Sustainable water development for developing countries

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The effective planning, design and management of water resources systems for sustainable development are severely hampered in developing countries by five major factors. First, use is frequently made of an incomplete framework for analysis, ignoring positive impacts of development. Second, there is a lack of appropriate methodology for applying environmental impact assessments in these countries. Third, there is a lack of adequate knowledge about the effects of water development projects. Fourth, there are institutional restraints, particularly the division of responsibilities among various ministries. Fifth, monitoring and evaluation are seldom integrated into project management. Each of these interrelated problems is discussed in turn.

There is a voluminous literature on at least some aspects of sustainable water development. In recent years it has generally been assumed, at least implicitly, that adequate knowledge is available on how to plan, design and manage water resources systems to reduce environmental disruption to a minimum, and any residual disruption could be considered acceptable to the society concerned. The real problem, it has seemed, is not a lack of knowledge but the appropriate application of the knowledge available to solve the problems. This 'application gap' has often been considered to be the real problem, especially in most developing countries.

However, a comprehensive and critical analysis of existing literature on environmental aspects of water development indicates that there are many problems which limit the potential application of available knowledge by engineers and decision-makers in developing countries. On the basis of this analysis, the following five major problems can be identified:

(i) an incomplete framework for analysis;
(ii) a lack of appropriate methodology;
(iii) inadequacy of knowledge;
(iv) institutional constraints; and
(v) the absence of monitoring and evaluation as a part of the management process.

We will consider each problem in turn. It should be noted, however, that they are not discrete: they are often closely interrelated.

(i) Incomplete framework for analysis

The framework currently used for analysing and considering various environmental issues associated with water development projects is overwhelmingly biased towards reviewing negative impacts only. Realistically, any reasonable water development project will have discernible impacts on rural development, environment and health, though the magnitude and extent of these impacts will vary from one project to another. Indeed, the very fact that any given project has been approved for implementation clearly indicates that decision-makers expect it to have certain impacts on society and the environment; otherwise there is no reason to waste scarce resources.

There are two issues worth noting with respect to the impacts of large water development projects. Firstly, even though it is axiomatic that any such large project will have certain impacts, the word

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'impact' in this connection, at least in recent years, has developed primarily negative connotations. While any large development project, irrespective of its nature, will have both positive and negative impacts, at present analyses of environmental and social impacts generally consider only adverse impacts and their potential amelioration.

To a certain extent the emphasis on the negative factors of projects and programmes is not difficult to explain. In the 1960s analyses of water development projects considered primarily technical and economic factors; environmental and social issues were generally ignored. Concerned with the adverse impacts of many development projects on society and the environment, a movement gradually developed to protect and preserve the environment. Environmental protection became an important item on the political agenda in the late 1960s, at least in many developed countries, through the activities of environmental pressure groups and non-governmental organizations.

This attitude to and perception of environmental protection was reflected in the United Nations Conference on the Human Environment held in Stockholm in 1972. An analysis of the Stockholm Action Plan that was finally approved by all the member countries of the United Nations would clearly indicate its negative approach to environmental management: stop all pollution stemming from any development activity, stop exhausting non-renewable resources and stop using renewable resources faster than their generation (Biswas and Biswas, 1982). The emphasis thus was primarily on adverse impacts of development.

Not surprisingly, environmental impact analysis, which was made mandatory in many developed countries in the last 1960s and early 1970s, was mainly concerned with the identification and amelioration of negative impacts; positive impacts were generally not considered. Because of this incorrect beginning, the term 'impact' has continued to have negative connotations.

So far as large-scale water development projects are concerned, another event in this period worth noting is the publication of a series of articles by Claire Sterling in the popular media on the adverse social and environmental impacts of the newly built Aswan Dam in Egypt. She concentrated only on serious negative impacts of the Aswan Dam, such as the loss of the Mediterranean fishery, the increase in schistosomiasis, rising salinity, reduction in the fertility of the Nile valley through the absence of silt deposition, and coastal erosion of the Nile delta. These articles, published at the peak of the environmental movement and in a 'small is beautiful' era, made the Aswan Dam a cause célèbre. In retrospect, they both helped and hindered later water development projects in terms of environmental issues.

They helped in the sense that the social and environmental impacts of water development, which were generally neglected at that time, became issues receiving due consideration. It was thus made clear to the engineering profession, which dominates the water development field, that there are other important dimensions in addition to the techno-economic ones in which society is primarily interested. Accordingly, increasing numbers of environmental and social impact analyses of water development projects have been carried out during the past decade. However, the emphasis has continued to be on the identification of only the negative impacts of water development and ways to ameliorate them.

Numerous examples can be provided of this all-pervasive bias. Only two will be cited here, one generic and the other case-specific.

On a conceptual basis, every time the health implications of irrigation projects are reviewed, the main consideration has been the presence of vector-borne diseases such as schistosomiasis and malaria. Irrespective of whether the evidence for such an increase in the prevalence of water-borne diseases due to water projects is reliable or not – an issue that will be discussed later – such an approach is not only highly biased but also somewhat simplistic and erroneous.

Viewed in any fashion, irrigation is an integral part of rural development. As a project develops, agricultural production increases as well. With better per capita food availability and more diversified crop production, food and nutrition levels increase. The situation is further improved by increased livestock holdings and the development of inland fisheries in reservoirs. An increase in the availability of animal protein is an important factor to consider in many irrigated agriculture projects, but has unfortunately been mostly neglected. For example, mid-term evaluation of Bhima Command Area Development Project in Maharastra, India, clearly indicates the impact of increased livestock holdings, even amongst landless labourers, on the people's nutritional standards (Biswas, 1987).

In addition, the health of rural populations is further improved as a result of advances in education, health facilities, the role of women and the overall quality of life. This is shown diagrammatically in Figure 1. At present, instead of considering the overall health situation in a project area, only the negative impacts are being accentuated.

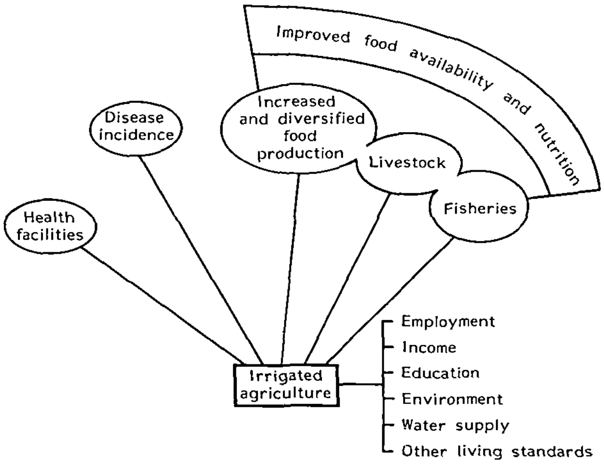

Figure 1. Interrelationships between irrigated agriculture and health.

The case-specific example is the overall impact of Aswan High Dam on fish production in Egypt. Since Claire Sterling's articles, much has been written on the decline of the fish catch in the Eastern Mediterranean due to the dam. On the basis of data available in FAO databanks, the author recently analysed fish production in Egypt in Lake Nasser, the Mediterranean and other areas for the period 1963–82. Figure 2 shows that fish production from the Mediterranean started to decline from about 1963. Production reached a minimum in 1975, but since then catches have been steadily rising. If the 'new' fish production system in Lake Nasser is considered, total catches have always been significantly higher than at any time in the Mediterranean. Fish production started to decline in Lake Nasser around the time of the closing of the dam, but it has now not only recovered but is higher than it was initially. If the combined fish production in the

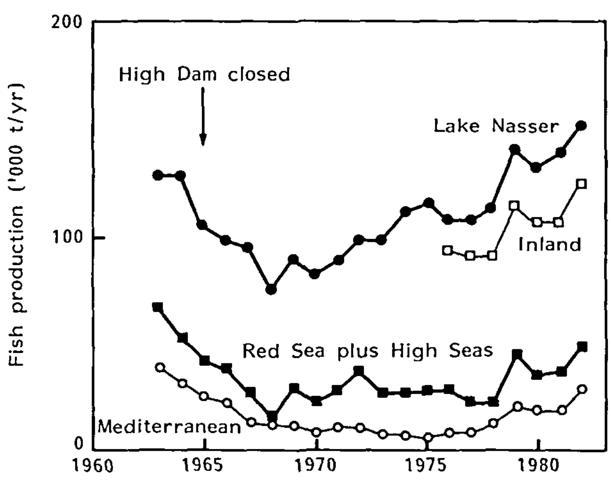

Figure 2. The contribution of Lake Nasser to fish production in Egypt, 1963–82.

Mediterranean and Lake Nasser is considered, there is no question that it has always been significantly higher than production from the Mediterranean alone before the dam was built. Accordingly, the overall impact of the Aswan Dam on fish production in Egypt is overwhelmingly positive, and not negative as most environmental literature indicates. The beneficiaries, however, are not the same. There is no question that the Mediterranean fishermen, who did not wish to be relocated to the Lake Nasser area, have suffered serious economic hardships.

What is thus needed is a balanced framework for analysis, which will identify both positive and negative impacts. The next step should be to decide how to maximize the positive impacts and minimize the negative. A framework that considers only negative impacts and ignores the positive is both incomplete and counterproductive.

(ii) Lack of appropriate methodology

A review of the processes currently used by developing countries to incorporate environmental issues in water management indicates that the methodologies available at present do not appear to satisfy the special requirements of developing countries. While environmental impact assessment (EIA) was made mandatory in the United States in 1969 through the National Environmental Protection Act, its acceptance so far in developing countries has been somewhat slow. The reason for this slow acceptance is not because of a concern as to whether the methodology is valid and applicable for water development projects and programmes but because of the lack of an operational methodology that can be successfully applied in developing countries with limited expertise, resources and time. The EIA methodologies that are being used in industrialized countries are not directly transferable to developing countries for various socioeconomic and institutional reasons. Even in developing countries where multilateral and bilateral aid agencies have carried out fairly comprehensive environmental impact analyses of water development projects, primarily with foreign experts and consultants, their overall real impact in developing countries has generally been minor. This is because such EIAs were carried out primarily to satisfy the internal requirements of the bilateral donor countries and the multilateral funding agencies, and generally not at the behest of the developing countries in which the projects were located. Not surprisingly, the involvement and interest of developing countries in such primarily external analyses have been minimal and somewhat superficial.

It is clear that complex, lengthy, expensive and time-consuming EIAs, as practised in developed countries, are not the right tool to assess the impacts of water development projects in developing countries. Under certain conditions, complex EIAs may even prove to be detrimental, and may hinder rather than enhance the overall process of water development. What is urgently necessary is to develop an operationally sound EIA methodology that is flexible and at the same time can be carried out within the constraints of limited finance, time and expertise available in developing countries.

Even though the United Nations Environment Programme (UNEP) has put much effort into trying to develop operational EIA methodologies for developing countries, it has to be admitted the process has been, for the most part, a failure. The guidelines prepared for various subjects are elementary, and are of no use to any operational agency. If, as argued by UNEP's regional office in Bangkok, EIA is to be considered only as a 'pre-project' activity, then project impacts, even though analysed and identified properly, are not likely to change radically. Without any follow-up monitoring and implementation activities, the usefulness of EIA is reduced significantly. It becomes primarily a paper exercise to satisfy legal and institutional requirements and not a tool for impact management.

It is now clear that nearly all of what has been developed at UNEP in the area of EIA has to be discarded. What is necessary is to develop some guidelines which can actually be used by professionals for water management.

(iii) Lack of adequate knowledge

There are many areas where adequate technical knowledge may not exist for getting reliable answers. Equally there are areas where 'conventional' knowledge can at best be dubious and at worst totally erroneous.

There are also many areas where we are not even asking the right questions. For example, the two most widespread and important vector-borne diseases are probably malaria and schistosomiasis, but we do not know to what extent a water development project *per se* may increase their incidence and the problem is further complicated by the case-specificness of the answers.

An exhaustive study by the Indian Malaria Research Centre has indicated that the resurgence of malaria occurred independently of the green revolution. There is, however, no question that irrigation, agricultural practices, rice cultivation and migration of agricultural labour have an important bearing on the mosquito vector fauna and malaria transmission (Sharma, 1987). The linkages are not clear, and there is no evidence to indicate a one-to-one relationship between irrigation development and additional incidences of malaria.

Figure 3 shows the district-by-district average annual parasite rate (API) between 1982 and 1984 on a rice acreage map of India. The API registers the number of malaria cases per thousand population in one year. It is found that for large parts of the country, with high acreages under paddy, malarial rates are negligible (API <0.5) or extremely low (API <2). There are some rice-growing areas where the incidence of malaria is moderate (API 2 to <10) or high (API >10). There does not appear to be any specific relationship between the area under rice cultivation and API: other parameters appear to govern disease transmission.

There are other complex issues that need to be considered for malaria. A study of two villages in the Kano plains of Kenya, one a newly established village within the 800-hectare Ahero rice irrigation scheme and another older village nearby in a non-irrigated area with traditional mixed agriculture, showed remarkable differences in terms of different mosquito species. In the new village 65% of mosquito bites were from the *Anopheles Gambiae* complex (the principal vectors of malaria in tropical Africa), 28% were of *Mansonia* species (vectors of lymphatic filariasis and Rift Valley fever) and 5% were of the *Culex quinquefasciatus* variety (another vector of lymphatic filariasis). In contrast, 99% of the mosquitoes in the older village belonged to *Mansonia* species and less than 1% were *Anopheles Gambiae*. Thus irrigation can change the transmission patterns of mosquito-borne diseases. This is an especially important consideration for tropical Africa, where most of the global total of more than one million deaths due to malaria now occur (Biswas, 1986).

There is also the issue of stratification as well. Evaluation of the Bhima command area development indicates that malaria appears to be attacking women more than men (Biswas, 1987). How widespread this stratification is, in India or elsewhere, is unknown since this type of question is not being asked at present, let alone answered.

If schistosomiasis is considered, there is no doubt that the presence of an irrigation system in a developing country, with extended shorelines of reservoirs and banks of canals, contributes to a better habitat for snails than existed before construction. This will naturally have a tendency to increase the incidence of schistosomiasis. While no sane person will argue with this simple and acceptable fact, the question as to what extent irrigation practices *per se* alone contribute to the increase in the incidence of schistosomiasis is difficult, if not impossible, to answer given the present state of knowledge.

A perusal of the available literature will indicate a plethora of statements and so-called 'facts and figures' on the increase in schistosomiasis and other vector-borne diseases due to the construction of irrigation systems. Such general statements had an

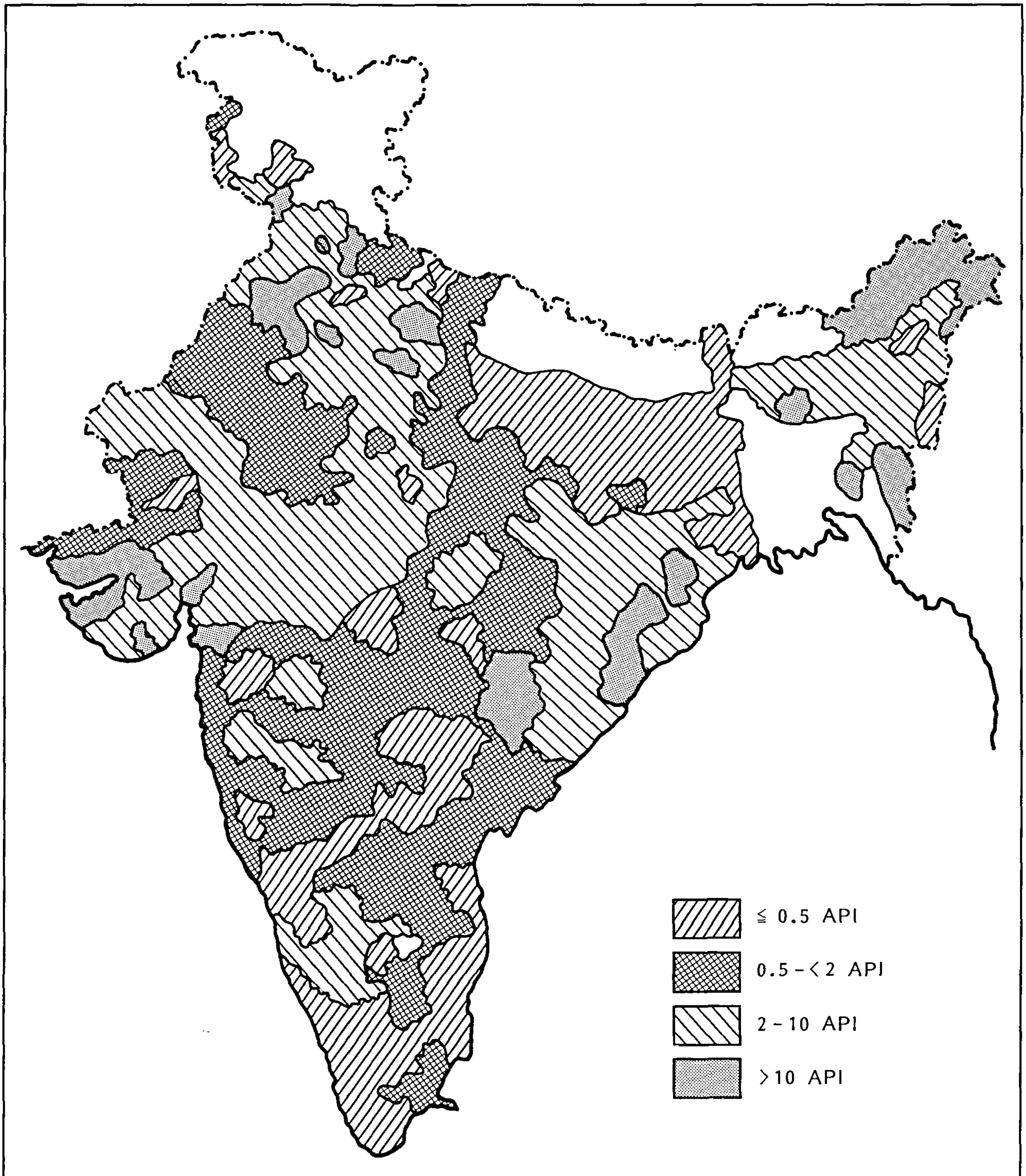

Figure 3. The relationship between area under rice cultivation and average API, 1982–84.

important role to play in the late 1960s and the 1970s in sensitizing engineers, decision-makers and the general public to the importance of vector-borne diseases, but very little further progress has been made in the 1980s towards giving water planners and administrators the specific information they need to improve planning and management processes. On the whole, the right questions are not even being asked; the same sorts of statement are being repeated *ad nauseam*, sometimes in different forms, and they are of limited use in the planning and operation of water resource systems. Since this is a serious issue, it will be discussed further in some detail.

One of the major problems with the incidence of vector-borne diseases due to irrigation projects stems from the lack of an adequate number of scientifically rigorous studies. The subject is replete with poor and conflicting information, the repetition of data that have seldom been critically examined, and the elaboration of personal biases. To a certain extent international organizations have contributed, albeit not deliberately, to this sad situation. For example, the World Health Organization estimate that globally some 200 million people are infected with schistosomiasis has remained remarkably constant since at least 1969. UNEP has incorrectly said in the past that schistosomiasis has been completely eradicated in China. Recent publications from the Food and Agriculture Organization (FAO) have erroneously stated that water development significantly increases onchocerciasis, whereas all the available evidence indicates the opposite. In 1987 the FAO once again repeated examples of increases in schistosomiasis resulting from water development projects based on poor and somewhat dubious data first published in 1978. A major problem in this area is the uncritical acceptance and repetition of published information, irrespective of its quality. As these types of dubious data have been published time and time again, they have gradually gained 'respectability'.

The second problem is the absence of data on pre-project environment and health-related conditions. Even now, when some baseline surveys are being carried out on pre-project conditions, environmental and health issues receive virtually no attention. Without knowledge of pre-project conditions it is not possible to say with any degree of certainty how vector-borne diseases have increased or decreased over time in any project area.

The third problem arises from the fact that objective and comprehensive evaluation of irrigation projects, including the incidence of vector-borne diseases, is never carried out at regular intervals. Accordingly, very little information exists on the basis of which realistic conclusions can be drawn. There are a few studies available on the incidence of vector-borne diseases in project areas, but they are seldom scientific or rigorous. Control samples are seldom taken. Equally little account is taken of the health of people who migrate into the project area due to the expanding economic opportunities, even though some of them may already have been infected with vector-borne diseases.

Finally, the present emphasis on vector-borne diseases due to irrigation projects is very narrowly based. It is assumed that the impact is always negative. This assumption is difficult to justify, since the health of the people in any project area depends on a multitude of factors, among which are employment and income generation, food availability and nutritional standards, education, the health facilities available, the impact on women and the environment and changes in the overall quality of life. Since all these factors change with the introduction of an irrigation system, the simplistic approach which is general at present is not adequate. A more realistic framework needs to be developed urgently for the analysis of health issues.

In addition to these types of complex problems, there are three important issues that should be noted in any discussion of the implications of water development on the environment. First, the impacts of water development on the health of the environment are many. Some of these impacts are direct and are comparatively easy to identify and predict in advance. Others may be indirect and project-specific and thus may often prove to be difficult to foresee and even more difficult to quantify. Most water resources projects produce a mixture of these two types of impacts. As would be expected, it is generally less difficult to predict and control primary impacts than secondary or tertiary impacts. Thus, in conducting an impact analysis of any large to medium-sized irrigation project a substantial number of specific and interrelated factors have to be analysed, both concurrently and sequentially, in a coordinated manner within an overall framework, by a variety of professionals, based often on incomplete or unreliable data. Considering the methodological limitations that are inherent in such impact analyses, it is a difficult task under the best of circumstances.

Second, the environmental impacts of projects, both direct and indirect, are never confined within the project boundary. Many of the impacts occur far from the project area. Accordingly, it is not possible to define a precise geographical boundary which could be said to contain all the impacts.

Third, time is another complicating factor. Certain impacts can be immediate, and thus can be identified during the implementation phase or soon thereafter. Other impacts, however, are slow to develop, and thus may not be visible in the early stages. For example, some unanticipated changes in the ecosystem and the environment could take more than a decade of operation of a project before they could even be identified. It is often not possible to make any definitive forecast of the timing of many impacts with any degree of reliability. A typical case is salinity development in irrigated areas, which could take 15 to 25 years in certain projects, but in others the problem may appear within two to three years, depending on physical conditions, drainage facilities and operation and maintenance procedures. The time dimension also makes intercomparison of the impacts of different water development projects a difficult process.

(iv) Institutional constraints

The sectoral approach to water development is a major institutional constraint in all developed and developing countries, and has an important bearing on the sustainability of projects. Large to medium-scale water development projects not only increase agricultural production and change the environment but also have other substantial impacts, for example on employment generation, education, health facilities, communication, energy availability in terms of fuelwood and electricity, domestic water supply, and women. These impacts are transmitted through a series of interconnected pathways, both direct and indirect, and are not always easy to identify or predict. They may also vary substantially in terms of both their nature and their magnitude from one project to another. Unfortunately, a holistic approach to land and water management that considers all these issues is rare indeed, though a few attempts are now being made.

There are many reasons for this sad state of affairs, but one of the most important is the division of responsibilities between the various ministries in a country. Typically, the Ministry of Irrigation or Water Development is responsible for irrigation development, the Ministry of Agriculture for agriculture-related issues, the Ministry of Health for health promotion, the Ministry of the Environment for environmental matters, the Ministry of Education for schools, the Ministry of Rural Development for rural issues, and so on. Because of long-standing rivalries, coordination and cooperation between the various ministries leave much to be desired. And yet, in any large-scale water development project, all these issues must be integrated within the project area. While it is easy to point out this necessity, how this integration can be effected in reality in the field is a very complex and daunting problem. There have not been many success stories.

Even if one single field such as health is considered, there are many issues that should be reviewed but are generally not. Because of the recent emphasis on negative impacts, the health issues typically considered at present are the adverse ones such as increases in vector-borne diseases. Indeed, it is very rare to find projects where health considerations include improvements arising from more reliable and varied food supplies for people in the project area resulting from increased agricultural production, fish catches in artificial lakes and larger livestock holdings. Improvements in health due to secondary factors such as better transport and communications in the project area, new education and health facilities and the improved status of women are rarely, if ever, considered. And yet, in terms of the overall health of the people in the project area, these factors are more important than increases in vector-borne diseases alone. Even for a single factor such as vector-borne diseases, much of our information is anecdotal and thus inadequate for decision-making purposes.

(v) Monitoring and evaluation

If water development projects are to be sustainable, monitoring and evaluation have to be integral to the management process.

While some literature exists on the integrated monitoring and evaluation of water development projects, unfortunately more reports are available on the pseudo-evaluations or superficial evaluations that have been carried out in the recent past at both national and donor agency – bilateral and multilateral – levels; these are primarily concerned with the protection and enhancement of the reputation of the organizations concerned and the individuals associated with the projects. These types of evaluation cannot have a beneficial impact on the management process since they either do not identify major problems and bottlenecks, or, if they do, they play down their importance. In the long run these pseudo- and superficial evaluations not only reduce the effectiveness of water projects but also damage the perceived usefulness of the monitoring and evaluation process.

A comprehensive and objective analysis of irrigation projects supported by the United States Agency for International Development in various developing countries indicated that the monitoring and evaluation practices of both donor and recipient countries have 'come in for criticism from each group about its own organization and about the activities of its counterpart', and that 'too little gets done by either group'.

In view of the unprecedented controversies which have raged in recent years over the efficiency and even the desirability of irrigation projects, it is essential that objective evaluations be considered mandatory, both to get reliable status reports on the operation of and benefits from the schemes and to use the results to improve the management processes further in order that beneficial impacts are maximized.

There are many reasons for carrying out systematic monitoring and evaluation of water projects, the principal ones being the following:

- to determine the extent to which the goals of a project have been achieved by assessing actual impacts and then comparing them with expected impacts;
- to obtain information as to why a project may not have had anticipated impacts by identifying the magnitude, extent and location of the problems in order that corrective actions may be taken to maximize beneficial project impacts;
- to increase our understanding of the management of the various interlinked processes and issues involved and to translate this understanding into action in terms of immediate, observable, concrete decisions;
- to learn how to improve the planning, implementation and management of similar projects elsewhere;
- to verify the relevant project assumptions;
- to plan later phases of the project more effectively based on the evaluation of first phase performances;
- to provide facts and success stories for the ministry or department concerned to help them defend existing policies and programmes and assist in getting additional financial support;
- to provide national policy-makers with objective information in order that they can decide to what extent such activities can be continued in other parts of the country.

It should be noted that these reasons are not mutually exclusive since they are often interrelated. Equally it is not enough to identify and analyse the technical, social and economic aspects of the various issues and problems; it is essential to know about institutional arrangements and vital that constraints be reviewed as well, since it is the institutions concerned which in the final analysis have to develop ameliorative policies and implement them.

There are some fundamental requirements for designing any monitoring and evaluation system for a water development project. Among the primary requirements are the following:

- timeliness;
- cost-effectiveness;
- maximum coverage;
- minimum sampling error;
- minimum measurement error;
- absence of bias; and
- identification of users of information.

These will be briefly discussed in turn.

Timeliness

Most management decisions have a time dimension, even though the timeliness of some decisions may be more important than others. For example, if farmers at the tail ends of watercourses are not receiving their share of irrigation water regularly, or if fertilizers and pesticides are not available at the right time of the cropping season, immediate remedial measures must be taken. If not, the result would be poor harvests, and the income lost by the farmers would never be recovered. Thus it is essential that information collected reach the appropriate decision-makers so that rational decisions can be made in time. Accordingly, monitored information should be channelled in a timely fashion so that it can be converted into decision and action.

It should be noted that management success depends not only on the timeliness of the information but also on the quality, extent and form in which it is channelled into the decision-making process. A problem often arises because even if the required information has been collected, it cannot be channelled into the decision-making process since it is either in a diffused or inappropriate form or cannot be obtained and analysed within the relevant timeframe.

The danger is that if monitoring and evaluation information from the project does not reach the managers on time, it is likely that one or more of the following consequences, which are not mutually exclusive, may occur:

- wrong actions may be taken;
- decisions taken may not be optimal in the long term;
- no action may be taken when it is desirable;
- decisions taken may result in irreversible damage; or

- decisions taken may unnecessarily increase the cost and time required for the resolution of a specific problem.

It is therefore essential that a monitoring and evaluation system for a water project be set up in such a fashion that relevant information in usable form reaches the people who need it on a continuing and timely basis.

Cost-effectiveness

Information collection, processing, analysis and scaling require financial resources, expertise, manpower and equipment. Since the ready availability of all these resources in developing countries is limited, any monitoring and evaluation system designed for irrigated agriculture should be cost-effective. This essentially means a sensible trade-off between the depth and context of the information to be collected as well as between its amount, relevance and accuracy. As a general rule, the overall value in use of information collected should exceed the cost of obtaining it.

From a management viewpoint the value of information generally increases with the increasing extent and the accuracy of information available, but it generally approaches a plateau at a certain stage, beyond which it increases only marginally. In contrast, the cost of obtaining information continues to increase with more coverage and higher accuracy. This is shown diagrammatically in Figure 4. The shaded area in the figure is the cost-effective zone, beyond which the cost of obtaining information will rapidly exceed its intrinsic value. Exactly where within a shaded area a decision should be made depends on a variety of factors such as the type of project, management experience and potential impact, but such trade-off considerations are often made on the basis of value judgements.

There is often a tendency to collect more data than necessary. For any monitoring and evaluation

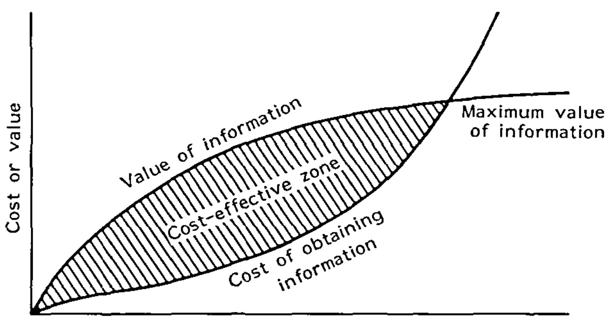

Figure 4. Cost-effectiveness of monitoring and evaluation information.

process to be efficient and cost-effective, it is essential to have a clear idea about who is going to use the data, what types of data are necessary, how the information will be used, and when and in what form it should be made available. Without such a clear focus, unnecessary and non-essential data may be collected, which is an expensive luxury all countries can do without.

Maximum coverage

In the monitoring and evaluation of water development projects, especially large ones, a major difficulty arises from the fact that there may be a wide area in which it is necessary to get an objective view of the operation of the system and its impacts on agricultural production and the overall quality of life of the people. Thus, maximum coverage taken literally may prove to be an expensive, complex and time-consuming process.

As a general rule, sociologists and anthropologists prefer to have as much breadth of coverage as possible. However, given the high resource costs of manpower, time, transportation and other related factors, as well as high opportunity costs, it may often be necessary to limit coverage to selected variables, and then to use the balance of available resources to obtain more detailed information on specific aspects and/or areas that are critical from a management viewpoint. Accordingly, maximum coverage in the present context should be interpreted to mean collection of the maximum data necessary for management purposes, subject to the availability of resources (funds, manpower, expertise, equipment and time).

Minimum sampling error

Since it is neither necessary nor desirable to monitor all possible developments in a project area, sample surveys are essential. Irrigated agriculture projects cover numerous issues and diverse disciplines, and accordingly there is no straightforward or uniform solution as to what may constitute a suitable sample size. For example, for analyses of rainfall, one rain gauge per square kilometre will be considered to be a very dense network, and thus totally unnecessary unless very exceptional circumstances warrant it. In contrast, the identical sample size would be totally unacceptable to sociologists. In the final analysis, the determination of sample size will depend upon the type of information to be collected and the use that will be made of it.

Minimum measurement error

The level of accuracy and reliability of any data that will be collected is an important consideration for any monitoring and evaluation process. Generally engineers and physical scientists are more concerned with the accuracy of measurements and data collected than are sociologists and anthropologists. For irrigation projects, measurement error could be a real problem when small farmers and landless labourers are being considered. They are often illiterate and may have some difficulty with precise numerical quantification. Accordingly, they may be unreliable or somewhat vague about the rate of changes, especially when they are within the order of 15 to 20% and some time has elapsed between the two periods in time which are being monitored. Enumerators and data collectors should be aware of this potential problem and attempt to ensure that the changes are properly reflected.

Absence of bias

Monitoring and evaluation of water projects often suffer from the biases of the people performing the task. Because of their disciplinary orientation, expertise and past experiences, evaluators may have the tendency to concentrate on specific issues at the cost of other issues which may be of similar importance. Among the common biases observed are focusing on water entering watercourses but not losses, irrigation but not drainage, fields near roads, along canals and watercourses, but not those to which access is difficult or uncomfortable, undertaking reviews during the healthier, better-fed dry season when the climate is pleasant but not during the food-scarce, unhealthy, unpleasant and wet season, and interviewing large farmers or men but not small farmers or women. Equally, there is a danger that biases may be introduced in terms of one's discipline, since unidisciplinary people often tend to concentrate on areas that are of primary importance to them.

It should be noted that in the real world an issue is an issue. It is often labelled engineering, economic, social or legal depending upon an individual's discipline, experience, and ways and means of approaching it. Thus, ideally, evaluations should be carried out by multidisciplinary people, who may specialize in one discipline but are knowledgeable in other disciplines. They should be flexible, observant, sensitive, eclectic and constructive. They should be capable of intermixing freely and questioning sympathetically and inventively. Since, in reality, such qualified and experienced individuals are very difficult to find, one may have to depend on whoever is available. To a certain extent the problem can be resolved by carefully choosing a multidisciplinary team, which may offset the biases of individual members by juxtaposing the insights of various disciplines. However, past experience indicates that the use of multidisciplinary teams for the monitoring and evaluation of irrigated agriculture projects, where team members are not familiar or do not have established working relationships with one another, generally does not produce an integrated multidisciplinary approach or report.

Identification of users of information

If the results of any monitoring and evaluation are to be actually used, it is necessary to identify who are going to be the users of information and their information requirements before designing a monitoring and evaluation system. At the different levels of management the hierarchy of information needs is different. For example, at a certain level detailed information on a specific aspect of an irrigation project may be necessary, whereas at other levels (generally higher), aggregated information may be required. The right type of information must be provided to the appropriate levels.

For any utilization-focused evaluation, after identifying relevant information users, it is desirable to (i) actively involve the users in ways that would increase their commitment to using the evaluation findings; (ii) train users to increase their understanding of evaluation and make it possible for them to play a useful role in the evaluation process; and (iii) provide genuinely useful information to the users so as to reinforce their future commitment to evaluation.

Trade-off between requirements

The principal requirements discussed above should not be considered individually in isolation since some reinforce each other and are thus mutually supportive but others may be in conflict. The quality of any monitoring and evaluation system is determined not by any one of the requirements but rather by how effectively all these factors are integrated in one system. For example, there is always a trade-off between maximum coverage, minimum sampling error, minimum measurement error and cost, and these trade-off decisions are generally case specific. There is no universal clear-cut solution.

There is sometimes a tendency to emphasize one or more of the requirements at the cost of others because of bias. A good example of this is the monitoring and evaluation of irrigation projects and programmes in Nigeria during the past 10 years that were funded by the World Bank. Massive resources were devoted to monitoring and evaluation activities, and equally massive amounts of data were collected by the Agricultural Projects Monitoring Evaluation and Planning Unit (APMEPU), which was established in Kaduna in 1975 to coordinate the monitoring and evaluation activities of the various agricultural development projects/programmes (ADPs). In spite of such intensive efforts by the APMEPU, the impact of the ADPs on food production or consumption is far from clear. A major problem arose because of the APMEPU's overriding emphasis on minimizing sampling errors. This contributed to a lopsided approach which gave high priority to statistical concerns but low priority to other requirements and scant consideration of the resources available to perform all the monitoring and evaluation tasks. While the sampling error was minimized, all kinds of other errors were introduced at unacceptable levels. This meant data massaging, futher analysis and re-analysis, which not only took time but also contributed to the development of a credibility gap between the unit and project management and other users of information. It is thus essential that a cost-effective monitoring and evaluation system be developed that provides the information required by managers in a timely fashion, subject to resource and manpower constraints. The development of an effective system is an evolving process that requires regular, good feedback between the monitoring and evaluation unit and users of the information.

Conclusions

Monitoring and evaluation are integral components of the management of any water development project. However, this does not mean that if monitoring and evaluation are carried out, the efficiency of management of projects will automatically be improved. On the basis of a review of the monitoring and evaluation activities of irrigation projects in Asia and North Africa, it appears that monitoring and evaluation are generally having far less impact on the management process than expected or even possible.

One of the main reasons for this sad state of affairs is that monitoring and evaluation are being imposed from above by donor agencies, both multilateral and bilateral, on developing countries. A stipulated condition of any loan or grant by the World Bank, IFAD or similar funding agencies has been to establish monitoring and evaluation activities within a project. The monitoring and evaluation requirements of these external agencies are not uniform. Furthermore, managers at project level do not have a good understanding of the process. Under such unsatisfactory conditions, monitoring and evaluation are carried out not because the managers feel that they are necessary, but essentially because they are a stipulated condition of the loan or grant. Accordingly, it is not surprising that monitoring and evaluation activities generally lack a sharp focus and the processes are seldom constructively reviewed by either national or international agencies. Monitoring and evaluation in many projects have become routine and perfunctory affairs that are done mainly because of administrative requirements, wherein activities and impacts are routinely monitored and documented, reports are neatly filed, but the project activities continue merrily on their way, unaffected in any sense, with a business as usual attitude.

For monitoring and evaluation to succeed, we need a new ethos. As has been aptly noted, the heart of evaluation is an attitude, a frame of mind which enables us to review project activities and performance in a constructively critical light. This should be done with emotional detachment. Managers need to develop a new evaluative mindset that allows them to appraise performance, reflect on what has been learned for future activities and then adjust policies, if necessary, in response to what has been learned. Without such an ethos, it is unlikely that the benefits of monitoring and evaluation can be fully harnessed.

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