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Adaptive, Participatory and Integrated Assessment (APIA) of the Impacts of Irrigation on Fisheries

Evaluation of the Approach in Sri Lanka

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International Water Management Institute

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The authors: Sophie Nguyen-Khoa is a Researcher at the International Water Management Institute; Laurence Smith is Senior Lecturer in Agricultural Economics in the Department of Agricultural Sciences and Kai Lorenzen is Senior Lecturer in Freshwater Fisheries in the Department of Environmental Science and Technology, both at Imperial College London.

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Please direct inquiries and comments to: *iwmi@cgiar.org*

Contents

Summary

Irrigated agriculture is the largest user of water globally and its development can have significant impacts on inland fisheries. These impacts can be varied and complex, and range from biodiversity concerns to economic impacts and changes in the livelihood opportunities of rural households. There is a need to improve the knowledge of these impacts and integrate their assessment into project planning and implementation. This paper describes an approach designed to meet this challenge and the results of its pilot-testing in Sri Lanka. The approach derives from a literature review of planning and appraisal methodologies, interaction by a multidisciplinary team of researchers and evaluation of the test case.

To date, most impact assessments for inland fisheries have focused on the ecological impacts of modified river flows and habitats without taking full account of production and livelihood impacts and interactions between these. The approach developed is focused on production and livelihoods, and intends to support improved management and sustainability of land, water and fish resources. It builds upon commonly used frameworks for Environmental Impact Assessment but places particular emphasis on a holistic assessment that is integrated across disciplinary perspectives and sectoral interests. It relies on participation by stakeholders for the capture of local knowledge, for identification and resolution of critical issues and conflicts of interest and for generation of management recommendations that will command broad-based support and local "ownership." Given inevitable variation, dynamism and uncertainty in its applications, adaptation and learning are also essential features of the approach. Continual monitoring and evaluation are used to refine both the process and its outcomes during implementation.

The main stages are a preliminary assessment, screening, scoping, impact assessment and identification of mitigation or enhancement measures. These stages are overlapping and iterative in practice. The assessment of impacts is optimized given time and resources constraints through a composite approach in which flexible and selective use can be made of available analytical tools, empirical models and methods for conflict resolution. Workshops sequenced according to the stages are used as the principal fora for participation and enable interaction between scientists, stakeholders and policymakers.

Testing consisted of a retrospective assessment of the Kirindi Oya Irrigation and Settlement Project (KOISP), a major agricultural development scheme in the dry zone of Sri Lanka. In this catchment preexisting fisheries were almost exclusively ancient reservoirs ("irrigation tanks") and coastal lagoons. The project has had a modest positive impact on the aggregate production of all catchment fisheries (net of output from a new headwater reservoir), but water management in the scheme has had a negative impact on the actual production of the preexisting reservoirs and lagoons. Together with overfishing and recent droughts this has degraded stocks and marginalized fishing as a livelihood of last resort. Potential improvements in water management across the catchment were identified that could deliver a range of environmental, social and economic benefits. Consensus was established that fishing should be sustained as a livelihood activity for landless and marginal farming households, and that complementarities between irrigation and fisheries could be better exploited.

Evaluation of the implementation, performance and impact of the approach for this case study was based on a structured set of indicators. Implementation was satisfactory in terms of the inputs used and activities completed. Performance was judged to be good insofar as the impact assessment results were sufficiently accurate and comprehensive to form a basis for identification and design of practical and feasible management responses that commanded broad-based local support. The outcomes also demonstrated the relevance and utility of the key features of the approach. Impact was more limited given the pilot nature of the exercise and time constraints that prevented full appraisal of proposed mitigation and enhancement measures. The strengths and limitations of the approach as revealed by the case study have been documented, and areas for improvement and needs for further research identified. Enhanced awareness of the importance of inland fisheries and institutional support at all levels of governance are critical requirements for adoption and successful use of the approach.

Introduction: The Importance of Improving the Assessment of the Impacts of Irrigation on Fisheries

Increasing recognition of the social and environmental impacts of the development and expansion of irrigated agriculture (including large dam construction) has emphasized the need for improved approaches for planning, impact assessment and management of such projects. Assessment of impacts of irrigation development on inland fisheries is an important part of this but it is particularly challenging. This is because of the range and complexity of issues that may need to be addressed and frequent deficiencies in the knowledge of the hydrology and ecology of many freshwater systems and the livelihoods dependent on them.

Irrigated agriculture worldwide is by far the largest user of freshwater and, consequently, impacts on freshwater ecosystems and the fisheries they support more strongly than most other human activities. By "fisheries" is meant the exploitation of natural living aquatic resources held in some form of common property regime (in contrast to aquaculture, which implies active husbandry and private ownership of stocks). To the extent that access to water bodies is open to all, and given that inland fisheries generally require few resources from those exploiting them, they can be very important in the livelihoods of the poor rural people. Inland fisheries can perform various functions in rural livelihoods, ranging from an activity of last resort or an element in a traditional and diversified semi-subsistence livelihood strategy to a specialized and full-time occupation (Lorenzen and Smith et al. 2004; Smith et al., 2005).

Changes in land use and the development of agriculture can affect the productivity and sustainability of fisheries in many ways and potentially with great severity. Habitat loss and degradation of the terrestrial and aquatic environment are the greatest threats to the sustainability of inland fisheries (Revenga et al. 2000; Bizer 2000), and dam construction and the expansion of irrigated agriculture are probably the most important factors that have impacted on inland fisheries in developing countries (Bergkamp et al. 2000; Jackson and Marmulla 2001; Lorenzen and Smith et al. 2004).

Despite these possible conflicts, irrigated agriculture and inland fisheries are both important to food production and livelihoods, and there can be complementarities between them. Irrigated agriculture can contribute to economic growth, to poverty reduction and to the sustainability of livelihoods through improvements in the levels and security of farm productivity, employment and incomes, and associated linkage and multiplier effects in the wider economy (Smith 2004). Globally, the total irrigated area is around 270 million hectares, about 17 percent of the cultivated land and producing approximately 40 percent of food and other agricultural commodities (World Food Summit 2002; FAO 2004). Irrigated land is thus disproportionately important to agricultural production, food security and rural employment for many regions of developing countries and, without irrigation, increases in yields and outputs that have fed the world's growing population would not have been possible (Rosegrant et al. 2002).

Whilst the importance of irrigation is not disputed, much less attention has been paid to the economic and social significance of inland fisheries. This neglect is partially explained by the artisanal characteristics of inland fishing that tend to make it inconspicuous, and by the preponderance of fishers amongst the poorest, the most marginalized and the least empowered groups within rural communities (although there are exceptions). Such fisheries make important contributions at the household level and, in the aggregate, to food production, food security, nutrition and employment. According to FAO statistics, in 1998, inland fisheries worldwide accounted for at least

15 percent of total global employment in capture fisheries and aquaculture and produced 7 million tons of fish, about 10 percent of the total fish output (FAO 1999). These are conservative estimates as most observers believe the output of inland fisheries to be underreported by 200 to 300 percent, meaning a higher range estimation of 21 million tons of fish.

The importance of inland fisheries to livelihoods also provides strong incentives for the preservation of aquatic habitats. Freshwater ecosystems are particularly biodiverse, for example, supporting some 40 percent of all fish species (Bizer 2000; Arthington et al. 2004). Subject to rising demand for water, degradation or loss of habitat and overfishing, approximately 20 percent of freshwater species are threatened, endangered or extinct, and protection of freshwater biodiversity is internationally recognized as an urgent priority (e.g., Revenga et al. 2000). However, as discussed in section 2 (The Impacts of Irrigation Development on Fisheries: Range and Complexity) fisheries production and livelihood objectives do not necessarily coincide with the preservation of biodiversity.

Until recently, adequate awareness, understanding and recognition of the importance of inland fisheries in developing countries have been lacking and, as a result, fisheries considerations have rarely been integrated into any stage of irrigation planning and development. Although awareness and knowledge of aquatic resources and the impacts of irrigation are improving, the best ways to assess and manage impacts are still to be established.

This paper describes a broad-based, interdisciplinary and participatory approach designed to assess and manage irrigation impacts on fisheries. The approach builds on the framework of environmental impact assessment and integrates a suite of specific assessment tools. First, the complexity of the interactions between inland fisheries and irrigation development is reviewed. Then the approach and its testing and evaluation are described and conclusions drawn.

The Impacts of Irrigation Development on Fisheries: Range and Complexity

Impacts of irrigation development on inland fisheries arise from physical modifications of aquatic habitats and their ecological effects, and from changes in exploitation patterns that may be forced by physical habitat changes or reflect changes in livelihood opportunities and access to resources. The mechanisms through which impacts arise are thus complex, and can rarely be understood and predicted on the basis of physical habitat impacts alone (Nguyen-Khoa et al. 2005). Even where physical habitat change is the main driver of fisheries impacts, the complex network of habitats on which many inland fisheries rely (e.g., Lorenzen et al. 2000; de Graaf et al. 2001) can pose great difficulties for predicting ecological impacts. Further complications can arise from the mobility of aquatic resources and the absence of fixed boundaries for their management. Fisheries, water, and land within a watershed (management of which influences water quality and quantity) are often open access or common property resources. For these any institutional arrangements that regulate access are important influences on processes of change and possible sources of conflict. Fishing tends to be an artisanal activity of the poor and a wide range of economic, social and institutional factors can determine the livelihood contributions that it makes (Smith et al. 2004).

Irrigation systems intentionally alter the natural hydrological system to retain or divert water. They may abstract and deplete (through evapotranspiration) a large proportion of the annual flow from river basins (Rijsberman and Molden 2001; Molden 2002). This and land engineering that often drains natural wetlands or modifies natural drainage channels will change the overall availability and ecological connectivity of natural aquatic habitats, in turn affecting the productivity and diversity of aquatic resources (Roggeri 1995; Welcomme 2001). This can have a wide range of impacts on fish ecology, and thus on fisheries production and livelihoods dependent on it.

Impacts on the productivity of fisheries can arise from change in production potential resulting from change in habitat availability, quality or connectivity, but productivity is also dependent on the level of exploitation in terms of fishing effort and efficiency of gear use. Net production impacts are not necessarily negative, as reservoirs, canals and drains can compensate for habitat loss by supporting productive fisheries (Jackson and Marmulla 2001; Nguyen-Khoa et al. 2003). A positive net impact is most likely in regions where natural water retention is low and flooding negligible or only short-term. However, conflicts of interest may arise if sustaining such fisheries imposes constraints on the design or operation of the infrastructure.

Impacts on the ecological integrity of the existing aquatic ecosystem are generally negative, as the species occurring in the unmodified ecosystem may be sensitive to changes in hydrology, water quality and habitat connectivity. There is often a strong congruence between management of fisheries for production and conservation but exceptions arise. For example, productive fisheries can exist in modified systems such as shallow reservoirs (Jackson and Marmulla 2001). Similarly, the total fish yield obtainable from a lake or reservoir is positively influenced by its trophic status but nutrient enrichment (eutrophication) of standing water may threaten aquatic biota adapted to nutrient-poor conditions (Welcomme 2001). Thus the loss of certain habitat types or habitat connectivity may cause a loss of biodiversity or ecological integrity without strongly affecting overall production levels while, conversely, a quantitative reduction in the extent of habitat may cause a proportional decline in fisheries production without great loss of species diversity.

Impacts on the value of fishing to rural livelihoods can arise as a consequence of changes in production potential, or as a result of changes in physical accessibility or rights of access to fishing grounds. Incentives for fishing will also depend on alternative employment opportunities in the local or wider economy, and degradation of the productive potential of a fishery may be compensated in livelihood terms by opportunities stimulated by the increased and more continuous output of irrigated farming (Smith et al. 2004)

In livelihoods terms, access to fisheries resources at critical times of the year or close to the dwelling may be more important than overall levels of production. According to Smith et al. (2004) for a rural household fish catches can be one or all of the following: a primary source of income, a supplementary source of income or own food production and a means of exchange by barter or in reciprocal social networks. As part of a diversified livelihood strategy, fishing can thus range from an activity of last resort in hard times, through a part-time use of surplus labor, to a specialized and wealth generating occupation when returns are high. Such variations in the livelihood role occur both across households and over time for individual households.

Some impacts can be quantified in monetary terms, for example farming and fishing output, whilst others cannot easily be quantified and valued, for example biodiversity and culture, although they may be considered important in decision making. Impacts on both natural and economic systems will also vary over a catchment area and with different time scales. They may also be differentiated within and between households, communities and catchments, whilst cumulative effects may arise at river basin or regional scale from interventions on more than one catchment. There is always the risk that the most vulnerable households will be most adversely affected by any negative impacts of irrigation development on fisheries but least able to gain from its benefits.

The mechanisms through which irrigation may impact on fisheries may be varied and interconnected. Typically, changes in the biophysical system (e.g., modified river flows, contraction of floodplain habitat, reduced habitat connectivity, and degraded water quality) lead to changes in the socioeconomic system such as in fishing efforts or access rights. In turn, human actions in response to such changes can affect the biophysical system. For example, an increase in the efficiency of fishing resulting from the contraction of floodplain habitat downstream of a dam may increase incentives for fishing effort and lead to overexploitation. After initially rising, returns from fishing will decline and vulnerable households may seek alternative livelihoods. User pressure on other open-access resources such as forests and grazing land may increase, with any resulting degradation of land further contributing to change in aquatic habitats. Alternatively, a new reservoir may provide a more productive and accessible fishery for poor households compared to the unmodified river channel, initiating a more positive round of changes in livelihood opportunities and use of natural resources. Further complication arises from the fact that fishing communities or other groups affected by such developments may anticipate the changes and react strategically if conflicts with their interests are likely to arise.

Opportunities for mitigation or enhancement measures in such processes may arise at any stage in the chain of cause and effect, and improved assessment of impacts should inform the selection, design and management of these by a government or the communities. This will clearly be difficult enough, but assuming the onerous information needs can be met, decision makers may also need to resolve trade-offs between complex multiple objectives and conflicts of interest. Conservation, farming and fishing interests may all seek to influence the management of land and water resources, and decision making must deal with trade-offs between non-commensurable variables and the competing interests of different groups.

It can be concluded that assessment of the impacts of irrigation development on fisheries must go beyond ecological and productivity changes to take account of the vulnerability of affected households, changing rural livelihood opportunities and the role played by fisheries in the socioeconomic development of the affected area. The assessment must be holistic, although focused on production and livelihoods, and management-oriented. It must also be part of a process that is capable of resolving conflicts and establishing broad-based acceptance of adopted measures.

Adaptive, Participatory and Integrated Assessment (APIA): An Approach for Impact Assessment

THE MERITS AND LIMITATIONS OF EXISTING APPROACHES

Impact assessments for inland fisheries completed to date have mainly focused on the ecological impacts of modifications to river flows, flood patterns and longitudinal habitat connectivity. In-stream flow methods have been used to assess ecological impacts of flow modifications, mostly for rivers without a significant floodplain habitat (Arthington et al. 2003). Fish population models for floodplain systems have been developed to provide quantitative predictions of effects of changes in flooding patterns on fisheries yields (Welcomme and Hagborg 1977; Halls et al. 2000; Lorenzen et al. 2003). Geographic information systems (de Graaf et al. 2001) and Bayesian network models (Baran et al. 2003) have been used to describe spatial and seasonal aspects of hydrology and their implications for fisheries production. Impacts of disruption in longitudinal habitat connectivity on migratory species are commonly assessed based on the knowledge of life histories (Bizer 2000; Jackson and Marmulla 2001). These tools can be powerful in assessing particular issues relevant to biodiversity conservation and fisheries ecology, but may not always capture overall production and livelihood impacts adequately. They tend to focus on target species without taking account of changes emerging at ecosystem or species assemblage level, for example compensating for the decrease of a species and maintaining catches in multi-species and multi-gear fisheries. They may also neglect complex interactions between project biophysical impacts, socioeconomic and other exogenous factors, and the ecological outcomes.

Economic cost-benefit analysis has been widely used for both appraisal and ex-post evaluation of irrigation projects. Whilst attempting a monetized and aggregate comparison of costs and benefits for the national economy has its merits, the approach has four main limitations of relevance here. The need to include externalities such as impacts on the environment is recognized but difficulties in quantification and valuation mean that the comparison of costs and benefits is never comprehensive and any excluded “intangibles” inevitably carry less weight in decision making. Standard methods take no account of the incidence and distribution of costs and benefits. At appraisal, it promotes a “blueprint” approach to project design and implementation, and in evaluation it may lack explanatory power. Finally, its use of discounting raises concerns in relation to long-term valuation of resources and sustainability objectives.

Environmental Impact Assessments (EIAs) of development projects are now in common use. The literature on EIA is extensive and a wide range of approaches have developed. Guidelines take various forms from checklists of possible impacts (e.g., ADB 1987; ICID 1993) to more elaborate networks (e.g., Ramsar 2000), flow diagrams (e.g., EU 1993; FAO 1995), and matrices and multi-criteria analyses (e.g., Petermann 1996) to support project decision making. Some approaches have attempted to integrate cumulative and combined effects through broader perspectives (e.g., World Bank 1991) and within integrated development programs (e.g., Petermann 1996). The public is often involved through various forms of participation (e.g., World Bank 1993; Fell and Sadler 1999).

A review of these approaches with regard to the impacts on fisheries has highlighted a tendency to rely on checklists that ensure coverage but this may result in only superficial assessment of causal relationships, interactions and feedback effects, and possible management responses. The resulting description of impacts may then be a static “snapshot,” with an absence of hierarchy or prioritization of the significance of impacts. Although a list of proposed mitigation measures is usually an end product, these often lack linkages into the design and management of the project or fail to adequately address local constraints to implementation, such as a lack of resources or the need for institutional reforms (e.g., Sadler 1996). Standard approaches may also lack means for balancing competing demands (e.g., Sadler et al. 2000) and means to resolve conflicting interests, for example conservation versus production objectives. Consequently, an EIA is often perceived as a bureaucratic necessity for obtaining project agreement and financing, rather than a tool to improve performance and sustainability.

Despite these possible limitations, the concepts and methods of EIA are clearly relevant to the impacts of irrigation development on fisheries. An EIA can provide a structured and sequential process, which can be sufficiently flexible in its implementation to accommodate the range and complexity of concerns identified above, whilst ensuring progress towards management-oriented outcomes. Viewed as a framework rather than as a precisely specified methodology, an EIA can also provide a process and reference points for a range of assessment tools and approaches selected as appropriate for the context-specific issues of concern. It is a composite approach of this type that has been developed for this application and is described further below. A further advantage is that the concepts of EIA are widely used and understood, enhancing the prospect for fisheries assessments to be routinely integrated into appraisals and evaluations of irrigation investments.

OBJECTIVES FOR AN IMPROVED IMPACT ASSESSMENT

The aim has been to develop a broad approach that allows identification of key issues and interactions, provides simple tools for exploratory assessments, and guides the use of more demanding tools (such as the models described above) within the assessment and management process. The approach is management-oriented and usable at all stages of the project cycle; that is for ex-ante appraisal of proposals, ongoing evaluation by project management, and ex-post evaluation of existing schemes.

The approach needs to be holistic in scope and able to take account of the needs and concerns of all stakeholders. It should be flexible and facilitate the use of an appropriate combination of formal and participatory research methods, drawing on primary and secondary sources of empirical information and synthesizing scientific and local knowledge,[1] to establish the main processes of change underlying predicted or observed impacts on fisheries and dependent rural livelihoods, and any sources of conflict. The flexibility should also facilitate an adaptive or learning response to the information generated at each stage of the assessment, within a structured and sequential process that ensures progress towards improved management of land, water and fish resources.

The outcomes should be relevant to the needs of decision makers and should improve project design and implementation by supporting the identification and design of mitigation or enhancement measures and other management options for sustainable irrigated farming and fisheries. The approach must also facilitate the development of local capacity to manage impacts and provide an information base, analytical tools and fora, with the potential to evaluate trade-offs and determine negotiated solutions to conflicts of interest.

Although the range of possible biophysical and socioeconomic impacts on fisheries can be varied and complex (section 2), the cost of impact assessment must be reasonable in relation to the magnitude of expected impacts and the total project cost. As a rule therefore, fisheries impact

[1] In this report, “local knowledge” is used to refer to both the indigenous technical knowledge of fishers and the broader technical and other knowledge of all stakeholders including that of communities and local officials.

assessments will often have to rely on limited primary data collection and relatively simple analytical methods, making effective use of local knowledge and comparative empirical information from other locations. This is particularly true for small- to medium-scale projects, whereas for very large projects more primary data collection and project-specific modeling of impacts may be justified.

The approach and the knowledge base to support its application are being synthesized in the "Guidance manual for the management of impacts of irrigation development on fisheries" by Lorenzen and Smith et al. (2004). Key features are described in more detail below. Their relevance to this application is supported by the convergence of research findings and project planning experience in various areas of natural-resources management. For example: participatory assessments (e.g., Pretty 1995; Abbot and Guijt 1998; Guijt 1998), integrated natural resources management (e.g., Campbell et al. 2001; Sayer and Campbell 2003; Harwood and Kassam 2003; Penning de Vries et al. 2003), and adaptive management (e.g., Holling 1978; Walters 1997).

FEATURES OF APIA

A Holistic and Integrated Approach

Holism is taken to refer to the objective of holistic coverage and understanding of issues, viewing the problem under study as a whole and in its broader context, rather than a as a specific methodology. It is not easy to define in advance what is required but a lack of holism will be apparent by default when a critical issue or linkage is neglected.

A holistic approach is called for here because, as illustrated above (section 2), the systems under study involve multiple actors and causal factors. Analytical boundaries are not easy to define because the impacts of concern can spread spatially, across sectors and over time, and interactions between chains of cause and effect can be difficult to disaggregate and predict with accuracy, not least because of the adaptive reactions of stakeholders. A broad picture of the interdependence between natural processes, fishing, farming and other land uses, and the wider socioeconomic environment help identify key relationships that might otherwise be overlooked or misperceived. It can also assist decision making when there are conflicts over water and land resources.

The major concern is not whether holism is relevant but how to implement it. This has been addressed by recognizing that assessments are more likely to be accurate and comprehensive when they draw on both technical expertise and local knowledge, and thus through the adoption of a flexible and composite approach that can provide anchor points to integrate both specialist inputs and the outcomes of participatory processes that give "voice" to all interests. Integration must also be achieved: of the inputs from disciplinary specialists (e.g., hydrology, irrigation engineering, fisheries ecology and socioeconomics); for analysis across sectors (agriculture, fisheries and alternative land uses and employments); and for the hierarchy of governance and institutions (from communities to local and the national governments). Finally, spatial and time scales for the assessment may initially be set based on a priori assumptions and preliminary assessment results, and then refined as an understanding of the issues of most significance is gained. It must be noted that integration is not equivalent to aggregation. The approach must be able to identify the critical variables from the broad picture as quickly as possible, and the ability to be simultaneously comprehensive in reviewing information but selective in the detailed analysis of key issues is important. Disaggregation of assessments by spatial area and by socioeconomic groups may be necessary once key issues have been identified.

Participation by Stakeholders and Policymakers

The approach involves "genuine participation" by stakeholders and policymakers, defined as their active, creative and continuous contribution throughout the process to the understanding of key problems and to management decision making. In the typology of participation proposed by Pretty (1995), this corresponds to "interactive participation," compared to lower levels that involve consultation only or higher levels of self-mobilization and determination.

The benefits expected from participation include the capture of local knowledge and an understanding of the values and priorities of different affected groups. These, in turn, can provide one form of validation for the outcomes of the assessment. A shared understanding of the perceptions and priorities of other groups can also change attitudes and promote consensus in the definition of key problems, management objectives and possible solutions. This is particularly important where causal factors are primarily anthropogenic, given that fisheries are often undervalued because of ill-informed or biased preconceptions. Indeed, simply initiating or improving the representation of fishers in negotiations with farmers and other water users can be of value in correcting past sources of bias. Finally, participation should promote acceptance and "ownership" of recommendations, improving their implementation and sustainability (for example, through greater compliance with regulation or the need to contribute to costs).

A series of workshops are used as the principal fora for participation, with the aim of creating an enabling environment for interaction between scientists, stakeholders and policymakers, which is open to reflection, self-criticism and evolution of negotiated agreements that can help resolve or at least reduce conflicts. Stakeholder representatives and policymakers are invited to the workshops at different stages in the impact assessment process.

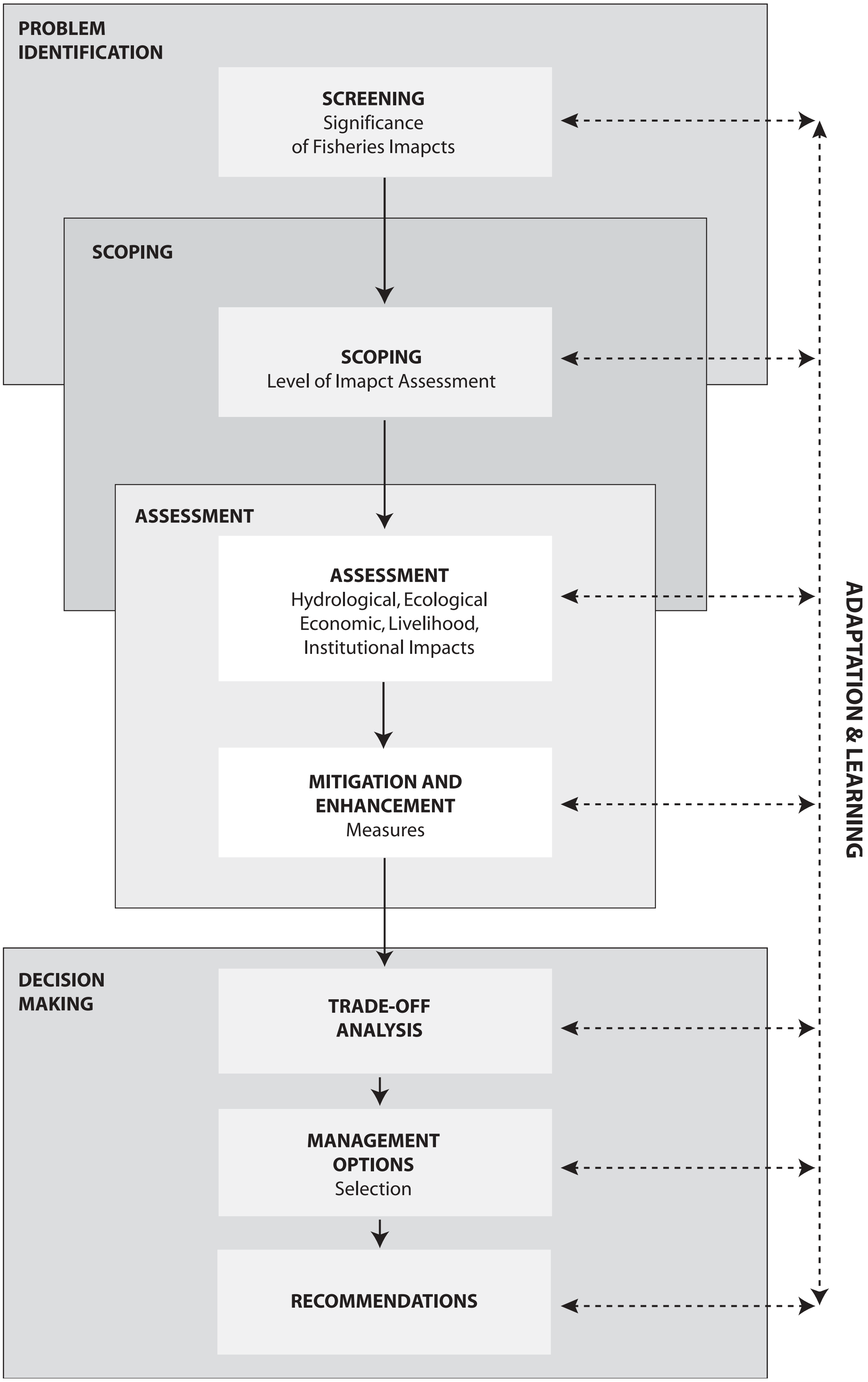
An Adaptive Approach

Adaptation and learning need to be inherent in the application of the approach. The progress and outcomes of the impact assessment should be continually monitored and evaluated, and adaptation will be a necessary response to the inevitable complexity and uncertainty. Thus feedback mechanisms should be in place to make sure that information gained is reviewed and used to correct or improve the process and the outputs produced by it. For example, the time and spatial scales selected for the assessment need to be kept under review throughout the process; similarly, the need for disaggregated analysis of impacts by spatial area or affected groups.

Improvements in the application of the approach will also come from experience and learning. For example, the study team needs to learn how best to facilitate the participatory process and recognize and integrate the diverse knowledge, values and priorities of stakeholders. They may also need to learn how to manage stakeholder responses and dynamic processes of institutional change that may be initiated by the implementation of the approach itself. Each application of the approach can thus be used as a learning experience within a country or organization, with the results and knowledge gained being used to improve the approach for that context.

The impacts of irrigation development should also be understood as a dynamic process of change rather than a static set of predictable or observed outcomes. Managing such impacts will be an ongoing process in which learning should continue so as to improve understanding of the processes involved and refine the implementation of management, mitigation and enhancement measures.

Figure 1. Diagram of APIA stages.



Stages of APIA

Following the conventional practice for environmental impact assessment, the approach involves stages of preliminary assessment, screening, scoping, impact assessment and identification of mitigation or enhancement options (figure 1). This should be followed by monitoring and evaluation of the measures taken when implemented.

The sequence of screening, scoping and impact assessment phases should be seen as overlapping and often iterative in practice. Continuous monitoring should refine the operation of the approach, checking its structure, and activities and functioning, tailoring it to local conditions and responding to challenges as they arise. Performance and impact should also be frequently evaluated in terms of the quality and utility of outputs, with iteration and refinement to improve these as necessary.

Preliminary Assessment, Screening and Scoping

To ensure comprehensive coverage and involve all stakeholders, the approach starts with a preliminary assessment of the probable impacts of irrigation development on fisheries for the case under investigation. This is ideally paralleled and completed through a stakeholder analysis that includes initial determination of both likely impacts for different groups and the role and influence of these groups for management and decision making.

The preliminary assessment may involve a combination of the following:

1. Identification of potential impacts on fisheries, livelihoods and biodiversity through the use of rapid-assessment tools and checklists, and review of the results at the first workshop with stakeholders.

2. Initial description and prediction of impacts through a workshop in which experts or knowledgeable stakeholders give descriptive, or possibly numerical rankings, of the importance and magnitude of possible impacts.

3. Reconnaissance field visits and community or stakeholder interviews in the field comparison with similar projects in comparable environments and with reference to available empirical information from secondary sources.

Based on the preliminary assessment, screening involves determination of whether an impact assessment is justified given the nature and importance of the possible impacts on fish production, livelihoods and biodiversity identified. It should reflect a holistic view of both possible impacts and the perceptions of stakeholders.

The scope of the assessment must be appropriate to the project and to the characteristics and economic scale of affected fisheries. It will not be possible to investigate all possible impacts in detail because resources (budget, time scale and expertise) will always be limited. Thus the purpose of scoping is to define, subject to resource constraints, the issues to be assessed and the level of analysis needed for each. It should avoid inessential data collection or concentration of resources on one issue (e.g., impacts on a single species) while neglecting others. It should also complete the establishment of contact with, and participation by, all relevant stakeholder groups. Thus a workshop at the scoping stage involves reaching agreement on a) the most critical issues, including the degree of urgency and irreversibility of change, b) the spatial boundaries for the areas affected, c) the physical and socioeconomic processes to be considered, and their interactions and time horizons, and d) the level of assessment for each of these. Scoping will primarily rely on the preliminary assessment for information, but should continue throughout the impact assessment as the study scope may need to be adjusted to take account of new information or changing circumstances.

Assessment of Impacts

The impact assessment focuses on the key issues identified during scoping, and involves four activities.

1. Description of the project.

2. Description of the current (baseline) situation; analysis is descriptive and summative with the aim of documenting a basis for evaluating project impacts.

3. Evaluation of project impacts through comparison of 'with' versus 'without' irrigation scenarios over time for the affected area. The possibility of change independent of irrigation should not be neglected, but in practice this usually involves comparison of the baseline with a predicted future (ex-ante appraisal) or reconstructed past situation (ex-post evaluation).

4. Identification of mitigation and enhancement measures and long-term management requirements.

As noted above a composite approach that can make selective use of analytical tools, empirical models and, possibly, methods for conflict resolution is needed, and these will contribute to the shared knowledge base and synthesis of conclusions completed in workshops. For example, the use of secondary data from comparable empirical studies, ecological modeling of population dynamics in different habitats, cost-benefit analysis of engineering options for mitigation of impacts, and livelihood analysis for vulnerable affected groups. Guidelines for the most relevant data and fisheries-specific tools and techniques have been compiled in the "Guidance Manual" (Lorenzen and Smith et al. 2004).

Decision Making and the Management of Impacts

Policymakers will usually have to reconcile multiple and often competing objectives for the management of land and water resources, and a holistic and participatory impact assessment will further reveal the priorities of multiple stakeholder groups. To support and inform decision making the assessment results and proposed mitigation or enhancement measures need to be specified in the form of management options, which can be compared and appraised by workshop participants. Options that gain broad-based support clearly merit the attention of decision makers. Within a final workshop(s) methods of trade-off or multi-criteria analysis in which stakeholders and experts determine priorities, assess the merits of different options and make choices may be a useful means to establish consensus (as used, for example, by Brown et al. 2001; Cropper et al. 2000; RESOLVE Inc. et al. 2000).

Where such a final stage is stakeholder-driven but includes government agencies or other organizations responsible and accountable for decisions and their implementation, it can function as a decision-making process. Depending on their scale and significance, decisions may still be subject to final approval at ministerial or parliamentary level, but if the process is endorsed by a government from the start, the reversal of decisions emerging from a stakeholder trade-off analysis should be an exception rather than the norm.

More commonly, the approach described will serve to better support and inform decision making by the responsible authorities. Compared to a narrow technical assessment alone, results and management recommendations should be well adapted to site-specific conditions and issues, and reflective of both scientific rationales and societal choices. Any conflicts of interest will have been identified and means to resolve these explored.

Implementation and Evaluation of the Approach

The approach was tested for a case study in Sri Lanka for evaluation of its implementation, performance and impact, and for improvement of its design and outcomes.

CASE STUDY LOCATION AND CHARACTERISTICS

The case selected to test the approach was an ex-post evaluation of irrigation development and its impacts on fisheries. This was for the Kirindi Oya Irrigation and Settlement Project (KOISP), a major agricultural development project in the dry zone of Sri Lanka. Implemented in 1986, the project rehabilitated and incorporated an ancient tank-based irrigation system, brought a large additional area of irrigated land under command, and resettled a substantial population in the new irrigated area. It consists of a large headwater reservoir, five ancient tanks (shallow reservoirs) and old and new command areas. The right bank command extends into a neighboring catchment from which drainage flows into two coastal lagoons. Inland fisheries production is almost entirely concentrated in the reservoir, tanks and lagoons, the Kirindi Oya river and irrigated rice fields having an innately low production potential in this location (further details of the scheme and its fisheries are provided in Nguyen-Khoa et al. 2002, and Nguyen-Khoa et al. 2005).

It was selected because important fisheries exist within the catchment, and significant project impacts and conflicts over water for farming and fishing have not been resolved yet. Secondary data on project performance and the fisheries were also available, and the logistics and scope of the assessment were expected to match the time and resources available.

CONDUCT OF THE IMPACT ASSESSMENT

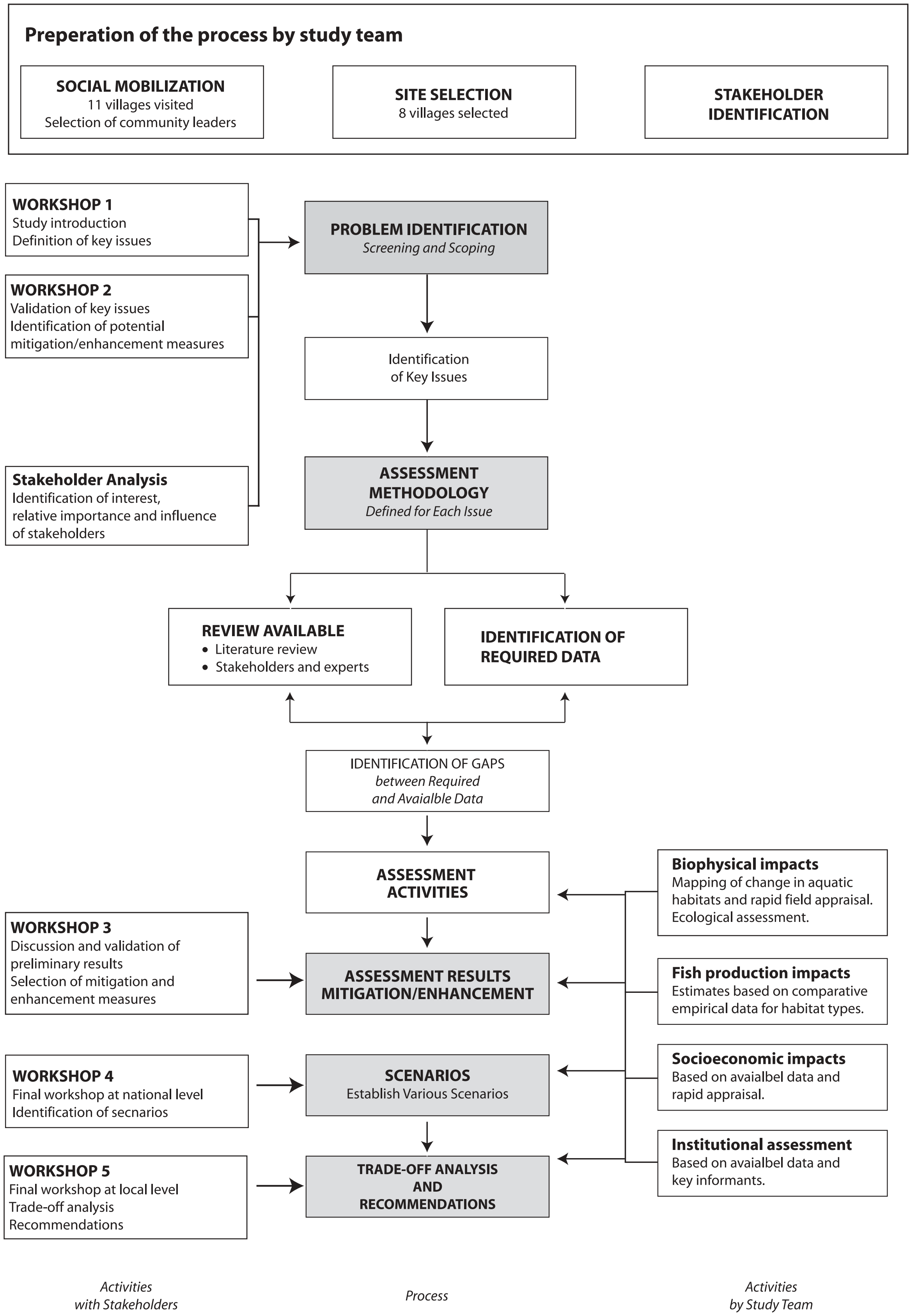
The assessment was carried out in February and March 2002 at a catchment level. Community participation was sought from eight villages, at least one from each of the following zones: above the main reservoir, close to the reservoir, old and new command areas, close to the lagoons, along the coast, and near the mouth of the river. Stakeholders from relevant national, provincial and district agencies were also invited to participate. Activities consisted of a series of five workshops interspersed by field surveys, interviews with key informants and compilation of a knowledge base from primary and secondary data sources and technical assessments (figure 2).

All workshops involved about 20 participants including eight from local communities and the remainder from government agencies and other organizations. Representatives from the national level were expected to attend at least the initial and final workshops, and any absentees were kept fully informed of activities and outputs throughout.

Through a literature review, site visits and meetings with key informants (government officers, researchers and community leaders), the preliminary assessment gained an overview of the situation and identified available data sources. The approach was introduced in the first workshop and participants defined all impacts of the KOISP on fisheries that they perceived.

Participants identified a large number of impacts associated with various sectors and domains (irrigated agriculture, fisheries, wildlife conservation, livelihood strategies and institutional arrangements), and classified these as either direct (e.g., decreased water availability) or indirect

Figure 2. Implementation of APIA in Sri Lanka



(e.g., environmental effects and changed patterns of labor use). Similar issues were grouped and only those with a root cause in the construction or management of the irrigation system were prioritized for detailed assessment. For example, restrictions on fishing access to the lagoons since the establishment of a surrounding national park were recognized as an important institutional issue for future fishery management, but not a direct impact of the KOISP. Finally, from the irrigation-derived impacts the most critical management priorities were selected. For example, diffuse pollution of tanks and lagoons by agro-chemicals carried in drainage flows was considered a future potential threat, but not a critical issue at the time of the assessment.

An initial consensus was that the following five critical issues had to be investigated:

- reduced river flow and floodplain habitat
- excessive drawdown of water levels for reservoir fisheries
- impacts of drainage inflows to the lagoons
- conflicts of interest between fishers and farmers
- a lack of institutional coordination between irrigation and fisheries agencies

The first three of these were seen as impacts of project construction and/or management, and the last two as contributing factors.

This refocused the study compared to the preliminary assessment and defined its scope. For example, as noted above, water quality issues and access restrictions to the National Park lagoon were de-emphasized as insignificant or lacking a causal linkage with the construction or management of irrigation. Experts in the study team had also initially prioritized potential biodiversity and productivity losses from reduced river flow and floodplain habitat, whereas stakeholders emphasized livelihood impacts arising from degradation of the reservoir and lagoon fisheries.

Given the economic scale of the fisheries concerned and the time and resources available, the assessment focused on these five issues using relatively simple methods, limited surveys and with reliance on comparative empirical data from other sources as much as possible. For impacts on the biophysical environment, baseline maps of aquatic habitats and land use were studied. Relevant features of impacted areas and the wider catchment were identified, and project-induced changes such as the new reservoir, canals, irrigated fields and drainage flows highlighted. This allowed identification of change in aquatic habitats and habitat connectivity. Fisheries production estimates for the pre- and post-project habitats were derived from existing local surveys of the reservoir and lagoon fisheries and comparative empirical data from other regions of Asia were used for the pre-project river floodplain fishery and for paddy rice fields. All production estimates were cross-checked with consumption and market estimates and validated with stakeholders. For socioeconomic impacts, stakeholder knowledge, secondary information and field investigations were used to assess the resource endowments, vulnerability and livelihood strategies of affected households, key factors in the policy and institutional environment, and past trends and current trajectories of change in all of these. Opportunities for mitigation and enhancement of impacts were identified but time for detailed formulation and analysis of these was very limited. Only the main results of this assessment are summarized below (further details can be found in Nguyen-Khoa et al. 2005).

SUMMARY OF RESULTS

The KOISP had a modest positive impact on preexisting fisheries in terms of aggregate production and value (table 1). As neither subsistence nor commercial fisheries developed in the floodplain the reduction of river flow and flooding was not important in terms of fisheries and its livelihood functions. The large new reservoir substantially increased aggregate fish production from the catchment, compensating for any losses downstream and also in the lagoons.

Table 1. KOISP fisheries balance in terms of production and value.

	Before KOISP			After KOISP		
Water body	Catchment area (ha)	Production t/year	Value Rs1,000	Catchment area (ha)	Production t/year	Value Rs1,000
Floodplain	6,200	124	50	0	0	0
Lagoons	15,000	150	225	1,500	150	60
Lunuganwehera	0	0	0	3,200	1,344	538
Tanks	1,608	1,013	405	1,608	1,013	405
Small tanks	300	189	76	200	126	50
River*	(117,800)	35	14		0	0
Total*	9,608	1,511	769	6,508	2,633	1,053
Change				-3,100	1,122	284

* The river does not contribute to catchment area but it contributes to fisheries production and value.
Source : (After Nguyen-Khoa et al. forthcoming). Productivity of reservoir and tank is based on data from Renwick 2001.

However, whilst the impact of construction has been to increase the aggregate potential productivity of fisheries in the catchment, scheme operation and water management have had a negative impact on the actual production of the preexisting reservoirs and lagoons. In combination with overfishing and the effects of the recent drought, this has degraded fish stocks and driven fishing towards being little more than a residual livelihood of last resort for households with few alternatives. Given local population growth and unemployment rates, particularly among landless second-generation settler households, this has provided an important social "safety net," albeit at low income levels. Alternative livelihoods for the economically marginalized, such as firewood collection, shell mining and lime-making tend to be more environmentally damaging.

Not all water management issues relevant to fisheries were linked to KOISP development. Problems of extreme drawdown in reservoirs were caused by a combination of extremely low rainfall and increasing demand for irrigation water from the preexisting reservoirs, neither of which is a direct result of the scheme's construction. Indeed, the project provides opportunities for mitigating the impacts of low rainfall by supplying water from the headwater reservoir, but this has not so far been utilized regularly and effectively for fisheries management in the preexisting reservoirs.

Improvements in water management across the KOISP catchment have the potential to deliver a range of environmental, social and economic benefits. Productive fisheries can be restored in reservoirs if savings can be made in the water needs of farming, and management regimes can take account of minimum levels needed to conserve sustainable fish stocks. The benefits of this will include contributions to national fish output, employment and improved nutrition for poor households. More research is needed on the ecology of the coastal lagoons, but similarly (though subject to wildlife conservation priorities) a productive and valuable fishery can potentially be restored through improved management of drainage flows, seawater flows (through management of sandbar breaching) and lagoon water levels. Here biodiversity and conservation objectives can potentially be realized, as well as social and economic benefits.

EVALUATION OF APIA

Evaluation of the implementation, performance and impact of the approach was based on a structured set of indicators (table 2). The indicators used were identified in relation to the objectives of the approach (see section under Objectives for an Improved Impact Assessment, p.5) and were refined in consultation with stakeholders in the workshops. The sources of information and means of verification of these indicators included direct observation by the study team, assessments by interviewed stakeholders, and anonymous workshop participant questionnaires. Peer review of outputs and longer-term evidence of uptake and adoption of both the approach and its outputs will become more important over time.

Table 2. Framework for evaluation of impact, performance and implementation of APIA.

Structured evaluation	Indicators	Means of verification
Impact		
National and international	Wider uptake and adoption potential of approach	Peer review Acceptance and use
KOISP-specific	Changes in water and fishery management within the KOISP	Monitoring and evaluation of implementation
Performance (outputs)		
Identified research needs	a) Clear specification to fill critical knowledge gaps b) Importance	Peer review Uptake and resource allocation
Management recommendations	Relevant and feasible Justify costs of impact assessment	User acceptance and adoption Study team and workshop assessments Peer review
Impact-assessment results	Accurate and comprehensive Management-oriented Understandable and usable	Study team and workshop assessments Peer review
Performance (key features)		
Adaptation and learning	Adaptation to resource constraints Response to outcomes and lessons Reaction to unanticipated outcomes	Study team and workshop assessments
Participatory	Commitment/genuine involvement Integral use of local knowledge Representation of interest groups Communication and conflict reduction	Study team and workshop assessments

Table 2. Continued.

Structured evaluation	Indicators	Means of verification
Holistic and integrated	Inter-sectoral and disciplinary analysis and recommendations Comprehensive spatial and temporal coverage Diagnosis of complex causal pathways Synergistic and innovative outcomes	Study team and workshop assessments Peer review
Composite assessment	Cost-effective use of available data Ability to resolve critical questions and knowledge gaps	Study team assessment
Outcome-oriented	Relevance, practicality and wide acceptance of results and proposals	Study team and workshop assessments Peer review
Implementation (activities)		
Workshops	Number, conduct and completion to schedule	Study team observation and assessment
Impact assessment	Coverage and analytical tools/methods	Study team and workshop assessments
Secondary data collection	Data adequacy: coverage, authority, accuracy, level of disaggregation	Study team and workshop assessments
Primary data collection	Data adequacy: coverage, authority, accuracy, level of disaggregation Cost-effectiveness of collection	Study team and workshop assessments Study team assessment

Implementation

Implementation of the approach has been evaluated in terms of the adequacy and timeliness of inputs required and activities completed.

Inputs

The venue for workshops held in the KOISP catchment was accessible for representatives of the community and the local-level agencies, and its facilities were adequate. The major disadvantage was that the distance from Colombo limited attendance by staff from government agencies at the national level.

The local study team was led by an international researcher in fisheries management. It comprised staff from the two partner institutions: a) a researcher, a postgraduate student specializing in fisheries and a senior research coordinator from the University of Kelanyia and b) two research officers with broader experience of water management, rural development and extension, one field officer and a senior research coordinator from IWMI. Short-term inputs were provided by international experts in the fields of fisheries ecology, agriculture, irrigation management, socioeconomics and institutional analysis. The impact assessment was thus well resourced in terms of disciplinary coverage and expertise, but these inputs were provided for research purposes, and a similar level of provision may not be achievable for routine impact assessments of this scale.

On average, 25 participants attended each workshop. This was a manageable number given the need for careful briefing and training to facilitate participation by representatives from communities and local-level agencies with little experience in such activity and lower educational standards.

Representation of the selected communities, each sector (agriculture, irrigation, forestry, wildlife conservation and fisheries) and each governance level (community, and local and national governments) was generally achieved. The exception to this was a final workshop held close to Colombo specifically to include national-level representatives, but which lacked adequate attendance by officials from the Irrigation Department. This highlighted that adequate participation by senior representatives from higher levels of governance can be difficult to secure even though it may ultimately be essential if the process is to lead to effective decision making.

Activities

Primary data were collected through reconnaissance visits to eleven villages throughout the Kirindi Oya and neighboring catchments (see Nguyen-Khoa et al. 2005) and interviews with agency staff at local level. These assessed the types, locations and scale of existing fisheries. This was followed by more structured rapid appraisal of the role and importance of fisheries in livelihoods through key informant and household interviews in a subset of eight villages representative of the different locations (upstream-downstream of the dam, around the reservoirs, and around the lagoons) within the area under direct influence (or influencing) of the irrigation project.

The impact assessment was able to draw on relatively comprehensive secondary sources of data concerning the agricultural, water management and economic performance of the KOISP itself, in the form of project feasibility studies and evaluation reports. Much less information was available on fisheries, apart from a small-scale study of the economic value of the KOISP tank fisheries (Renwick 2001), and some empirical data on the productivity of reservoirs in Sri Lanka (De Silva 1988; Amarasinghe 1998). Some statistical data on the local regional economy such as sources and levels of employment were available, but disaggregation of information at district level or below was rare.

A composite approach to assessment was adopted that made selective use of a relatively simple range of tools and analytical methods as described above (figure 2, p.14 and section under Conduct of the Impact Assessment, p.13). Given the limited time and resources for primary data collection, much of the assessment of biophysical, fish production and livelihood impacts relied on the use of local knowledge and comparative data from secondary sources. Despite this, the methods used were judged to be adequate in terms of their coverage and predictive ability, and able to meet the objectives of the assessment. Further evaluation of their performance is made below.

Four workshops were held in the project area and a final one near the capital to ensure participation by national-level government staff (figure 2). The timing, conduct and duration of these workshops were satisfactory. This was the minimum number needed for the assessment of impacts, but further sessions were needed to complete the design and appraisal of proposed mitigation and enhancement measures and for actual decision making and planning for implementation. The workshops were observed to be an appropriate means for implementing the assessment. They were effective and efficient for dissemination and validation of information, particularly the impact assessment results. They also successfully provided a forum for exchange of information and priorities, debate and mutual learning. This created an enabling environment for perspectives and attitudes to change, allowing a consensus of views to emerge, and establishing the potential to resolve conflicts of interest.

Performance

The performance of the approach has been evaluated in terms of its effective demonstration of the key features and objectives of its design, and the relevance and utility of its outputs.

Key Features

Outcome-Oriented

From the outset of the process, participants were tasked with both assessment of impacts and identification of means to improve management of water, farming and fisheries. The sequential process reinforced this, as did the maintenance of a shared responsibility for the solving of problems and decision making at each stage. A regular flow of assessment results to, and between, stakeholders helped sustain interest and lead to definition of management options. For example, it became clear that increased efficiency of irrigation water use would help alleviate water management related fisheries problems by allowing retention of more water in reservoirs and reducing drainage flows into the lagoons; there was a strong local consensus that this needed to be identified as an overall long-term priority. Given these features, a clear focus on management relevant outcomes was achieved, although time to complete the final specification of these was inadequate as noted above.

Composite Assessment

The composite approach to assessment used (figure 2 and section under Conduct of the Impact Assessment) did maintain flexibility and enabled selective and cost-effective use of available data sources and appropriate analytical tools given tight time and resource constraints. For example, a balance of the gains and losses in fisheries-production potential resulting from the project was needed but production data for the KOISP floodplain were not available. To overcome this, authoritative and comparable data from Lao PDR (Lorenzen et al. 2000; Nguyen-Khoa et al. 2003) were used as the basis for an appropriate adjusted estimate (Nguyen-Khoa et al. 2005). Similarly, in a complementary analysis, data from comparable fisheries in Sri Lanka and Bangladesh were used in the estimation of a dynamic biomass model used to predict fish-stock dynamics in relation to reservoir drawdown levels (Lorenzen et al. 2003; Nguyen-Khoa et al. 2005).

Overall, the case study effectively demonstrated that adequate empirical data and appraisal methods exist for fisheries impacts to be cost-effectively included as a routine part of impact assessments for irrigation developments (identified as significant by screening). The relevant available data and methods have been compiled in the "Guidance Manual" (Lorenzen and Smith et al., 2004) as a resource for future work of this nature.

Holistic Assessment: Integration of Sectoral Issues and Scientific Disciplines

The assessment encompassed all relevant sectors (irrigation, agriculture, fisheries, water-resources planning and other land uses including forestry and wildlife conservation) and disciplines (fisheries ecology, hydrology, irrigation engineering, socioeconomics and institutional analysis). The following examples illustrate some of the benefits of the integrated assessment achieved.

Factors outside the fisheries sector were identified as critical to the sustainability of inland fisheries, and could be neglected by a narrow focus on fisheries alone. First, in this catchment the construction and management of infrastructure for irrigated agriculture were the major influence on the development and sustainability of inland fisheries. Second, levels of unemployment and landlessness in the area meant that the economic contribution of fisheries could not be considered in terms of the value of fish output alone. It was recognized that fisheries were important as a livelihood of "last resort" and/or source of income supplement for significant numbers of landless and marginal farming households (Smith et al. 2004) and that their degradation could increase pressure on other natural resources including forests and wildlife conservation areas. Also providing another example of the outcome orientation of the process, strong local agreement was reached that priority should be given to preserving the range of livelihood functions performed by fisheries for poor households.

Comprehensive spatial and temporal coverage of the assessment was promoted. The wide variety of issues initially identified led the investigation to range throughout the catchment including, for example, collection of local knowledge of volumes of fish catch and diversity from the pre-project period to date for all locations. It was notable that the most adverse economic, social and ecological project impacts on fisheries were occurring in coastal lagoons outside the Kirindi Oya catchment.

However, degradation of the lagoon fishery was not solely the result of project impacts. The holistic assessment diagnosed that this was caused by a combination of factors including overexploitation, the effects of a prolonged drought and the impacts of project drainage inflows. This was important in a context where most local stakeholders, experts and managers perceived drainage from the irrigation scheme to be the major causal factor, and facilitated consideration of a wider range of possible mitigation measures than had been the case in the past. In particular, workshop participants began to look beyond engineering solutions in the form of expensive drainage diversion canals to catchment-wide improvements in the management of water resources, and water-use efficiency of irrigation and fisheries.

Participation of Stakeholders and Policymakers

Degree of participation achieved. Stakeholders were identified in the screening and scoping stages, when the necessary degree of participation by different groups was also defined. Actual and necessary participation were monitored and evaluated throughout the process, so as to be aware of any decline in commitment if the cost of participation (time and resources) was becoming too high, and to identify any need for stronger inputs from a particular group following identification of a specific issue. Participants themselves were part of this evaluation process.

The inclusive and participatory nature of the approach was strongly appreciated by the participants, who were all able to make active contributions to identification of issues, analysis and debate. Their commitment to the process was demonstrated by regular attendance and, in the event of unavoidable absences by individuals, through their replacement by colleagues. The degree of interaction and information exchange between sectoral interests, and between local interests and district and national agencies was high, and was remarked upon by agency staff as both innovative for the region and effective. Overall, it is concluded that there was a satisfactory level of "genuine participation" in the process of impact assessment and identification of management options by all stakeholders. The exception to this was the poor representation of the Irrigation Department in the final stages of the process.

Integrated use of local knowledge. The interaction between local and scientific knowledge improved the understanding of inter-sectoral issues, the nature and causes of project impacts and the resolution of problems. This was particularly important in the identification of the focus of the study and the objectives for improved management. For example, in prioritization of the key issues identified for the assessment (see section under Conduct of the Impact Assessment), five were selected from an initial list of nine. This selection was contingent on the values and priorities of stakeholders, and technical specialists working alone would have determined priorities differently.

Another example of the use of local knowledge was the determination of the low productivity of the unmodified river channel and floodplain. This was anticipated by fisheries ecologists and confirmed by community interviews. Similarly, a combination of knowledge of fish-population dynamics in shallow water bodies and local fishing, access regulation and irrigation practices will be essential in the development of improved management of reservoir drawdown levels and fish stocks.

Overall, the knowledge and perception of impacts differed between groups, and such differences were of value in achieving the holistic perspective and then appropriately narrowed scope of the study, ensuring that critical issues were not overlooked or left unresolved.

Representation of interest groups. As noted above, representation of the selected communities and each sector and governance level was achieved in terms of workshop attendance. During the workshops, specific attention was also paid to ensuring adequate representation by all interest groups in terms of their opportunity to express interests and concerns. On major issues each group was sequentially given the chance to state its position. Approximately the same time was allowed for each, with additional time for those less able and experienced in presenting their cases (for example, representatives of fishing communities with low educational levels). Thus attempts were made to balance stakeholder power and influence throughout the process. This specifically addressed an imbalance in favor of farmers compared to fishers that was present at the start; fishers initially being much more diffident and reticent in expressing their views. Compared to this initial situation, the needs of fishers progressively gained weight in the process. This was demonstrated by an observable increase in the awareness, understanding and integration of fisheries needs in debates on how to improve water management in the catchment. For example, irrigation managers (particularly representatives of the Project Management Committee) suggested that fishers should be invited to the seasonal water planning meeting ("project committee meetings" occurring about once a month in KOISP and *kanna* meetings coordinated by the Division Secretariat). This was a suggestion considered inconceivable or at least not negotiable prior to the process.

Communication and conflict reduction. The assessment revealed the conflicts of interest that existed between farmers and fishers, and the sectoral agencies responsible for irrigation, fisheries and wildlife conservation. These were reinforced by variation in the perceptions and knowledge of these groups with regard to causal factors and the severity of project impacts. Collation, dissemination and discussion of the impact assessment results in ways that were accessible to all were observed to decrease uncertainty and the levels of misunderstanding and controversy between such stakeholders. The creation of a shared responsibility for problem-solving and time-bound generation of management-oriented solutions also contributed to this (further details can be found in Nguyen-Khoa and Smith 2004).

For example, farmer and fisher groups were in conflict over reservoir levels during periods of water scarcity and over lagoon water levels and management of a drainage connection to the sea (a breachable sand bar). These conflicts initially appeared irreconcilable but the assessment approach reduced tensions by establishing the main causal factors underlying the conflicts and a shared knowledge of the severity of the issues for each group. This led to a more positive and creative dynamic in which both sides collaborated and identified possible solutions and principles for agreement, deemed equitable and acceptable by all, even though final resolutions and detailed design of implementable proposals were not achievable within the time frame available.

Overall, it was demonstrated that the approach provides an effective means to promote communication and a common understanding of problems across sectors and interest groups that have different concerns and priorities. Options gathering broad-based support could be identified and used as the basis for preliminary recommendations accepted as legitimate by all participants, even when this required change in attitudes and behavior. This was also achieved despite differences in the education level, skills as a representative and language. However, although not an issue in this case, it is recognized that such participatory processes can also raise or exacerbate conflicts that have lain dormant because of a lack of means for their expression. This is most likely when a "voice" is given to groups that have previously been the most marginalized and neglected.

Adaptation and Learning

As time and resources for a study are inevitably limited the first objective of an adaptive approach is to be able to match the impact assessment to the resources available and priorities of the situation. As noted above, the integration of scientific and local knowledge in the screening and scoping phases, and the selective use of data sources and analytical methods for impact assessment largely enabled this to be achieved within a short time frame. However, a genuinely adaptive approach also implies that there must be sufficient flexibility to extend the time frame and/or provide more resources when early findings show that this is justified. Identification of the need to investigate complex and previously un-researched issues may provide such a justification. In this case study, a longer time scale would have been advantageous in enabling a more comprehensive analysis of the information collected and a more detailed appraisal of mitigation or enhancement measures. More time was also needed to improve awareness of the process and raise participation from higher governance levels. In particular, lobbying with regard to the characteristics and merits of emerging recommendations was needed within the Irrigation Department.

As noted above, the process and its outcomes were continually monitored and evaluated by the study team and workshop participants. Validation of assessment results was both formal, through direct consultation during workshops, and informal through further meetings and interviews with key informants. Questionnaires that corresponded to the main phases of the impact assessment were also systematically distributed at the end of workshops. These evaluated the process (for example, organization and conduct of the workshops), the understanding gained by participants, and the value of the outputs to date. Any gaps in the knowledge generated to date and further needs were also identified. This established the ability to respond to outcomes and lessons learnt. For example, the first workshop revealed the need for time to be spent in building the capacity of members of fisher groups to act as representatives and active workshop participants. This involved additional briefings and confidence-building exercises. Identification of the conflict between farmers and fishers over reservoir drawdown prompted additional investigation of available data and methods to model the problem and develop management guidelines. Disagreements over the estimated value of shrimp production used in the fisheries balance analysis prompted the pragmatic response that a range of values be used and carried forward into any assessment of trade-offs. As the study progressed new questions beyond the initial assessment of impacts came to the fore, for example: Were local government agencies genuinely willing to include consideration of fisheries' needs in the water management policy? What is the most efficient way to support coordination between irrigation and fisheries agencies?

It was also learnt that the timing of responses to outcomes and lessons was critical. A valuable quality for the approach is a capability to recognize windows of opportunity for change or improvement. For example, recognition of the moment when attitudes of farmers with regard to the needs of fishers "softened" and the focus could progress from discussion of problems to identification of solutions; also, timing of awareness creation at the national level and dissemination of recommendations to coincide with the formulation of a national integrated water resources management (IWRM) policy.

Flexibility and adaptation were also necessary to cope with unanticipated outcomes. For example, the nature of the conflicts between farming and fishing interests identified early in the assessment shifted emphasis away from the impacts of construction to operational issues and, specifically, aspects of water management within the scheme.

Outputs

Impact-Assessment Results

The detailed impact assessment results are presented in Nguyen-Khoa et al. 2005, and were briefly summarized above (see section on Implementation and Evaluation of the Approach, p.13). These were judged to be accurate and comprehensive in terms of coverage of important issues, and as a basis for identification and design of management responses. Key results of relevance to the management of the KOISP included the following: a) the identification of the main processes causing degradation of catchment fisheries, assessments of the number, location and vulnerability status of fishing households negatively impacted by scheme construction and more significantly by the operational conflicts of interest between irrigation and fishing, b) the severity of these impacts in terms of lost income relative to returns to labor and capital in alternative livelihoods, and c) the relative insignificance of impacts on aquatic biodiversity.

It can also be claimed that the results are management-oriented, understandable and usable. Of the fisher-farmer conflicts only those relating to water management and sandbar opening in the lagoons were directly attributable to the construction of the KOISP. Conflicts over reservoir water management arose from general water scarcity due to low rainfall and increasing irrigation demand. The project management has some ability to alleviate the problem in the downstream tanks through releases from the main reservoir, but expansion of the command areas, rice monoculture and water allocation regimes dominated by farmer interests exacerbate the problems. Linkages between fisheries and irrigation institutions have never been strong in the project area, but increasing both control over water resources and demands have made this lack of linkages a more pressing problem. Opportunities to address this within current institutional arrangements by inclusion of fisheries in the national IWRM policy were identified. All of these issues that are amenable to mitigation by relatively low-cost measures were well understood by stakeholders. These results demonstrated a sensible focus on existing resources, capabilities and opportunities.

Management Recommendations

As noted above, the impact assessment revealed relevant and feasible opportunities for improvement without radical changes in the system, emphasizing in particular the linkages between fisheries production and management of the irrigation system. At first, the remedial measures proposed by stakeholders tended to lack creativity, with a tendency to repeat obvious options and past attempts that had already proved unsuccessful or costly, for example, an ineffective (and now silted) canal constructed to discharge water from the lagoons to the sea or proposed drainage diversion canals around the lagoons. This was partly the result of a lack of time to carry out more comprehensive appraisal of the technical and economic feasibility of options, revealing costs and risks, and probably other impacts and trade-offs. Then as understanding and consensus grew there was some innovation in recognition of the potential benefits of integrated combinations of measures, addressing interacting effects that might otherwise impede effectiveness, and improving the institutions central to water, land and fisheries management. Time and poor representation of the Irrigation Department in the final workshops limited full assessment of such an integrated set of solutions, but it is notable that two important general principles received unanimous support from the participants. First, that particular attention should be paid to the needs of the poorest sections of communities and to the preservation of their livelihood opportunities. Second, that it was imperative to improve water management within the catchment to optimize allocation of the resource, and that it was potentially possible to raise the aggregate benefits from water use by considering the needs of fishing and other uses alongside those of farming. The promising potential of these outcomes, the degree of integration achieved and the broad-based support for the proposals led to the conclusion that the approach has the potential to generate management recommendations likely to be superior to those originating from a conventional technical (and single sector) analysis alone.

Key Research Priorities

The approach was successful in identifying knowledge gaps and research priorities, the relative importance of these, and in screening out other issues. For example, there is a clear need to research and develop the most effective management regimes for rehabilitated reservoir and lagoon fisheries, a priority, given their livelihood importance in a depressed region. There is also a need for a nationwide strategic assessment of the impacts of water resources developments on inland fisheries, taking account of cumulative impacts at river basin level in a context of growing water scarcity. In contrast, this case suggests that in-stream flow studies or the design of facilities for fish passage across dams and other structures are a low priority from fisheries production and livelihoods perspectives, even if desirable for biodiversity conservation.

Impact

As this was a pilot testing of the approach the evaluation of its impact can only be tentative and preliminary, and no changes in water or fishery management were expected to take place immediately as a result of the assessment. Assuming the recommendations made were refined in detail and taken up by scheme managers, a more rigorous evaluation would then require monitoring of implementation of the recommendations, plus a continued process of consultation among the relevant stakeholders.

Despite this, the use of the approach for the KOISP demonstrated significant positive outcomes for each of the following. It began a process of increasing the representation and influence of fisher communities in scheme-level processes of water management, and improved communication and cooperation between farming and fishing interests. It used modern and innovative methods to address complex and longstanding conflicts of interest between competing uses for water. It produced information of relevance and practical use to scheme management, identified possible mitigation and enhancement measures and established a broad-based local consensus on feasible management improvements. The management orientation of the approach meant that identification of potential impacts of its use and possible institutional uptake pathways were part of the process, and this helped ensure outcomes that were relevant and significant. Strong interest in the continued use of the approach was demonstrated by the reactions of workshop participants and responses to workshop evaluation questionnaires.

Weak representation of the Irrigation Department in the final stages did leave the consensus achieved incomplete. The experience also showed that recommendations will have most impact after detailed costing and feasibility studies are completed. The capability of local agencies and communities to implement recommended measures and adapt to the technical changes inherent in them may also need to be enhanced.

In terms of uptake and adoption potential at the national level, the following claims can be made. The approach raised awareness of the socioeconomic importance of fisheries and irrigation impacts among policymakers, stakeholders and relevant experts, and should increase the weight given to fisheries in the policy agenda for water resources management. For example, a member of the Water Resource Secretariat showed a strong interest in the provision of better understanding and guidance on how to address and give weight to fisheries and environmental issues, as required by the IWRM policy. Interest at the national level was also evidenced by strong representation in the process from the fisheries scientific community and most relevant government departments. The opportunity to influence national policymaking needs to be developed through further awareness creation, dissemination of the results and completion of additional project and strategic assessment studies that clarify how best to integrate fisheries into water policy. A disadvantage that needs to be overcome is that the approach falls between sectors and agencies, and thus may lack both a natural institutional home and a “champion” to carry it forward.

At the international level, there is potential for uptake of the approach, particularly in countries with significant inland fisheries that contribute to the livelihoods of large numbers of poor households. An ex-ante pilot assessment has been successfully conducted for a proposed irrigation scheme in Lao PDR (Nguyen-Khoa et al. 2005), which has again demonstrated the relevance and utility of the approach and its outcomes. For uptake internationally, the Guidance Manual (Lorenzen and Smith et al. 2004) exists as a resource that includes both a knowledge base and guidelines for the approach described in this report.

Discussion: Strengths, Limitations and Challenges

The evaluation of the KOISP case study has demonstrated the following strengths of the approach. By emphasizing "genuine participation" by all relevant stakeholders it can exploit the known strengths of participatory processes including the incorporation of local knowledge and establishment of local "ownership" of measures agreed for implementation. For the KOISP, it successfully brought stakeholder groups together and established a common understanding of the key impacts and their causes in the project area. It also established a consensus (at least at the local level) on the need to include fisheries considerations in water use planning, and on a range of possible mitigation and enhancement measures.

The screening and scoping stages achieved the rapid identification of key issues, working estimates of the magnitude of observable (or likely) impacts, and definition of priorities for mitigation or enhancement. The production and livelihoods orientation of the process helped screen out other issues and to ensure the relevance of the assessment and its outcomes to resources users and management agencies. Adequate representation and participation by all stakeholders in the impact assessment were desirable and the varying perceptions of the relative importance of impacts help ensure comprehensive coverage of all relevant issues and identification of the most pressing areas of conflict, although it also initially raised tensions between groups and was difficult to manage.

The approach worked well as a framework rather than a prescriptive process, leaving scope for incorporation of alternative concepts, tools and methods as necessary. The initial use of simple and transparent tools such as mapping of habitats and budgeting of fisheries production on the basis of comparative yield information provided quantified estimates of the value of fisheries, which were transparent and accessible to stakeholders. Iteration could then allow a phase to be prolonged and analysis repeated or refined as necessary to overcome a constraint, fill a knowledge gap and achieve improved and widely supported outcomes. This provided flexibility to deal with the uncertainty inherent in the prediction or evaluation of complex and variable phenomena. The appropriate use of techniques such as a sensitivity analysis was useful but, overall, it was important to acknowledge where uncertainty existed and to respond with an iterative and adaptive approach well informed by continuous monitoring and evaluation.

This composite, adaptive and participatory approach not only produced technically valid assessment results of value to the scientific community, but also initiated a negotiation process and the potential for conflict resolution between the interests of farmers and fishers. It also demonstrated the ability to contribute to higher-level processes given suitable entry points, for example, timeliness in relation to IWRM initiatives in Sri Lanka.

The weaknesses of the approach include the known limitations and sources of bias that can affect participatory processes. Unbalanced power for some groups over others might impede or block the reaching of certain otherwise objective outcomes. There can also be sociocultural barriers to participation by, or negotiation between, stakeholder groups and there is the potential for creating or exacerbating conflicts through bringing to the fore issues that had lain dormant or hidden, or by revealing those simply incompatible or unresolvable. Achieving representation and a "voice" for all groups was possible in the case of the KOISP, but it takes time, patience and specific efforts to ensure achievement of these for the least educated, confident and influential. In the case study, initially strong and resistant farming interests became more amenable to the potential benefits of improving water management and reducing conflicts between fishers and farmers. Where such consensus cannot be easily reached, additional approaches for conflict resolution may be needed (e.g., RESOLVE Inc.

et al. 2000). These could be used within the flexible framework of the approach and are indeed more likely to be successful as complementary rather than as independent measures.

Compared to a narrow technical assessment, a participatory and holistic approach may complicate the specification of management objectives and processes for selection of preferred outcomes. It may also slow down the process of investigation and increase costs. For example, integration of local knowledge may not be straightforward and, in general, more resources (time, budget and expertise) will be needed. In particular, workshop facilitation and communication skills and strategies are needed. Transparency for all decisions is essential, requiring effective processes of knowledge management, representation and communication. In the KOISP assessment, the maintenance of a regular flow of analysis and information to and between stakeholders helped define management options whilst reducing tensions arising from conflicts of interest. Working within constraints and, particularly, time management, are inevitably key elements of the process. Getting the process right and achieving integration, genuine participation and adaptive learning may slow down the production of outputs but with regular use and refinement adjustments to the process, they should take less time, and it should be possible to focus resources on achieving desired outcomes. Successive rounds of use and evaluation will develop capacity, refine the approach to match local conditions and help promote the necessary institutional acceptance.

The commitment by stakeholders to attend a series of workshops is also demanding. Attendance at four to five workshops was expected from local stakeholders, and at least one to two for national representatives (the first and last workshops). The roles of all stakeholders and policymakers need to be clearly defined at each stage of the process and responsibility and true commitment are required.

As noted, isolated impact assessments on a project basis may neglect important cumulative or counteracting impacts of irrigation at the river-basin scale. Strategic assessments at a basin scale may then be preferable, but this approach will be more difficult to apply at river-basin scale, given the increased number of interest groups (and hence participants), and also the potential data requirements and complexity of the possible range of issues. Similarly, there may be a need to extend the time horizon of the assessment, seeking to predict ecological changes and socioeconomic trends for periods of 10 years or more into the future, but with comparable practical difficulty.

Implementation of the approach can be complex because it requires both technical and practical issues and constraints to be addressed, for example for the KOISP, the capacity building of primary stakeholders alongside modeling of fish stock dynamics in shallow reservoirs. There is a need to harmonize disciplines and different scientific approaches and paradigms, and the approach thus requires simultaneous management of data, people and processes.

Management of the process can thus be challenging for a number of reasons. The approach will be implemented within an existing social and political setting, seeking to benefit from the interaction of a wide range of stakeholders, and to be as objective and scientific as possible, but subject to the risks and constraints arising from sensitivities between groups, new or existing conflicts, and irrational reactions or interpretations. This raises the need to determine the minimum degree of scientific rigor necessary for reliable decisions, whilst recognizing that a failure to integrate local knowledge and concerns can also lead to erroneous or non-implementable results and a false impression of coverage and accuracy. This, and the degree to which the process is open-ended and flexible, may not suit technicians or decision makers expecting deterministic and "blueprint" solutions. Outcomes have to be kept under continual review, based on updated knowledge or changing objectives of stakeholders and decision makers, and ensuring adaptation to system dynamics and evolving conditions.

The approach requires access to comprehensive and up-to-date knowledge of existing methods in each relevant discipline, plus the ability to select appropriate tools in relation to the issues raised and given the available resources. For example, given the seasonality of fisheries and their dispersed and inconspicuous nature, it is often impractical to estimate production during short project-impact studies. However, comparative empirical data on fisheries production might be available for the different habitat types and geographical areas, and these can be used where location-specific data are lacking.

Successful use of the approach depends on first ensuring that there is institutional support for its use at appropriate levels of governance, with recognition of the importance of integrating fisheries concerns into the planning of irrigation or other water resources developments. As in the KOISP case, key issues will tend to be identified at the local level and this is also where the complexity of interactions and trade-offs can best be investigated and understood. It is clear, however, that adequate representation from the level of governance with authority for resource allocation or policy decisions is also essential, particularly during the problem identification and decision-making phases. The effort needed to create awareness and generate political will at all government levels for processes of this nature should not be underestimated. Ultimately, such approaches need to be institutionalized as part of the regular procedure. This may be in the form of adapted procedures for EIAs, as these are already widely integrated in planning procedures in most countries.

The KOISP impact assessment highlighted that effective future management of created, restored or protected natural fisheries is equally important as the assessment and management of irrigation-scheme impacts. Enhancement of habitats, monitoring of stocks and regulation of exploitation levels need to be well integrated on a spatial and temporal basis with the management of irrigation water allocation regimes. This confirmed that management of irrigation impacts on fisheries needs to be multi-sectoral, taking account of multiple and competing water uses within a river basin and involving processes that can recognize and resolve trade-offs between competing interest groups in the management of irrigation and water resources more widely.

Such trade-offs and decision making will also depend on the priorities given to the development of the area in which the irrigation scheme is located. Irrigated agriculture is often assigned a key role in driving the economic and social development of areas suited for it, but management of such projects must at least ensure that negatively affected groups are not made significantly worse-off without adequate mechanisms for compensation and the mitigation of impoverishment. Also that too strong a disparity in the distribution of benefits and costs does not create or exacerbate recurrent conflicts. Consideration of fisheries and their productive and employment potential is important because they can perform a range of significant roles in this context. They may be particularly well suited to meeting the needs of some of the poorest and most vulnerable groups either neglected or adversely impacted by irrigation, because of their relatively low barriers to entry as a livelihood activity. Differentiated policy and management responses are required, which are well adapted to local conditions, and which recognize that fisheries can perform a range of livelihood functions from an activity of last resort, through being one element in a diversified livelihood strategy, to a specialized and remunerative occupation. The approach described here has been shown to have the potential to encompass such complexity and generate policy relevant outcomes.

CONCLUSIONS

An Adaptive, Participatory and Integrated Assessment (APIA) for the impacts of irrigation development on inland fisheries has been developed. This used a recently improved knowledge base and was pilot-tested through an ex-post assessment of the impacts of the KOISP in Sri Lanka.

The approach combines a holistic and integrated assessment of impacts, with participation by stakeholders, and an adaptive response to the information generated at each stage of a structured and sequential process. The rigorous evaluation of the application and effective combination of the underlying concepts (adaptation, participation and integration) provide insights into the merits and limitations of the approach.

Implementation and evaluation of the approach for the KOISP showed that APIA facilitated a relatively rapid assessment of gross production and livelihoods impacts, and opportunities for mitigation of negative, or enhancement of positive, impacts. Results validated the use of a flexible and composite methodology that made cost-effective use of formal and informal methods of research and secondary data sources, including data derived from comparative empirical studies. Resources available for primary data collection could be targeted at key issues and the understanding of causal factors. Although the time available for this case was limited, the approach maintained sufficient flexibility to allow more refined or rigorous assessments to be made of specific issues if required.

The outcomes have included contributions to the knowledge of the impacts of irrigation on fisheries (as presented in Nguyen-Khoa et al. 2005), a practical framework to guide holistic, participatory and adaptive impact assessments, identification of possible limitations and essential requirements for successful use of the approach, and identification of future research needs. Key contributions to the knowledge of most relevance to development and use of the methodology itself are that modified aquatic systems can support significant fisheries production and thus that irrigation development can have a range of both positive and negative impacts, with fisheries not always being degraded or restricted to a livelihood activity of last resort. Land and water management options within irrigated systems can be crucial to sustaining or enhancing fisheries and complementarities can be identified and exploited, although production and livelihood impacts may not coincide favorably with biodiversity impacts. Even where aggregate net impacts on fisheries productivity are neutral or positive it is important to make an assessment of impacts that is disaggregated spatially and for different socioeconomic groups of stakeholders.

A holistic, participatory and adaptive impact assessment is advantageous in respect of all of these issues, and thus its benefits compared to a conventional narrow technical assessment have been shown to include the following:

- The ability to study inland fisheries in a larger context of multiple competing uses for water and alternative livelihood opportunities, with explicit identification of conflicts within a sequential, structured and management oriented process.
- The aim for addressing the most important issues and solutions to be sought.
- The emphasis on existing opportunities and the need for workable and cost-effective mitigation and enhancement measures, with avoidance, where possible, of costly modifications to the irrigation infrastructure or other engineering solutions.
- The strong motivation for stakeholders to seek out complementarities between irrigation and fisheries and to minimize trade-offs, with the potential to determine “win-win” solutions from resolution of conflicts between farmers and fishers.

In terms of its limitations, use of the approach can be demanding of time, expertise for its implementation and requirements for its support. In particular, adequate awareness and strong institutional support for its use are essential at all relevant levels of governance. Participatory processes can be biased if the representation and influence of competing groups is unbalanced, and there is risk that conflicts that are difficult to resolve receive undue emphasis. Participation and local knowledge can be of great value, but should not be a substitute for rigorous technical assessment where this is necessary.

In terms of future research needs, improvements can still be made in the knowledge base and tools available for the assessment of impacts of irrigation on fisheries and, in particular, for analysis of interactions and determination of causal relationships. Thus completion of further case studies in contrasting natural environments will help broaden and deepen the knowledge base and contribute to improvements in methodology. Finally, there is a need for more study of the possible cumulative and synergistic impacts on fisheries of multiple irrigation schemes and other water resources developments within a river basin.

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Postal Address:
P O Box 2075Colombo
Sri Lanka

Location:
127, Sunil Mawatha
Pelawatta
Battaramulla
Sri Lanka

Tel:
+94-11 2787404

Fax:
+94-11 2786854

E-mail:
iwmi@cgiar.org

Website:
http://www.iwmi.org

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