsequent discussion while the instrumental variables results are also shown for completeness.

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[7] The instruments identified for predicting IMC and IIC in the Perf-Index-I regressions include village area, distance to markets, distance to mandal, number of castes in village, share of common forest land in village, and whether the group displays and actively shares information about watershed activities. In the Perf-Index-II regression, the instruments identified were village area, distance to markets, number of castes in village, share of common forest land, share of degraded land in village area, number of permanently migrating households, seasonally migrating households, and highest school standard in the village.

Table 8. Determinants of success of collective action—Management of community natural resource investments[8]

Variables	Ordinary Least Squares			Instrumental Variable Method		
	Coefficient	St. Err	Z-Stat.	Coefficient	St. Err	Z-Stat.
Index of institutional capacity	0.074	0.095	0.79	-0.123	0.215	-0.57
Index of mobilization capacity	0.484	0.124	3.89***	0.504	0.204**	2.47
Project implementing agency	0.161	0.184	0.87	0.132	0.161	0.82
Age of watershed	0.041	0.094	0.44	0.065	0.083	0.78
Medium rainfall zone dummy	0.469	0.262	1.79*	0.480	0.235**	2.04
High rainfall zone dummy	0.041	0.278	0.15	0.162	0.270	0.6
Quality of road to village	0.460	0.177	2.6**	0.472	0.164***	2.88
Degree of conflict resolution problem	-0.135	0.162	-0.83	-0.141	0.147	-0.96
Degree of leadership problem	0.051	0.218	0.23	-0.045	0.194	-0.23
Leader's acceptability	0.191	0.300	0.64	0.421	0.293	1.43
Degree of transparency in fund management	-0.082	0.146	-0.56	-0.017	0.132	-0.13
Minute reading in meetings	0.311	0.179	1.74*	0.261	0.171	1.52
Share of backward caste	-0.175	0.349	-0.5	-0.159	0.337	-0.47
Share of forward caste	0.109	0.491	0.22	0.014	0.433	0.03
Share of marginal and landless households	-0.075	0.503	-0.15	-0.015	0.433	-0.03
Share of households owning cattle before the project	-0.004	0.005	-0.78	-0.005	0.004	-1.16
Number of households	-0.001	0.001	-1.02	-0.001	0.001	-1.11
Number of seasonally migrating households before project	-0.006	0.005	-1.24	-0.006	0.005	-1.24
Number of permanently migrating households before project	0.020	0.011	1.85*	0.021	0.009**	2.25
Highest school standard in village	0.097	0.045	2.14**	0.097	0.040**	2.41
Number of schools	0.025	0.113	0.22	0.045	0.104	0.43
Households with phones before project	-0.002	0.005	-0.32	0.000	0.004	0.02
Households with electricity before project	0.001	0.001	2.11**	0.001	0.001**	2.24
Preference for female employment	1.867	0.453	4.12***	1.981	0.472***	4.19
Proportion of degraded land	23.832	16.734	1.42	23.228	14.773	1.57
Proportion of rain-fed land	0.469	0.744	0.63	0.654	0.646	1.01
Constant	-2.882	1.587	-1.82*	-3.295	1.406**	-2.34
R-Squared	0.68					
Adjusted R-Squared	0.54					

[8] *, **, *** indicate significance at 10 percent, 5 percent and 1 percent level, respectively.

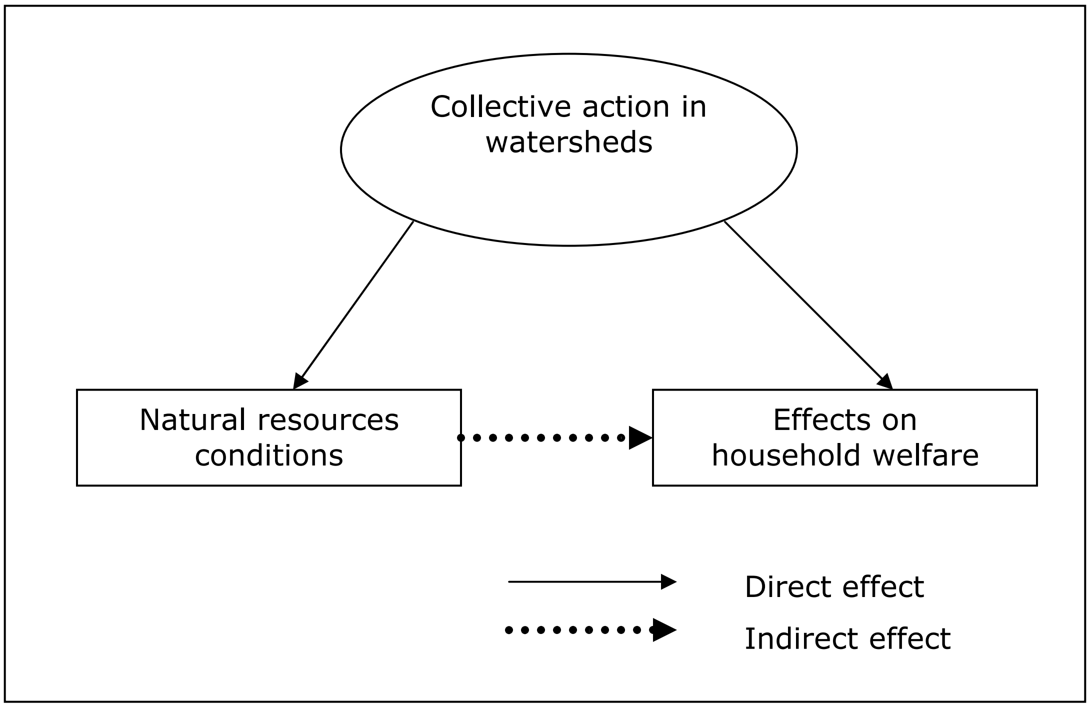
Hausman test (OLS is inconsistent under Ha, efficient under Ho)	Chi2(3) = 2.51; P-value = 0.4728
Wu-Hausman endogeneity test (Ho: Index 1 and Index 2 are exogenous)	F(2,56) = 0.52915; P-value = 0.59202

The significant (p-value <0.1) and positive correlates with this index include the internal mobilization capacity (IMC), medium rainfall zone, quality of the road linking the village, culture of reading minutes in meetings, number of permanently migrating households, highest school standard in the village, number of households using electricity before the project, and preference for female employment. Other included variables that proxied the problems of leadership and conflict management in watersheds were not significant. Only the reading of minutes from past meeting seems to have a positive effect on the natural resource performance index. Most notable in these results is the strong positive effect of collective action in terms of the internal mobilization capacity on this index (Perf-index-I). There seems to be little doubt that well-organized communities in terms of coordinating joint watershed activities and investments have been better able to manage the joint natural resource assets (wells, ponds, check-dams, forests, and grazing lands) of the community. Interestingly, better natural resource management is also positively correlated with the level of rainfall (highest gains being in the medium rainfall zone), the quality of the road, and access to education and electricity. The importance of the before project seasonal and permanent migration patterns seems to capture the severity of land degradation and water scarcity problems in the village that may stimulate greater determination by the community to change these outcomes and reverse the downward spiral. Well organized communities who perceive the threats to their current and future livelihoods are more likely to succeed in their collective efforts. Preference for female employment is also consistently significant in both the level of collective action and performance regressions, indicating the importance of distributional mechanisms for the success of watershed programs.

Effects on household welfare and poverty

This section presents the determinants of stated changes in the poverty levels and livelihood assets of households within the watershed communities. Before we present the results it would be useful to show the complexities involved in capturing the effect of collective natural resource investments on poverty. Whereas the effect of collective action on natural resource conditions is more direct, its ultimate influence on household welfare and poverty can be transmitted through direct and indirect pathways. The joint investments in improved natural resource management (such as wells, ponds, check-dams, forests, and grazing lands) will initially influence the condition and availability of water, soils, and woodlots. The effect on natural resource conditions may, however, also take time to have a measurable impact on the condition of the resource. Depending on the distribution of natural resource assets and the resource gestation period, improved natural resource conditions may ultimately translate into economically useful ecosystem services that improve household welfare and reduce rural poverty. This is an indirect effect. However, watershed interventions may also have components that affect livelihoods relatively immediately and more directly. This may include increased employment opportunities for the poor that generate cash incomes and other associated watershed technologies (such as new crop varieties, improved application of fertilizers, fodder for animals, and so on.) that generate more immediate benefits to participating farmers. This can be considered a direct effect on household welfare. These direct and indirect effects are described in the schematic diagram in Figure 5. The statistical analysis undertaken here aims to capture these direct and indirect effects.

Figure 5. Direct and indirect effects of collective action in watershed management



As discussed earlier, the index for changes in the household asset ownership and poverty conditions (Perf-index-II) measures the outcomes of both the direct and indirect effects of collective action. In order to capture the indirect effect of natural resource investments, we use the changes in the natural resource conditions directly affected by the community watershed project. Any direct effect of collective action on changes in poverty and household livelihood assets is captured by including the IIC and IMC indices. In addition, other variables that were considered to influence the performance of watershed activities on poverty and livelihood assets were also included. However, as in the case of Perf-Index-I, we cannot rule out the possibility that unobservable factors that affect performance will also affect the indices of collective action (IMC and ICC). A similar approach of instrumental variables is used to test this potential endogeneity bias based on a full regression and jointly insignificant variables excluded from the performance regressions but used to instrument the potentially endogenous variables. The model specification tests are presented below.

As in the case of Perf-Index-I, the Hausman test indicated that the OLS specification is consistent and there is much less to be gained from using the two-stage instrumental variables approach (see Table 9). The consistency of OLS parameters cannot be rejected (Chi2 (4) = 3.26; P-value = 0.515). However, the test for over identifying restrictions showed that the hypothesis of correlation with the error term could not be rejected (Sargan statistic Chi-sq (5)=13.465; P-value = 0.019) – indicating that we could not find more appropriate instruments for the potentially endogenous variables. In order to check further as to why OLS remains consistent even when we lacked good instruments, we tested for endogeneity of IMC, IIC, and the index of changes in the condition of natural resources variables. The Wu-Hausman endogeneity test (F(3,55) = 0.212; P-value = 0.888) indicated that the null hypothesis that the collective action and natural resource indices in this specification are exogenous cannot be rejected. Hence, we mainly present our discussions in relation to the consistent and efficient OLS results.

The variables with significant positive effects include quality of the road to the village, degree of information sharing and dissemination about the watershed project, level of access to telephones before the project, access to education in the villages, and preference for female employment. The significant and negative correlates include distance to Hyderabad and to the local administration (*mandal*), population share of the upper caste households, number of households with access to electricity before the project, and the overall size of the group (number of households). Most importantly, we could not find any of the collective action variables to have any significant effect on the changes in livelihood assets and poverty conditions in the community. Neither did we find any significant indirect effect of changes in natural resource conditions on the changes in poverty and livelihood assets in the community. However, this does not imply that the watershed projects did not generate any economic benefits to the community. It only implies that effect of any such outcomes on the poor and landless members was limited. The evidence of preference for female employment on poverty and livelihood assets indicates that communities with better distributional arrangements for reaching out to the less-privileged sections of the community will have a positive effect on poverty.

The negative effect of some of the variables like access to electricity and the share of the forward caste in the community are not immediately clear. Access to electricity is directly associated with better off households and large farmers owning private tube wells for irrigation. In Andhra Pradesh, electricity is largely subsidized by the government, and the irrigation water pumping costs to farmers who own tube wells are very minimal. The negative effect of well ownership (related to farm-level access to electricity) and the share of the forward caste in the community may therefore reflect the difficulties in designing meaningful institutions for collective action when access to and control over certain common watershed resources is not equitable (Deshpande and Reddy, 1991). Large farmers owning tube wells and those who have the upper hand in benefiting from common resources are likely to have higher interest to maintain the status quo, hence reducing the poverty impacts of collective action (Reddy and Shiferaw, 2007). Most of these effects seem to capture the effect of equity in sharing the benefits of collective action, indicating that the larger the proportion of the relatively better-off groups within the community, the lesser the chances for watershed collective action to improve conditions for the poor and marginal households.

Table 9. Determinants of success of collective action—changes in asset endowments and poverty indicators

	Ordinary Least Squares			Instrumental Variable Method		
Variables	**Coefficient**	**St. Err**	**Z-Stat.**	**Coefficient**	**St. Err**	**Z-Stat**
Index of institutional capacity	-0.129	0.091	-1.41	-0.219	0.200	-1.09
Index of mobilization capacity	-0.098	0.138	-0.71	-0.234	0.253	-0.92
Index of changes in natural resources	-0.130	0.124	-1.05	-0.049	0.207	-0.24
Project implementing agency	-0.166	0.167	-0.99	-0.227	0.148	-1.53
Age of watershed	0.099	0.088	1.13	0.133	0.077	1.72
Medium rainfall zone dummy	-0.006	0.408	-0.02	-0.089	0.414	-0.21
High rainfall zone dummy	0.026	0.262	0.10	0.008	0.249	0.03
Quality of road to village	0.429	0.177	2.42**	0.396	0.173	2.28**
Distance to mandal (km)	-0.017	0.009	-1.92*	-0.020	0.008	-2.42**
Distance to Hyderabad (km)	-0.003	0.001	-1.95*	-0.003	0.001	-2.13**
Degree of conflict resolution problem	0.154	0.154	1.00	0.107	0.148	0.73
Degree of leadership problem	-0.287	0.216	-1.33	-0.382	0.192	-1.99*
Leader's acceptability	0.345	0.289	1.20	0.473	0.289	1.64
Degree of transparency in fund management	0.089	0.135	0.66	0.151	0.118	1.28
Minute reading in meetings	-0.053	0.165	-0.32	-0.065	0.147	-0.44
Information dissemination	0.577	0.240	2.4**	0.593	0.246	2.41**
Preference for female employment	1.231	0.505	2.44**	1.209	0.646	1.87*
Share of backward caste	-0.176	0.316	-0.56	-0.072	0.289	-0.25
Share of forward caste	-1.363	0.467	-2.92***	-1.420	0.416	-3.42***
Share of marginal and landless households	0.395	0.447	0.88	0.505	0.380	1.33
Number of households	-0.002	0.001	-3.49***	-0.002	0.001	-3.35***
Number of schools	0.217	0.108	2.00**	0.277	0.099	2.79***
Households with phones before project	0.011	0.003	3.35***	0.012	0.004	2.94***
Households with electricity before project	-0.002	0.001	-3.27***	-0.002	0.001	-3.64***
Households owning cattle before the project	-0.006	0.004	-1.36	-0.006	0.004	-1.76
Constant	-0.303	1.184	-0.26	-0.239	1.128	-0.21
Number of observations	85					
R squared	0.67					
R squared adjusted	0.53					
Hausman test (OLS is inconsistent under Ha, efficient under Ho)	Chi2(4) = 3.26; P-value = 0.5150					
Wu-Hausman endogeneity test (Ho: Index 1 and Index 2 are exogenous)	F(3,55) = 0.21182; P-value = 0.88779					

The insignificant direct and indirect effect of collective action on poverty and improvements in household welfare may be attributable to many factors. First, the effect of collective action may take many years to have any visible impact on poverty. This is a major attribute of natural resource investments that often require a longer gestation period to generate income gains to the resource users. Second, the poorest households often lack access and control over some of the most important productive assets (for example, irrigation water, pastures, and so on) and may not directly benefit from investments that use land and water as the main entry points. In one of the districts covered in this study, Reddy (Reddy et al., 2004b) found that over 80 percent of the tube and open wells for irrigation were owned and controlled by the large farmers (farm size >10 acres). Second, the transmission of effects from improved natural resource conditions to productivity increases may involve a significant time lag and may not be realized within a period of 4-5 years (the common time span for completion of watershed projects studied here). In the watersheds covered under this study, limited benefits seem to have trickled down to the landless. Only 11.5 percent of the watersheds have any special provisions for increasing the welfare of the poor and landless households. A very limited number of the watersheds, 2.3 percent have reported that the landless benefited from using check-dams in the watersheds (see Table 10). However, most of the watersheds (92 percent) indicated that the poor and landless farmers had benefited from increased availability of temporary employment opportunities through the watershed development programs. While the lack of direct or indirect evidence of the effect of collective action on changes in poverty levels shows that the impacts on the poorest groups is minimal, it does not imply that income levels have not increased. Rather, the distribution of income growth does not seem to favor the poor. More analysis on this will be carried out in the future using the household data collected from these villages.

Table 10. Percentage of watershed communities (n=87) reporting benefits for the landless

Variables	Percent	Std. Err.
Benefits from check-dams	2.3	0.151
Benefits from common woodland	58.6	0.495
Benefits from common grazing land	64.4	0.482
Employment during the project	92.0	0.274
Special provisions to the landless	11.5	0.321

5. CONCLUSIONS

Rain-fed areas in the semi-arid tropics are characterized by low and erratic rainfall, poor soils, high levels of agro-ecosystem degradation, and pervasive poverty. India is one of the countries in South Asia that has adopted micro-watershed development as a strategy for poverty reduction and sustainable rural development in dry land areas. Some studies have shown that integrated watershed management interventions that also include improved access to markets and agricultural innovations are useful strategies for reducing poverty, improving livelihood resilience, and sustainability in these less-favored areas (Joshi et al., 2004a,b; Reddy et al., 2004b). However, results from our analysis show that this approach cannot succeed without collective action and coordination of resource use decisions by several actors and communities at the landscape level. The real benefits of watershed programs in terms of improving livelihoods, reducing poverty, and enhancing sustainable intensification of agro-ecosystems will critically depend on participation of resource users in community collective action. Whereas individual farmers often lack the capability and the incentive to improve local public goods, local institutions for collective action can help internalize externalities and reduce transaction costs for management of local commons. This contributes towards the empowerment of communities and facilitates joint investments for improving productivity and resource use sustainability at the landscape level.

Using empirical data from 87 watershed communities in semi-arid India, this study has shown that collective action in watershed management can be captured through a set of variables that indicate the capacity of communities to design and enforce certain common institutional arrangements, and their ability to mobilize local financial and labor resources for watershed investments. The level of collective action in terms of internal institutional capacity was affected negatively by the size of the groups (number of households and area of the village) while distance from markets and high rainfall seem to increase it. On the other hand, collective action in term of internal mobilization capacity decreased with rainfall, size of the group, number of seasonal migrants, and distance from the seat of the local administration, but increased with area of the village, flow of information within the village, and the share of land under village commons. The mobilization capacity also seems to increase with equitable distribution of benefits and preference given for employment of the rural poor and female workers. However, the results clearly show that in most watershed communities the level of collective action is very limited, indicating that only few communities have achieved higher active participation of resource users in watershed programs.

At the same time, we also found only few (10-15 percent) watersheds that were able to significantly harness the potential of collective action to achieve desired economic and environmental objectives. There is a strong correlation between higher levels of collective action and higher performance of communities in facilitating resource improving investments, especially water-harvesting structures and good management of these resources. The effectiveness of watershed groups in terms of their performance on this index depended on other variables like rainfall, access to education and other social services, governance structures in terms of conduct of meeting and proper archiving of information, resource degradation or scarcity problems (captured through degree of out-migration), and the quality of the road linking the village. On the other hand, the correlation between higher collective action and changes in the index of poverty parameters was not statistically significant. The analyses also showed that changes in watershed natural resource stocks did not have a significant effect on changes in household welfare, indicating that the indirect effects of collective action on the poorest segments of the community are still limited. This offers evidence that the links between collective action and poverty are not always straightforward as distribution of rights and other factors will condition how effectively the poor will be able to benefit from improved natural resource conditions within the watershed.

Overall, the results indicate that collective action has made a significant contribution in terms of improving the investment and management of critical jointly held natural resource assets (such as wells, check-dams, community forests, grazing land, and so on), but there is lack of evidence on its effects on improving the asset endowments of the resource poor and reducing poverty levels within the semi-arid watershed villages included in this study. In order to improve active participation of the resource users and the poverty impacts of watershed programs, there is a need to promote pro-poor interventions and institutional arrangements that enhance equitable sharing of both costs and benefits. Much less is also known about the emergence of effective local institutions for watershed collective action and how such institutions adapt during the post-project phase and influence the propensity for sustainable community management of local investments. Without effective and adaptable local institutions, the long-term sustainability of watershed investments will remain one of the key lingering questions. Future studies would need to investigate these factors and offer new insights on how preexisting proclivity for collective action and differences in biophysical and market conditions, and national and provincial policies may shape the process and determine the outcomes and impacts of watershed programs.

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