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# Watershed Management: Lessons from Common Property Theory

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**Abstract:** Watershed development is an important component of rural development and natural resource management strategies in many countries. A watershed is a special kind of common pool resource: an area defined by hydrological linkages where optimal management requires coordinated use of natural resources by all users. Management is difficult because watershed systems have multiple, conflicting uses, so any given approach will spread benefits and costs unevenly among users. Theories from commons research predict great difficulty in managing complex watersheds and explain why success has been limited to isolated, actively facilitated microwatershed projects with a focus on social organization. Encouraging collective action is easiest at the microwatershed level but optimal hydrological management requires working at the macrowatershed level. Research suggests potentially severe tradeoffs between these two approaches. Resolving the tradeoffs is necessary for widespread success in watershed development but solutions are not clear. Examples from India illustrate the argument.

**Keywords:** commons, watershed, India

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## 1. Introduction

A watershed or catchment is an area that drains to a common point, and watershed development seeks to manage hydrological relationships to optimize the use of natural resources for conservation, productivity, and poverty alleviation. Achieving this requires the coordinated management of multiple resources within a watershed, including forests, pastures, agricultural land, surface water and groundwater, all linked through hydrology. Watershed development is an important component of many countries' rural development and natural resource management strategies. The World Bank, for example, invested $1.73 billion in watershed development from 1990-2004 (World Bank 2007), and the Government of India spent over $6 billion from 1996-2004 (World Resources Institute 2005).

This paper introduces critical challenges to making watershed development work and presents lessons from research on watersheds and theories about managing the commons. Commons theories do not predict that watershed management can be widely successful, and they explain why most projects operate at a subvillage microwatershed scale. The paper demonstrates tradeoffs between operating at a small, microwatershed scale to encourage successful collective action versus a large, macrowatershed scale that is more suitable from a hydrological perspective, and it suggests some lessons for policy and practice. The empirical focus is mainly on India but findings are more broadly applicable.

Many watershed resources are characterized by high exclusion costs and subtractability, the two main attributes of common pool resources.[1] Many natural resources in a watershed are often held in common, such as pastures, forests, ponds, and groundwater. Other resources tend to be managed individually, especially agricultural land, but also some patches of pasture, forest, and captured runoff water. A watershed is defined, however, by the hydrological linkages among all these resources. Collective action among all watershed resource users is needed to manage hydrological processes for maximum productivity of the whole watershed system. Through these hydrological linkages, a watershed system is in fact a high exclusion cost, subtractable environmental resource, in other words a common pool resource that faces typical commons management problems. In complex, multiple use commons like watersheds, interests must be balanced both within and across diverse interest groups to generate agreement on regulations about resource access, allocation, and control (Steins and Edwards 1999a).

A watershed is a useful hydrological unit but not a natural unit of human social organization (Rhoades 1999; Swallow et al. 2001), and the hydrological linkages among different parts of a watershed often are not visible beyond very small scales. As a result, self-organization among watershed users is unlikely beyond the smallest watersheds, and it is difficult to examine watershed governance outside the context of a special project or other effort to promote management.[2] Accordingly, this paper focuses primarily on efforts to promote better watershed governance where project investments have tried to strengthen the natural resource base.

[1] A high exclusion cost or nonexclusive resource is difficult to exclude others from using. For a subtractable or rival resource, one user's welfare is diminished by other users.

[2] Examples of endogenous watershed management are rare in the literature and invariably concern very small watersheds with visible upstream-downstream linkages (e.g. White and Runge 1995, Murray 1994).

It could be argued that upstream-downstream hydrological relationships within watersheds are just externalities[3] that can be managed through such approaches as Coasian bargaining,[4] command-and-control, or taxes and subsidies. However, especially in developing country contexts characterized by dense population and small holdings, command and control, taxes, and land use restrictions are unenforceable (Pagiola et al. 2002). Coasian bargaining is rarely feasible due to high transaction costs of generating and enforcing agreement among numerous, dispersed actors.[5] The nonexclusive nature of watershed hydrology is what makes management difficult (Randall 1983).

### 1.1. Watershed terminology

Watersheds can cover areas of any size, because small watersheds are subsections of large watersheds that themselves can be nested within larger watersheds up to entire river basins. Attention must be paid to what is being described in any given setting. Often microwatershed refers to a small area about the size of a village, while macrowatershed refers to something much larger. A casual review of the literature found discussions of watershed management covering from two hectares (White and Runge 1995) to 30,000 hectares (World Bank 2007).

Scale can refer to either hierarchy or magnitude (Swallow et al. 2001). For scale as a hierarchy, a watershed is part of a series of hierarchical relationships, whereby a small microwatershed is nested within a larger watershed, which in turn is nested in an even larger watershed. As a magnitude, scale refers to size, for example the number of hectares that a watershed covers or, from a socioeconomic perspective, the number of people living in it. On the other hand, watershed agencies refer to 'scaling up' their operations meaning to replicate their projects over many locations.

Watershed development and watershed management are often used interchangeably. In this paper, watershed development refers to programs with technical interventions (planting trees, building check dams, etc.) to raise the productivity of certain resources and bring water resources under control. Watershed management refers to managing hydrological relationships in a watershed, which may involve protecting certain resources from degradation rather than making physical investments in their productivity. Technical interventions are likely to be fruitless without subsequent management. Watershed governance refers to institutional arrangements to guide management.

[3] Externalities are unreimbursed costs or uncharged benefits accruing to people resulting from someone else's actions.

[4] Coasian bargaining is negotiation among affected parties to resolve an externality in a mutually acceptable way, conditional on the cost of the solution being less than that of the problem itself.

[5] Coasian bargaining cannot work when there are high transaction costs associated with generating and enforcing agreement among a large number of actors. If a watershed had only a single occupant there would be no externality. With only an upstream occupant and a downstream occupant, Coasian bargaining would be straightforward. However, transaction costs increase exponentially with each additional independent actor.

Watershed projects have different objectives depending on the perceived natural resource management problem in a given area. In the United States, watershed management is mainly about protecting water quality. In many areas it is about flood control. In hilly, semi-arid areas of India, the focus is on water harvesting, or trapping runoff during the rainy season for later use when water is scarce. In flatter areas with less opportunity for water harvesting, it is more about concentrating soil moisture to raise rainfed agricultural productivity. In virtually all watershed projects, soil conservation is either a specific objective or a means of achieving another objective. This paper focuses primarily on projects that harvest water and concentrate moisture, which are widespread in areas with seasonal water scarcity.

## 2. What watershed projects aim to achieve

Watershed projects in developing countries that focus on water harvesting and soil conservation typically state three objectives: 1) conserve and strengthen the natural resource base, 2) make agriculture and other natural resource-based activities more productive, and 3) support rural livelihoods to alleviate poverty. The first objective builds the foundation for the second, which in turn supports the third.

In seasonally dry areas where watershed projects focus on water harvesting, the natural resource base in question typically includes soil, water, agricultural land, pastures, and forests. Surface water bodies may also support small fisheries. Steps to strengthen one of these natural resources inevitably affect others and the livelihoods that depend on them. Watershed projects typically begin by investing in soil conservation in the upper watershed. Upper watersheds often are hilly, with pasture or forest land use rather than agriculture. In such cases, soil conservation typically involves increasing vegetative cover since bare ground is more prone to erosion. This involves planting new vegetation and making the area off-limits to grazing animals. Water harvesting involves building small dams to capture runoff from upper watersheds after heavy rains. Reducing erosion reduces silt in runoff water and in water harvesting ponds, thus lengthening their lifespan. Water harvesting in turn benefits farms further down the slope by providing irrigation, either via surface water or by recharging groundwater.

These interventions are designed to eventually raise the productivity of all natural resources in the watershed. Soil becomes more productive for agriculture, water is captured for irrigation, and pastures and forests yield more biomass. All livelihood activities that depend on these resources may be enhanced, and employment may increase as agriculture becomes more productive and additional labor is needed for harvesting and other operations. One important point is that improvements in different natural resources have different durations. Water harvesting for example can begin almost immediately but forests and pastures take time to yield increased biomass, and they are off limits to grazing and harvesting during revegetation.

Spectacular benefits have been documented in well-known watershed projects in India. In Sukhomajri in Haryana state, the entire village ecosystem and economy were transformed through protection of common lands and irrigation. The common areas became a lush, valuable forest, and stall-fed buffaloes and cross-bred cows almost entirely replaced goats, turning the village into a major seller of milk. These changes resulted in a sharp rise in incomes, with all households gaining (Kerr 2002). In Ralegaon Siddhi, Maharashtra, irrigated area rose from 0 to 70 percent through water harvesting and transformed the village economy. Nearby, under the Indo-German Watershed Development Project, irrigation raised labor demand such that within four years, laborers in one village indicated that they could find 9-10 months of employment compared to only 3-4 before the project (World Resources Institute 2005).

### 2.1. Socioeconomic Challenges to Successful Watershed Development

Various challenges make watershed management more complicated than suggested by the glossy statistics from successful projects, which have raised unrealistic expectations of what can be achieved widely. Many success stories, for example, are found in hilly, bowl-shaped microwatersheds with very favorable conditions for water harvesting. In more typical cases, benefits are incremental and gradual. With a less visible connection between investments made and benefits realized, organizational challenges become more apparent (Kerr 2002).

One of the biggest challenges to watershed management is that its costs and benefits are distributed unevenly, yet cooperation is required to make it work. Uneven impacts result from spatial variation and multiple, conflicting uses of natural resources. The conflict between using upper watersheds for grazing and protecting them for regeneration to support downstream irrigation is a good example. If the benefits are large and quickly maturing, those who lose in the short term may be willing to wait for gains, and devising mechanisms to diffuse costs may be manageable. But this is more difficult in the majority of cases where benefits are gradual and incremental. Even in higher rainfall areas of India vegetative regeneration takes about three years – too long to ask poor people to refrain from using resources they need.

Accordingly, watershed projects need to create mechanisms to encourage natural resource utilization consistent with the common good. After the failure of early projects that focused only on technology, beginning about 1990 they more commonly incorporated efforts to promote watershed governance to share net benefits. This is a simpler task in village-level microwatersheds with discernable hydrological linkages and established social relationships than in macrowatersheds spanning multiple villages.

### 2.2. Technical Challenges to Successful Watershed Development

In India, recent hydrological research suggests that watershed projects may be exacerbating precisely the water shortages they aim to overcome. At the macro-watershed level (covering many villages), Batchelor et al. (2003) document cases where water harvesting in upper watersheds reduced water availability downstream. Calder et al. (2006) refers to this as ‘catchment closure,’ whereby water harvesting upstream concentrates groundwater locally and then intensive pumping exhausts the shallow aquifer. In this case watershed development prevents both surface runoff and groundwater from moving naturally downstream. It suggests two perverse project outcomes: first, what is good for one microwatershed can be bad for others downstream, and second, what is good for a watershed in the short term can be bad in the long term.[6]

Recent literature presents additional cases detailing inaccurate understanding of technical relationships in watersheds. One example is faulty assumptions regarding the role of trees in watershed hydrology. All over India and elsewhere, trees are planted in watershed projects with the stated objective of promoting groundwater recharge. A motto of the Tamil Nadu Forest Department is ‘Save Trees to Save Water.’ However, most trees have precisely the opposite function because they are net consumers of water (Calder 2002). Similarly, soil scientists long estimated landscape-wide erosion rates by extrapolating upward from experimental erosion plots, as if all land in a watershed eroded at the same rate and all eroding soil disappeared entirely from the watershed. More recent evidence shows that due to filters in the landscape, most eroding soil simply moves from one part of a watershed to another (e.g. Swallow et al. 2001). Some farmers actually benefit from soil erosion through silt deposition on their land and even actively encourage erosion to move soil to where it can be most productive (Chambers 1990).

Uncertainty and misunderstanding about technical watershed relationships, combined with the uneven distribution of benefits and costs of management, create severe challenges to managing watersheds. This raises questions about what really can be expected of watershed development as a strategy for transforming rural natural resources and livelihoods. Rhoades (1999) raised this question regarding participatory watershed approaches and discussed many of the challenges listed here. He suggested the need for more empirical analysis of whether participatory approaches can really be replicated widely, and he argued that project workers need better science, better methods, and better organizational skills along with donor money and patience. As discussed below, to date there have been more evaluations but most participatory approaches still operate in small microwater-

[6] The absence of measures to manage groundwater demand contributes to this problem in India. Electricity to run pumps is free in some states and subject to a low, flat fee in others, allowing pump owners to draw unlimited water without affecting their costs. In addition, whoever pumps water first owns it (Singh 1992) and this encourages overpumping.

sheds. Most evaluations still cover the small success stories and it remains unclear whether watershed management can succeed beyond a few small exceptions.

## 3. Common property theory and watershed management

Can watershed management achieve the triple objectives of improved natural resource conservation, higher agricultural productivity, and poverty alleviation? We know this is so in some cases, but can it succeed widely? Under what conditions can it overcome the problem of uneven distribution of costs and benefits in the face of poorly understood, often invisible hydrological linkages? Theories about determinants of successful commons management may provide insights into this question.

### 3.1. Enabling conditions for successful management of the commons

There is a long line of literature on conditions that encourage successful commons management. Wade (1988) and Ostrom (1990) offered sets of favorable conditions, and Baland and Platteau (1996) updated them. Agrawal (2001) synthesized and revised these factors, focusing on those that enable sustainable governance of the commons. For watershed projects, the key issue is a group's ability to establish a new governance system to effectively manage the watershed commons.

Table 1 presents a list of factors associated with emergence of self-governance of the commons. It draws on Agrawal's (2001) synthesis but includes only those factors likely to be important for establishing a new, successful management system. Additional factors draw from Ostrom (1999), who distinguished between design principles of long-lived management systems and factors conducive to emergence of new systems. Many factors in Agrawal's synthesis draw from Wade (1988), and Baland and Platteau (1996).

Watershed characteristics correspond poorly to the list of enabling conditions in table 1. This provides many clues about why watersheds are difficult to manage and why projects might work better in a village-based microwatershed than a much larger area. Beginning with resource characteristics, eight favorable attributes are listed: small size, well-defined boundaries, low mobility, possible storage of benefits, predictability, feasibility of improving the resource, traceability of benefits to a management intervention, and availability of indicators of the resource condition. Almost all of these attributes present problems because they rarely characterize watershed management. For example, invisible boundaries, mobility of groundwater and surface water, unpredictability and infeasibility of improvement, and lack of traceability all pose challenges to collective action in many watershed cases. Even where some of these conditions are more favorable, mobility of water leads to an uneven distribution of benefits and costs, which raises major challenges. It is important to note that problems of mobility, clarity of boundaries, and traceability apply regardless of the scale but are mitigated somewhat in smaller watersheds.

Group characteristics include small size, clearly defined boundaries, shared norms, trust, past successful experiences, appropriate leadership, interdependence among group members, heterogeneity of endowments but homogeneity of interests, and low levels of poverty. All of these attributes except poverty point to the advantages of working in a watershed no larger than a village, because most of these characteristics will not be found among multi-village groups. Homogeneity of interests will be difficult to achieve in most watersheds due to conflicting uses of shared water resources and upstream-downstream differences in interests. Likewise, some watershed uses are dependent on others but dependence is not always mutual, therefore the condition of interdependence may not hold. Regarding poverty, working at a small scale makes it feasible to systematically exclude areas with high poverty rates.

The next set of conditions concerns the relationship between characteristics of the resource and the users, including overlap in location between the two, high levels of dependence by users on the resource, and sufficiently gradual demand growth and technical change to allow emerging institutional arrangements time to establish. Upstream-downstream watershed relationships sharply undermine the first of these conditions, although less so in smaller microwatersheds where at least this relationship may be perceptible and the inhabitants may know each other.

*Table 1: Factors conducive to emergence of local institutions to manage the commons†*

**1. Resource system characteristics**
a. Small size (W, O)
b. Well-demarcated boundaries (W, O)
c. Low levels of mobility (A)
d. Possibilities of storage of benefits from the resource (A)
e. Predictability (O)
f. Indicators of resource conditions are available at reasonable costs (O ’99)
g. Traceability of resource improvement to a particular intervention‡
h. Feasibility of improving the resource (O ‘99)

**2. Group Characteristics§**
a. Small size (W, B&P)
b. Clear boundaries (W)
c. Shared norms (B&P)
d. Trust (O ’99)
e. Past successful/organizational experiences (O ’99)
f. Appropriate leadership (B&P)
g. Interdependence among group members (W, B&P)

h. Homogeneity of interests (even with diversity of economic and political assets) (O, B&P)
i. Low poverty (A)
j. Low discount rate (O ’99)

**3. Relationship between resource system and group**
a. Overlap between user group residential location and resource location (W, B&P)
b. High levels of dependence by group members on resource system (W)
d. Demand growth and technical change are gradual enough to give emerging institutional arrangements time to establish (A)

**4. Institutional arrangements**
a. Ability to establish favorable institutional arrangements|

**5. External environment**
a. Autonomy (W, O ’99)
b. Availability of low cost adjudication (A)
c. Low cost exclusion technology with respect to the external world (A)
e. Supportive external sanctioning institutions (B&P)
f. Appropriate levels of external aid to compensate local users for conservation activities (B&P)

† Adapted from Agrawal (2001) (A), who drew upon earlier lists by Ostrom (1990) (O), Wade (1988) (W), and Baland and Platteau (1996) (B&P). Agrawal (2001) focused on factors contributing to sustainable governance rather than emergence of self-organization. Ostrom and Wade distinguished between these two sets of factors but Baland and Platteau did not. This table includes those factors from Agrawal’s list that are important for self-organization and adds others presented by Ostrom (1999).
‡ This factor is specific to watersheds. For example, it needs to be apparent that treating the upper watershed influences groundwater availability downstream.
§ Ostrom (1999) also includes low discount rate as an important group characteristic. It is excluded here as it is likely to be a function of other included variables such as poverty, ability to exclude outsiders, and past experiences with collective action.
| Favorable institutional arrangements that Agrawal mentioned include: a) rules are simple and easy to understand (B&P); b) there are locally devised access and management rules (W, O, B&P); c) rules are easy to enforce (W, O, B&P); d) there are graduated sanctions (W, O); e) low cost adjudication is available (O), f) monitors and other officials are accountable to users (O, B&P), and g) restrictions on harvests match the regenerative capacity of resources (W, O). Another related factor that Agrawal cited was fairness in the allocation of benefits from the common resource (B&P). Agrawal cites these as enabling conditions for sustainable governance of the commons. Ability to establish such rules rather than their actual existence is the appropriate indicator for a group that is trying to develop a collective management system.

Table 1 also mentions the ability to establish favorable institutional arrangements. Agrawal's arrangements to facilitate sustainable governance included simple rules, locally devised access and management rules, ease of enforcing rules, graduated sanctions, availability of low-cost adjudication, and accountability of monitors and other officials to users. These conditions again show the advantages of working in small rather than large watersheds, because rules cannot be simple, enforceable, locally devised or easily adjudicated if they cover multiple villages in poor communication with one another. Accountability of monitors is a problem where resources have multiple, conflicting users because monitors may be more accountable to one group of users than another. Agrawal also mentioned the need to match restrictions on harvest to the regenerative capacity of the resource. This brings to mind the observation by Calder et al. (2006) of catchment closure, whereby trapping water resources upstream and pumping it heavily prevents its regeneration downstream. The problem is that where the microwatershed is the management unit, an approach that provides local benefits within the microwatershed may cause harm in other microwatersheds downstream. In other words, whereas addressing socioeconomic concerns favors small microwatersheds as the unit of operation, addressing this hydrological problem requires working in large macrowatersheds and the two may be incompatible.

The final set of enabling conditions in Table 1 concerns the external environment: autonomy and low-cost exclusion technology with respect to the outside world, supportive government, and access to low-cost adjudication. There are many examples of all of these factors both favorable and detrimental to successful watershed management and often they are beyond local managers' control.

### 3.2. Platforms for managing the commons

'Platforms' for analysis and negotiation have been discussed in the literature as a means to promote collective action on the commons.[7] Steins and Edwards (1999a, 1999b) drew on this idea in an effort to move away from theoretical discussions about people's propensity to work collectively and toward discussions of approaches to help them do so. They produced a special journal issue to examine the use of platforms to manage complex, multiple-use common pool resources such as watersheds. They concluded that platforms have great potential to improve commons management, listing several factors that help them work. Table 2 cites these factors as quoted from the text of their article. They are quite complex and subtle, and it is easy to imagine difficulty in making them work widely. The discussion of nested platforms is useful, because microwatersheds each with their own platform could be nested within a larger macrowatershed platform, such that each platform helps assure that management approaches are compatible both

[7] In this context, platforms are forums in which diverse stakeholders jointly analyze and negotiate diverse interests and develop action plans to solve natural resource management problems.

within and among microwatersheds. Very few watershed programs in India operate this way, although the World Bank supported projects are intended to (World Bank 2007).

*Table 2: Factors associated with effectiveness of nested platforms in governing complex common pool resources†*

1. It is important that nested platforms‡ correspond with the resource system level that is at stake – in ecological, economic, and social terms – and that they are stakeholder-based, rather than user-based.§
2. 'Back up' by small-scale local platforms can facilitate decision-making and effective representation in larger-scale nested platforms for collective CPR management.
3. The empowerment of platform participants to elicit their views is important to challenge inequalities (in terms of gender, ethnicity, education, and skills) and dominant power relations, and to create a situation in which communication is as open (and voluntary) as possible.
4. Stakeholders' priorities, as well as the resource system, are dynamic and are constantly being reshaped. Consequently, nested platforms are subject to the same dynamics.
5. In collective CPR management, social learning about the ecosystem at stake and the different stakeholders' views and actions is vital to agree on action strategies and to break down existing power structures that may hinder collective actions.
6. Platforms for resource use negotiation are always nested within other decision-making structures. The latter influence the role of the nested platform and create the context within which new platforms for solving certain resource management problems are necessary or redundant.
7. A too strong reliance on the formation of nested platforms as the solution to complex resource management problem may overshoot the mark; sometimes it can be more effective to let platforms evolve from smaller-scale initiatives to tackle the perceived problem.
8. There is good reason to believe that the presence of a third party is beneficial to the performance of nested platforms.

† Source: Steins and Edwards (1999b). The eight factors assembled in this table are exact quotes from the text of the original article.

‡ 'Nested platforms' refers to the fact that decision-making processes take place at multiple levels, including the legislative level that sets the legal framework, the collective choice level whereby broad rules are made that govern interactions among different organizations, and the operational level where specific rules are made regarding day-to-day decisions (Steins and Edwards 1999a).

§ Stakeholders are broader than users; they include all those who affect and are affected by the resource system.

An important facilitating factor in Table 2 is the presence of a third party facilitator to smooth negotiation processes and protect the interests of the weak. Ravnborg and Guerrero (1999) particularly stressed this in their study of the role platforms play in a watershed management project operated by the International Center for Tropical Agriculture (CIAT) in Colombia. It appears to further reinforce the argument that successful watershed management needs to take place on a small scale and in a limited number of places so that such facilitation is actually feasible.

## 4. Evolution of Indian watershed projects

This section applies the lessons from theory in the previous section to the experience of Indian watershed projects. It begins with an overview of the evolution of Indian watershed development and a review of project evaluations. It then shows how the lessons learned from successive generations of watershed projects are consistent with what commons theory would predict. Briefly stated, Indian watershed projects began in the 1970s and 1980s with a highly technocratic approach that failed to recognize the need to address the challenges of watershed governance. Since about 1990 projects have taken a more participatory approach that focuses more on social organization, but success remains elusive. This is not surprising given the insights from theory introduced in the previous section.

### 4.1. Early projects

Early large-scale projects in the 1980s included the World Bank-supported Pilot Project on Watershed Development and the Model Watershed Program of the Indian Council of Agricultural Research. All of these projects took a purely technocratic approach as the benefits of watershed development were assumed to be self-evident and uncontroversial. The World Bank-supported Pilot Project operated at a vast scale of tens of thousands of hectares, with little effort to organize the inhabitants. Project managers learned the hard way that collective action to manage common pool resources was difficult to come by, especially when benefits were gradual, incremental, and unevenly distributed (World Bank 2007).

### 4.2. NGO programs

In the late 1980s various Indian NGOs including MYRADA in southern India, Social Centre in Maharastha, and the Aga Khan Rural Support Programme in Gujarat embarked on watershed development focusing much more on social organization (Hinchcliffe et al. 1999; Farrington and Lobo 1997). From their perspective, watershed technology was fairly straightforward and the real challenge was to organize communities to work collectively for successful outcomes. For example, MYRADA's projects focused on identifying separate interest groups (low caste people, women, landless, farmers with irrigation, etc.), building their organizational capacity and helping them negotiate with one another to ensure that watershed investments could satisfy everyone's interests (Fernandez 1994). In fact, MYRADA would not even consider investing in watershed development until a village had achieved strong organizational skills. Meanwhile, Social Centre would begin by identifying villages where topography was favorable for water harvesting and where people could show evidence of collective action around natural resources. Villagers also had to promise not to plant water intensive crops like sugarcane, which would allow a small minority of well-off farmers to capture benefits. Many other NGOs operated similar programs.

All of the NGO projects worked at a very small scale to facilitate social organization, with the village- or sub-village watershed as the unit of operation. Most of them were not replicated very widely, enabling the NGO to provide close supervision.

### 4.3. New generation government programs

Government programs learned the lessons from their earlier failures and the successes of the small NGO programs. New programs in the 1990s aimed to apply these lessons.

Integrated Watershed Development Project: The IWDP was initiated in 1990 with support from the World Bank. This new project was developed at a time when the commons literature was blossoming and this helped in understanding the problems of the earlier Pilot Project. The project's supporting documents showed links to early attempts by Wade (1988) to identify the conditions associated with successful common pool resource management. Project managers in India were also strongly influenced by the work of Jodha, who wrote about the reliance of the rural poor on common lands and the reasons for their declining area and productivity (for a summary see Jodha 1992).

The IWDP still operated in very large watersheds covering tens of thousands of hectares, but for operational purposes they were divided into smaller microwatersheds with more distinguishable boundaries. User committees were established to represent different interest groups in the watersheds and were given certain powers to make rules; systems of graduated sanctions were established based on traditional institutions; monitoring systems were established; etc. The new institutions were established on a weak footing, however. Committees sometimes existed in name only, monitoring systems were propped up by project funds, and people agreed to things apparently just to gain project funds (Kerr and Pender 1996). Of course these are typical problems facing heavily funded development projects but they demonstrated why Ostrom's (1990) principles cannot be used as a blueprint.[8]

Ministry of Rural Development: The Ministry radically redesigned its watershed projects based on an advisory committee's recommendations in 1994 (Government of India 1994). These projects became the centerpiece of government rural development efforts in semiarid, unirrigated areas. The 1994 Guidelines drew heavily on the experiences of NGOs like MYRADA, operating at village-level microwatersheds as the new unit of implementation, devoting attention to participation, and endorsing indigenous practices and management systems. NGOs became eligible to implement these projects.

Government-NGO collaborative programs in Maharashtra: In the mid-1990s, two new programs aimed to combine the technical expertise of government agen-

[8] Ostrom regularly points out that the design principles must not be treated as a blueprint but her warning often seems to be ignored.

cies and social organization skills of NGOs. The Indo-German Watershed Development Programme (IGWDP) followed the model of Social Centre described above, and the Adarsh Gaon Yojana (AGY) followed the approach taken by Mr. Anna Hazare of Ralegaon Siddhi, site of the most successful watershed project in Maharashtra (Kerr et al. 2002). Hazare, one of India's best known social activists, believed that successful village-level watershed management required practical steps to protect the natural resource base and a commitment to personal responsibility. Accordingly, to be eligible for the AGY, a village had to ban open grazing and tree-cutting in upper watershed pastures, engage in group labor (shramdan) for the benefit of the village as a whole, forego alcohol consumption, and practice family planning. To be eligible for the IGWDP, villages had to demonstrate the capacity for collective action and agree not to grow water intensive crops like sugarcane.

### 4.4. Evaluations of Indian Watershed Projects

There have been a number of evaluations of Indian watershed projects over the years but very few compared different approaches or tried to correct for selection bias. Among the individual evaluations there appears to be an overrepresentation of well-known, highly supervised projects known to be successful. This was the case for a special edition of the Indian Journal of Agricultural Economics (1991) and a set of self-evaluations of participatory projects reported in Hinchcliffe et al. (1999), for example. Overrepresentation of successful cases often stems from implementing agencies aiming to promote their work and data sets being more available for heavily supervised projects with large budgets. Ratna Reddy et al. (2004) purposely selected success stories in an evaluation of the Ministry of Rural Development projects in order to assess the potential for successful watershed development to improve rural livelihoods.

Joshi et al. (2005) conducted a meta analysis of 311 evaluations that estimated benefit-cost ratios of watershed projects, based on all available studies. Presumably the success stories are also overrepresented in this work.

Kerr et al. (2002) randomly selected 86 villages in Maharashtra and Andhra Pradesh to compare the performance of first-generation government watershed projects with a technical orientation, NGO projects focusing on social organization, and the two NGO-government collaborative projects described above. This study tried to correct for selection bias.

As mentioned, Batchelor et al. (2003) found that successful water harvesting in upper watersheds came at the expense of lower watershed areas due to catchment closure after heavy pumping in upper watersheds.

Most evaluations are favorable. The early evaluations of heavily supervised projects showed impressive results, as did the self-assessments in Hinchcliffe et al. (1999). Ratna Reddy et al. (2004) found only modest impacts on livelihoods. Joshi et al. (2005) found a mean benefit cost ratio of 2.14 in their meta-analysis, with stronger performance in more participatory projects than more technocratic ones. Joshi et al. expressed surprise at finding projects covering more than 1250 hectares performing stronger than those covering less than 1250 hectares. However, the 1250 hectare cutoff is not very useful for assessing the impact of watershed size on performance. The more important distinction is whether the watershed covers more than one village, because village-level watersheds are still part of a natural social unit. In the study by Kerr et al. (2002), 39 out of 86 villages exceeded 1250 hectares, so the 1250 hectare dividing line does not address this issue.

Kerr et al. (2002) found that NGO-government collaborative projects performed the best, followed by purely NGO projects and lastly by the first generation government projects. The projects with an NGO component had a strong social organization focus that dealt specifically with the uneven distribution of benefits and costs, and they operated in smaller watersheds within a single village. On the other hand, government projects were solely technocratic, and the one government project that operated in multiple-village watersheds performed the worst. The successes by the projects with an NGO component came in the form of reduced soil erosion, higher crop income, improved management of common pastures, more employment, and increased irrigation. The authors cautioned that the successful cases were consistently in small microwatersheds and did not operate widely, with no evidence they could replicate substantially or operate in higher scale watersheds.

### 4.5. Discussion

Indian watershed projects evolved from the mid-1980s to the present by gradually intensifying their focus on participation and social organization while also reducing their size. These shifts resulted mainly from the demonstration effects of early NGO projects but in some cases with influence from the literature on community-based natural resource management. In many respects the changes from large to small and from technocratic to participatory reflect the factors believed to facilitate the emergence of local institutions to manage the commons. It is more likely that the experience of the Indian watershed projects helps to validate those factors, and less likely that the literature guided the Indian projects, with perhaps some iteration between the two. The NGOs likely identified the advantages of a participatory approach simply through their experiences on the ground.[9] Some larger projects like those supported by the World Bank drew both on the experiences of successful NGOs and on the literature, which tended to reinforce each other.

Although the watershed literature frequently cites studies of the commons to explain the need for social organization efforts, it is conspicuously silent about the

[9] In some cases NGOs documented their experiences. See for example the many reports by MYRADA (www.myrada.org) and Seva Mandir (www.sevamandir.org).

mismatch between characteristics of watersheds and the factors believed to contribute to successful commons management. An exception is Ravnborg (2000), who commented that had she paid attention to Ostrom's design principles, she never would have undertaken the CIAT watershed project in Colombia. This would have resulted in one less successful watershed project. On the other hand, because it operated on a tiny scale with intensive external assistance that cannot be replicated widely, that success may be an exception that proves the rule.[10]

Successful watershed projects have beaten the odds by overcoming inherent constraints to collective action, but they have not surmounted two remaining obstacles. First, projects with high investment in social organization may not be replicable beyond a small number of cases. Second, operating on the basis of a workable social unit (a village microwatershed rather than a macrowatershed that crosses administrative boundaries) apparently trades one set of problems for another.

Regarding the first problem of constraints to replication, there is little evidence that very successful projects have replicated beyond a few villages. Even those that have successfully expanded their operations reveal major limitations. For example, the IGWDP undertook a systematic approach to replication and after 12 years its successful village level projects number in the hundreds, but it works in an area with tens of thousands of villages. The IGWDP's deliberate approach has yielded strong performance, in sharp contrast to government projects with much wider coverage (Kerr et al. 2002).

Although wide replication, or 'scaling up', appears to be the Holy Grail for projects designed to elicit social change, there are many reasons why it is not a realistic goal. Manski (1995), for example, points out that the conditions of a pilot project will not likely be replicated exactly in other sites, because conditions will differ. Similarly, a pilot project is likely to be carried out differently than the scaled up version, even with identical design, because a larger effort may affect market wages or strain the supply of competent program administrators. Project outputs also may change when a project expands, for example if a market saturates. For watersheds, catchment closure becomes a more serious problem as watershed development expands because it induces greater pumping of groundwater.

The big question concerning the tradeoff between operating at an optimal hydrological unit versus an optimal social unit is its severity. In the early days of watershed projects, ignoring the optimal social unit resulted in failure because projects could not achieve effective watershed governance. More recently, the

[10] The CIAT watershed covered about 7000 hectares with about 1100 inhabitants scattered in 23 villages. Based on previous experience and literature on collective action, the CIAT team chose to work with small groups of 30-40 families covering about 200 ha subwatersheds to address natural resource management problems. Through a long process, the subwatershed groups gradually developed platforms for diverse stakeholders to jointly analyze and negotiate diverse interests and develop action plans to manage natural resources. CIAT acted as facilitator (Ravnborg and Guerrero 1999).

pendulum has swung in the opposite direction and most projects operate at the village level, disregarding hydrological linkages between microwatersheds. Catchment closure has emerged in part by ignoring these linkages, and it shows the need to address them by working at a macrowatershed scale. However, such an approach is incompatible with the strategy made successful by the IGWDP of investing exclusively in separate microwatersheds where water harvesting potential is high and communities have demonstrated the ability to work collectively.

## 5. Implications for policy and practice

The best watershed management approach certainly depends upon the situation and objectives. Some possibilities are: 1) stay small and give up on complex, higher scale watershed management; and 2) build capacity for higher scale watershed management through improved institutional arrangements and improved technologies.

### 5.1. Give up scaling attempts and accept a smaller impact

Theory and experience have shown that collective action is more likely in small, village-level watersheds, and that project agencies can best facilitate watershed management if they work in a small number of locations. The IGWDP follows these principles, working only where it perceives a high probability of success. It is important to recognize that this approach does not discriminate against villages deemed poor candidates. First, being bypassed by a project that would not work is no great loss, and second, rural areas of developing countries have many other needs besides watershed development. For example, survey respondents in India expressed strong preference for investments in medical facilities, roads, latrines, and other infrastructure as opposed to watershed development (Kerr et al. 2002). In an era of decentralization, people should be able to choose between watershed and other investments like infrastructure and government services.

A United States Forest Service watershed program aiming to reduce nonpoint source water pollution learned similar lessons about the need to prioritize its work, as success in individual project sites correlated closely to local civic capacity. An evaluation by Doppelt et al. (2002) recommended focusing the watershed projects in areas with high civic capacity while investing in such capacity elsewhere.[11] For MYRADA, whose programs were described in section 4.2, not only was building local organizational capacity critical for watershed management, but an initial capacity building investment led to numerous other economic opportunities (Fernandez 1994).

[11] Doppelt et al. (2002) define civic capacity in terms of social capital, community competence , and civic enterprise. They do not suggest a means of easily identifying civic capacity before starting a project apart from assessing it through interactions with pertinent groups such as local government and nonprofit organizations. The Indo-German Watershed Development Programme and the Adarsh Gaon Yojana in Maharashtra, India, discussed above, also selected their project villages on the basis of civic capacity, defined in terms of demonstrating the ability to self-impose and abide by certain rules of collective restraint prior to investing in a new project (Kerr et al. 2002).

In India, the recommendation of staying small is futile because the Indian government aims to expand watershed development as widely as possible. Other recommendations are needed.

### 5.2. Build capacity to operate at macrowatershed scales

Research has shown that the microwatershed approach may be creating hydrological problems that would be best addressed by operating at a macrowatershed scale. This would require working simultaneously to promote watershed governance capacity both within and between microwatersheds.

Within microwatersheds, this calls for continuing to build organizational, administrative, and governance skills at local levels as mentioned above. For example, very little of MYRADA's approach to watershed management seems to be about watersheds, reflecting its conviction that strong organizational capacity is the most critical ingredient (Fernandez 1994). Such capacity is needed to bring together stakeholders with conflicting interests, design workable compromises, and put them to work. Better governance may help in enforcing whatever agreements can be developed.

At the macrowatershed scale, new institutional arrangements are needed to promote interaction among microwatershed groups within large macrowatersheds, as described in section 4.5 above. This would involve developing something like a 'nested platforms' approach at a macrowatershed scale. It could involve specific mechanisms to facilitate the interaction such as new legislation or new arrangements for sharing upstream-downstream costs and benefits. The CGIAR's SCALES project aims to build cross-scale institutional mechanisms for watershed management, addressing village- and basin-level interaction (Swallow et al. 2005).

Macrowatershed management could also benefit from improved technology to understand and track upstream-downstream relationships. Technologies that could track hydrological relationships and trace impacts of natural resource use in one location on another would open new possibilities for developing indicators and monitoring systems to facilitate management. If such technologies seem like a fantasy, consider that remote sensing and GIS have revolutionized research on land use and land cover change, laying the groundwork for various complex institutional arrangements such as global markets for carbon sequestration.

On a less futuristic level, Calder et al. (2006) shows how EXCLAIM, an existing simulation model with a visual interface, can model hydrological relationships to visually demonstrate upstream-downstream relationships and the spatial effects of management changes.

### 5.3. A final word

Commons research emerged in the 1980s in response to the incorrect presumption that the tragedy of the commons was inevitable. Commons researchers do not imagine that all commons can be well-managed, yet watershed projects are organized as if this were so, with most watershed agencies aiming to spread their projects as widely as possible despite unfavorable conditions for collective action. It is as useful for commons research to point out the limits of common property resource management as to highlight its potential.

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