Is participatory water management effective?
Evidence from Cambodia

Anand N. Asthana

CENTRUM Católica, Pontificia Universidad Católica del Perú, 9th Street, Los Álamos de Monterrico, Surco, Lima 33, Perú.
Tel.: +51 1 313 3400, Fax: +51 1 313 3417. E-mail: aasthana@pucp.edu.pe

Abstract

Participatory management of water resources presents special problems because the interests of the farmers located at the head and the tail of a canal do not match and government machinery is usually the sole arbiter. This paper attempts to quantify the benefits of participation in irrigation systems in Cambodia through a survey of 50 irrigation projects in the country. We find that participation by stakeholders does improve project performance. We find that even in the absence of a coherent state bureaucracy, state-society synergy can exist and participation can lead to better project outcomes.

Keywords: Economic analysis; Irrigation; Participation; Water management; Water resources

1. Introduction

There is some disenchantment with irrigation projects in developing countries. These projects, which once symbolised technological prowess and food security, now evoke ambivalent feelings. In addition to environmental and displacement aspects highlighted by a wide variety of non-government organisations (NGOs), there is disappointment with respect to economic factors (time and cost overruns) and political economy aspects with respect to inequities and corruption. Because benefits do not reach expectations, some supporters of higher investments in irrigation have since become opponents of new projects (Iyer, 2003).

The World Banks’ lending for dam building has declined from US$1 billion per year in the early 1990s to a mere US$100 million per year at the beginning of the current decade. Recently, there has been a surge in funding for irrigation projects but this funding is mainly for dam safety, rehabilitation of displaced persons, environmental management and integrated water resources management (IWRM). The focus is on utilisation of existing irrigation potential. There is growing realisation that better engineering is not the main instrument through which this utilisation can be achieved. There is an ongoing debate about how to improve the management of the projects.

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2. Reasons for poor performance

Examples of failed irrigation projects in developing countries are often explained by mistakes or corruption in the planning and construction phase. The research over the last three decades points towards failure in operations and maintenance too (e.g. Easter, 1990). At the same time, there are examples of highly complex irrigation systems being managed by communities successfully without much technical support (e.g. Coward, 1986).

Cost and time overruns could be due to mistakes or corruption. However, this may not always be the case. When capital is scarce, there is intense competition to get a project sanctioned. There is a tendency to understate the time for completion and the cost involved. This can happen in any infrastructure project, for example, roads. Further, there is incentive to exaggerate the benefits to be obtained; for example in the case of an irrigation project, the command area. What is truly disturbing is not why the potential created is less than the designed potential, but why the existing potential is unutilised. Earlier research in economics has identified the following reasons for not utilising the existing potential:

- Low relative economic value of water does not warrant investments in institutional change, capital investments and administrative efforts (Young & Haveman, 1985).
- Water has a “collective good” character (Herfindahl & Kneese, 1974).
- There is government failure owing to rent-seeking behaviour and poor management (Krueger, 1974).

These problems are further compounded by the fact that the water reservoir is not merely for irrigation but also for flood control, insurance against droughts, domestic and industrial water supplies, recreation and commercial fishing. The water itself may provide hydropower or be used for purposes like cooling a thermal power plant before it is used for irrigation and therefore the supply may not be as per the optimal demand pattern. In the West these problems of multiple use are taken care of by adopting IWRM; an idea that is two generations old but was pushed through in the 1990s as a new concept. In the United States, IWRM is like motherhood and apple pie; nobody is opposed to it. In the developing countries, the alacrity with which the governments “declared” adoption of IWRM is reflective of the hundreds of millions of dollars of aid money that became available. The state of Punjab in Pakistan immediately copied the water laws of the state of Colorado in the USA. Advised by the Asian Development Bank, Cambodia and its neighbours established the Mekong River Commission. After attracting significant donor support, the commission moved away from its mandate towards investment facilitation. A global water discourse largely driven and financed by international organisations has crowded out the emergence of endogenous condition-specific solutions (Molle, 2007). Some components of IWRM are difficult to implement in developing countries, as discussed in Section 7. The focus of this paper is on the distribution of water among the farmers in the command area rather than allocation of water at the dam or basin level.

The major problem is interdependencies among farmers. Technological externalities are created when farmers contribute to operations and management (O&M). A farmer could confer a benefit to another

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1 Within the irrigation sector, the competition could be between territory A and territory B. Within a territory, the competition could be between sector X (say, irrigation) and sector Y (say, roads). In either case there is bound to a tendency to attract the project by understating the cost and problems and overstating the benefits.

2 For a dissenting view, see Biswas (2004, 2008).
farmer served by the same canal, or it could be a case of loss to the downstream farmer when the upstream farmer withdraws water. The asymmetry is apparent from the fact that activities of farmers in the head reaches affect the farmers of the tail reaches, but the activities of downstream farmers do not affect upstream farmers.

Thus, irrigation water is not a public good because it is possible to exclude and reject it and is not non-rival. It is a common good with special characteristics. The factors that need to be considered are assurance, reciprocity and fairness. Farmers desire an assured supply of water at a time of their preference. In a small group, the free rider problem is minimised by peer pressure and reciprocity comes in. By and large, the farmers agree that it is fair for the tail-enders to have the same rights to irrigation water as the head reach farmers. We will explore the concept of participation further in a separate section.

3. The setting

The area of study covers the Kingdom of Cambodia. Economic historians have referred to Khmer Empire between 9th and 15th century as a “hydraulic economy” because of its advanced irrigation system and the numerous canals leading into the water ways of the Mekong delta contributing to economic growth. This applied until the construction efforts of the Khmer kings came to a somewhat mysterious end in the 15th century (Ear, 1995). According to some scholars, the kingdom’s vast and intricate canal system silted up owing to disuse and lack of repair, an indication of sudden labour losses in warfare or from epidemic disease (Etcheson, 1984). According to French economist Rémy Prud’homme (1969), by extension of its protection in 1863, France brought stability to Cambodia; but the colonial authorities, guided by a liberal ideology, without public policy in mind, allowed the market to rule. Not much irrigation infrastructure was created during the colonial period nor during the period following independence until the Khmer Rouge took up a number of irrigation projects.

The Khmer Rouge’s policy of depopulating the cities led to elimination of a large number of intellectuals, including engineers. While the administrative structure of the hydraulic economy (i.e. how the water was shared by the irrigators) is not known, the Khmer Rouge glorified it anyway. Deriving their authority from the old temples and legends, they adopted an all enslaving idea of “Angka” to re-establish the glory of the hydraulic economy of the ancient Angkor empire. The whole population was effectively reduced to slave labour in a programme of public works that sought to subdivide the country into squares of 100 m, with an irrigation canal every 1 km. Functional small-scale irrigation systems were destroyed. Most of the newly built systems were ill-designed, betraying a lack of knowledge of hydrology among the Khmer Rouge cadres. With the help of the multilateral and bilateral aid agencies,

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3 Inevitably, the rivers have been inextricably linked to the religious practices and culture of Cambodia. Ancient kings apparently worked out the day on which the Mekong and the Bassac rivers would, once a year, suddenly start to flood, conjoin and, under terrific water pressure, appear actually to reverse their flow back into the Tonle Sap lake. There was a ceremony at which the “divinely appointed” King would order the water to flow backward. In modern times, the showman King Nordom Sihanouk exploited this phenomenon to considerable effect.

4 There are many books on the atrocities and genocide committed by the Khmer Rouge written by contemporary historians, journalists and others. Among the recent books, arguably, the best is by Philip Short (2004). However, no references are available on the specific impact of Khmer Rouge on irrigation projects. What is mentioned in this paper is based on field visits and interaction with farmers. There are projects where a person has to climb a tree to reach a platform from where the gate is opened or closed.
most of these projects have been rehabilitated. Water users’ committees have been elected on a non-party basis for many of these projects. Once a new project or a rehabilitation project is completed, the contractor usually leaves his office hut and equipment to be used by the water users committee. However, not all the committees are functional.

Around 70% of Cambodian workforce is employed in subsistence farming with rice as the main crop, although the agricultural sector contributes to only one-third of the GDP. The World Bank (2007) classifies Cambodia as a transforming economy. Agricultural productivity is low compared to neighbouring countries in South-East Asia. Average yields are 1.5 tonnes per hectare for rainfed rice and 2.5 tonnes per hectare for irrigated dry season rice (NIS, 2007).

A Human Development Report classifies Cambodia as a medium human development country. In the peer group of neighbours, it is below Vietnam and Laos (UNDP, 2007). Cambodia is yet to recover fully from the genocide at the hands of the Khmer Rouge. Of late, literacy has been picking up⁵. Yet, in rural areas the average adult has only five years of schooling. Per capita income is US$454 or PPP$1,453; the rural incomes being two-thirds of the overall per capita income. Unlike sub-Saharan Africa, a significant proportion of small holders in Cambodia are net sellers of food. Increase in efficiency of irrigation systems is seen as an important activity by the government and the donor agencies.

4. Participation

While there are many definitions of participation, they generally include in some measure the notions of contributing, influencing, sharing, or redistributing power and of control, resources, benefits, knowledge and skills to be gained through beneficiary involvement in decision-making. Delli Priscoli (2004) identifies five important dimensions of participation in water resources management. These are (i) ethical; (ii) linkage with civic culture; (iii) tension between the technical and political; (iv) reconciliation of the discontinuities between the geographic and the jurisdictional boundaries; and (v) need for better conflict management. Two volumes on public involvement published by the US Army Corps of Engineers (Creighton et al., 1992, 1998) explain how participation has evolved over time. Starting with mere “public information”, public involvement was formalised in hearings before the decision. At the time, it was viewed by technocrats as tolerating nuisance from various interest groups. The concept of public involvement evolved further to consensus seeking (influencing the decision) and finally to dispute resolution with agreement to the decision. Managers have come to accept public participation as a value-based consensus building exercise.

In the developing countries, the situation is much more complex. Most of them do not have élite organisations like the US Army Corps of Engineers or the French Ingénieurs des Ponts et Chausées.

⁵ France’s mission civilisatrice (civilising mission) in Cambodia did not include spread of education. By 1945, Cambodia had only two lycées (secondary schools). But Cambodia has had a culture of learning based in Buddhist temples and pagodas since the 12th century. Although predominantly used by monks (men who came from every social class), these pagodas were also open as educational sites for the general population. After independence many schools were established. In the 1960s Cambodia had a very high rate of literacy—above 90%. However, during the Pol Pot regime, schools, universities and pagodas were closed and destroyed between 1975 and 1978. From 1980 onwards, literacy started rising, albeit slowly. Currently, literacy (age 15 and over who can read and write) is estimated to be 74%.
A few highly qualified cadres like the Brazilian National Corps of Road and Sanitary Engineers and the Indian Administrative Service can be counted as exceptions. Many developing countries emerging from conflict situations do not even have a coherent state bureaucracy. In many such countries, the state is viewed by the wider society as a predatory organisation.

The deficiencies inherent in individualistic markets like those in a statist paradigm are well known. Analysis of the mechanism through which participation by groups can minimise these deficiencies is an important area of research. These mechanisms have been explored by Nugent (1993) and Ostrom et al. (1993), among others. Instead of assuming a zero-sum relationship between government involvement and private cooperative efforts, Peter Evans (1996) argues for the possibility of “state-society synergy” and explores the forms and sources of this synergy. According to Evans, active government and mobilised communities can enhance each other’s developmental efforts.

The Asian Development Bank (2001) defines participation as “a process through which stakeholders share control of development initiatives and of decisions and resources that affect them” and has determined participation as being one of the four pillars of good governance, the other pillars being accountability, transparency and predictability. The World Bank (2006) defines participation as stakeholders’ influence and share of control over “priority setting, policy-making, resource allocations and access to public goods and services”. According to these institutions, participation is a voluntary process by which people influence or control the decisions. The essence of participation is exercising voice and choice.

The absence of a robust government structure, dependable and competent public institutions and a coherent state bureaucracy makes state-society synergy harder. Cambodians are “oddly reluctant” to analyse the violence and corruption that plagues their society (Short, 2004). According to a Global Competitiveness Survey coordinated by the World Economic Forum “the additional payments to secure the contract with the Government” have a frequency of 93%, the highest in the world (Kaufmann et al., 2007). There is little judicial redress available against corruption. On the other hand, judicial officers are among the least trusted government actors and courts are seen as the most corrupt of the public institutions (Asia Foundation, 2004). Studies indicate that bribes intended to influence outcomes are considered morally wrong, but are commonly accepted by the citizens (e.g. Nissen, 2006; Ford & Seng, 2007). Among the 163 countries included in the Corruption Perceptions Index for 2006, only eight countries fare worse than Cambodia (Transparency International, 2007).

Evans (1996) argues that state-society synergy is constructible, even in the more adverse circumstances typical of Third World countries, because micro level social capital is latently available. This synergy usually combines complementarity with embeddedness and is most easily fostered in societies characterised by egalitarian social structures, as in Cambodia. The government must provide tangible assets like canals and intangible assets like a rule of law. Citizens contribute local knowledge and experience. As the beneficiaries of the final product, community members can also contribute their time without wages. These complementarities provide a potential basis for synergy but not an institutional basis for realising it. When people working in public agencies are closely embedded in the communities they work with, the public—private divide is bridged creating state—society synergy.

Exercise of power cannot be transferred to the people by a fiat or simple hands off approach on the part of the state. Such an approach did not yield the expected results in case of Nepalese canal management, whereas Taiwanese farmers run their irrigation systems much more effectively with the help of state employees who are enmeshed in a form of a dense network of social relationships (Lam, 1996a, b; Lam et al., 1996; Moore, 1989). The Nepalese system assured complementarity by giving legal recognition to
the water users’ organisations; in Taiwan, complementarity is complemented by embeddedness, creating a basis for fruitful participation.

While it is intuitively apparent that participation by the stakeholders is the best way to improve the management of common property, it is not so apparent whether participation affects the project outcomes, especially when the interests of the stakeholders are heterogeneous. There is surprisingly little statistical evidence that addresses the question of whether beneficiary participation is a significant independent contributor to outcomes in the case of irrigation projects meant to benefit smallholders.

Participation is not a “free lunch”. There are costs in terms of money and time spent in institution building, training and so on. Even then, the results of participation could be negative. Cooke & Kothari (2001) focus on four different problems of participatory development, which are risk shift (diffusion of responsibility), the Abilene paradox (common breakdown of group communication in which individual members mistakenly believe that their own preferences are counter to the group’s and do not raise objections), groupthink (members of the group avoid promoting viewpoints outside the comfort zone of consensus thinking) and coercive persuasion. If the dominant person or section captures all or a disproportionate share of benefits, others could be left worse off compared to the situation if the government were managing the project. There could be a gulf between the strident rhetoric of participation, empowerment and appropriate development and what actually happens in practice. Negative consequences like strengthening local strongmen or males over females may also occur (Meinzen-Dick & Zwarteveen, 1998; Tembo, 2003).

Thus, participatory processes can lead to the unjust and illegitimate exercise of power. A situation of “elite capture” by traditional chiefs in Sahelian countries is known (Platteau, 2004). In Khmer society, which is not divided by tribes and castes and where economic inequality in rural areas is not glaring, this problem was not observed. It may be noted, however, that while more active participation is possible, the factors that limit the establishment of democratic spaces for participation are to be found in the institutional set-up and, more importantly, in the trauma caused by the conflict and in Cambodian socio-cultural norms (Pellini, 2005).

5. Social capital

There has been a proliferation of literature on social capital in recent years and the concept is being applied to analyse almost every economic phenomenon, ranging from repayment of loans in a group lending micro-finance programme (Karlan, 2005) to food security in a mountain region in Perú (Díaz et al., 2002). Without using the term social capital, economists have long recognised the role of “trust” in establishing economic efficiency and in coping with market failures. David Hume, Adam Smith and Antonio Genovesi, who were 18th century economists, recognised the importance of trust in economic transactions and analysed economic and social institutions that create conditions under which rational trust is possible (Bruni & Sugden, 2000). Arrow (1971) notes that “in the absence of trust, opportunities for beneficial cooperation would have to be forgone”. While trusting the concept of “trust”, economists are divided on whether social capital is a good analogy or a bad metaphor.

Many studies have been conducted to examine how social capital can help circumvent the collective action problem in the provision of local public goods. In the field of irrigation in developing countries,

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these studies include Ostrom et al. (1994), Ostrom (2000), Bardhan (2001) and Kikuchi et al. (2001). In their study of the irrigation systems in developing countries, while highlighting the importance of institutions, Ostrom and her collaborators analyse how social capital has been helpful in eliciting cooperation among farmers, evolving a common norm of behaviour and circumventing problems of collective actions. Farmers need to work out arrangements that will permit them to build and maintain irrigation systems and share the water that these systems provide. These problems involve small numbers of agents who know each other and interact repeatedly.

The theory of repeated games explains how self-interested, calculating individuals can reach cooperative, efficient outcomes in this setting, but the same theory permits inefficient outcomes as well. Ostrom and her colleagues (Ostrom et al., 1994) describe how farmers solve these problems and traces their solutions to the ability to construct commonly understood, commonly practiced, self-enforcing rules of behaviour; and the ability to do this is what these authors call social capital. These authors further demonstrate that these arrangements often take into account delicate balances of conflicting interests that are not transparent to outside observers, leading to the valuable lesson that external assistance, even when supplying enhanced technology, need not improve performance.

Small communities develop different methods to solve collective-action problems. These methods can be placed in a general theoretical framework, but they require sensitivity to local conditions to work. Arrangements that enable people to put social connections to good work are local. Ostrom’s (2000) point is that sometimes groups are able to commit to an institution that provides a sensible way to govern the commons. We should be looking not only for the features of institutions that facilitate good outcomes, but how to arrive at these institutions and what makes them stable. The studies by Bardhan (2001) on the irrigation communities in South India and by Kikuchi et al. (2001) on the irrigation system in the Philippines also offer interesting illustrations of the importance of social capital in the management of community resources.

Many ardent advocates of the concept of social capital concede that social capital is not really a form of capital in the strict sense of the term. For example, Ostrom (2000), who argues that social capital is a fundamental concept and an essential complement to natural, physical and human capital, notes that social capital is different from other forms of capital in some important ways. She identifies four key differences. First, social capital does not wear out with use—on the contrary, it erodes from a lack of use. Second, it is not easy to see or measure. Third, it is hard to construct through external (for example donor) intervention. Finally, national and regional government institutions strongly affect the level and type of social capital available to individuals to pursue long-term development efforts.

It could be argued that stocks of social capital accumulated over long periods of time would make participatory exercise more fruitful. However, prior endowment of social capital is not the key constraining factor. The limit seem to be set more by the difficulties involved in scaling up micro level social capital to generate solidarity ties and social action on a scale that can generate effective participation. In the Taiwanese and Nepalese cases discussed in the previous section, it is difficult to presume that the difference derives from historically higher levels of social capital in Taiwanese rural communities. On the contrary, researchers have explicitly mentioned that farmers in Taiwan do not stand out as having unusual levels of trust and solidarity (Lam, 1996a; Lam et al., 1996). This is not to say that the community norms are irrelevant to the local functioning of an irrigation system. The point is that such community norms are perhaps no stronger in Taiwan than they are in Nepal, where irrigation is a problematic affair.

The recent proliferation of studies on social capital has not been accompanied by a commensurate increase in analytical rigour. Unearthing underlying social capital mechanisms is very difficult in view
of problems of quantitative and qualitative data, circularity of argument and limited ability to discriminate between alternative hypotheses regarding the underlying processes. Accordingly, instead of trying to measure social capital, participation has been included as a relevant variable. The existence or non-existence of participation has been taken to be the existence or non-existence of a functioning water users committee. A functioning water users committee has been taken to be a surrogate for existence of participation. Participation gives access to latent immeasurable social capital which in turn can be hypothesised to improve project performances, which is measurable.

6. Measuring the impact of participation

This study is based on analyses of 50 medium and minor irrigation projects, which were selected on a random basis prior to commencement of this study by Japanese Bank of International Cooperation through consultants M/s Mott MacDonald for another broader research project. In 21 of these projects, water users committees had been duly constituted and were functioning. The study required contacting not only the officials of the Ministry of Water Resources and Meteorology but also international support agencies and their consultants whose offices are located in the country mainly in Phnom Penh and Siem Reap. Many of the evaluation reports dealt with policies, in-depth studies and institution-building activities. Since the focus of the study was on physical implementation of the projects, the data was verified and updated for each project on the basis of field visits.

6.1. Preliminary analysis and choice of variables

For the reasons mentioned earlier, it is highly unlikely that the entire designed command area can be irrigated. Our objective is to see whether participation by beneficiaries, as evidenced through a functioning water users’ association, can bring about any improvement and, if possible, to measure this improvement. The dependent variable, project effectiveness, is the proportion of the designed command area that is actually being irrigated.

As a first step, the mean and median of project effectiveness of the projects with participation were compared with those without participation. Since the sample size is large, meaningful comparisons can be made. Project effectiveness in the case of projects with participation was found to be higher.

The statistical significance of the differences in means in project effectiveness ratios are based upon the t statistic from a parametric test (on the assumption of unequal variances) of whether the difference is significantly different from zero. To test differences in medians, the Wilcoxon Rank Sum test was used. The difference in means and medians were found to be highly significant. The results are reported in Table 1.

Next, we choose other variables expected to affect project effectiveness. One obvious variable is the size of the project. When we regress the project effectiveness ratio against the size of the project (designed command area), we find a significant negative relationship ($t = 2.0$). Similar results are obtained when the project effectiveness ratio is regressed against the natural logarithm of the size of the project. We use the test designed by MacKinnon et al. (1983), often called the MWD test and find that the log of size will be more appropriate as an explanatory variable. Similar analysis led to the conclusion that the log of age and, as a variable for remoteness, the log of distance should be included as the explanatory variables.
Geographically and ethnically, Cambodia does not have much diversity. Most of Cambodia is relatively flat with vast tracts of land given over to rice production. The largest part of the country—about 75% of the total—consists of the Tonle Sap Basin and the Mekong Lowlands. To the southeast of this great basin is the Mekong Delta, which extends through Vietnam to the South China Sea. The basin and delta regions are rimmed with mountain ranges covered with forests. Cambodia’s population distribution is fairly equal, that is, population density does not vary much. Dummy variables for the geographical regions have not been used. However, one geographical variable has been included for remoteness, as explained later in the section.

About 90% of Cambodians are Khmers. This proportion is even higher in rural areas. Unlike many developing countries, village society is not fragmented by caste or tribe and inequalities of income and social status do not abound. No ethnic or social dummy has been used in the study.

Geographical remoteness has an effect on the project effectiveness in underdeveloped countries. For instance, spare parts are difficult to get in far off areas. Several proxy variables were considered. Phnom Penh is the only big urban business centre in the country. The distance from Phnom Penh was found to be a dependable surrogate variable. After preliminary analysis, the log of this distance was used in regression analysis. For project complexity, we relied on the information furnished by government engineers and this has been included as a dummy variable.

Important variables which can affect the project effectiveness are literacy and income levels, among others. These two variables capture inter-project disparity in our analysis and not the disparity between beneficiaries of the same project. Previous experience of participation in other projects in the village, for example drinking water and sanitation projects, may also influence the project effectiveness.

Since the sample size is large, the degree of freedom did not constrain the number of variables to be chosen. Variables not chosen were those which were unlikely to have any significant effect at all or which were very closely correlated (e.g. female literacy with overall literacy).

Table 2 presents descriptive statistics for the variables hypothesised to explain efficiency. Statistics are presented both for the entire sample and for two groups of 25 projects, each by dividing the entire sample in half, based upon project effectiveness ratio. While it is true that the participation has been tried more often in projects where other factors are favourable; since multi-collinearity is not strong, meaningful results can be obtained through regression.

The bivariate regression in Table 3 shows the results of the project effectiveness being regressed against the participation dummy variable. The coefficient was found to be significant. However, the coefficient appeared to be rather high. This indicted that there are other factors which are correlated with participation and contribute to project effectiveness. The project effectiveness \( E \) is the dependent variable which will be affected by participation by stakeholders \( P \) and also by other independent variables (matrix \( Z \)).
Before we test this model we need to see whether the model is correctly specified.

6.2. Halo effect and simultaneity

Notwithstanding the voices of caution mentioned earlier, participation is generally regarded as a good thing. In studies trying to measure the effects of participation, democracy, decentralisation, transparency and so on, the halo effect can affect the measurement of the dependent variable. The halo effect is a systematic measurement error induced by an association between subjectively measured variables even in the absence of any true relation between these variables. It is a psychological tendency to associate all good things (Hamermesh & Biddle, 1994; Isham et al., 1995). In this study, the dependent variable, project effectiveness, is a cardinal variable and not a subjectively measured ordinal variable. This obviates the problem of the halo effect.

A more serious problem could be simultaneity. Could it be that as participation affects effectiveness, effectiveness also affects participation? When the project is effective for extraneous reasons, do people join the participation bandwagon? It is important to test for simultaneity because, in the presence of simultaneity, while Equation (1) will continue to hold, another relationship will develop:

\[ P_i = \lambda + \delta^* E_i + \eta \]  

where \( P_i = 1 \) for projects with participation and \( P_i = 0 \) for projects without participation.

We observe that \( \eta \) affects \( P \) in Equation (2) and \( \eta \) and \( e \) are correlated. Since in Equation (1), an explanatory variable is correlated with the independent variable, the ordinary least squares (OLS) regression will not give correct results.

\[ E = \alpha + \beta^* P + \gamma^* Z + \epsilon \]  

(1)

Table 2. Descriptive statistics of explanatory variables.

<table>
<thead>
<tr>
<th>Explanatory variables</th>
<th>Mean (median) of the whole sample (2)</th>
<th>Below median project effectiveness (3)</th>
<th>Above median project effectiveness (4)</th>
<th>Difference in means (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainfall (in cm per year)</td>
<td>168 (168)</td>
<td>168</td>
<td>168</td>
<td>0</td>
</tr>
<tr>
<td>Total command area (in ha)</td>
<td>1,090 (991)</td>
<td>1,193</td>
<td>987</td>
<td>-206*</td>
</tr>
<tr>
<td>Age of project (years since construction/rehabilitation)</td>
<td>18.5 (18.0)</td>
<td>19.4</td>
<td>17.6</td>
<td>-1.8*</td>
</tr>
<tr>
<td>Distance from capital (in km)</td>
<td>198</td>
<td>236</td>
<td>160</td>
<td>-76*</td>
</tr>
<tr>
<td>Literacy (in % for 15+ age group in project area)</td>
<td>71.0 (71.0)</td>
<td>72.3</td>
<td>69.7</td>
<td>2.6*</td>
</tr>
<tr>
<td>Per capita income (in US$ average in the project area)</td>
<td>589 (564)</td>
<td>501</td>
<td>677†</td>
<td>176*</td>
</tr>
</tbody>
</table>

† Significant at 5% level.

7 For a dissenting view on the importance of halo effect, see Murphy et al. (1993).
The problem of simultaneity can be easily solved by using an instrumental variable in a two-stage least square regression (2SLS)\(^8\). In the presence of simultaneity, the use of OLS is inappropriate, but if there is no simultaneity, we should avoid using 2SLS. The reason is that 2SLS may not give wrong results, but OLS estimates are unbiased (even for small samples) and have minimum variance. In such a case, OLS estimators will be BLUE (best linear unbiased estimators).

A version of the Hausman test can be utilised to test this possibility. First, we estimate \( P \) in Equation (2) as a linear probability model\(^9\) to obtain \( \hat{P} \), then substitute this linear probability in a new equation:

\[
E = \alpha + \beta \cdot P + \gamma \cdot Z + \delta \cdot \hat{P} + \varepsilon
\]

We then test the hypothesis that \( \delta = 0 \) and conclude that the hypothesis is not rejected. Hence \( P \) can be treated as exogenous.

The results of the multivariate regression are reported in the last column of Table 3. We find that the coefficients of all independent variables have the expected signs, but not all the independent variables are significant. Rainfall, project complexity and average per capita income in the command area are not statistically significant at an appropriate level. The adjusted \( R^2 \) has improved.

Table 3. Regression results.

<table>
<thead>
<tr>
<th>Explanatory variables</th>
<th>Regression coefficients</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bivariate</td>
<td>Multivariate</td>
</tr>
<tr>
<td>Participation variable</td>
<td>0.17*</td>
<td>0.11*</td>
</tr>
<tr>
<td>Rainfall (in 100 cm)</td>
<td>-0.01</td>
<td></td>
</tr>
<tr>
<td>Project complexity</td>
<td>-0.01</td>
<td></td>
</tr>
<tr>
<td>Total command area (log of)</td>
<td>-0.0009(^\dagger)</td>
<td></td>
</tr>
<tr>
<td>Age of project (log of)</td>
<td>-0.0002(^\ast)</td>
<td></td>
</tr>
<tr>
<td>Distance from capital (log of)</td>
<td>-0.0002(^\dagger)</td>
<td></td>
</tr>
<tr>
<td>Literacy (%)</td>
<td>0.0003(^\ast)</td>
<td></td>
</tr>
<tr>
<td>Per capita income (in US$100)</td>
<td>0.0009</td>
<td></td>
</tr>
<tr>
<td>Previous participation</td>
<td>0.01(^\dagger)</td>
<td></td>
</tr>
<tr>
<td>Sample size</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Adjusted ( R^2 )</td>
<td>0.54</td>
<td>0.68</td>
</tr>
</tbody>
</table>

\(^8\) For a just or exactly identified structural equation, the method of indirect least squares (ILS) is used. For an overidentified equation, as in the present case, 2SLS is the favoured method, where a linear combination of the predetermined variables serves as an instrument, or proxy, for the endogenous regressor. A noteworthy feature of both ILS and 2SLS is that the estimates obtained are consistent, that is, as the sample size increases indefinitely, the estimates lose their bias and converge to their true population values.

\(^9\) The linear probability model is plagued by several problems, such as non-normality and heteroscedasticity of the error term, the possibility of the estimated dependent variable lying outside the 0–1 range and the generally lower values of \( R^2 \). But these problems are surmountable. Since the sample size is not small, the non-normality problem has been minimised. The heteroscedasticity problem has been solved by the use of a weighted least squares. Resort to restricted least squares or mathematical programming was not required as the values of the estimator of \( P \) did not lie outside the 0–1 range.
6.3. Interpretation of results

While the participation variable is highly significant, other variables are also significant. It was noticed that the project effectiveness of smaller projects is higher, although technical supervision of larger projects is at a higher level of governmental machinery. Similarly, age, that is years since the project was constructed or rehabilitated, is also significant. While literacy level in the project area has a positive effect, remoteness has a negative effect.

We find that the impact of participation is fairly strong and significant. To test the robustness of the model, we have tried to introduce a few variables and replace a few variables by others (like female literacy by overall literacy; dummy for the province in which the project is situated; absolute values instead of logs). We have tried out an “inappropriate” 2SLS model also, but the results remain robust. As explained earlier, a project, even in the best of conditions, is unlikely to achieve anywhere near 100% of the designed potential. However, if the project is irrigating half the designed area, with participation, the irrigated area can go up to 60% or more. The impact of participation may not be dramatic, but it is substantial and highly significant.

7. Beyond participation

Historically, the state has played a leading role in water development and regulation. Vital natural resources like water are to be regulated, managed and utilised for public welfare. Large scale development of water resources requires mobilisation of substantial financial and other resources and a long term perspective on financial and other returns on investment. Triggered by the food crisis of the 1960s, huge investments were made by developing country governments with and without external aid to create new irrigation schemes. While the Green Revolution had significantly reduced food shortages, by the mid-1970s it was becoming clear that the irrigation schemes were performing below expectations. Engineers were blamed for a “dam the river and damn the consequences” attitude. The response was “on-farm water management” or “command area development”. This was not a reform, just an extension of minor canals to field channels and training of farmers. During the 1990s, in response to lack of success in these schemes and to the dominant paradigm of “roll back the state”, farmers were invited to participate in water users association in a meaningful manner. While the success of participatory schemes is being debated, new ideas for modification of the schemes, substitution of the scheme by other schemes and for analysis of systems are coming up.

7.1. River basin organisations

A recent trend has been to promote river basin organisations as a tool for managing competition for water at the basin level. Effective integrated management of river basins has provided long-term benefits in developed countries. Attempts to impose developed country models of river basin organisations are unlikely to succeed when the objectives and institutional contexts are so different. It is extremely difficult to build organisations for managing river basins representing the interests of thousands of smallholders (Shah et al., 2005; Wester et al., 2005). The idea that a specific organisation is necessary for integrated management of a basin may be based on a false assumption that the physical reality of integrated river-basin systems ipso facto requires an organisation coinciding with its boundaries (Mollinga et al., 2007).
7.2. Private sector partnership

In most developing countries the agricultural holdings are held privately but the state provides support relating to inputs including seeds, fertilisers, extension activities and so on. In other development sectors, including health and drinking water and sanitation, disillusionment with state agencies has lead to private sector involvement through a market mechanism. In the surface irrigation sector, a trend towards privatisation has not come in. This restraint is remarkable because many other development sectors considered ripe for privatisation also have the potential to create exploitative monopolies as serious externalities.

Water pricing and tradable water rights can create economic incentives for improved water management. Measurement of water deliveries and collection of fees is difficult in the drinking water sector as they also are in irrigation. Although privatisation of drinking water elicits opposition from human rights groups, it is moving ahead faster than privatisation of surface irrigation water. Tradable water rights represent a higher form of efficiency because of inclusion of allocative efficiency in the system. This need not be a perverse form of privatisation, cutting the poor off from water use. On the contrary, there have been small scale experiments wherein the poor have been allocated water rights with transfer rights. However, water markets, like institutional arrangements, require a physical infrastructure that could allow water to be transferred from one user to another with minimal losses in transit and without affecting third parities. In absence of such physical and institutional infrastructure, there is no prospect of scaling up the system of transferable water rights.

Even in reform oriented developing countries, evolution of a water market mechanism that is contextually sensitive and politically feasible will take a long time. At the moment, participation and state-society synergy seems to be the available option for the old statist paradigm.

8. Conclusion

There has been a lot of debate in the literature about whether participation is a means or an end (Picciotto, 1992; Narayan, 1995). Promotion of citizen participation has been seen as empowerment for its own sake and also as a means to further the opportunities for democracy. This factor is relevant for a country like Cambodia, which is in the process of establishing a genuine multi-party democracy. While indirect benefits of participation are many, this paper confines itself to direct benefits of participation. Field observations revealed that participation fostered individual and community empowerment. It also promoted new water-management and organisational skills in the community. Finally, it strengthened local organisations, which then went on to undertake other development activities.

Improving local participation is seen as one of the most promising ways to make irrigation schemes perform better (Uphoff, 1992; Burns, 1993). The pioneering efforts in the Philippines inspired similar efforts in the rest of South-East Asia. Irrigation agencies fielded organisers to facilitate farmer involvement in operation and maintenance of irrigation systems. Many reports have detailed the experience of individual projects. However, besides Uphoff’s (1986) book there have been few attempts

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10 For a review of modern economic analysis as it relates to the conduct of water policy decisions, see Ward (2007).
to look comparatively at what has been learned about participation in irrigation. Our comparative analysis shows strong association between project performance and beneficiary participation. This paper provides development practitioners with strong statistical findings that participation causes higher project effectiveness.

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References


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