Modelling Soil Erosion, Sediment Transport and Closely Related Hydrological Processes (Proceedings of a symposium held at Vienna, July 1998). IAHS Publ. no. 249, 1998.

Evaluation of the impacts of projects to reduce human-induced soil losses in watersheds

CHARLES L. ABERNETHY
5 Havelock Road, Colombo, Sri Lanka

C. M. WIJAYARATNA
International Irrigation Management Institute, 127 Sunil Mawatha, Pelawatte, Battaramulla, Sri Lanka

Abstract Watershed management projects, especially in developing countries under pressures of rising populations, present peculiar challenges in design and evaluation, because they aim to produce specific physical outcomes through socio-economic actions. Efforts to reduce human-induced soil losses, without displacing the relevant communities, need time and persistence, because such efforts must involve persuasion, rather than direction, of the communities towards both different styles of socio-economic behaviour and new land-use practices. In tropical and subtropical environments, several encouraging successes in community-based projects of this kind have been reported over the last 10–15 years. Such projects address multiple goals: reducing soil loss, increasing dry-season flows, reducing floods as well as improving the economic value of land and livelihood of people. Therefore, such projects must be multi-dimensional and multidisciplinary, and these considerations have time and cost implications. In these circumstances, evaluation of project packages is necessary though difficult. Developing better insights into the benefit–cost effects of their various characteristic components would be valuable. Identifying and quantifying intermediate benefit targets are desirable, since the apparently slow rate of delivery of intended ultimate benefits may lead to "fatigue" and weakening of support from funding agencies; this, in turn, can lead to some displacement of objectives, or to substitution of more modest objectives. Persistence of funding support may, on the other hand, be enhanced by establishing programmes of continuous evaluation, internal to such projects. This paper discusses the methodologies of monitoring and evaluation programmes that focus primarily on measuring the physical results that are due to promoting socio-economic actions and adjustments of land-use behaviour within the community.

INTRODUCTION

The twentieth century has seen some great increases of soil erosion rates, especially in the developing countries (Abernethy, 1990). These rates are linked to, but appear often to be greater than, population increase rates. This excess rate of erosion increase can probably be explained by socio-economic factors.

Human-induced soil erosion typically proceeds through actions which degrade and ultimately remove protective vegetation, or which increase and concentrate surface water runoff. Programmes which aim to arrest and reverse this type of erosion must inhibit and reverse some of these causative actions. Sometimes this is attempted through policies of excluding people, or prohibiting certain sorts of activities, from vulnerable areas; but enforcement is difficult and such programmes often fail.

Greater success is achieved, sometimes, through programmes which try to induce voluntary changes of socio-economic behaviour and land-use practices at the "grassroots" level, without displacing people or disrupting their communities. Such programmes may involve interactions between rural people and teams of professionals from varied disciplines. These programmes aim to produce definite physical outcomes such as reduced runoff of water and soil, but they may use many non-physical means—such as education, market development, and legal structures of property rights—to get these physical outcomes.

In this paper we principally use experiences from the SCOR (Shared Control of Resources) project operating since 1993 in the Nilwala Ganga and Huruluwewa basins in Sri Lanka, and we draw also on earlier projects in the literature, such as at Sukhomajri in Haryana, India (Chopra *et al.*, 1988) and the Machakos district of Kenya (Tiffen *et al.*, 1994).

Such projects aim to cause changes of behaviour that will be sustainable and permanent. Because the rural populations whose behaviour is to change are usually poor, and averse to the economic risks inherent in adopting new activities, such projects cannot be expected to deliver results in a short time frame. Their time-scale may typically be a decade or two. In these circumstances, monitoring and evaluation are vital because of their role in sustaining the belief, motivation and support of all stakeholders in the project, by demonstrating its level of success. They are technically difficult because of the complex interactions between physical and non-physical processes.

CHARACTERISTICS OF WATERSHED MANAGEMENT PROJECTS

A watershed management project aims to establish new forms of organization, new processes of decision making, and probably new rule systems, as well as new techniques of land use. These new forms of organization will be of no value unless they are independently sustainable, long beyond the project's own life. Thus we can immediately deduce that the project must involve willing participation of existing populations as full partners from the earliest stages of project formulation and goal identification.

Community-based watershed management projects typically address multiple goals, to ensure their support among a wide range of stakeholders whose interests are not identical. These goals may commonly include: reducing soil losses; increasing dry-season streamflows; reducing flooding; improving the economic value of land; improving the livelihood of existing inhabitants.

These goals form a package, and are mutually dependent. If economic benefits are not felt, we cannot expect soil-conserving behaviour to be sustainable. Reduction of flooding is a benefit received by inhabitants of the lower parts of the watershed, due to changed behaviour on the upper parts. That change will not happen unless the upper inhabitants are also able to feel an economic improvement for themselves.

The strategy for achieving these goals usually relies heavily on the adoption of new land-use practices by the existing inhabitants. The essential menus of such practices are likely to include such features as introduction of tree planting on steep or vulnerable areas, new crop types which are perennial or provide enhanced coverage to the soil, restriction of grazing animals, small engineering works such as graded bunds, water-storage ponds, etc. Since these projects are usually conceived in response to actual, ongoing deterioration of the watershed conditions, they commonly introduce new practices and prevent older practices considered to have been causes of damage.

These menus, within which choices have to be made, add up to major changes in the inhabitants' activities. New rules about access to common resources have to be devised and accepted by the people. Cooperation among sets of neighbours has to develop, addressing aspects like the location and alignment of engineering works. The techniques of growing and marketing unfamiliar crops have to be learned.

The possible strategies for overcoming inevitable resistance caused by change can be classified broadly as: compulsion, incentives, demonstration, and persuasion. Most projects probably use elements of all these, but the success of such projects is likely to depend upon persuasion, supported by some practical demonstration of the benefits of proposed changes. It is important to evaluate (a) the health and robustness of these community institutions and processes, and (b) visible physical changes on the land and in the rivers.

A few specific examples of project components, from the SCOR project in Sri Lanka, may be helpful to clarify the above general points. Among the project's institutional strategies linked with physical goals are:

- helping villagers to formulate, implement, and monitor their own land and water resource use plans on a sub-watershed basis, with a combined focus on production and conservation of resources;
- developing consultative mechanisms, with government departments' and resource-users' participation, for the resolution of problems and conflicts arising in the change processes;
- assigning to individuals or groups usufructuary rights in designated sections of State forests, so as to develop a local economic interest in forest protection;
- promoting establishment of farmers' companies, able to handle such aspects as contracts and marketing for new, higher-value crops to replace reliance on low-return crops, including in certain cases, rice monocropping.

All of these processes take time. Rural people need a degree of evidence that the proposed change is really viable for their specific circumstances, and that it will (for example) survive the predictable adversity of unusually wet or dry seasons. Shaxson (1997) expressed this process of adoption of innovations in the following way:

> *In Year 1 nobody knows much about the project's offerings; it takes time for better institutions to develop, and only a few people are bold enough to try out the new ideas. In Year 2 everyone watches the results achieved by the bold ones, and, if the season is unfavourable, suspends their judgement for another one or more seasons. In Year 3, a few more may try for themselves, and, if successful, start sending information across farmer-to-farmer networks. It is only in about Years 4 and 5 that significant numbers of people begin to change, and results of project efforts are more widely seen.*

The early years of such projects may appear to show slow progress, but it should be seen as the necessary laying of a foundation, upon which all subsequent progress will be based.

A different aspect of the time-scale question may be illustrated by reference to

Fig. 1. A project is conceived in response to ongoing deterioration of the watershed such as soil loss, hydrological change towards more frequent flooding, and increased sediment content of the river system. It is reasonable to assume that, when a watershed management project begins, the damaging actions on the land surface are continuing, and matters in the river system are becoming worse.

So, in the initial years of such projects, we expect deterioration to continue. Stakeholders, such as the affected inhabitants or the project's sponsors, should not expect otherwise. As Fig. 1 suggests, we should expect that key indicators of physical deterioration will peak some years into the project's life, and only then will turn to the favourable direction. In general, it is not possible to establish clearly when this turnover arrives although it can be anticipated in 5–10 years. The processes have high year-to-year variability (discussed below) and field measurement of the physical outcomes is usually subject to substantial error. Therefore, monitoring should continue for some years beyond the turnover point, to estimate trends of improvement reliably.

PROJECT SUSTAINABILITY

The sustainability of a project is perhaps its most significant characteristic, from an evaluation perspective. Sustainability is notoriously difficult to assess, since it involves predicting the future, but to some extent surrogate indicators may be found,

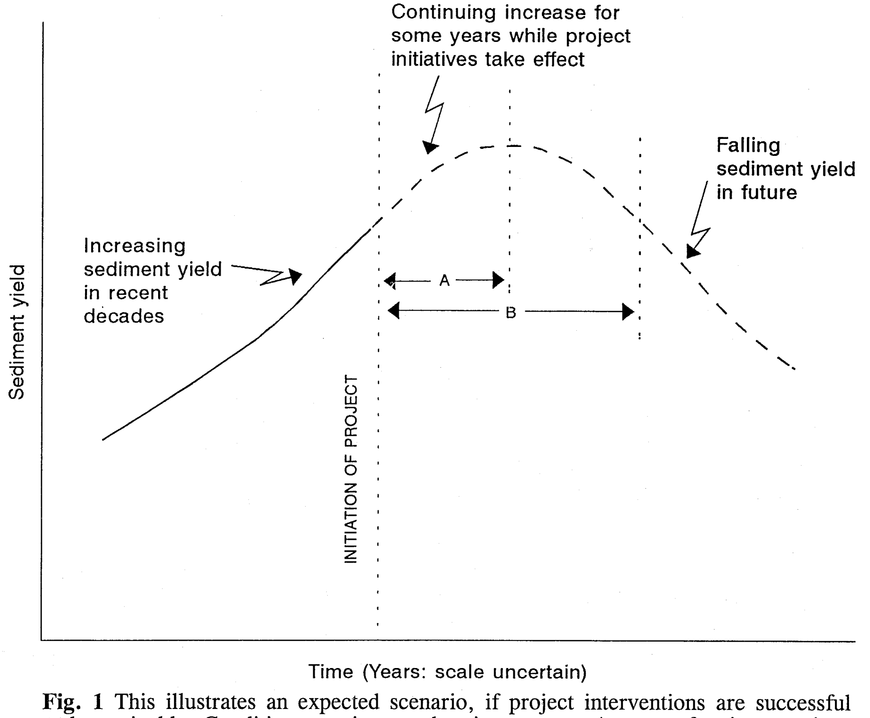

Fig. 1 This illustrates an expected scenario, if project interventions are successful and sustainable. Conditions continue to deteriorate up to A years after interventions begin, and do not return to the project's initiation level until B years have elapsed.

such as those representing institutional robustness and resilience.

A project which is able to deliver its benefits only as long as external interventions continue, and is likely to collapse without them, cannot be rated very highly. This is one reason why time should be taken to "grow" viable local institutions. The pace of adoption of external ideas can quite often be accelerated by incentives, but in that case (as Pretty, 1994, has noted of rural development projects more generally) there is a strong likelihood that, when incentives cease, newly introduced land-use practices will also cease.

Watershed management projects deliver their ultimate physical benefits over long time periods. The Kenyan case described by Tiffen *et al.* (1994) seems to indicate a period of around 20 years, or perhaps more, and other examples so far suggest that at least 10 years are likely to be needed before benefits are adequately established and consolidated. It may not be easy to sustain the motivation of all participants and sponsors throughout such time spans.

STRATEGIES OF EVALUATION

In this section we outline some general principles and strategies of monitoring and evaluation programmes that seem appropriate to projects of the type described above, where a mixture of physical and socio-economic interventions is used to generate results in both physical and socio-economic domains.

A primary purpose of evaluation is to see whether objectives are attained, so evaluation is not very meaningful unless goals and objectives are clear. But the goals of these projects are likely to be achieved in quite long time spans. Evaluation should not wait until that stage, because continuous evaluation is needed for various other reasons, such as comparing the degrees of success achieved by different kinds of intervention. Project sponsors also customarily require interim evaluations of project achievement every 3–5 years.

A plan containing explicit intermediate targets though necessary is not easily arranged, because it may conflict with another requirement, which is to maintain flexibility and a capacity to adjust project activities at the pace and in the directions that local inhabitants find acceptable. This inherent and unavoidable problem is often resolved by maintaining some continuous, structured process of project review through workshops and other fora of interactive dialogue.

These processes contain a risk that a continuous process of adjustment of intermediate targets may result in gradual substitution of more modest targets. In other words, the achievement of long-range overall goals may be jeopardized by accepting weaker, diluted intermediate targets. For that reason, short-range plan revisions should always be presented within a revision of the plan for attaining the overall goals.

A key decision about monitoring is whether to focus attention on good-quality measurement in small sub-areas, or to undertake wide-scale assessments which need large resources. Focal observations (such as measurements of the recovery of especially denuded sub-watersheds) are not usually sufficient, because their findings are not transferable to the watershed as a whole. Full basin-scale measurement of overall progress towards the long-range goals (for example, measurement of annual sediment transport out of the watershed) should be regarded as an essential element.

There is no space available to review all the choices available and proposals that have been made concerning indicators that could be monitored in such projects. However, some broad principles can be seen.

Measurement programmes can be very costly, so there is a need to identify indicators that have maximum information content in relation to their cost of measurement. These programmes also must help us distinguish trends, in processes that are likely to take many years; so repetitive measurements are necessary, in which extraneous sources of variation (such as those due to changes in the details of measurement methods) are suppressed as far as possible.

We have noted earlier how the practical difficulties of measurement and the intrinsic variability of the natural processes imply that improvements of sediment and water runoff may not be clearly proven until many years have passed. Therefore, we need to seek other kinds of intermediate and surrogate indicators which, even if they cannot tell the whole story, are likely to help us to know at a reasonably early stage whether the project is on the correct track. An example of this approach, in the SCOR project, is the development of a set of indicators of institutional strength, which can be used to measure progress in this key area. These measure: organizational performance; organizational financial viability; membership satisfaction; organizational sustainability; collaboration and integration; constitutional arrangements; organizational involvement in interventions.

These can be thought of as "early-warning" indicators. Strong values of such indicators do not guarantee that the desired physical results will be achieved; but weak values very probably mean that desired physical results will *not* be achieved, and that project methods are in some way defective. Changes in attitudes of participants such as watershed inhabitants/resource users, Government agencies/officials, policy makers towards interventions (focused on integrated production and conservation) as well as the changes in behaviour of those actors, such as the adoption of practices including engineering measures, tree planting, relevant market developments, policy changes, etc., could be taken as the intermediate targets and indicators at the next level.

Measurement programmes should be designed on an interdisciplinary basis. Since one of the primary needs in evaluation is to help us understand which are the most successful components in a programme package, and since we expect non-physical interventions to produce physical results, the economist or sociologist or institutional specialist must automatically be concerned with the hydrological and soil-loss measurement programmes.

Maximum use should be made of the resources of local inhabitants in conducting monitoring. They should be fully aware of the monitoring programme, and its results should be transparent and available to them. Many kinds of monitoring require trained technical skills; but others do not, and the use of (for example) school children and young people can greatly expand the scope of data collected.

The difficulty due to variability of the physical processes is illustrated by Fig. 2. This diagram shows the annual ratio of runoff to rainfall, over 30 years, at the main recording station on the Nilwala Ganga, one of the watersheds where the SCOR project now operates. A best-fit straight line through these data points indicates that the runoff ratio was increasing at about an average rate of 1.5% through these years, one of the highest rates among the major basins of Sri Lanka. No climate or rainfall trend seems to have been responsible: indeed, when plotted similarly, the rainfall shows a slight, insignificant decline. So it is reasonable to deduce that in this diagram we are looking at an effect that is due to land-use changes, and that one likely consequence may be exacerbated flooding, which in fact has taken place.

Although these trends may become apparent over a period of 30 or 40 years, it is not at all practical to identify them over shorter time scales. Even over 30 years the confidence level of the estimated trend is not very high. Within this record we can readily find time intervals of 5 or even 10 years within which (if our data were limited to these periods only) we would interpret the information quite differently.

An example of this sort demonstrates how difficult it is for an evaluator to determine whether a watershed management project is truly reversing such a trend, in the long term. Rapid proof of achievement of the larger goals is not obtainable, so it becomes necessary, in the short term, to evaluate in terms of surrogate indicators.

An important need in watershed management projects is to find out which of the many possible project strategies and component activities are the most successful, or seem to contribute most rapidly and effectively towards achieving the overall project goals. If this can be answered, it seems we should be able to design cheaper projects with more rapid impacts. Analysis of these questions is however very difficult because of the interdependent nature of the components, and because of the interactions of physical and non-physical processes. It is tempting to say that the components are so interlocked that a separate analysis of their contributions is not relevant, but this attitude is also intuitively difficult to accept. It does not seem likely that all interventions have equal merit and equal impact. Even if we include a large array of diverse project components, there are choices to be made about how much will be done in each component, and how these actions will be distributed in physically different parts of the watershed.

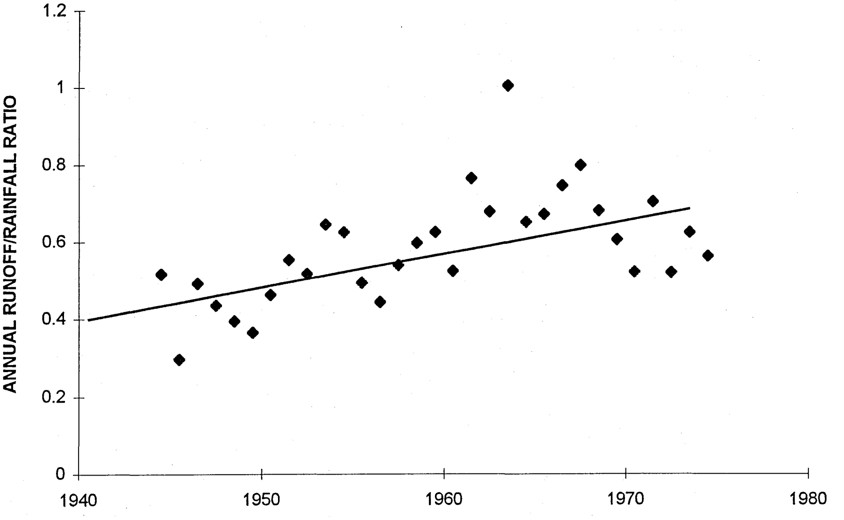

Fig. 2 The ratio of annual run off volume to annual rainfall volume, Nilwala Ganga at Bopagoda, Sri Lanka. The trend line indicates a mean rate of increase of 1.50% per year. The relative standard error of estimate, about this trend line, is 20.1%.

Modelling will probably play a large role in the future evolution of projects of this kind, and it is reasonable to expect that it will partially resolve the difficulties discussed in the preceding two sections. It will have to be interdisciplinary modelling, and it will have to use quantitative linkages between the physical and socio-economic domains which, in general, are not yet available. At this stage, there is not yet much consensus even about the answers to relatively simple quantitative questions of this type, such as: "To what extent can irrigation water charges reduce the abstraction of irrigation water from rivers?" So, in relation to the much more complex questions that arise in watershed management, we cannot yet provide the sort of quantitative links needed for constructing conventional models.

However, this seems to be the most promising line of advance in generating a better understanding of the principles of design of watershed management projects.

CONCLUSIONS

Programmes aimed at arresting human-induced environment degradation including soil losses, without displacing communities, take time to show impact and need persistence because such efforts must involve persuasion of people and not direction or control, to effect changes in land use. Environmental impact is a long-term phenomenon; low-income people cannot readily incur risk; adoption of new practices is a gradual process; evolution of viable local institutions takes time; and cooperation/interactions among inhabitants should develop to address aspects like engineering works (such as graded bunds), restrictions on grazing animals, tree planting in vulnerable areas, new rules about access to common resources, achieving economies of scale, etc. Action-research too takes time to test strategies/techniques before making recommendations, adjusting policies, and convincing policy makers, which all increase the required time periods. Moreover, projects involving interventions usually are launched in watersheds that undergo deterioration at a certain rate. This process will continue for some time and it may take 5–10 years to reach the turnover point.

In such programmes, **physical outcomes** like reduced runoff and soil loss are achieved through **non-physical inputs** such as education, market development (for profit-oriented conservation), property rights and local organizations. Helping watershed users to formulate, implement, and monitor changes is a learning process. In addition to this "time" factor, year-to-year fluctuations in impact-related variables make field measurements difficult, and longer-term impacts on sediment and water runoff may not be clearly proven in the short run.

Therefore, interim evaluations (of the order of 3–5 years) can be conducted to assess intermediate targets using surrogate indicators of socio-economic and physical interventions. For example, institutional strength may be measured using: organizational performance, organizational financial viability, membership satisfaction, organizational sustainability, collaboration and integration, constitutional arrangements and involvement of organizations in interventions.

Changes in attitudes of participants such as watershed inhabitants/resource users, government agencies/officials, policy makers towards interventions (focused on integrated production and conservation) as well as the changes in behaviour of those actors—such as the adoption of practices, including engineering measures, tree planting, relevant market development, policy changes, etc.—could be taken as the intermediate targets and indicators at the next level.

Non-physical interventions are expected to produce physical outputs, and the economists or sociologists or institutional specialists should be concerned with the hydrological and soil-loss measurements. A participatory and multidisciplinary monitoring and evaluation strategy could produce better results in such programmes.

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