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How sustainable is participatory watershed development in India?

Jetske Bouma[a], Daan van Soest[b,*], Erwin Bulte[b]

[a]International Water Management Institute (IWMI), Hyderabad, India, and Department of Economics, Tilburg University, The Netherlands
[b]Department of Economics, Tilburg University, The Netherlands

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Abstract

Watershed conservation is widely recognized as a major strategy for rural development throughout the developing world. In India, the apparent success of participatory approaches to watershed development resulted in a decentralization of project planning, implementation, and management to local communities at the village scale. We explore the effectiveness of this so-called community-based approach in achieving sustainable soil and water conservation in four semi-arid regions in India, and analyze what factors explain project success. We confirm the result of earlier studies that participatory approaches are more effective in establishing soil and water conservation in the short run. However, our main result is that investments in community organization fail to ensure household commitment to maintenance in the longer term. Without better returns to investment in soil and water conservation and without local institutions to coordinate investment in the long run, the sustainability of participatory watershed management is seriously threatened.

JEL classification: O12, O19, Q01, Q25

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1. Introduction

In India's semi-arid regions, watershed development (WSD) is one of the main strategies for rural development. Over the past decades the government of India annually invested approximately $500 million in WSD (Government of India, 2000). The main objective of the program is to increase the productivity of rainfed agriculture by rehabilitating the resource base, thus offering rural households a sustainable way to increase their livelihood conditions. In early periods, investments were rather technical and implementation was mostly top-down. However, evidence that this approach was not very successful, combined with the apparent success of bottom-up approaches pursued by nongovernmental organizations (NGOs), stimulated a gradual shift in focus (e.g., Kerr et al., 2002). By now, most watershed programs have evolved towards participatory WSD, decentralizing the planning, implementation, and management of soil and water conservation (SWC) to local communities at the village scale.[1]

Participatory WSD has become a good example of the so-called community-based and -driven approaches that have become one of the fastest growing mechanisms for channeling development assistance (Mansuri and Rao, 2004).[2] The popularity of the approach stems from the claim that involving communities in project design and implementation improves investment targeting, increases government responsiveness, empowers the poor and strengthens community governance. However, evidence of the extent to which community-based approaches live up to these expectations is scarce: Mansuri and Rao (2004) detect a general dearth of well-designed evaluations

* Corresponding author. Tel.: +31 13 466 2072; fax: +31 13 466 3042.
E-mail address: D.P.vansoest@uvt.nl (D. van Soest).

[1] Soil and water conservation is the aggregated term for investments in bunding, drainage line treatment, small dams and other measures to reduce soil erosion, increase soil moisture, and recharge water storage structures and/or groundwater aquifers. WSD explicitly plans and implements soil and water conservation at the larger scale of the watershed (i.e., the area from which all water drains to a common point) in order to technically optimize investment. It is basically a systems-based approach that explicitly accounts for up-down stream linkages and externalities of resource conservation at the plot and inter-plot scale.

[2] For example, the World Bank's portfolio for community based and driven approaches doubled over the last 6 years to roughly $7 billion. Regarding definitions, "community based" actively includes beneficiaries in project design and management, "community driven" gives communities direct control over key project decisions, including management of investment funds (Mansuri and Rao, 2004).

with few examples proving a causal link between the participatory intervention and project outcomes.[3] With respect to participatory WSD in India, a major evaluation was undertaken by Kerr et al. (2002). This study found participatory approaches to be more effective than the earlier top-down approach, attributing success mainly to its flexibility and to the time and resources committed to community organization.

The main objective of this article is to assess the extent to which participatory approaches are also more effective in the long run. Whereas most studies focus on the short-term effectiveness of participatory WSD, there are indications that its long-run impact is much smaller. ODI et al. (2002) conclude from a qualitative study of several projects that maintenance of SWC is poor because institutions for community governance fail to manage resources in a sustainable way. Kerr et al. (2002) argue that poor maintenance can be attributed to poor investment targeting and over-subsidization. If households receive SWC structures they do not really want, these structures are unlikely to be maintained in the long run.

To what extent investments in community organization result in better investment targeting[4] and stronger conservation management at the village scale, is an open question. We address this question by analyzing the impact of participatory WSD on the intention of households to contribute to soil and water conservation in the long run while controlling for other factors such as market access, income inequality and resource scarcity. This allows us to identify conditions under which WSD efforts are more likely to succeed.

The methodology used is a cross-sectional analysis of data from 697 randomly selected households in four meso-scale watersheds. To distinguish between short- and long-term impacts, we study the effect of interventions on stated actual household investments in SWC, and on the intention of households to contribute to the operation and maintenance of SWC structures in the future. Whereas our analysis of actual household SWC investments confirms that participatory approaches are more effective than top-down approaches in the short run, our analysis of household intentions indicates that investments in community organization do not increase the sustainability of WSD in the long run. The article is organized as follows. In the second section of the article we present the conceptual framework. The third section deals with the methodology and describes the characteristics of the data set. The results of the analysis are presented in section four, and in section five we draw conclusions.

2. Conceptual framework

With relatively poor resource endowments and low and erratic rainfall, the revenues of agricultural production in India's semi-arid regions are uncertain (Walker and Ryan, 1990). Soil fertility and water scarcity are major constraints for agricultural production, and the average productivity of dryland agriculture is low. Technological development and investments in rural infrastructure (electricity, roads) did improve living standards through access to markets, inputs and ground water irrigation (Fan et al., 1999), but water scarcity and rainfall insecurity remain crucial production constraints (Ryan and Spencer, 2001). Also, because of the ongoing intensification of agriculture, groundwater depletion and soil erosion have become serious threats.

Extensive research has shown that SWC can increase the productivity of dryland agriculture and improve the sustainability of resource use (e.g., Wani et al., 2002 and 2003). However, a recurring concern is that farm households are reluctant to invest in SWC (e.g., Barbier, 1990; Heerink et al., 2001; Pender and Kerr, 1998). There are two explanations for why this may be the case.

First, the private benefit–cost ratio of SWC is often low, especially when compared to investments in (groundwater) irrigation and agricultural intensification (Walker and Ryan, 1990). Low farm gate prices, uncertain revenues, and increasing opportunity costs of labor due to improved off farm employment opportunities tend to make investment in rainfed agriculture unattractive.[5]

Second, investments in SWC have important public good externalities that give individual households an incentive to free ride (Baland and Platteau, 1996 and 1997). Depending on the type of investment, the size of the externality varies. For example, *in situ* investments in soil conservation tend to have fewer externalities than investments in water harvesting, because with water harvesting more of the benefits of conservation are shared.[6] In the presence of significant externalities, investment decisions depend on the expected behavior of others. If people trust others to reciprocate SWC investment or if a local authority exists to control free rider behavior, the likelihood of collective investments increases. Since in most dryland watersheds no organizations exist to coordinate soil and water conservation,[7] community organization is needed to facilitate local cooperation and to enhance local commitment and trust.

[3] Similarly, Agarwal (2001) notes that there are few systematic evaluations of community resource management: since most studies use a case study approach, it is generally not possible to compare the relative importance of factors influencing community resource management success.

[4] Kerr et al. (2002) suggest that the negative impact of subsidization on SWC maintenance seems less pronounced in participatory projects.

[5] Also, with over 30% of the households in India's semi-arid regions being classified as poor (Ryan and Spencer 2001), farm households tend to go for short-term benefits instead of investing in sustained productivity (Bardhan and Udry, 1999).

[6] The costs and benefits of soil and water conservation are not only shared at the village, but also at the inter-village scale; investments in the upper catchment area of the watershed tend to affect downstream areas as well. This is what inspired the WSD approach: by planning and implementing SWC at the scale of the watershed, investments can be coordinated and externalities internalized at the watershed scale. Critics however have pointed to the fact that communities do not function at the level of the watershed (Kerr et al. 2002, Rhoades 1998, Swallow et al. 2001). Hence, most watershed development projects are implemented at the village scale, and up-down stream externalities are insufficiently addressed (Batchelor et al., 2003; Shah and Raju, 2001).

[7] Traditionally, local institutions for community resource conservation and management did exist. Local warlords, kings, or religious organizations made the required investments and coordinated the operation and maintenance on the longer term (Mosse, 2003). With the invasion of Muslim and, later, colonial

To address the low benefit–cost ratio of SWC investments and to stimulate poor households to take up conservation measures on their plots, interventions in WSD heavily subsidize SWC investment. Depending on the program, households contribute only 0%–25% to investment costs in terms of voluntary labor. With project wages above the market wage and with high unemployment, in most cases investments are effectively subsidized by over 100% (Kerr et al., 2002). An important reason for the over-subsidization of investments in WSD is the fact that in most regions the WSD program did not start as a project aimed at increasing the productivity of dryland agriculture, but as a program to offer employment in times of drought (Shah, 2005). Although the focus shifted over time, subsidy rates remained high.

To increase the effectiveness and sustainability of WSD interventions, project implementers increasingly invest in community organization.[8] There are several reasons why such investments are expected to increase the sustainability of WSD. First, investments in community organization increase the effectiveness of participation. This is important to better target project investment and to reach a socially acceptable distribution of project benefits. Second, investments in community organization strengthen local institutions and hence community governance. Thus, it contributes to control of free riding behavior and coordination of investments at the village scale. At the most basic level, this implies the establishment of a watershed committee,[9] but investments in local capacity building, empowerment, and communication are also needed to enhance community governance in the long run (Joy and Paranjape, 2004).

Evidence of the extent to which investments in community organization have indeed improved the sustainability of WSD is sketchy. In the short term, investments in community organization seem to have improved effectiveness through better-targeted investments and a better distribution of project effects (Farrington et al., 1999; Joshi et al., 2004; Kerr et al., 2002). In the longer term however, the impact of investments in community organization is less clear and it is difficult to assess whether lack of SWC maintenance is caused by over-subsidization, lack of investment in community organization or because of external effects. This is what this study attempts to contribute: to assess (i) whether investments in community organization have improved the sustainability of soil and water conservation in India's semi-arid watersheds, and (ii) whether any effects can be attributed to SWC subsidization, investments in community organization or external factors (such as market access, or resource scarcity).

With regard to the importance of external factors, from the literature on farm household decision making and local resource management, the impact of contextual factors, such as market access, resource scarcity and inequality, on household decision making is well known (e.g., Agarwal, 2001; Baland and Platteau, 1996; Bardhan and Udry, 1999; Ostrom, 1990; Ray, 1999; Wade, 1987). The incentive to invest in soil and water conservation, or, for that matter, to cooperate in collective investments, largely depends on the net benefit the household expects to make. In resource-scarce environments this benefit might actually be relatively small. Kadekodi and Chopra (1999) argue that the relationship between resource scarcity and cooperation is in fact nonlinear. Users do not cooperate if resources are very scarce, but may decide to cooperate if the resource base is rehabilitated and the expected benefits of cooperation increase. Similarly, increased market integration is expected to have an ambiguous impact on local resource management. The increased value of resource use associated with market integration affects the conditions for local management positively, but the increase in "exit options" and volatility of income may affect resource management in a negative way (Kurian et al., 2002). The impact of inequality on community resource management is ambiguous as well (Baland and Platteau, 1996; Mansuri and Rao, 2004). If the distribution of resource access is highly unequal, resource conservation might benefit as individual owners have an incentive to provide public good investments. But high inequality also affects community resource management negatively, as it reduces the incentive to cooperate and decreases the transparency of village decision making.

3. Methodology and data collection

To analyze the impact of investments in community organization on the sustainability of participatory watershed development, we use household survey data from 697 randomly selected, land-owning households in four meso-scale watersheds.[10] Table 1 shows the characteristics of the watersheds.

forces, traditional structures were disrupted. Increased population pressure, integration of semi-arid regions in the mainstream economy and new irrigation and crop technologies further reduced the strength of community resource management, and in most cases water conservation and storage structures were no longer maintained (Jodha, 1996).

[8] Also, the government guidelines for WSD evolved from rather top-down, technology based subsidization programs toward more participatory approaches: In the WSD guidelines of 1995, participatory watershed management and investments in community organization became the norm.

[9] Formally, the village council, or Panchayat Raj institution (PRI), is responsible for the management of resources at the village scale. However, since PRIs usually do not have the capacity or resources to manage resources effectively, WSD programs have focused on the establishment of a functional watershed committee instead. The extent to which watershed committees actually contribute to community governance varies a lot: in some cases, the watershed committee exists only on paper, whereas in other cases it continues to coordinate investments in a transparent and democratic way. Most watershed committees however dissolve after project implementation. For this reason, the most recent government WSD guidelines (the "Hariyali guidelines"; Government of India, 2003) give PRI's a more important role in WSD.

[10] Study sites and data collection form part of the LEAD project "Livestock–Environment Interactions in Watersheds," a study undertaken by IWMI—India and partners and financed by the Swiss Development Cooperation (SDC) and the FAO. Although in the four study sites a total of 800 households were surveyed, due to missing data we could only include 697 households in the analysis. Landless households accounted for less than 5%.

Table 1
Characteristics of the study sites[a]

	Very low rainfall < 500 mm	Low rainfall > 500 mm
Remote area	Kanakanala watershed, (Koppal district) Karnataka	Kalyanpur watershed, (Udaipur district) Rajasthan
Integrated area	Vaiju Babulgaon watershed, (Ahmadnagar district) Maharastra	Kosgi watershed, (Mahbubnagar district) Andhra Pradesh

Source: IWMI (2005).
[a]For a more extensive characterization of the study sites, see Appendix 1.

Table 2
Investments in soil and water conservation per watershed[b]

Watershed	Implementing agent	Watershed area (ha)	Area treated	Costs per ha treated area (Rs/ha)[c]
Kosgi	DPAP (government)	3,460	58%	3,553
Kanakanala	SAMUHA (NGO)	13,064	48%	2,582
Kalyanpur	DPAP (government) and Seva Mandir (NGO)	7,488	27%	5,488
V. Babulgaon	DPAP (government) and WOTR (NGO)	4,876	24%	6,826

Source: IWMI (2005).
[b]For a more extensive description of project interventions, see Appendix 2.
[c]1 USD = 35 Indian Rs.

In each watershed, 4–6 villages were selected based on their location in the meso-watershed.[11] From the selected villages, 20% of the households were randomly drawn to participate in the survey. Of the total of 22 villages selected for the household survey, some had been treated by a NGO, some had been treated by a governmental organization (GO) and some had not been treated at all. Table 2 shows the intensity of treatment[12] in the four watersheds and whether WSD was implemented by a GO, NGO or a combination of both. Overall, NGOs invested much more in community organization, participatory planning and implementation than GOs. In fact, the NGOs represented include some of the most successful examples of WSD in India. In the following, when we mention participatory we refer to the NGO approach.

The selection of villages for WSD treatment is based on the location of the village in the meso-watershed. As treatment of

Table 3
Representation of households in terms of WSD treatment and location

		Not treated		GO treated		NGO treated
Number of sample villages		7		7		8
Number of sample households (HHs)		234		320		249
Location in watershed (% of HHs)	Up	0	Up	37%	Up	54%
	Middle	68%	Middle	63%	Middle	0
	Down	32%	Down	0	Down	46%

Source: IWMI (2004).

the upper catchment of the watershed tends to also benefit downstream villages, WSD programs target upstream villages first. Since geographical location is something we can control for, project selection of upstream villages does not necessarily bias our results (Ravallion and Wodon, 1998). However, upstream villages could also be poorer than downstream villages, which might constitute another WSD selection criteria, or there could be other project placement criteria that bias results in an unobservable way (Baker, 2000). To detect a potential selection bias we conducted several tests. First, assuming average income to be a reasonable indicator for the level of economic development and poverty, we tested whether treatment was in any way correlated with average income. The lowest P-value being 0.79, there seem to be no significant differences in average income between treatments and sites. Second, we estimated the probability of NGO, GO, or no treatment using village level indicators such as village homogeneity, average income, location, and inequality. Except for location, none of the factors were significant. Hence, we can safely assume that project placement does not affect our results in a significant way, except for effects associated with the geographical location of the village in the meso-watershed for which we added a separate control. In Table 3, the representation of sample household in terms of received WSD treatment and location in the watershed is shown.

For the analysis of the household survey data we specify two empirical models. In the first model the dependent variable is a binominal variable that reflects whether the household has *actually* invested in SWC or not. This is a stated variable, based on whether the household indicated that investments in soil and water conservation were made at the plot level.[13] In the second model the dependent variable is a binominal variable that expresses whether the household has the *intention* to contribute to SWC in the future. Again, this is a stated variable.[14] Since

[11] To account for possible up-down stream externalities we explicitly selected villages from the upper, middle, and lower region of the meso-watershed. However, because of low availability and poor quality of hydrological data we could not assess the importance of up-down stream externalities in a quantitative way. The information from village meetings and household interviews however indicated that positive up-down stream externalities exist. Contrary to the accepted belief that upstream villages benefit less, households from upstream villages generally indicated they had benefited from WSD considerably as well.

[12] Intensity of treatment refers to the percentage of the (meso-) watershed treated and the costs of investment per hectare. Since exact data on treatment costs and area treated were hard to come by, figures are only indicative of the intensity with which treatment of the meso-watershed has taken place.

[13] Since most households only invested in soil and water conservation on one of their plots we conduct the analysis at the household and not the plot level. If the household invested on more then one plot, we included only one plot, usually the largest plot, in the analysis.

[14] Since different answers were possible, we defined two dependent variables. In the first, all positive answers (use less water, more stall feeding, operation, and maintenance [O&M] of structures on own plot, O&M collective structures etc.) are grouped into one category ("Planned contribution All"); in the second definition only the answers specifying O&M activities were taken as a positive

in both cases the dependent variable is discrete, we use probit analysis.[15]

In the first model, our main interest is whether outside intervention influences the probability of household SWC investment, controlling for external factors. We tested the following model:

$$SW_i = \text{constant} + C\beta_1 + I\beta_2 + X_i\beta_3 + \varepsilon_i, \qquad (1)$$

where SW_i is a discrete measure of household investment in SWC, C is a vector of contextual variables, I is a vector of variables measuring the type of intervention and X_i is a vector of control variables including income per capita, land holding, access to irrigation, location in the watershed and land quality.

Regarding C, most of the set of contextual variables is derived from the location of the watershed in the region and the agro-hydrological zone. While the socio-economic conditions of remote watersheds may be characterized as those of a subsistence economy, watersheds that are better integrated into the regional and national economy may be regarded as cash economies. Furthermore, watersheds differ with respect to aridity and income inequality. Income inequality seems to depend mainly on the distribution of resource access (i.e., irrigation and land), which is relatively equal in Vaiju Babulgaon and relatively unequal in Kosgi. In Kanakanala, irrigation is relatively underdeveloped, and hence inequality is relatively low.

Our intervention variables, I, capture the nature of the agent implementing WSD. In Kanakanala an NGO initiated watershed investments, in Kosgi a GO, and in Vaiju Babulgaon and Kalyanpur a GO treated some villages whereas other villages were treated by an NGO. In all four sites at least one of the selected villages was not treated at all.[16] As mentioned before, NGOs spent more on community organization, but they often spent more on physical SWC investments as well. In the first model, we cannot separate these two effects since data on investment costs per household or village lack. In the second model we attempt to separate these two effects by using direct and indirect intervention effects.[17] Table 4 presents summary statistics for X_i, or the vector of control variables.

As Table 4 shows, average income is four times higher in the Vaiju Babulgaon watershed as compared with the other watersheds. To control for the higher level of socio-economic development in this watershed, we included the variable "average income per region," in the regression analysis.[18] Access to irrigation is defined as a dummy representing whether a household has access to surface water (a village tank), deep groundwater (a tube well), or shallow groundwater (open well) irrigation through the ownership of pumps, wells, or land located near the irrigation canal. Land holding size is relatively large in Kanakanala, as population pressure is relatively low. In Kalyanpur average landholding size is smallest since more than 50% of the watershed has a slope of over 5%. Land quality, mainly determined by soil type, slope, and access to irrigation, is heterogeneous in all four watersheds. Most households own different plots of land with different soil types, slopes, and access to irrigation. For the analysis, we have used only land quality information regarding the plot on which investments in SWC were made. Because of the poor quality of slope data, the importance of slope in determining household investment in SWC could not be assessed. Finally, the households' perceived influence on village decision making is a dummy variable which measures whether the household feels capable of influencing village decision making: with this variable we expect to measure the households' position in village decision making.[19]

Table 4
Summary statistics (standard deviations in parenthesis)

	Kosgi	Kanakanala	Kalyanpur	V. Babulgaon
Number of observations	149	186	174	184
HH with investments in SWC	30%	35%	36%	61%
Households that plan to contribute to SWC–All	17%	12%	59%	93%
HH that plan to contribute to SWC–O&M	13%	11%	52%	79%
Average income per capita (Rs)	2,824 (3,752)	2,531 (1,825)	1,808 (1,681)	10,668 (8,172)
Gini coefficient income	0.41 (0.07)	0.35 (0.06)	0.38 (0.08)	0.36 (0.04)
Average landholding (acres)	4.10 (5.52)	9.41 (7.66)	2.64 (4.31)	5.87 (8.00)
HH with access to irrigation (%)	58%	17%	75%	95%
HH with black soil in the relevant plot (%)	34%	17%	21%	31%
HH that feel capable to influence village decision making (%)	23%	39%	18%	47%

Source: IWMI (2004).

answer ("Planned contribution only O&M"). The two definitions allowed for extra robustness tests, which showed minimal differences between the two definitions (see Table 7).

[15] In the absence of specific knowledge about the distribution of data, there exist no general criteria to determine whether probit is the most suitable method to use (Greene, 2003). Since the outcomes of logit and probit were quite similar, we chose probit as it allows for an easier interpretation of results.

[16] Villages in the process of treatment have been included under the "not treated" category.

[17] Since NGOs do not offer higher subsidies (they often offer lower subsidies) we do not expect higher investments to result in extra distortions. Instead, we expect higher investment cost to translate into higher-quality investment and better coverage of households in the area treated. This has actually been confirmed in village meetings and household interviews in the four watersheds.

[18] In fact, the Vaiju Babulgaon watershed is not only characterized by a high level of socio-economic development, but also by a homogeneous, landowning, and high-caste (i.e., influential) farming population. Whereas 82% of the population in Vaiju Babulgaon consists of high caste farmers, in Kalyanpur 94% of the population consists of "tribals" with less agricultural background. Kosgi and Kanakanala have a more heterogeneous population, with 70% of the households belonging to less privileged castes.

[19] Although we expected the type of intervention to influence the households' perceived ability to influence decision making, the households' landholding and

The second model aims at unraveling the impact of several factors on the intention to invest in operation and maintenance in the future. The model basically uses the same set of control variables, except that to test for the indirect effect of more households having invested in SWC we used the predicted SW from the first model and calculated the average predicted SW at the village scale. Also, we added a variable representing the existence of a maintenance fund.[20]

$$Plancontribution_i = \text{constant} + C\beta_1 + I\beta_2 + PI\beta_3 + X_i\beta_4 + M\beta_5 + \varepsilon_i. \quad (2)$$

We expect participatory WSD interventions to influence the households' intention to contribute to sustained SWC in two ways. First, we expect participatory WSD interventions to directly influence the households' intention to contribute through investments in community organization. This is captured by the relevant coefficient on vector *I*. Second, we expect an indirect effect as WSD interventions increase the number of households investing in SWC. We expect this to have a positive impact on the households' intention to contribute because the more households invest in SWC the higher the expected returns to maintenance due to positive scale effects. This indirect effect, which is basically the effect of effective subsidization, is captured by the coefficient on *PI*. *M* is a vector of dummy variables representing whether the village has a functional maintenance fund or not.

Data were collected from October 2003 till March 2004 through village meetings, secondary data collection, and a household survey among 800 households. Data collection took place in three stages. First, village meetings were organized in all watershed villages to collect baseline information. Based on this information and the location of villages in the watershed, four to six villages were selected. In these villages, a second round of more extensive village meetings was organized. The information from these meetings was used for a quantitative ranking of village performance indicators. Third, in the selected villages 200 households were randomly selected for an extensive household survey. Per village, 20% of the households were interviewed for the survey, each questionnaire taking 1–2 hours. Data collection and entry was undertaken by the NGOs that had been involved with WSD implementation from the start. For the data collection, 4–8 surveyors per watershed were trained and sent to question the households in pairs. Afterwards, questionnaires were crosschecked for mistakes and omissions. Although data were collected in 2003–2004, questions regarding agricultural production and land use refer back to the previous year, or 2002, which was a drought year in all four sites.

Table 5
The impact of WSD interventions on household investment in SWC (standard errors in parenthesis)

	Household SWC investment	
	Coefficient (S.E.)	Marginal effects
Average income region (rs)	0.08 (0.04)	0.03**
Cash economy (dummy)	−0.07 (0.21)	−0.03
Very low rainfall region (dummy)	−0.40 (0.22)	−0.16
NGO investment WSD (dummy)	0.67 (0.18)	0.26***
GO investment WSD (dummy)	0.02 (0.17)	−0.01
Downstream location in watershed (dummy)	−0.34 (0.17)	−0.13 **
Upstream location in watershed (dummy)	0.13 (0.17)	0.05
Land holding size (acres)	0.04 (0.01)	0.02***
Household has access to irrigation (dummy)	0.24 (0.14)	0.09
Income per capita (Rs '000)	0.02 (0.01)	0.01
Gini coeff. income capita	−4.01 (0.92)	−1.6***
Black soil (dummy)	0.29 (0.12)	0.11**
Household can influence decision making (dummy)	−0.01 (0.11)	0.01
Constant	0.46 (0.39)	
Number of observations	697	
Log likelihood!	−416.0	
LR Chi2 (df)	115.2 (13)	
Likelihood ratio statistic (Pseudo R^2)	0.12	

*** significant at the 1% level.
** significant at the 5% level.

4. Results

Table 5 presents the results of the first model. The regression analysis confirms the results of earlier studies that NGOs are more effective. The probability of households investing in SWC increases by 26% in watersheds subjected to participatory intervention. Government intervention, in contrast, does not have a significant effect.[21]

Second, households with larger landholdings and black soils are more inclined to invest in SWC than households with smaller

educational status proved more important. Hence, we did not need to use the predicted value to control for potential endogeneity problems and could use the stated variable instead. We did test for endogeneity in the main analysis, using both the stated and the predicted variable, but no significant differences were found.

[20] Village maintenance funds were established by several NGOs to finance the maintenance of collective structures on the long run. The watershed committee generally manages the maintenance fund. Of the 22 villages included in the sample, three villages have a functioning maintenance fund. Household interviews and village meetings showed that most households in villages with a maintenance fund believe the fund will maintain all investments, including investments on private land.

[21] The robustness of results was confirmed with a Chow test that showed NGO treated households to significantly differ from other households (P-value = 0.012). The Chow test is conducted by first estimating the model with the full set of observations, and second estimating separate models for the subsets of observations between which a structural difference is expected. By comparing the sum of the log likelihood of the unrestricted models with the log likelihood of the restricted model the likelihood ratio of the two models can be derived (Greene, 2003).

Table 6
Hit and miss table of predictive accuracy for the SWC investment model

	SWC = 1	SWC = 0	Total
Probability > 0.5	139	69	208
Probability < 0.5	152	337	489
Total	291	406	697

landholdings and red or other soils. This confirms the finding that small landowners are less willing to invest because the fixed costs of land loss to SWC investment are relatively high. Also it confirms that households with black soil are more likely to invest since the soil moisture retention capacity of their soil is relatively high (Wani et al., 2002 and 2003).

Third, village income inequality has a negative impact on household SWC investment. If, like we argued before, income inequality indeed reflects an unequal distribution of resource benefits at the village scale, this suggests that an unequal distribution of conservation benefits negatively affects resource conservation. Other contextual variables are not significant. This could be an indication of the subsidization effect. If households are heavily subsidized, the relative costs and benefits of conservation (i.e., opportunity costs of labor, relative benefits of conservation, etc.) play no role. The significant, positive effect of average income level per region could either indicate that average income levels are important for household SWC investment, or that the specific characteristics of the Vaiju Babulgaon watershed are conducive for household investment in SWC.

The predictive power of the model can be assessed from Table 6. The Table shows that the model estimates the probability of overall household SWC investment with great accuracy (0.413 as compared to the actual probability of 0.417) but that the behavior of individual households is estimated with an accuracy of only 68%. Predicting individual households' behavior is difficult because of the many forms of unobserved heterogeneity across households. Also, household specific factors, such as slope and location in the micro-watershed, are missing from the analysis.

Now that we have confirmed the result that participatory approaches are more effective in the short run, we turn to our key question, whether participatory approaches are more effective in the long run as well. In Table 7 we present our main results.

First, results show that contextual factors become significant once households have to finance investments in SWC themselves: both market access and aridity now have a significant, negative effect. The negative impact of high aridity suggests that high resource scarcity reduces the incentive for resource conservation, possibly because the benefits of investment are relatively low. The significant, negative effect of market integration seems to indicate that with the development of a cash economy, the importance of rainfed agriculture for household income decreases and the opportunity costs of labor start to play a more prominent role. Since more market integrated watersheds tend to have better access to labor markets, the incentive for households to maintain SWC in these watersheds could be attenuated.

Second, household access to conservation benefits increases the probability of households' contributing to resource conservation in a significant way. This is in accordance with the results of Kerr et al. (2002), who show that households with

Table 7
The impact of WSD interventions on household future contributions (standard errors in parenthesis)

	Planned contribution–All		Planned contribution–Only O&M	
	Coefficient (S.E.)	Marginal effects	Coefficient (S.E.)	Marginal effects
Average income region (rs)	0.60 (0.12)	0.24***	0.37 (0.09)	0.14***
Cash economy (dummy)	−1.97 (0.28)	−0.68***	−1.66 (0.26)	−0.57***
Very low rainfall (dummy)	−2.17 (0.49)	−0.72***	−1.49 (0.38)	−0.53***
NGO investment WSD (dummy)	0.28 (0.93)	0.11	−0.40 (0.76)	−0.15
GO investment WSD (dummy)	−0.34 (0.22)	−0.14	−0.48 (0.21)	−0.18**
Downstream location in watershed (dummy)	0.39 (0.54)	0.15	0.37 (0.45)	0.14
Upstream location in watershed (dummy)	0.83 (0.27)	0.32 ***	0.45 (0.23)	0.18**
Land holding size (acres)	0.02 (0.04)	0.01	0.01 (0.02)	0.004
HH has access to irrigation (dummy)	0.66 (0.31)	0.26**	0.59 (0.24)	0.21**
Income per capita (Rs '000)	0.02 (0.03)	0.01	−0.002 (0.02)	−0.001
Gini coeff. income per capita	0.29 (5.22)	0.12	5.72 (4.18)	2.18
Black soil (dummy)	0.44 (0.36)	0.17	−0.01 (0.24)	−0.004
Predicted probability of HH investment in SW (%)	−2.3 (3.3)	−0.91	−1.17 (2.13)	−0.45
Average predicted SWC investment in village (%)	1.86 (2.48)	0.74	4.68 (2.38)	1.79**
Availability of maintenance fund (dummy)	−1.16 (0.34)	−0.41***	−1.36 (0.30)	−0.38***
HH can influence decision making (dummy)	0.48 (0.14)	0.19***	0.30 (0.12)	0.12**
Constant	−1.71 (2.57)		−4.31 (2.15)	
Number of observations	697		697	
Log likelihood	−251.1		−304.0	
LR Chi2 (df)	463.3 (16)		340.5 (16)	
Likelihood ratio statistic (Pseudo R^2)	0.48		0.36	

*** significant at the 1% level.
** significant at the 5% level.

Table 8
Hit and miss table of predictive accuracy planned contribution model—All/Only O&M

Classified	Planned contribution = 1	Planned contribution = 0	Total
Probability > 0.5	265/221	34/55	299/276
Probability < 0.5	73/72	325/349	398/421
Total	338/293	359/404	697

access to irrigation invest structurally more in operation and maintenance. Similarly, influential households are more likely to contribute to long-term soil and water conservation, probably because they have better control over how benefits are shared.

The most striking and interesting result, however, is that the type of intervention has no significant effect on the households' intention to contribute to SWC in the long run. This result is robust for the alternative definition of the dependent variable (i.e., including only planned contributions to O&M), although in that scenario GO interventions do have a significant, negative impact.[22] Also, the indirect effect of increased SWC investment is insignificant at the household and village scale. This indicates that household SWC investment does not affect the intention to maintain investment in a significant way. This result is also robust for the alternative definition of the dependent variable, although in this case the percentage of SWC at the village scale does play a positive and significant role. The availability of a maintenance fund negatively affects the households' intention to contribute to future SWC.[23]

The predictive accuracy of the model is satisfactory, as can be inferred from Table 8. The model predicts long-term household participation accurately and for individual households, the respective scores for "Planned contribution–All" and "Planned contribution–Only O&M" are 85% and 82%.

To test the robustness of results we performed two Chow tests to (*a*) compare the intentions of NGO treated households with those of other households and to (*b*) compare households that had invested in SWC with households that had not. The first Chow test confirms the result that the type of intervention has no structural impact on the intention of households to contribute to future SWC. The second Chow test confirms that whether the household had invested in SWC or not has no significant effect on the broader intention to contribute to resource conservation. However, it is significant with regard to the households' intention to contribute to O&M ("Planned contribution–Only O&M").[24]

The results indicate that the sustainability of participatory WSD is seriously threatened. On the one hand, household investments in SWC do not increase household commitment to contribute to SWC in the long run. Investments in community organization and awareness do not compensate for this effect. The direct effect of interventions on the households' intention to contribute is also insignificant. The establishment of a maintenance fund might improve the sustainability of participatory WSD[25] but this comes at a certain cost: when a maintenance fund exists, individual households are less likely to contribute to operation and maintenance.

5. Conclusions

We have examined whether investments in community organization increase the sustainability of WSD interventions in India's semi-arid watersheds. While participatory approaches are associated with more effective WSD project implementation in the short term, we find that interventions have no impact on the intention of households to contribute to operation and maintenance in the longer run. This result seriously questions the sustainability of participatory WSD, as it reduces the likelihood that SWC investments will be voluntarily maintained.

Although lower SWC subsidies could possibly improve the sustainability of participatory WSD, the main challenge for outside agents aiming to change the long run development trajectory of semi-arid watersheds is to overcome the poor incentives for local resource conservation. With rising opportunity costs of labor and low returns to SWC investment, the long-term incentive to maintain SWC investment is low. Local maintenance funds might help increase the sustainability of participatory WSD, but establishing maintenance funds would come at the cost of further reducing the incentives for individual households to voluntary contribute to future SWC.

With over 30% of the population in India's semi-arid watersheds below the poverty line and with an increasing problem of groundwater depletion and soil degradation, investments in resource conservation and increased productivity are crucial for poverty alleviation and the development of India's semi-arid regions. However, without addressing the wider context in which rainfed agricultural production takes place, current WSD programs cannot be expected to substantially change the outlook for India's rural poor. More structural government interventions seem to be required to make WSD sustainable in the longer term.

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[22] Results are robust when contextual variables are replaced by watershed scale fixed effects.

[23] Household interviews and village meetings indicated that in villages with a maintenance fund, households felt that the fund should maintain all investments, including investments on private land.

[24] The *P*-value of the test comparing NGO treatment with the rest is 0.63. The *P*-value of the test comparing households with SW with households without SW is 0.38 for "Planned contribution–All" and 0.06 for "Planned contribution–O&M."

[25] Village meetings and household interviews indicated that in villages with a well functioning watershed committee and maintenance fund, structures were better maintained.

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Appendix 1: Hydrological and biophysical characteristics of the study sites

Basic hydrological and biophysical data were collected for the meso-scale watersheds with the help of field visits, primary hydrological data collection (rainfall, runoff, temperature), maps and secondary data regarding land use, groundwater, rainfall, soil type, and climate. Primary data were collected for the year 2003–2004, a year with above average rainfall in Kosgi, average rainfall in Kalyanpur, but below average rainfall in Kanakanala and Vaiju Babulgaon (IWMI, 2005).

Table A1 presents the biophysical and demographic characteristics of the study sites. The total area is the total geographical area of the villages located in the watershed. Since some of this land might be located outside the watershed, total area differs from total watershed area. In V. Babulgaon and Kalyanpur, the difference between total area and watershed area is caused by the relatively large share of government-owned forestland. Total arable land is again based on the geographical area of the watershed village and arable land is defined as cultivated and cultivatable land. In Kosgi watershed, conditions for agricultural production are most favorable whereas in Kanakanala watershed conditions are relatively poor.

Appendix 2: Details of the WSD interventions in the project sites

In the Kosgi watershed, watershed implementation by the government was finished in 2001. Investments were targeted at ground and surface water recharge, horticulture development, bunding and percolation pits. Implementation was not participatory and few investments in community organization were made. Of the four villages selected for the study, three were treated.

In Kanakanala, the NGO SAMUHA is implementing WSD. Of the villages selected for the study, watershed work is ongoing in two villages and treatment is finalized in three. In one village, no watershed work has taken place. Overall, investments focus on increasing soil moisture and biomass, erosion reduction, and improved access to supplemental irrigation. Implementation has been participatory and some investments in community organization have been made. For investments on private lands, households contribute 25% of the costs, for investments on common lands the community contributes 10% with voluntary labor.

In Kalyanpur, the NGO Seva Mandir has implemented WSD in three of the selected villages, whereas in three villages the government invested in WSD. Investments focused on soil moisture and biomass improvement, reduction of soil erosion and improved access to supplemental irrigation. In the Seva Mandir villages substantial investments in community organization were made, but government implementation was nonparticipatory and top down. In one village, no WSD treatment took place. For investments by Seva Mandir on private land, households contributed 15% of the costs, for investments on common land the community contributed 10% in labor. If investments were made by the government, contributions were 10% and 5%, respectively. In one of the Seva Mandir villages a functional maintenance fund exists.

Table A1
Biophysical and demographic characteristics of the study watersheds

State	Kosgi Andhra Pradesh	Kanakanala Karnataka	Kalyanpur Rajasthan	V. Babulgaon Maharastra
Total number of households	4,242	2,643	1,711	1,298
Total number of villages	9	21	11	7
Total area	4,590 ha	13,402 ha	4,664 ha	3,472 ha
Watershed area	3,460 ha	13,064 ha	7,488 ha	4,876 ha
Area treated	58%	48%	27%	24%
Average rainfall	739 mm	499 mm	584 mm	430 mm
Aridity[a]	0.5	0.31	0.39	0.32
Share of land irrigated	30%	1% –5%	10%–20%	10%–15%
Share of land area with slope > 5%	0	17%	49%	42%

Source: IWMI (2005).
[a]Precipitation/evapotranspiration.

In Vaiju Babulgaon, the NGO Watershed Organisation Trust (WOTR) invested in two out of five selected villages and in one other village government investments were made. Government investments were not participatory and badly implemented, but investments by WOTR were such that one of the two villages is considered a model site: considerable investments were made in community organization, and in both villages a functional maintenance fund exists. Households contributed 16% to the costs for both investments on private and common land. In the remaining two villages no structural investments in WSD were undertaken, although under drought relief some investments did take place.

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