

# Environmental impact assessment for groundwater management

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*Groundwater plays, and will continue to play a critical role in satisfying water requirements of most arid and semi-arid countries. Thus, sustainable groundwater development and preservation of groundwater quality should receive priority attention. This paper outlines the process through which environmental impact assessment of groundwater development projects can be carried out in arid and semi-arid developing countries. An appropriate framework for environmental impact assessment is suggested. It is recommended that such impact assessment should be at the centre of any good groundwater development and management plan.*

Throughout history groundwater has been an important source of water that has been extensively used for human consumption and for agricultural production. Even now, groundwater plays a critical role in satisfying the water requirements of many countries, both developed and developing. For example, 90% of the rural population and 50% of the total population in the USA depend on groundwater for their domestic water requirements. Similarly 73% of the population in West Germany, 70% in The Netherlands and 30% in the UK depend on groundwater for domestic purposes. In some parts of the world, as much as 75 to 85% of the water used for irrigation comes from groundwater.

Groundwater is expected to play an increasingly important role in Egypt, and in many other similar arid countries, in the coming decades. Preliminary estimates carried out in Egypt indicate that 500 billion  $m^3$  of groundwater is available in the Nile Valley and the Delta. The current annual rate of abstraction of groundwater for domestic, industrial and agricultural purposes in Egypt is estimated at about 2.6 billion  $m^3$ . It is expected that this rate can be increased by about 90%, to 4.9 billion  $m^3$ , which is approximately equivalent to the annual recharge rate.

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## Environmental aspects of groundwater management

Like surface water, groundwater has many implications if it is to be managed in an environmentally sound manner. The three main considerations for environmentally sound groundwater management are the following:

- (i) Groundwater development must be sustainable on a long-term basis. This means that the rate of abstraction should be equal to or less than the rate of recharge. If the rate of abstraction is higher than the rate of recharge, it will result in groundwater mining, which can be carefully considered for some specific cases. If mining occurs, groundwater levels will continue to decline, which will steadily increase pumping costs, and then at a certain level it would no longer be economic to pump it for many uses such as agricultural production.
- (ii) Human activities which could impair the quality of groundwater for potential future use should be controlled. This would include leaching of chemicals like nitrates and phosphates from extensive and intensive agricultural activities, contamination by toxic and other undesirable chemicals from landfills and other environmentally unsound waste disposal practices, bacterial and viral contamination due to inadequate

sewage treatment and wastewater disposal practices, and increasing salinity content due to inefficient or improper irrigation practices.

- (iii) Improper groundwater management often contributes to adverse environmental impacts. Among these are land subsidence in certain urban centres due to a high rate of groundwater abstraction, as in Bangkok, and sudden strict control of groundwater abstraction which allows the groundwater table to rise steadily over its recent long-term levels, which could contribute to structural damage as in London and Birmingham in the UK.

### **Environmental impact assessment (EIA)**

EIA can be considered to be a planning tool which assists planners in anticipating potential future impacts of alternative groundwater development activities, both beneficial and adverse, with a view to selecting the 'optimal' alternative which maximizes beneficial effects and mitigates adverse impacts on the environment. EIA procedures have been successfully used in several developed countries during the past two decades, but only within the past 10 years or so has EIA been introduced in several developing countries. While most EIAs carried out in the past, and being carried out at present, have dealt with the potential environmental implications of proposed development projects, there is an urgent need to monitor environmental changes once a project is operational. Such monitoring is necessary not only for those projects in developing countries for which EIAs were carried out during planning stages, but also for the vast majority of currently existing development projects which received very little environmental attention during their planning and construction phases.

EIA can be used not only for groundwater development projects but also for plans, programmes and policies. Many projects are the direct outcome of the implementation of plans and policies. Often the implementation of a plan or policy requires a variety of different individual projects to enable its objectives to be achieved. If EIA were restricted to single projects only, then the cumulative regional and national impacts of development actions would be ignored. It is necessary, therefore, to assess the impacts of 'higher level' development actions such as plans, programmes and policies to gain a greater understanding of the cumulative impacts of development. Such EIAs will, of necessity, be general and can be supplemented by more detailed EIAs at the project level.

Past experiences indicate that as a general rule several national institutions and/or agencies are

involved in water development, such as Ministries of Water Resources, Agriculture, Health, Energy, and Public Works. Often the organizations concerned have their own sectoral short- and long-term policies on environmental issues as well as the necessary legal mandate. These policies are not always compatible with each other, and under such conditions they are unlikely to be very effective in maintaining and/or improving overall environmental quality. EIA, if carried out properly, could contribute to an integrated environmental planning process which could effectively respond to critical social and environmental needs on a long-term sustainable basis.

### **EIA for developing countries**

It is generally recognized that EIA can identify major areas of environmental damage due to development activities in a systematic and comprehensive manner. However, notwithstanding the intrinsic value of EIA, past experiences clearly indicate that there is an urgent need to develop procedures so as to make them more adaptable to conditions in developing countries. It is now quite evident that detailed, expensive, time-consuming and sophisticated EIA techniques used in many developed countries at present are unlikely to be of much practical value for use in developing countries in an operational sense (Biswas, 1991). Such difficulties are to be expected, since the direct transfer of technology from North to South, with differing social, economic, physical and institutional conditions, has not been an easy process; outright successes have generally been exceptions rather than norms (Biswas and Qu, 1987).

In adapting EIA for use in developing countries, it may be useful to take note of differing characteristics, such as limited resources in terms of information technology, which can be equally applicable to all developing countries. Various alternatives are available and each country must choose its own system.

### **Objectives**

The objectives for applying EIA to groundwater management could be the following:

1. to identify adverse environmental problems that may be expected to occur;
2. to incorporate into the development action, appropriate mitigation measures for the anticipated adverse problems;

3. to identify the environmental benefits and disbenefits of the project, as well as its social and environmental acceptability to the community;
4. to identify critical environmental problems which require further studies and/or monitoring;
5. to examine and select the optimal alternative from the various relevant options available;
6. to involve the public in the decision-making process related to groundwater management; and
7. to assist all the parties involved in the specific development project to understand their individual roles, responsibilities and overall relationships with one another.

### **General principles**

Both human activities and natural phenomena can cause groundwater deterioration, but as a general rule it is human activities that contribute to maximum damage through over-exploitation and irrational use. EIA can be successfully used to identify beneficial as well as adverse consequences of human activities, and is thus of prime importance to all parties involved in development planning and implementation of groundwater projects. It is equally applicable to all new development actions as well as to the expansion or modification of currently existing actions. Furthermore, in most developing countries few environmental considerations were incorporated in past development actions. Consequently many of the benefits that were originally anticipated by the planners are either not occurring or are being negated by unanticipated adverse side-effects. There is thus a need to carry out environmental reviews of existing projects so that the major problems can be rectified.

EIA reports should be presented in a simple form so that decision makers can readily digest and make use of the analysis in making rational decisions. However, EIA should aim at maintaining the availability and use of groundwater on a sustainable basis. Since environmental losses and gains cannot always be evaluated in straight economic terms, the expected changes in environmental values, which often can only be considered in a subjective way, have to be taken into account in the decision-making process.

EIA is already a legal requirement for water development projects in many developing countries, but it has to be admitted that its use thus far for groundwater development projects has been very limited. A legal requirement by itself, though an essential first step, cannot ensure that EIA will actually be conducted, or that, if conducted, it is properly carried out and effectively used within the

prescribed decision-making framework. Both legal and institutional mechanisms need to be simultaneously developed in order that EIA procedures can be implemented effectively. The existence and implementation of these mechanisms should ensure that groundwater development plans likely to have significant environmental impacts are automatically subjected to the EIA process. The legal and institutional mechanisms for EIA should be formulated in all developing countries as early as possible to provide a solid and enduring foundation for EIA.

The interdisciplinary nature of groundwater problems means that close cooperation and coordination are essential among the various government departments dealing with specific types of problem. Where expertise is not available within the government itself, it is necessary to consult with universities and other scientific establishments so that EIA can be properly conducted. The interdisciplinary nature of groundwater problems also means that the teams conducting EIA should also be multidisciplinary and interdisciplinary.

To provide adequate environmental information for EIA, it is essential to set up national groundwater data banks which can facilitate the use of the information available. The efficiency in the handling and use of data is highly likely to increase significantly under such circumstances. Currently in many developing countries data are collected by various governmental authorities on groundwater. Owing to the lack of appropriate interdepartmental coordination, it is often difficult – if not impossible – to obtain an aggregate picture on data collected. This means that the available groundwater data may not be used for EIA, since people may not be aware of their existence. In some cases it could even result in duplicate data collection, which is a poor use of the very limited financial resources available in many countries.

The flow of environmental information on groundwater development between developing countries is highly unsatisfactory at present. It is not unusual to find that the flow of technological information from developed to developing countries is better established than between developing countries, even though the latter may be more beneficial and relevant because of similar social, economic and institutional systems.

Developing countries must carry out EIA of groundwater projects to the best of their national capability. Therefore it is urgently necessary to train their own experts in EIA. Foreign experts are no substitute for well-trained local experts. The involvement of local expertise will not only ensure that EIAs are carried out which are more relevant to local

needs, but will also ensure a significant reduction in EIA costs when compared with those conducted by foreign experts. It is crucial that EIAs in developing countries be cost-effective.

### EIA framework

An EIA procedural framework for a groundwater development project is shown in the flow chart in Figure 1. A feasibility study of a project basically

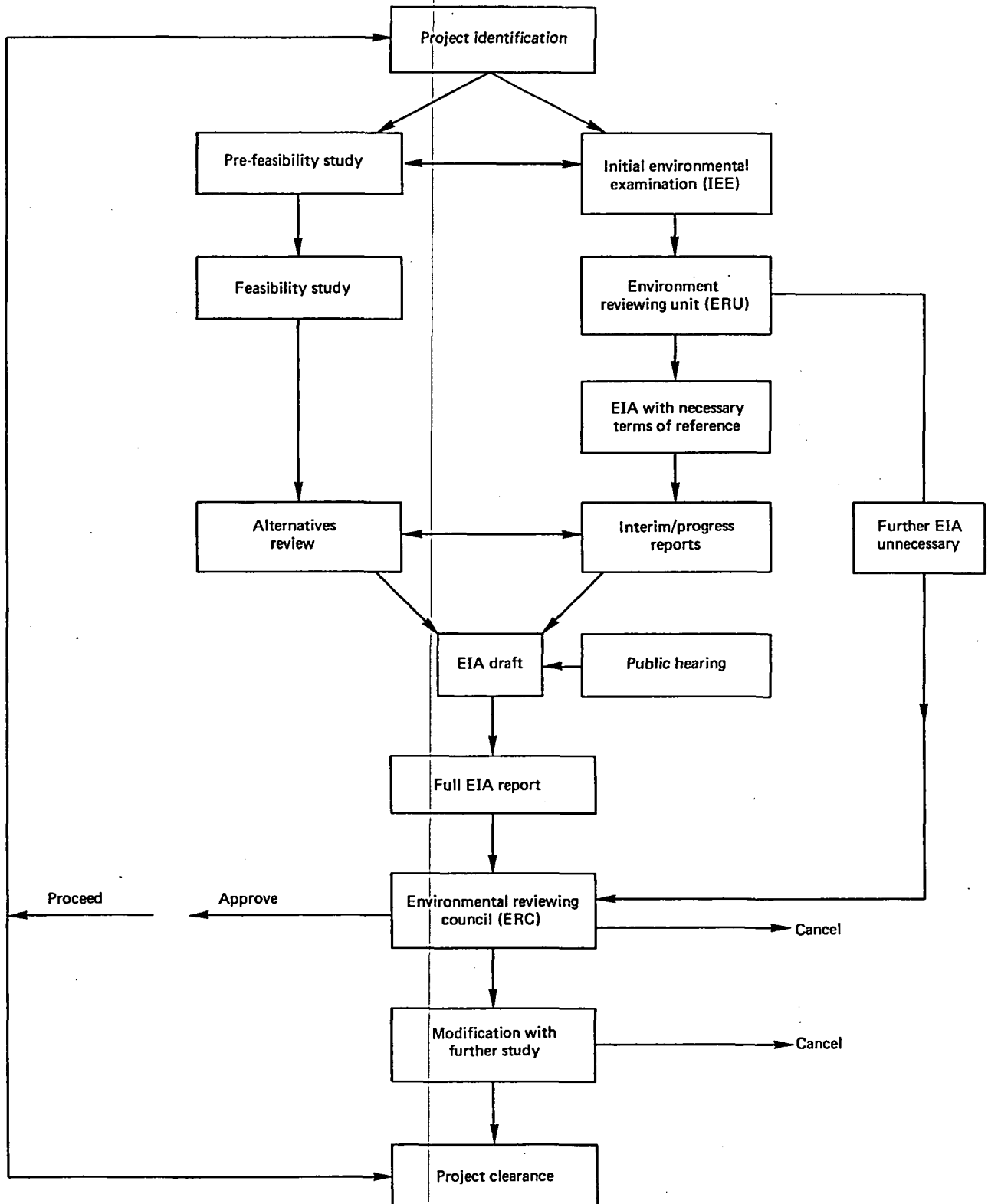


Figure 1. Flow chart of project analysis.

depends on data and information on the technical, economic and social aspects of the project. To avoid higher cost and unnecessary time delays, EIAs of groundwater projects should be carried out along with the initial feasibility study.

Before going into detailed analysis, it is advisable that as soon as the project brief (eg its scale, nature, location, time frame, etc) is known, an initial environmental examination (IEE) of the project should be undertaken to determine whether it requires a full EIA. This activity is often known as 'screening'.

After an IEE is completed, it should be reviewed by an environmental reviewing unit, together with the pre-feasibility study report, in order that the technical, economic and social as well as environmental aspects of the project can be carefully examined and evaluated in a comprehensive fashion. If the reviewing unit finds no serious adverse environmental impacts, the project should be sent to the environmental reviewing council (ERC) for approval. If approved by the ERC, the project can be implemented, provided it complies with all existing environmental regulations. If, however, after deliberation the ERC requires further assessment on environmental impacts, a detailed EIA with appropriate terms of reference (which may include baseline data requirements and the use of a particular EIA method) may be prepared by the developer and/or the environmental agency.

Interim or progress reports of the EIA study being undertaken should be submitted for review and evaluation at regular intervals so that the parties concerned are kept informed of the states of the analysis.

Based on the study, an EIA draft should be prepared which should consider different, viable alternatives available. Public hearings could be arranged to encourage and facilitate public involvement and participation in the EIA. Thereafter a full EIA report could be prepared. The report should then be reviewed by the ERC, which could either approve it or ask for further study and modification. The ERC can also recommend that the project be cancelled on account of highly undesirable environmental consequences. In cases where further analysis is required the new EIA report has to be reviewed again by the ERC. After this review the project could either be approved for implementation, with or without suggestions for specific modifications, or be cancelled (eg not fit to be approved owing to undesirable environmental side-effects).

After the implementation phase of a groundwater project is approved, it is essential that some institu-

tional infrastructure exists which checks both that the recommendations made by the ERC are being actually carried out, and also that unexpected adverse environmental consequences which were not identified during the EIA are not occurring. It is equally essential to monitor results during the operational phases of groundwater projects. Unfortunately, in many countries, after EIAs have been carried out no monitoring is generally done to ensure that the ERC's recommendations are being observed by developers; nor are there arrangements to monitor developments during operational phases.

## **Concluding remarks**

Good environmental impact assessment has to be at the centre of any sound groundwater management plan. However, because of the complexities and uncertainties that are invariably associated with groundwater regimes, it has generally not been possible to carry out proper environmental impact assessment of groundwater development projects in nearly all developing countries. Accordingly, many such projects have proved to be neither sustainable nor environmentally acceptable on a long-term basis.

With substantial improvements in indigenous expertise on groundwater management, and with concomitant increases in interest in regular monitoring of the quality of groundwater, more and more developing countries like Egypt and India should now be in a position to initiate and implement rational groundwater management plans. The fact that the Cairo Round Table Meeting took place in October 1991 is a further clear indication that many arid and semi-arid countries are giving groundwater the importance it deserves in terms of total benefit to their national economies. As environmental impact assessment becomes an integral part of the planning and management of groundwater management practices, there is no doubt that it can only be considered to be a beneficial development for all the countries concerned.

## **References**

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