

Social Issues

# Human Health and Dams

Draft Final Report

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Prepared for the WCD by:  
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This is a draft working paper of the World Commission on Dams. The report published herein was prepared for the Commission as part of its information-gathering activity. The views, conclusions, and recommendations are not intended to represent the views of the Commission.

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# DAMS AND HUMAN HEALTH - EXECUTIVE SUMMARY

## 1. Recommendations

The World Health Organization welcomes the independent inquiry by the World Commission on Dams (WCD) and the opportunity to contribute positively to the debate on dams. It offers the following recommendations for consideration by the Commission:

- **Health impact assessment (HIA)**

There is an overwhelming need to include health impact assessment (HIA) as an integral component in the planning of dams and other major water infrastructure projects

In this submission the state-of-the-art of HIA is covered extensively, with special emphasis on the method and procedures, the links between Environmental Impact Assessment, Social Impact Assessment and Health Impact Assessment, and the need to incorporate HIA in any future international conventions and in national legislation on dams.

- **Capacity building**

Appropriate capacity in HIA and community health management needs to be built both within the health sector and in the sectors primarily responsible for dams.

A conducive policy framework, effective inter-institutional arrangements and staff in all relevant institutions trained in the skills of intersectoral communication and collaboration are three essential elements that need to be addressed by national capacity building activities.

At the international level, the World Health Organization is the indicated agency to provide a framework for the health impact assessment of large, often transboundary dam and river basin development projects.

- **Documentation of successes and efficacy of current practices**  
An information and education oriented data base should be compiled:

(a) describing the limited number of health success stories based on careful dam design and operation, and explaining the key management processes in detail.

(b) with an assessment of the efficacy of already implemented health risk management techniques.

This submission points out that there is scattered information on good practice in dam design and operation for health. It provides a coarse characterization of the knowledge bases of the health issues associated with dam projects. The number of successful integrated health risk management experiences in dam projects is limited, but there is a relatively large body of evidence of singular methods of good practice which have been proven to be effective under specific eco-epidemiological conditions, with an emphasis on health issues determined by environmental factors.

- **Action oriented research**

Special funding should be directed towards action research in existing and planned dam construction projects in order to strengthen existing knowledge bases and improve health outcomes. Models for reservoir management and dam operation to reduce health risks of affected communities and a number of environmental management concepts for vector control require testing of their



feasibility and effectiveness. Comprehensive documentation of the economic aspects will be crucial for successfully transferring tested methods to routine management and operations.

- **Budgeting for health**

A health component should be negotiated as a budgeted item for all project loans in order to safeguard and enhance health.

Any health budget allocated in the context of a dam project should be used primarily for preventative actions, and secondarily for strengthening of health services, with the optimal balance decided on a case by case basis. Such an investment in health should not be considered a substitute for the existing health care system.

- **Prioritising the health issues**

It is important that the health priorities are not pre-judged but allowed to emerge from the health impact analysis and community consultation.

Development agencies may have a limited or biased understanding of the health issues associated with a dam project in a given location. Priority setting therefore has to rely on a comprehensive and independent HIA complemented by an expression of the risk perceptions of affected communities. This will not only promote a correct focus on key health issues, but also enhance community ownership of the risk management measures.

- **Prioritising dam projects for impact assessment**

Screening procedures for HIA needs must be the minimum requirement for all dam projects.

A robust screening procedure, preferably anchored in legislation, will ensure that limited financial and human resources for HIA are used to their maximum capacity.

The cumulative effect on health of many small dams should be dealt with through strategic assessment of representative cases.

- **Transparency**

The health impact assessment and planning process should be open to scrutiny by all stakeholders and communities.

All components of the planning process, including HIA, benefit from the inclusion of all stakeholders at all stages of the process.

## 2. GENERAL CONSIDERATIONS

As dams, large and small, continue to be planned, constructed and operated with the aim of achieving important socio-economic development objectives, their potential to alleviate poverty can, and in many cases will, contribute significantly to the improvement of the human health status.

It is, however, the issue of equity gaps that is at the root of the adverse health impacts of dams. Benefits of dams are not disputed, but it is the uneven distribution of the benefits, including the health benefits, and of the health risks that needs to be addressed in their planning, construction and operation. A simple health accounting is not satisfactory: it is not acceptable to simply balance out the health gains of one part of the population against the health losses of another, to arrive at a net health benefit of dams. It is the increased risks for vulnerable groups that need to be identified at an early stage and managed as an integral part of dam design and operation. The protection and



promotion of human health in the context of dam projects can only be ensured if all potentially affected communities have an opportunity

- to consider how dam construction and operation will affect their own health, and
- to participate fully in the planning, assessment and decision making process

Negative health impacts of dams represent a hidden cost to the health sector. Taking human health into consideration at the planning stage makes good economic sense. Not only does it allow to keep the additional burden on the health sector limited to a minimum, but it also permits an optimal use of "win-win" opportunities for the dam operators and public health. Many of the health safeguards that should be considered good practice can be incorporated into dam projects at minimal additional costs, because they imply design changes that permit a more flexible operation. Changes in environmental and social determinants of health, resulting from a dam project, will also provide an incentive for the health sector to review the delivery of its services and improve performance and efficiency.

Three requirements are essential in order to effectively protect and promote health in relation to dam projects: (1) a supportive policy, (2) an acceptable procedure and (3) a usable method of risk assessment.

The lack of an appropriate policy framework means:

- lack of assessment of policies, programmes and projects for health impacts;
- greater than necessary adverse impacts of development on health;
- the tendency of vertical disease control programmes to ignore environment and development links;
- lack of funds for research in health impact assessment.

Environmental Impact Assessment (EIA) is an established policy and procedure in many countries and development agencies, but EIAs normally make limited reference to health. The health issue most commonly included is poisoning due to pollution; in the case of dams, filariasis, malaria and schistosomiasis, are also often cited. Other important health aspects are often neglected.

In many cases, health is addressed in a strictly 'medical' sense rather than through a wider cross-cutting view of community health. This tends to produce recommendations for strengthening health services which, although important, often do not lead to broad improvements in the identification, characterization and management of community health risks.

Some health issues have physical environmental determinants, others have primarily social determinants that will be brought to light only by a social impact assessment (SIA). Health, therefore, has a stake in both EIA and SIA, with a number of unique features that distinguish it from either of these. The solution favoured by WHO is to create a separate and parallel procedure for health impact assessment (HIA). The middle way is to plan for integration while maintaining a separate profile for health. The state-of-the-art of HIA methodology and procedures is presented in detail in the WHO submission. Critical action required in any dam project includes:

- Adding specific references to health to the Terms of Reference provided to the consultants undertaking an impact assessment and indicating the method of health impact assessment to be used.
- Providing quality assurance mechanisms through appraising or evaluating the health component of completed impact assessments.



The health issues associated with dams can be conveniently represented in six major categories: communicable diseases, non-communicable diseases, injury, malnutrition, psychosocial disorder, and lack of social well-being. The existing knowledge bases concerning the impact of dam construction and operation vary for the different categories.

### 3. OPTIONS FOR PREVENTATIVE AND HEALTH PROMOTIONAL ACTION

Many of the adverse health outcomes associated with dams and associated infrastructure developments (e.g. irrigation schemes) can be prevented or mitigated if a broader and more holistic view of project construction and operation is taken. Along with a range of insightful engineering approaches should come a recognition for the need to take an integrated, multi-disciplinary approach to environmental, social and health management. This new understanding can lead to the implementation of a range of innovative design and operational features for water infrastructure projects. Such changes may be cost effective and provide the desired health outcomes that formally were considered controllable only through medical intervention or by more drastic environmental control procedures.

There are a number of fully or partially validated options which can mitigate the adverse effects on human health of dam construction. These planning options fall into a number of categories including engineering design considerations, operational water management, social and community planning. Recommendations and suggestions for good management practice are listed in table 1. A number of general observations need to be made first:

- Preventative and health promotional measures tend to be site specific. They are linked to the geographic variation in health conditions associated with dams as well as to the relative effectiveness of measures in different ecological and epidemiological settings.
- The secondary effects of measures need to be taken into account and trade-offs will have to be found to come to a final decision.
- Whatever the technical merit of "good practice" interventions, they will only be effective and sustainable if the process of their design and implementation is transparent and participatory.



Table 1. Examples of techniques and good practices for managing health risks

Poverty reduction	Poverty reduction empowers and enables people to make choices and to safeguard themselves and their families from many environmental hazards
Zooprophylaxis	In specific settings, there is a possibility of using livestock as diversionary hosts to protect people from malaria
Wetting and drying of floodplains or streams	Controls some mosquito species, addresses nutritional issues related to traditional agriculture such as flood recession cultivation
Health centres	Ensuring that health centres are equipped and functional before dam construction, and building capacity and capability of health personnel
Water supply and sanitation	Reduces diarrhoea, intestinal parasites and schistosomiasis. Domestic water supplies should be protected from contamination by flood waters.
Vaccination	May be appropriate for certain arboviruses
Handling moribund animals	Control of Rift Valley Fever
Canal or river flushing	Floods have a flushing effect on stagnant waters, removing pollutants such as human waste, clearing drains or flushing away mosquito larvae.
Community control	Increasing empowerment and reducing uncertainty enhance health
Communication	Early warning of critical events such as floods, health promotion
Dam design	Dam off-takes that release first flush inflows with high levels of pollutants
	Structures that enable extensive control of operational water levels
Irrigation channel design and improved hydraulic structures	Minimising low flow zones to prevent vector breeding
	Reduction of contact patterns with contaminated water (schistosomiasis)
Dam siting	Siting dams in areas that require minimum population and livestock displacement
Settlement planning	Siting new settlements away from vector breeding sites
	Adequate design of community water supply and sanitation, including careful management of wastes
	Staged resettlement linked to infrastructure development
	Culturally sensitive community planning
Irrigation management	Management of cropping systems to enable wetting and drying cycles and to use water efficiently (aimed at mosquito vectors breeding in flooded rice fields)
	Minimise long term salinisation, siltation and water logging
Upstream management	Catchment management to minimise flood and pollution risks
In-flow forecasting	Early warning of floods
Water release schemes	To enhance floodplain productivity and hence nutrition
Reservoir management	Prevent excessive growth of aquatic weeds and toxic cyanobacteria
	Maintain shallow de-weeded reservoir margins near settlements
Floodplain	Sensitive management for habitat and vector control

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Good operation and maintenance	Delivering a reliable and cost-effective service
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## TABLE OF CONTENTS

<b>1. Background .....</b>	<b>1</b>
1.1 Human Health in Environment and Development .....	1
1.2 Equity and health .....	2
1.3 The economic perspective .....	3
1.4 Policy .....	4
1.5 Legislation .....	5
1.6 Integration of HIA with Environmental Impact Assessment .....	5
<b>2. Human health issues related to dam construction and operation .....</b>	<b>7</b>
2.1 Categories of health issues .....	7
2.2 Regional differences .....	8
2.3 Differentiation on the basis of dam size and purpose .....	9
<b>3. Options for preventative or health promotional action .....</b>	<b>10</b>
3.1 General considerations .....	10
3.2 Good Practice - the Planning Framework .....	11
3.3 Good Practice - Design and operation options .....	12
3.4 Good Practice - Off site management and environmental protection .....	13
<b>4. Recommendations for improving health outcomes .....</b>	<b>14</b>
4.1 Health impact assessment (HIA) .....	14
4.2 Documentation of successes and efficacy of current practices .....	15
4.3 Action oriented research .....	16
4.4 Budgeting for health .....	16
4.5 Prioritising the health issues .....	17
4.6 Prioritising dam projects for impact assessment .....	19
4.7 Transparency .....	19
<b>5. Health impact assessment (HIA) .....</b>	<b>21</b>
5.1 Introduction .....	21
5.2 HIA Procedures .....	21
5.2.1 Timing .....	23
5.2.2 Screening .....	23
5.2.3 Steering committee .....	23
5.2.4 Scoping and agreeing Terms of Reference .....	23
5.2.5 Choosing an Assessor .....	24
5.2.6 Spatial boundaries .....	24
5.2.7 Temporal boundaries .....	26
5.2.8 Appraisal and dissemination .....	27
5.2.9 Negotiation .....	28
5.2.10 Implementation and monitoring .....	29
5.3 HIA Methods .....	29
5.3.1 Stakeholders .....	29

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5.3.2	Health determinants .....	30
5.3.3	Weight of Evidence.....	32
5.3.4	Management of health risks and enhancements .....	33
6.	Acknowledgements.....	36
7.	Bibliography.....	37
8.	References.....	38



## Tables, figures and boxes

Table 1. Principal categories of health issues and the extent of existing knowledge about their association with dam projects.....	8
Table 2. Examples of regional variation in health conditions.....	9
Table 3. Examples of health outcomes from dam construction and management.....	10
Table 4. Flight range of insect vectors.....	26
Table 5. Typology of human circulation.....	26
Table 6. Examples of association of health issues with timing.....	27
Table 7. Examples of the association of health issues with different project stages.....	28
Table 8. Examples of local stakeholder communities and important health issues.....	30
Table 9. Examples of health determinants and their classification.....	32
Table 10. Examples of techniques for managing health risks.....	33
Figure 1. Procedures and methods used in health impact assessment .....	22
Figure 2. Spatial boundaries of dam health assessment.....	25
Box 1. Four strategic directions of the World Health Organisation, September 1999 .....	2
Box 2. Health Opportunities in Water Resources Development.....	15
Box 3. Flushing canals for malaria control in Sri Lanka .....	16
Box 4. Freshwater cyanobacterial toxins – an emerging dam-related health issue .....	17
Box 5. Examples of health impacts from India .....	18
Box 6. The compounded malaria impact of microdams in Ethiopia.....	19



## 1. Background

### 1.1 Human Health in Environment and Development

Throughout the world, especially the developing world, dams and related water infrastructure projects continue to be planned, constructed and operated to meet human needs through energy generation, agricultural production and the supply of drinking water. For most countries, dams are a crucial part of economic and social development and, as such, they aim to achieve important socio-economic development objectives. Through their potential to alleviate poverty they can contribute significantly to the enhancement of human health.

The intended development objectives of dams, including poverty reduction, are invariably accompanied by a range of unintended impacts on the natural environment and on human communities. These communities may be affected in quite different ways and, as well as beneficiaries, there are potential losers. It is this observation of health benefit inequity that forms a central theme in the present submission. Informed action can protect vulnerable groups against increased health risks and ensure a more equitable distribution of benefits, including health benefits.

WHO welcomes the independent inquiry by the World Commission on Dams (WCD) and the opportunity to contribute positively to the debate. WHO has long been concerned about the effect of dams and other water resources development projects on human health and has catalogued their health impacts, particularly on a range of communicable tropical diseases. The present WHO contribution to the WCD advocates that health considerations should always be included alongside economic, environmental and social issues in decision making on dams. Furthermore, it provides an analytic framework for the incorporation of such considerations into dam planning, construction, operation, rehabilitation and disaster preparedness.

Bearing in mind a target audience of mainly non-health specialists, this paper uses the broadest socio-environmental definition of human health. As envisaged by the founders of WHO, health is considered to be:

“...a state of complete physical, mental and social well-being, and not merely the absence of disease and infirmity”.

The preservation of human health can only be ensured if all potentially affected communities have an opportunity:

- to consider how dam construction and operation will affect their own health, and
- to participate fully in the planning, assessment and decision making process

At times, this submission makes a distinction between recommended actions that are practical - in the sense that they are readily achievable through realistic and feasible modifications to current practices and planning procedures - and those actions that should be undertaken in an ideal world. It is understood that the WCD is interested in both, as is certainly the WHO.

At different times in the past, WHO's concern over health in development has been expressed with different emphases. The 1986 World Health Assembly Technical Discussions on Inter-sectoral



Action for Health and the review of the impact of development policies on health (Cooper-Weil *et al.*, 1990) are two of several examples. Currently, the WHO Global Cabinet has defined four strategic directions, two of which address different aspects of the environment-development-human health continuum (see Box 1 in bold). Along similar lines, the World Bank recently defined one of its comparative advantages in the *Roll Back Malaria* initiative as its capacity to include health concerns in infrastructure projects for which it provides loans.

Box 1. Four strategic directions of the World Health Organisation, September 1999

- Reducing the burden of excess mortality and disability, especially that suffered by poor and marginalised populations
- Reducing the risk factors associated with major causes of disease and the key threats to human health that arise from environmental, economic, social and behavioural causes
- Developing health systems which are managed to ensure equitable health outcomes and cost-effectiveness; responsiveness to people's legitimate needs; are financially and procedurally fair; and, encourage public involvement
- Promoting an effective health dimension to social, economic and development policy.

In addition to an international health policy framework, WHO has provided technical guidance to its Member States in the form of guidelines for the resolution of these problems including:

- Guidelines for forecasting the vector-borne disease implications of water resources development (Birley 1991);
- Parasitic diseases in water resources development (Hunter *et al.* 1993).

It has also been instrumental, through its Collaborating Centre arrangements with the Liverpool School of Tropical Medicine, in stimulating a wider debate, including the publication of:

- The Health Impact Assessment of Development Projects (Birley 1995);

WHO and its Collaborating Centres the Danish Bilharziasis Laboratory and the Liverpool School of Tropical Medicine have a long-term commitment to building national managerial capacities in inter-sectoral planning of development projects and including health considerations. Together, they have developed and tested a task oriented problem-based learning course entitled *Health opportunities in Water Resources Development*, and the next phase will be course implementation and institutionalisation in Africa.

## 1.2 Equity and health

As already noted, the development and economic objectives of dams are often not fully compatible with an equitable distribution of the benefits and stresses between different stakeholder and community groups. For example, with dams for hydropower generation or drinking water



supply, the beneficiaries may be hundreds of kilometres away in urban centres, while the local and downstream communities may suffer from the adverse health effects of environmental change and social disruption. In irrigation schemes, those living in the tail end of the system and relying on water from canals to meet their domestic needs may be exposed to increased levels of pesticide residues. Additionally, if proper drainage is lacking, they may be exposed to increased transmission of vector-borne diseases. Downstream impacts on water availability and quality, agricultural production, livestock and fisheries may lead to persistent malnutrition and communal violence.

Clearly, improved health is inherent to the general poverty reduction objectives of dams, *but it is the issue of equity gaps that is at the root of the adverse health impacts of dams*. For this reason, a simple health accounting is not satisfactory. In other words, it is not acceptable to simply balance out the health gains of one part of the population against the losses of another, to arrive at a net health benefit, as one might do in an economic or financial analysis.

It is very important that this point is accepted by all involved in the dam planning and evaluation process. Benefits of dams, also for health, are not disputed. It is the risks to health, however, resulting from inequity, that need to be identified at an early stage and managed as an integral part of dam design, construction and operation.

### 1.3 The economic perspective

The economic arguments in favour of including health concerns in dam projects are clear. Most developing countries and most development agencies spend about 5% of their budget on the health sector, and most of this health budget is spent on the delivery of health services. A considerably larger part of the national budget or of development loans is spent on the development and management of infrastructure projects, including dams. Decisions on infrastructure development that may be critical to people's health status are, however, made without proper consultation of health authorities and experts.

When negative health impacts occur, they represent a hidden cost of the project that is transferred to the health sector without adequate provision for alleviation. They also represent an increase in pain, suffering, and loss of education achievement and of productivity for the affected community. Improving the health status of the community through preventative action by other sectors is an efficient way to help to reduce the burden on the health sector. It is assumed to also have a multiplier effect by ensuring that relatively small investments for health protection and promotion at the construction phase will produce substantial health improvements.

There are three main requirements needed in order to protect and promote health: (i) a supportive policy, (ii) an acceptable procedure, and (iii) a usable method of assessment. None of these is sufficient in itself. Good policy supports good planning and management. It also enables laws to be enacted that establish requirements and regulations to conserve human health. Good planning depends on good procedures for assuring quality and inclusive debate. Good assessment methods enable the health risks and benefits of different options to be analysed and compared.

### 1.4 Policy

The international development aid policy of many industrialised nations aims to reduce poverty and improve the quality of life of poor communities. The aid flows through many bilateral and



multilateral channels and transforms the social, physical and economic environment of stakeholder communities. Planning procedures have evolved that assess economic, environmental and social impacts of projects, programmes and policies. Assessment of human health impacts has been limited.

The absence of appropriate policy framework for impact assessment means:

- lack of assessment of development policies, programmes and projects for health impacts;
- greater than necessary adverse impacts of development on health;
- the tendency of centrally managed, disease specific control programmes (known as vertical programmes) to ignore environment and development links;
- lack of funds for research in health impact assessment

Principle one of Agenda 21 (United Nations 1992) places people at the centre of development justifies the inclusion of health concerns in all development policies and recommends environmental and health impact assessment (UN 1993). In Europe, the Maastricht Treaty, 1992, and the Amsterdam Treaty, 1999, require that the EC shall ensure that proposals do not have an adverse impact on health, or create conditions that undermine health promotion. The European Policy for Health advocates multisectoral accountability through health impact assessment for both internal and foreign policies (WHO 1998). The European Charter on Transport, Environment and Health recognises the need for health impact assessment (WHO 1999). The UK government has published a White Paper on Public Health and a report on health inequalities that establish policies for the assessment of health impacts of all government policies (Acheson *et al.* 1998; Secretary of State for Health 1999).

The Organisation of African Unity Harare Declaration on Malaria Prevention and Control stresses the need for environmental and health impact assessment in development (OAU 1997). Other countries where health impact assessment policies have been developed include Australia (Ewan *et al.* 1992), Canada (Kwiatkowski 1996), New Zealand (Public Health Commission 1995), Philippines (Philippine Environmental Health Services 1997), Sweden (Berensson 1998) Finland (Koivusalo *et al.* 1998) and Netherlands (Putters 1998). There are, no doubt, many other initiatives.

Many civic society groups cite health risks as a principal concern when they object to dams or other development projects. For example, about 60% of submissions received by WCD from civic society groups explicitly cited human health concerns (WCD, pers. comm.)

Development projects may contain subsidies that provide 'perverse' incentives to site projects in particular places or benefit specific communities. For example, farmers may be given subsidies to extract groundwater for irrigation with the result that a nearby community must pay more to obtain drinking water from the same diminishing supply. Dams may sometimes be located in remote regions in order to establish a national presence in a border area or to encourage migration of a majority ethnic group into an area inhabited by a minority ethnic group. Other motivations may include the award of high value construction contracts or a decision to control downstream flows into a neighbouring country. In these examples, policy changes are required to ensure coherence.

WHO would like to see the WCD add its weight to this changing policy climate and to recommend that health be added to the list of issues that must be addressed to ensure that dams are supportive of, and not detrimental to health, and for all communities.



## 1.5 Legislation

Policy can be implemented through a range of instruments. These include international conventions, national legislation and regulations. Not all the instruments are, however, legal in nature; they may also include changes in departmental practices, and agreements with local and regional communities. Existing regulatory mechanisms could be used, such as those associated with environmental laws. There are also a series of international standards that could be used to support health. These include ISO9000, on quality assurance, and ISO14000, on environmental protection.

At present there is no law requiring human health to be safeguarded in the context of development projects. The World Commission on Dams may recommend the development of international conventions or national legislation for the construction and operation of dams. WHO would like to see explicit statement about health included in such instruments.

## 1.6 Integration of HIA with Environmental Impact Assessment

Environmental Impact Assessment (EIA) is an established policy and procedure in many countries and development agencies, but EIAs normally make limited reference to health (Birley and Peralta 1995; Birley *et al.* 1998). The health issue most commonly included is poisoning due to pollution, which partly reflects a bias towards the health problems of industrialised countries. In the case of dams, filariasis, malaria and schistosomiasis are frequently cited. Other important health aspects are often neglected, such as:

- the increase in incidence of sexually transmitted diseases associated with the movement of people to large rural dam construction projects.
- loss of culture-specific traditional health practices. In many developing countries, indigenous people depend upon such practices, which are part of their everyday life and health culture.

EIA guidelines published by many development agencies make limited reference to human health (e.g. World Bank 1991a-c; Department for International Development 1999), although the World Bank's environmental sourcebook has been recently updated on the issue of health (Birley *et al.* 1997). In most cases, health is addressed in a strictly 'medical' sense rather than through a wider cross-cutting view of community health status. This then results in recommendations for strengthening of health services which, although important, fail to address opportunities for the management of community health risks in project design and operation.

One solution to the lack of adequate routine health impact assessment is to give health a stronger profile in Environmental Impact Assessment. However, not all health issues have physical environmental determinants; some have primarily social determinants and require social impact assessment (SIA). Health has a stake in EIA and a stake in SIA, with a number of unique features that distinguish it from either of these. An alternative solution is to create a separate and parallel procedure for health impact assessment (HIA). If health is subsumed in environmental or social assessment then it may be hidden and neglected and the scarce resources invested in the development of theory and practice of health impact assessment may be lost.

The middle way is to plan for integration while maintaining a separate profile for health. Health issues can be added to other impact assessment by requiring the following steps (Birley and Peralta 1995; Scott-Samuel *et al.* 1998):



- Add specific references to health to the Terms of Reference provided to the consultants undertaking an impact assessment and indicate the method of health impact assessment to be used.
- Provide a quality assurance mechanisms through appraising or evaluating the health component of completed impact assessments.

## 2. Human health issues related to dam construction and operation

### 2.1 Categories of health issues

The health issues associated with dams can be conveniently represented in six major categories. The existing knowledge bases concerning the impact of dam construction and operation vary for the different categories. Table 1 provides an overview. Each knowledge base has been described according to the volume of knowledge (large or limited), the reliability of that knowledge, the transferability between projects or regions and the quantifiability of the knowledge in terms of epidemiological statistics. The basis for characterisation of the knowledge bases was a limited amount of expert opinion and further refinement is desirable.

A method is required to attribute these risks to particular dam project components. This is provided by health impact assessment (HIA), which is described below.

It is difficult to provide a measure of the size of the problem. The total annual global mortality from floods is probably relatively small (perhaps 100,000 -Miller, 1997). Such deaths are vivid because they affect large groups of people simultaneously, have an element of dread, are outside the control of the individual and are not part of everyday life. In contrast, communicable diseases such as malaria and diarrhoea kill far larger numbers of people and especially children (World Bank, 1993). Transport injury rates are also very high and there is widespread malnutrition associated with protein-energy deficit or diet. There is a substantial difference between the perception of risk and the statistical measurement of risk. It is thus usually the case that familiar voluntary risks (e.g. drowning during normal recreational swimming) are not given the same weight as unfamiliar, often dramatic, involuntary ones (e.g. drowning during a once-in-a-hundred years flood event). The choice of priority is a matter for the community.



Table 1. Principal categories of health issues and the extent of existing knowledge about their association with dam projects

Health Issue	Examples	Knowledge base
Communicable disease	vector-borne, water-borne, sexually transmitted, zoonoses, other parasitic	large, reliable, ecosystem specific, some quantification
Non-communicable disease	poisoning by minerals, biological toxins, pesticide residues, industrial effluent	Geographically limited, reliable, generalisable, and frequently well quantified
Injury	drowning, construction injuries, communal and domestic violence, catastrophic failures, seismic activity, traffic injury	limited, reliable, transferable, some statistics
Nutrition	lack of protein, carbohydrate or essential elements	limited and controversial, limited transferability, reasonably quantified, limited reliability
Psychosocial disorder	stress, suicide, substance abuse, social disruption, unrest violence, decreased tolerance	low volume, of poor reliability with little quantification and cultural variation
Social well-being	quality of life, social cohesion and support structures, self-determination, human rights, equity	low volume, of variable reliability and quantification and considerable cultural variation

There is a considerable body of evidence about the global burden of disease and a measurement unit has been constructed to compare pain, suffering, disability and loss of productivity from different illnesses. This unit is known as the disability-adjusted life year, or DALY. It is designed to assist in the allocation of scarce resources within the health sector (World Bank 1993). While useful in evaluating the relative burden of many diseases and illnesses, further research is needed before it can be used to analyse the health issues associated with dam projects and serve as a basis for the selection of health safeguards.

## 2.2 Regional differences

There is regional variation in the prevalence rate of certain health conditions. This variation is most obvious when the condition depends on ecological factors such as the presence of insect vectors, which in turn depends on environmental determinants such as vegetation type or rainfall. Clear differences are observed between hot tropical climates and cooler temperate climates in the transmission of many vector-borne diseases, or in the occurrence of toxic cyanobacterial blooms, for example. Some of the more generalisable regional differences in health conditions throughout the world are described in .



Table 3. Examples of regional variation in health conditions

Warm v cold climates	Various communicable diseases depend on a pathogen lifecycle which has a stage in the environment and transmission is then temperature, rainfall and water cycle dependent, e.g. malaria, schistosomiasis and cholera. Toxic algal blooms more prevalent in warmer climates.
Africa v Asia	Communicable diseases such as yellow fever, rift valley fever, onchocerciasis, trypanosomiasis are not found in Asia. Schistosomiasis has a very limited distribution in Asia but a wide distribution in Africa. The malaria vectors of Asia have different habits to those in Africa. Communicable diseases such as Japanese encephalitis and dengue fever are found in the Asian region.
S E Asia	Opisthorchiasis is an example of a parasitic disease that is most common here. Schistosomiasis is restricted to a belt of China, Philippines, a valley in Sulawesi and a small section of the Mekong river. The habits of the snail host are considerably different to Africa and S America. The malaria vectors tend to be associated with the forest fringe.
America	Malaria is sometimes associated with forests but there are many different habitats, schistosomiasis is focal, zoonoses include Chagas disease and leishmaniasis.

### 2.3 Differentiation on the basis of dam size and purpose

Because many health concerns are associated with the interface between land and water, the health impacts of many small dams may be equal to or greater than the impact of a few large dams of equal total volume. This is due in part to the increased ratio of overall shoreline to water storage volume. For example, breeding sites for mosquitoes tend to be in shallow backwaters. Hence, small dams should not be ignored in a regional health context, particularly where significant numbers of such dams exist or are planned.

The purpose of a dam will be reflected in the infrastructure associated with it and in its operation. This will have specific consequences for its impact on environment and health. Reservoirs for irrigation water supply have an impact on the landscape and ecology of the agricultural production area that they serve, in contrast to hydroelectric dams. Typical dam functions include: irrigation, electricity generation, water supply, flood control, recreation, inland navigation and fish breeding. Each will have a range of positive and negative health impacts on a range of stakeholder communities.



### 3. Options for preventative or health promotional action

#### 3.1 General considerations

The minimum requirement for any development project should be that it does not adversely affect the health of local communities. Unfortunately this largely remains a distant objective. The health impacts can be difficult to quantify but they can be categorised as an increase, decrease or no change in the risk of disease and in opportunities and enhancements for health. The ideal objective is that the health of all communities should be enhanced and promoted by the project. In the search for procedures, methods and technical solutions that assist in achieving these objectives, many technical solutions can be found to the problems of negative impacts of dam construction – good practices –, as Table 4 and illustrate.

Table 4. Examples of health outcomes from dam construction and management

Successful	Panama Canal Authority  Tennessee Valley Authority	Health was accepted as an integral objective of the river basin development and the most important problem, malaria, was quickly controlled around dam sites. The success of carefully planned engineering measures has been sustained for almost a century along the Panama Canal and half a century in Tennessee.
	Mushandike Irrigation Scheme, Zimbabwe	Rehabilitation of this scheme in the 1980s included health concerns into the planning, design, construction and management. It included the development of new, self draining hydraulic structures, improved canal infrastructure with optimal gradients and reduced risks of seepage, and the provision of ventilated improved pit latrines in the fields, deployed according to a grid pattern.
Not successful	Senegal Valley Authority (OMVS)	Health was not accepted as an integral part of planning for the Diama and Manantali dams. An epidemic of Rift Valley Fever occurred when the dams were filled, schistosomiasis prevalence rates reached record levels and riverside inhabitants experienced diarrhoeal disease, malnutrition and malaria.

Recommendations for good management practice are listed below. First, a number of general observations need to be made:

- Preventative and health promotional measures tend to be site specific. They are linked to the geographic variation in health conditions associated with dams as well as to the relative effectiveness of measures in different ecological and epidemiological settings.
- The secondary effects of measures need to be taken into account and trade-offs will have to be found to come to a final decision. The reliance on swamp drainage for malaria vector control,



- for example, which was considered good practice in the 1920s and 1930s, would currently be unacceptable in many instances because of the importance attached to wetland conservation
- Whatever the technical merit of "good practice" interventions, they will only be effective and sustainable if the process of their design and implementation is transparent and participatory.

There is an extensive though rather scattered literature on good practice (WHO 1982; Oomen *et al.* 1988; Jobin 1999)

### 3.2 Good Practice - the Planning Framework

Many dams around the world have been associated with significant, and even serious, health problems. The reasons for this are complex but the fact that dams are normally designed based largely on hydro-engineering criteria is a contributing factor. Fortunately, many of the adverse health outcomes associated with dams and associated infrastructure developments (e.g. irrigation schemes) can be ameliorated if a broader and more holistic view of project construction and operation is taken.

Along with a range of insightful engineering approaches should come recognition for the need to take an integrated, multi-disciplinary approach to environmental, social and health management. This new understanding can lead to the implementation of a range of innovative design and operational features for water infrastructure projects. Such changes may be cost effective and provide the desired health outcomes that formally were considered controllable only through remedial medical interventions.

As already noted, the key process driving this increased understanding is the integrated Health Impact Assessment (HIA). In the context of the overall dam planning framework, it is very important that the HIA is implemented as early as possible in the planning cycle. Certain aspects of the HIA, such as the gathering of baseline human health data, may require more time to complete than other aspects of the overall environmental assessment process. Often this data must be collected across different seasons because of the strong impact of the seasonal cycle on vector reproduction and activity, as well as the impacts on human and social behaviours.

It is also very important that the HIA is undertaken using formal methodologies as outlined by WHO or by national health organisations and experts, and with proper institutional and/or regulatory backing (See section 5 for details). In addition, overlaps and synergies will be usually be identified between the HIA and environmental (ecological) and social impact assessments. From a health perspective, it will usually be apparent that many of the identified social and environmental impacts, also lead to clearly identifiable health impacts. Because the health specialist(s) carrying out the HIA may not be familiar with these environmental or social outcomes, such post-analysis and integration is essential if all potential health problems and opportunities are to be identified and addressed during the subsequent dam planning process.

Finally, a key aspect in the planning cycle is the need to have all sections of the stakeholder community (defined in its broadest and most inclusive sense to mean anyone who may have an interest in or be affected by the construction if the dam) involved throughout all aspects of the HIA process, and generally in all aspects relating to dam construction and operation.



### 3.3 Good Practice - Design and operation options

There are a number of fully or partially validated options, which can mitigate the adverse effects on human health of, dam construction. These planning options fall into a number of categories including engineering design considerations, operational water management, social and community planning. Some examples are:

- Multiple depth off-takes which allow release of first flush inflows that may contain high levels of contaminants and nutrients, and allow a high control of variation in operational water level (which can be advantageous in the control of disease vectors such as snails and mosquitoes).
- Minimising low flow zones in artificial channel networks to minimise habitats for development of disease vectors.
- Siting dams in areas that require minimal population displacement.
- At all potential sites, ensuring careful examination of reservoir bathymetry so as to avoid dam sites that have extensive shallow areas conducive for insect and snail breeding. While shallow margins can never be totally avoided, catchment topographies that give rise to large reservoirs of low average depth (and therefore large wetted perimeter) should be avoided (such reservoirs will also be undesirable from an evaporative loss point of view).
- Provision of simple infrastructure at critical places along the reservoir shore to reduce water contact for specific target groups (fishermen, women, and children).
- In-reservoir management to prevent eutrophication and excessive growth of problematic organisms such as toxic cyanobacteria and aquatic weeds. The development of massive blooms of toxic cyanobacteria is an area of increasing concern, especially in poorer countries where safe drinking water treatment is less common or absent, and where exposure to toxic blooms may go unmanaged or unreported (see text Box 4).
- Careful settlement planning that ensures that, wherever possible, and in balance with other planning and social needs, population settlement occurs away from areas of impounded and slow flowing water. This will minimise human exposure to disease carrying vectors (see table 4 for more information).
- Adequate planning for, and design of, community water supply and sanitation, including careful management of sewage and waste. This will reduce the rate of reservoir eutrophication and the occurrence and severity of toxic cyanobacterial blooms, as well as generally reducing water pollution.
- Management of cropping systems to maintain seasonal wetting and drying cycles (while ensuring efficiency in water use), crop diversification and synchronisation of cropping patterns. In particular, there should be no agricultural advocacy or economic analysis carried out that encourages excessive multiple cropping within a single production year. Extended crop drying periods are important controls on the development of water borne insect disease vectors in irrigation areas.
- Staged and planned controls over population movement into and out of the affected region e.g. planned community infrastructure construction, culturally sensitive community planning.
- Well formulated dam environmental management plans that will support sustainable fisheries practices, enhance the growth of natural predators of animal disease vectors, and minimise excessive growth of aquatic weeds and animal pest species.



### 3.4 Good Practice - Off site management and environmental protection

The spatial boundaries of the health impact of dams generally extend beyond the confines of the reservoir and the immediate downstream area. Therefore a number of offsite environmental management measures may also be considered.

- Catchment management to minimise negative impacts on the impoundment including population and agricultural growth in the upper catchment and pollutant in-flow
- Adequate in-flow forecasting for disaster prevention because of increased settlement on the downstream floodplain and heavy dependence of livelihood on the new production system
- Water release regimes that minimise impacts on downstream ecology and productivity especially in regions where there is a significant nutritional reliance on the downstream river production
- Management plans for irrigation areas that minimise long term salinisation and water logging and therefore impact on community nutrition and viability
- Sensitive management of flood plain wetlands and water resources to ensure wetland protection, but at the same time minimising excessive growth of water borne diseases vectors. As with irrigation cropping developments, natural seasonal wetting and drying cycles will be an important management tool. Traditional irrigation and drainage practices often lead to permanent inundation and wetting of previously ephemeral wetlands. The outcome of this is both the degradation of the wetland and an increase in the growth of disease vectors.



## 4. Recommendations for improving health outcomes

### 4.1 Health impact assessment (HIA)

There is an overwhelming need to include health impact assessment (HIA) as an integral component in the planning of dams and other major water infrastructure projects

HIA is an instrument for safeguarding the health of stakeholder communities. Prospective health impact assessment provides a mechanism for scrutinising and comparing the health outcomes of different project plans. Changes may then be included in the plans and operations so as to safeguard and promote human health. This recommendation is seminal and is discussed in detail in the next section.

Ideally HIA should be integrated with Environmental Impact Assessment (EIA) and Social Impact Assessment (SIA) as much as possible, while at the same time ensuring that the importance of human health as an assessment parameter is not lost in the integration process.

Furthermore, the HIA should be commissioned as early in the project planning cycle as possible, when alternative designs are being discussed. This will allow a comparative assessment to be made of the health impacts of each design, and importantly, it will allow time for baseline data to be collected throughout a full annual climatic cycle (see sec. 3.2).

The imperative need for HIA should be incorporated in any future international conventions and in national legislation on dams.

#### Capacity building

Appropriate capacity in HIA and community health management needs to be built both within the health sector and in the sectors primarily responsible for dams.

National authorities cannot use instruments such as HIA to their full potential until there is a significant body of trained personnel, and this is clearly lacking throughout the world at the present time. Health sector personnel will benefit from training in impact assessment procedures and methods, and will be better placed to appreciate the concerns of other sectors. In turn, other important sectors, in particular the dam design and construction (engineering) sector, should work towards the development of an understanding of the association between their decisions and human health.

Where lacking, all groups should develop skills and training in inter-sectoral communication and collaboration. This training should include an appreciation of the principles of health impact assessment. These are generic skills that apply equally to all development policies, programmes and projects. Training courses need to be self-sustaining and widely available in all countries and regions as optional components of post-graduate degrees as well as free standing short courses. The participants of such courses need to be empowered by their managers to implement the skills that they acquire. This includes career rewards for engaging in inter-sectoral activity that may go beyond their original job specifications. Wherever possible, this new expertise should be established and maintained local to the project. Orientation courses are also required for different stake holders, especially policy makers and elected members of local administrative bodies (See Box 2 for more details).



Institutional support is required to foster these training programmes and provide quality assurance mechanisms. The World Health Organisation could be one institution to provide that support through its headquarters, Regional Offices and country representations. It can also provide the international framework for health impact assessment of large development projects, as a service to the World Bank, Regional Development Banks and bilateral agencies. A programme of training and re-orientation is then needed within WHO to build its own capacity to undertake such functions. On a longer term a self-sustaining financial mechanism as well as a local institutional basis should be found to support this framework and the associated activities.

#### Box 2. Health Opportunities in Water Resources Development

Capacity and skills to break through the barriers that exist between public sectors are critically important for health to be considered effectively in the planning, design and implementation of infrastructure projects. Formal secondary and tertiary education generally aims at the formation of specialists. Adult learning is most effective when it is problem-based and allows participants to learn from each other rather than through passive information transfer such as formal lectures. The World Health Organisation, the Danish Bilharziasis Laboratory and the Liverpool School of Tropical Medicine have developed and tested a three-week training course for mid-level managers in ministries and other public authorities. In the context of water resources development -fully documented real projects are used- the participants work, in inter-sectoral groups, through a series of tasks representing crucial decision making moments in the project cycle. To a large extent, these tasks revolve around HIA. Evaluations of five courses (three in Africa, one each in the Americas and Asia) suggest high levels of acceptability, effectiveness and efficiency. The value of such training efforts is highly enhanced when simultaneously policy reform is promoted allowing for the trained staff to effectively engage in inter-sectoral collaboration (Birley *et al.* 1996)

## 4.2 Documentation of successes and efficacy of current practices

An information and education oriented data base should be compiled:

- describing the limited number of health success stories based on careful dam design and operation, and explaining the key management processes in detail.
- with an assessment of the efficacy of already implemented health risk management techniques.

This information will lead to a considerable improvement in the existing health management knowledge base and will streamline health-sensitive dam planning

Examples of good health planning in dam and water infrastructure construction include: Panama Canal, Tennessee Valley Authority, Owens Falls in Uganda, Puerto Rico small dams, simplification of the Gorgol irrigation project in Mauritania, and remedial action on the Dez Project in Iran and the Mushandike Irrigation Scheme in Zimbabwe. There are also dams that have included engineering measures for safeguarding health that have not been evaluated. These include water supply reservoirs in Katsina and Kaduna States, Nigeria, the Ghazi-Barotha Power Canal in Pakistan, Manantali reservoir in Mali.



Post construction evaluations of dam projects should routinely include a retrospective health assessment as well as a prospective health impact assessment that takes into account the long-term (50-100 years) temporal boundaries (also see section 5 for more details).

### 4.3 Action oriented research

Special funding should be directed towards action oriented research in existing and planned dam construction projects in order to strengthen existing knowledgebases and improve health outcomes

There are a number of well-documented health problems associated with dams that require remedial action, with examples including dams in the Senegal, Blue Nile and Volta river basins. There is good reason to believe that the adverse health, social and environmental impacts could be alleviated by changes in dam operation. Such projects should be given priority attention for funding and implementation of health management strategies.

Similarly, there are a number of incompletely tested ideas for environmental management methods for vector control. One example involves fluctuating reservoir outflows. There is a shortage of funds to support such research because it falls between environmental and health budgets.

#### Box 3. Flushing canals for malaria control in Sri Lanka

The synergistic potential of multidisciplinary research on malaria in a specific ecological setting was recently demonstrated by the work done in the Huruluwewa watershed, Anuradhapura District, Sri Lanka. The joint efforts of Peradeniya University and the International Water Management Institute (IWMI) focused on a strategic assessment of the local ecology of malaria vector mosquitoes and a water balance estimation/flow measurement in the irrigation scheme. The primary vector species in Sri Lanka is *Anopheles culicifacies*, known to use stream and riverbed pools as its main breeding sites. The water management options suggested by the research include flushing of streams and irrigation canals at critical times to reduce mosquito densities and malaria transmission. Routinely applied, this will require new decision making criteria for irrigation water management, and further feasibility studies involving both government institutions and farmers. The availability of existing reservoirs to manage water levels in streams/canals, and the capacity to recapture the released water downstream are important factors contributing to the feasibility of the proposed water management regime. Further testing of different options for flushing regimes can provide an optimal combination with both health and agricultural benefits (van der Hoek *et al.* 1998; Matsuno *et al.* 1999).

### 4.4 Budgeting for health

A health component should be negotiated as a budgeted item for all project loans in order to safeguard and enhance health.

Economic assessments of dam projects that do not include the consideration of health issues tend to transfer a hidden cost to the health sector. That is, the cost of providing health and medical support to communities for illnesses that arise because of unforeseen (though avoidable) consequences of dam construction. The health budget, which is not



necessarily administered by the medical sub-sector, should be used primarily for preventative rather than curative actions, with the optimal balance decided on a case by case basis. It should complement the existing general health infrastructure and should not be considered as a substitute for the existing health care system.

#### 4.5 Prioritising the health issues

It is important that the health priorities are not pre-judged but allowed to emerge from the health impact analysis and community consultation.

The HIA will identify a wide range of health changes attributable to the project. Many of these positive health enhancements, while others will be negative health impacts that have to be prioritised for preventative action. Table 1 (sec. 2.1) indicated the range of health issues that may be affected by a dam project. Development agencies are often aware of one or two major issues - examples include schistosomiasis and AIDS - and assume that these have over-riding priority, sometimes to the neglect of other potentially very important health issues. Boxes 4 and 5 highlight some important health risks that do not always receive the attention they deserve in health assessment procedures for dam construction.

##### Box 4. Freshwater cyanobacterial toxins – an emerging dam-related health issue

In tropical, sub-tropical and arid regions of the world it is almost inevitable that new dams will become eutrophied (nutrient enriched) rather quickly, often within the first few years of filling and operation. Eutrophication brings with it problems of excessive aquatic weed growth or 'blooms' of toxic cyanobacteria (cyanobacteria are a type of microscopic algae). Arid zones of the world are particularly at risk, where the artificial impoundment of water in the hot climate creates the perfect ecological environment for the growth of toxic cyanobacteria. Added to this natural climatic effect is the enhanced rate of nutrient pollution that accompanies the growth of towns and agriculture in the catchment around a dam, often with inadequate effluent collection and treatment facilities.

Blooms of freshwater algae and cyanobacteria have always occurred in eutrophied waterways, but the toxicity of these organisms has only been elucidated in recent years. There are several types of cyanobacterial toxins found throughout the world, all of which are potentially dangerous to humans and animals if consumed in sufficient quantities. Additionally, some cyanobacterial toxins can promote liver cancer during chronic low level exposure, and most cyanobacteria can cause a range of gastrointestinal and allergenic illnesses in humans exposed to toxins in drinking water, food or during swimming (Chorus and Bartram (WHO), 1999). A drinking water guideline concentration for the common cyanobacterial toxin microcystin has recently been developed by the WHO.

The most severe and well-documented case of human poisoning due to cyanobacterial toxins occurred in the Brazilian city of Curaru in 1996. Inadequately treated water from a local reservoir was used for patients in a local kidney dialysis clinic. As a consequence, more than 50 people died due to direct exposure of the cyanobacterial toxin to their blood stream during dialysis. Elsewhere in South America, in 1988, more than 80 deaths and 2,000 illnesses due to severe gastroenteritis have also been linked with toxic cyanobacteria in a newly constructed dam. In China, a high incidence of primary liver cancer has been linked to the presence of cyanobacterial toxins in drinking water (Chorus and Bartram (WHO), 1999).



In addition, there are often differences in perception of risk between subject experts (health specialists) and affected communities. Such differences in opinion can not simply be dismissed out of hand as subjective or emotive. There are various approaches to establishing priorities, including the following:

- estimating the frequency, severity and probability of health impacts;
- conducting an economic analysis that compares the cost of all health outcomes;
- determining the subjective perception of risk expressed by the stakeholder community;
- negotiation of opportunities for mutual gain;
- comparison with standards;
- reducing health inequalities.

Box 5. Examples of health impacts from India

**Downstream: monsoon dryness**

When dams obstruct a river, the protection provided to aquifers and soil by the outward freshwater flow disappears, and tidal surges may invade the rivers and cause flooding. This is already evident along Western state of Gujarat's long Saurashtra coast. Reports by independent experts, including a World Bank-instituted independent review, expressed similar fears regarding the Narmada (Anon, 1982)

**Water pollution**

The impounding of river water in reservoirs has dramatically reduced flow in many rivers, rendering them incapable of diluting effluents or sustaining much of their natural fauna and flora. The diversion of the river Yamuna's water into Upper and Lower Yamuna Canal at the Tajewale barrage at the Himalayan baseline constricts the downstream flow. Industries and towns in the North Indian state of Haryana's and later Delhi itself seriously pollutes the remaining insubstantial flow. The health of downstream communities is placed at risk because of the high levels of toxic pollutants and pathogenic micro-organisms (Anon. 1997).

**Fluorosis**

Large reservoirs and the irrigation they bring in command areas elevate sub-soil water, changing the levels of calcium and trace metals, and can increase fluorosis. The Nagar Junasagar dam in South Indian Andhra Pradesh triggered a crippling syndrome of knock-knees (*Genu valgum*) among villagers in the command area. According to Hyderabad's National Institute of Nutrition, seepage from the reservoir and canals increased the level of sub-soil water. This in turn elevated the molybdenum uptake of sorghum plants, and augmented soil alkalinity. *Genu valgum* has been found in villages in Coimbatore district, situated within a radius of 30 km from the Parambikulam-Aliyar dam, and from villages near Karnataka's Hospet dam (Anon. 1982).



## 4.6 Prioritising dam projects for impact assessment

Screening procedures for HIA needs must be the minimum requirement for all dam projects.

There are often more projects that require health assessment than there are resources available. Typical screening criteria include number of people affected, location in sensitive sites, and use of unusual technologies and procedures. Multiple screening procedures can be used and these are equivalent to rapid health assessments. Several of the largest dams in the world have serious health impacts. Because of their unique size and nature, such dams should be evaluated as a special category.

The cumulative effect of many small dams may be more important than the effect of one large dam. It is impractical to conduct separate assessments for each small dam. A preferred approach is to conduct a strategic assessment of the small dam construction programme.

### Box 6. The compounded malaria impact of microdams in Ethiopia

Recent studies in Ethiopia using community based incidence surveys revealed a 7.3 fold increase of malaria incidence associated with the presence of microdams. The study sites were all at altitudes where malaria transmission is seasonal (in association with the rains). The increase was more pronounced for dams below 1900 meters of altitude, and less above that altitude. In addition, observed trends in incidence suggest that dams increase the established pattern of transmission throughout the year, which leads to greatly increased levels of malaria at the end of the transmission season (Ghebreyesus 1999).

## 4.7 Transparency

The health impact assessment and planning process should be open to scrutiny by all stakeholders and communities.

As with all forms of impact assessment, and indeed the entire planning process, it is crucial to include all stakeholders at all stages of the process. This is good practice for all kinds of assessment and development activities, not just HIA. Health concerns simply provide a specific example. In addition, the community is the critical source and repository of health knowledge and information.



## 5. Health impact assessment (HIA)

### 5.1 Introduction

Much of the preceding discussion points to the need to include health impact assessment (HIA) when dam projects are designed or changed. HIA is an instrument for safeguarding the health of stakeholder communities. A recent broad definition of HIA is the estimation of the effects of specified actions on the health of defined populations (Scott-Samuel *et al.* 1998).

For the purpose of this paper WHO prefers a more operational definition: a health impact is a change in health risk reasonably attributable to a project, programme or policy. A health risk is the likelihood of a health hazard affecting a particular community at a particular time. Assessments can be retrospective or prospective. The retrospective kind is the business of normal science and serves to enlarge our knowledge base. It measures and records what has happened. The prospective kind is part of the development planning and project assessment procedure. It projects the likely consequences of a future project based on available evidence. The health impacts themselves may be positive or negative. It is expected that most development projects have mostly positive impacts and these include reductions in health risks as well as positive health enhancements.

The various components of health impact assessment have been debated over the past 15 years especially in the context of water resource development. They can broadly be classified as policy, procedure and method. The policy context was described earlier in this document. The distinction between procedure and method is important. At the early stages of HIA development methodological questions were considered more important. Experience proved otherwise. The problem is not so much technical as knowing when and where to conduct the assessment. This section of the document starts by providing a summary of the procedure so that each stakeholder is informed of the framework in which the assessment should be carried out. See Figure 1.

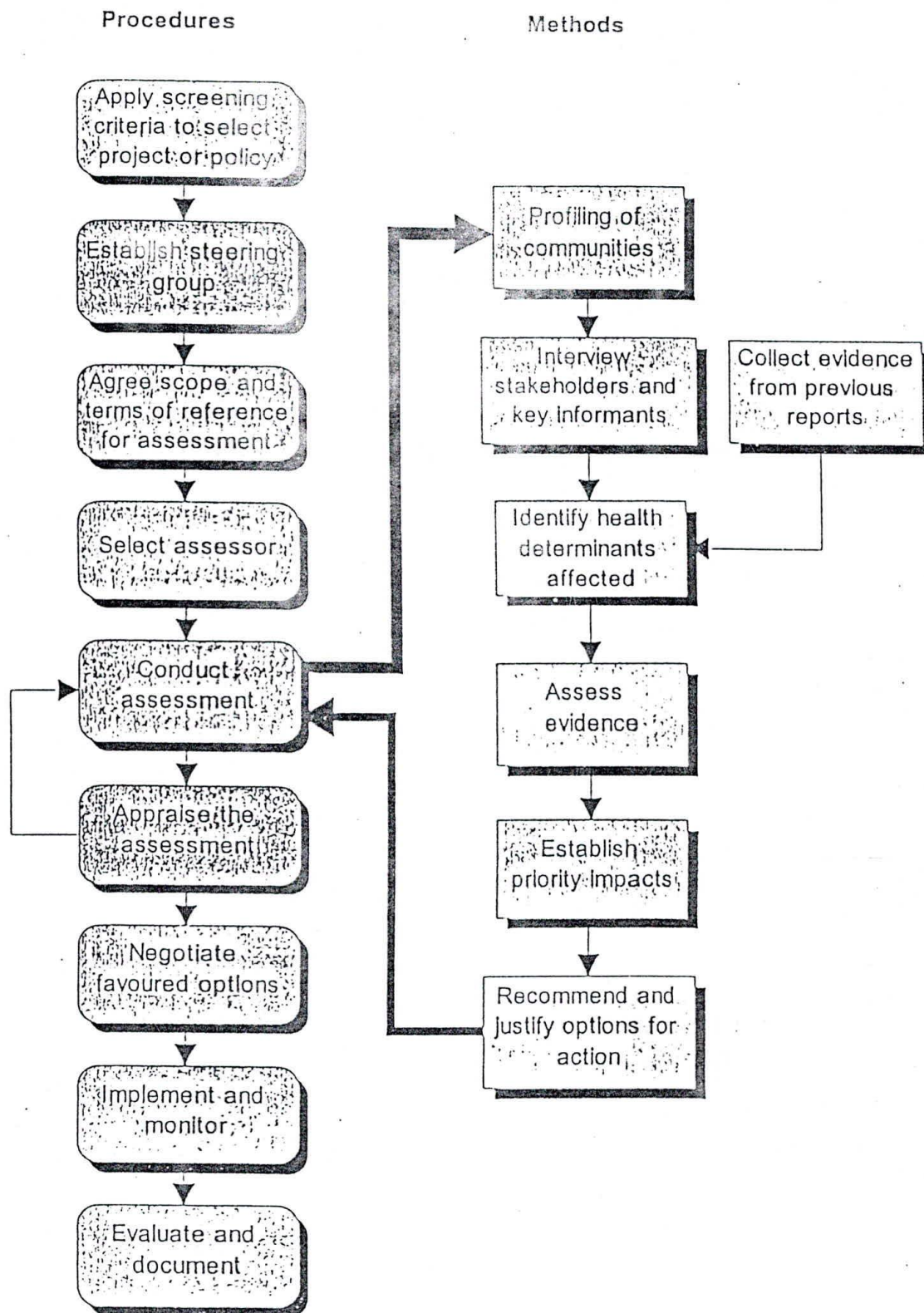
### 5.2 HIA Procedures

The procedure that is describe here and in Figure 1 will be familiar to anyone who is already informed about impact assessment, such as environmental assessment specialists. It may not be familiar to many members of the health community who wish to have a role in future assessments. In addition, there should be community participation by involving stakeholder representatives in all stages of the procedure. The main components of procedure are as follows.

1. Timing
2. Screening
3. Establishing a steering committee
4. Scoping
5. Agreeing Terms of Reference
6. Choosing an assessor
7. Undertaking an assessment (see method)
8. Appraising
9. Disseminating
10. Negotiating
11. Agreeing actions
12. Implementing
13. Monitoring and evaluating



Figure 1. Procedures and methods used in health impact assessment





### 5.2.1 Timing

Timing – when to commence the HIA – is crucial because of the frequent observation that impact assessments are commissioned too late, sometimes even when the first concrete has already been poured. They should be commissioned when alternative designs are being discussed so that a comparative assessment can be made of the health impacts of each design. The timing should also allow the health assessor to interact with other members of the design and assessment team. Additionally, time should be allowed for seasonal differences in baseline community health conditions to be observed and recorded (see also sec. 3.2).

### 5.2.2 Screening

Screening procedures are used to decide which projects should receive a particular level of HIA, or whether indeed a HIA is necessary at all (as discussed in sec. 4.7). However, it is difficult to conceive of any large dam project for which a health assessment would prove unnecessary. Individual small dam projects may not, upon initial consideration, seem likely to require an HIA. However, as already noted, small dam developments need to be examined strategically and in a regional context. In particular whether several other such dams already exist in an area whose cumulative health impact may be similar to or even worse than that of a large dam of identical total storage capacity.

### 5.2.3 Steering committee

Following screening a multidisciplinary Steering Group should be established to determine the scope and Terms of Reference of the assessment and to provide advice and support as it develops. Its membership should include representatives of the commissioners of the HIA, the assessors carrying it out, the proponents (i.e. those developing, planning or working on the dam project), affected communities, and other stakeholders as appropriate. Members should ideally be able to take decisions on behalf of those that they represent. A single committee that takes charge of all assessment and feasibility studies is the preferred option. This broad committee should include a specialist health representative.

### 5.2.4 Scoping and agreeing Terms of Reference

The outcome of the screening procedure should be the starting point for scoping and the formulation of Terms of Reference (TOR). Scoping serves to define the health issues that should be considered in detail (generically listed in Table 1), the stakeholders, and the boundaries of the assessment in time and space. Based on the scoping exercise, TOR are formulated.

The purpose of the TOR is to provide a basis for a quality assurance procedure for the work being undertaken. The TOR is project specific, but should include the following elements.

- Steering Group membership should be listed in the TOR, together with members' roles, including those of Chair and Secretary.
- The nature and frequency of feedback to the Steering Group should be specified.
- The methods to be used in the assessment should be described in adequate detail.
- The TOR should outline the form and content of the policy, programme or project's outputs, and any conditions associated with their production and publication. Issues associated with publication of outputs include ownership, confidentiality and copyright.
- The scope of the work should be outlined - what is to be included and excluded, and the boundaries of the HIA in time and space. Positive as well as negative health impacts should be included in the assessment (see sec. 2.1, table 1).



- An outline programme - including any deadlines - should be provided.
- The budget and source(s) of funding should be specified.

The TOR is a crucial element of the HIA procedure, with the quality of the assessment being determined in part by the quality of the TOR. In the case of dam projects, it should be written by an expert with experience/ expertise in community health and/or environmental sciences and with definite experience in working with displaced people. It will need to be agreed by the Steering Committee. It is important that the TOR has a broad view of health issues as outlined in Table 1. When the assessment report is complete, it is appraised by the Steering Group to determine whether it satisfies the TOR.

### 5.2.5 Choosing an Assessor

Project proponents who are commissioning work on health impacts are frequently unclear about the kind of person that they should commission to carry out the HIA. This is made more difficult by the general lack of availability of special training or expertise. In an ideal world, a team encompassing all the requisite skills and knowledge would undertake the assessment, but in reality, some compromise will usually be necessary. The following list is provided for guidance. The person or team contracted to undertake the HIA should ideally have the following qualifications, education and experience:

- Experience with prospective health/ environment / environmental health impact assessment.
- Training in public health, environmental health or equivalent.
- Familiarity with both environmental and social determinants of health
- Able to adopt a holistic perspective of health issues (see Table 1).
- A record of publication or experience linking environmental change and health issues.
- Able to carry out key informant interviews and produce an analytic report that cites sources and indicates assumptions.
- An understanding of water resource development issues.
- Familiarity with disease ecology, for example the ecology of vectors associated with the floodplain.

An involvement with field based health research such as epidemiology or human ecology.

A number of training courses have now been pilot tested in both developing and developed countries (Birley *et al.* 1996; Birley *et al.* in prep). But they have not yet been widely disseminated or institutionalised (see for more details sec. 4.2, Box 2).

### 5.2.6 Spatial boundaries

It is common that administrative, ecological and hydrological boundaries do not coincide. Rivers may flow through several countries, regions and local government districts. The boundaries used in different kinds of impact assessment need to be integrated. Health impacts are sometimes associated with boundary problems and confusions over jurisdiction.

Figure 2 illustrates the various geographical boundaries and components of dam projects. They include reservoir, upper catchment, irrigation scheme, floodplain, estuary, urban slums, and coast. The health impacts cover the whole river basin both upstream and downstream of the dam wall, and ultimately, it is the extent of human movement that determines the lateral extent of the zone of interest rather than any particular biogeographic zones (e.g. catchment boundaries). This includes



seasonal movement by pastoralists, displacement to urban slums, and circulation between river basins by fishing folk. Communities displaced by reservoirs may migrate to the upper catchments and change the local land use. Others will be formally resettled in newly designed and constructed villages, with all the difficulties that this entails. Increased deforestation in the upper catchment area to increase water yields into the reservoir may also have local health impacts, as well as negative impacts on water quality in the dam itself due to increased sediment and nutrient run-off, hence contributing to the risk of toxic algal blooms. The displaced communities also migrate to distant cities where they swell the peri-urban slums.

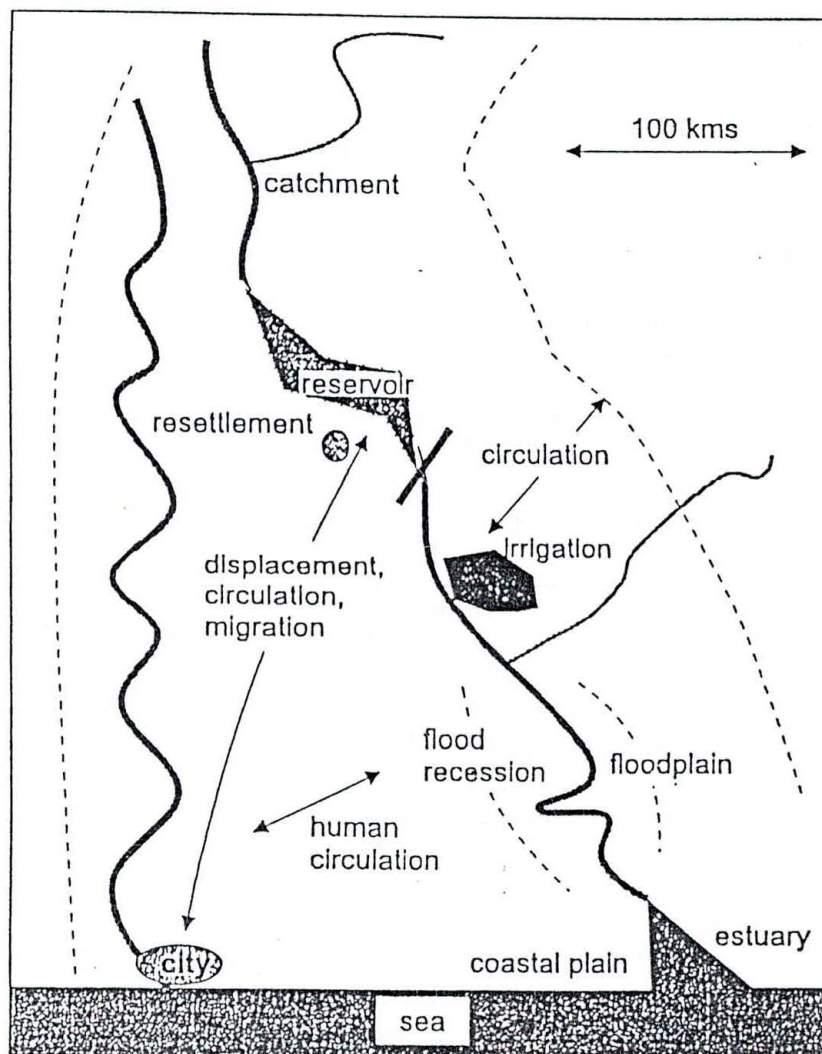


Figure 2. Spatial boundaries of dam health assessment

The association between human circulation and health issues is illustrated in Table 5. At a smaller scale and depending on the specific river system, the river floodplain includes a flood recession zone that may extend 50 km and the reservoir has a draw-down zone that may extend 5 km laterally around the perimeter of the dam. At an even smaller scale, the local flight range of insect



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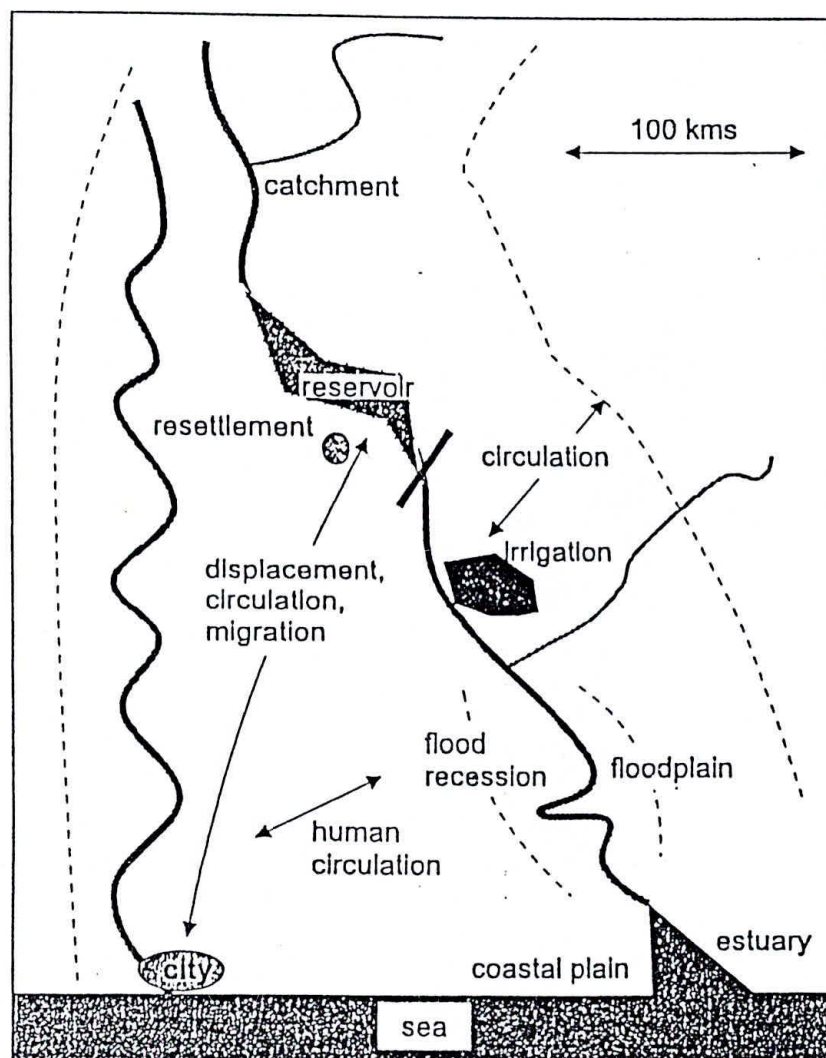


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vectors between breeding and feeding sites ranges from 0.1-10 km as Table 5 indicates. Longer migratory flights or long-range transport of insects by prevailing winds imply that if a project creates new insect breeding sites then sooner or later they will be colonised.

Table 5. Flight range of insect vectors

Vector	Local movement (km)	Migration (km)
Simuliid blackflies	4-10	400
Anopheline mosquitoes	1.5-2.0	50
Culicine mosquitoes	0.1-8.0	50
Tsetse flies	2-4	1

Table 6. Typology of human circulation

	Circulation			Migration		
	Daily	Periodic	Seasonal	Long-term	Irregular	Regular
Rural/rural	Cultivating <sup>1</sup>	Hunting <sup>1</sup>	Pastoralism <sup>1,2</sup>	Labouring <sup>1,2</sup>	Nomadism <sup>1,2</sup>	Resettlement <sup>3</sup>
Rural/urban	Commuting <sup>1</sup>	Trading <sup>1,2,3</sup>	Labouring <sup>1</sup>	Labouring <sup>1,2,3</sup>	Drought <sup>1,2,3</sup>	Labouring <sup>1,2,3</sup>
Urban/rural	Cultivating <sup>1</sup>	Trading <sup>1</sup>	Labouring <sup>1</sup>	Trading <sup>1,2</sup>	Refugees <sup>1,2,3</sup>	Retirement <sup>1</sup>
Urban/urban	Commuting <sup>1</sup>	Trading <sup>1,3</sup>	Trading <sup>1</sup>	Relocation <sup>3</sup>	Refugees <sup>3</sup>	3

<sup>1</sup> communicable disease (e.g. vector-borne diseases, STDs)

<sup>2</sup> malnutrition/injury

<sup>3</sup> psychosocial (e.g. alcoholism, stress, depression, violence)

(after Birley 1995)

### 5.2.7 Temporal boundaries

The temporal boundaries consist of the stages of the project cycle: planning, design, construction, operation, rehabilitation, decommissioning. In the case of dams the complete time-span may be 50-100 years and the health impacts will differ in each stage. Some health problems are immediate, rapid or acute in onset while others are slow, delayed or chronic. See Table 7 and Table 8 for more details. The baseline conditions, before construction, usually only provide a partial basis for an accurate forecast of later conditions because of the environmental and demographic change that occurs. The experience of similar projects in comparable eco-settings is a more reliable basis for forecasts.

### 5.2.8 Appraisal and dissemination

The completed HIA report must be appraised by the steering committee to ensure its quality. Before final acceptance the report should also be disseminated to all major stakeholder communities and their feedback should be incorporated. The appraisal includes both technical and



### 5.3.2 Health determinants

Health determinants are the factors that are known or postulated to be causally related to states of health. Health determinants can be listed and classified. The direction of change of health determinants associated with a project can be inferred. They can be divided into those that can be managed, such as housing, and those that cannot be managed, such as age. Some health determinants are listed and classified in this paper but the list is not yet complete. The causal relationship between determinants and health outcomes is well demonstrated in some cases but further work is required in other cases. The relationship is clear in some cases while in others it is multifactorial and complex. In the past there has often been a tendency to focus on the bio-physical environment using a life-cycle model of disease and to ignore social determinants such as poverty and loss of health culture.

Table 11 indicates examples of health determinants. Some of these will be changed by the project. The change may be positive or negative in terms of their likely health outcomes. It is not always possible to associate a change in health determinants with a change in health outcome. Generally, the risk of a change in health requires several health determinants to act together. For example, numerous mosquitoes only increase the incidence of disease if people do not protect themselves from the bites, immunity is low and the health services fail to provide vector control, prompt diagnosis and treatment. Similarly, the spread of HIV-AIDS may be mitigated substantially through local education on safe sex practices, distribution of condoms to construction and site workers and empowerment of local communities to manage the influx of temporary workers. Personal protection depends on poverty, housing design, knowledge, attitude and belief, occupation. In seasonal climates vector-borne diseases often have seasonal changes in incidence. The artificial flood may extend or reduce the transmission season.



### 5.2.10 Implementation and monitoring

The actions agreed must be implemented at appropriate stages of the project. Monitoring provides a tool for ensuring that implementation proceeds as agreed and to detect the occurrence of any unforeseen health effects. It is likely to be based on indicators and the affected communities are often well placed to scrutinise those indicators providing that they are empowered to do so. For example, they can report whether domestic water supplies and health centres are functioning, insect bites are more numerous, food security is enhanced, fear of injuries decreased, and whether the sense of well-being is improved. The election or re-election of community leaders can capture some of their concerns. Part of the agreed budget should be available for maintenance of community infrastructure and salaries for care providers.

## 5.3 HIA Methods

When policy and procedure have been established, the actual assessment can take place. It consists of inferring changes in health determinants that are reasonably attributable to the project and that could affect each stakeholder community during each stage of the project. The changes, taken together, produce health outcomes or changes in health states. These are expressed in a minimum of three ranks: no change, increased health risk, increased health enhancement. Quantification is generally difficult either because the data is lacking or because there are no known functional relationships between cause and effect. Poisoning and contamination are an exception, because the dose-response model provides a functional relationship. Research is needed to improve the predictive models for other health concerns.

The best forecast of what will happen is the history of what has happened on similar projects in comparable regions. Reviews are an important tool and a number of reviews are available (e.g. Cooper Weil *et al.* 1990; Birley 1995; Jobin, 1999).

In an ideal world, the assessment would start by collecting baseline data over a period of at least two years prior to final agreement on dam design. This will provide a profile of the existing communities, their environment, seasonal changes in health risks (e.g. due to vector breeding cycles) and the capabilities of their institutions. The data collection would be repeated after the project was operational and the difference would provide a record of health impact and its likely causes. The record would add to the available knowledge base and improve the assessment of future projects.

By contrast, the objective is to present evidence, infer changes and recommend actions to safeguard, mitigate and enhance human health. The inferences may not always be founded on extensive data, but they must be persuasive. The argument is based on the precautionary principle and best practice (see section below on Evidence).

### 5.3.1 Stakeholders

Health impact assessment differs from environmental impact assessment by placing the human community first. There are many different stakeholder communities and outlines some health impacts which are largely focused on the local stakeholders. Settlement location, occupation, age and gender and economic status can serve to identify local stakeholders. Demographic information about the size of each community and its future change in size is often poor but may still be important for the analysis. The assessment compares the health impact of the project on two or more communities and establishes whether health inequalities are likely to change. It is consistent with other analysis of distributional effects and with health inequalities research.



Table 8. Examples of the association of health issues with different project stages

	Communicable disease	Non-communicable disease	Injury	Nutrition	Psychosocial disorder/ social well-being
Planning	-	-	-	-	Stress, fear, anxiety
Construction	STD's, malaria	Dust-induced respiratory tract problems	construction related	Loss of subsistence	uncertainty and disempowerment
Early operation	schistosomiasis, diarrhoea, malaria, zoonoses	toxic algal blooms	disputes between communities drowning	loss of subsistence crops and grazing	displaced communities lose coherence
Late operation	schistosomiasis, diarrhoeal diseases, malaria, onchocerciasis	contamination of drinking water, mineral variation of soils	drowning	loss of agricultural lands	-
Decommissioning	-	-	drowning	loss of irrigation	depression

### 5.2.9 Negotiation

The usefulness of the assessment lies in the weight that it provides to the commissioners of the HIA during the period of negotiation with the project proponents to ensure that health is safeguarded and/or enhanced. The negotiators will seek to argue that the predicted health impacts and the recommendations for mitigating risk and safeguarding health are, indeed, realistic. They will also agree priorities.

Once a HIA has been carried out, the consideration of alternative options (or the undertaking of a formal option appraisal) does not conclude the process. Even when there appear to be clear messages regarding the best way forward, it cannot be assumed that these will automatically be adopted. Political imperatives, either within or beyond the Steering Group may ultimately determine the outcome. Disagreements or power inequalities between different stakeholder factions may be similarly important. In these and other such cases, the quality of leadership shown by the Steering Group Chair and members can prove crucial. Achieving agreement on options for mitigating or enhancing predicted health impacts might require skilful negotiation on the part of those involved.

The outcome of negotiation will be a budget and an intersectoral agreement for implementation of recommended risk management measures.



procedural issues. The appraisal of technical issues is concerned with the method of assessment, the knowledge base and the nature of the evidence and inference that has been used. The procedural assessment is concerned with sources of bias, problems of timing, the adequacy of the Terms of Reference and the extent to which the TOR has been met. Following a satisfactory scrutiny of the conclusions of the HIA report, the recommendations are appraised for their technical feasibility, social acceptance and economic soundness.

The final outcome of the appraisal is acceptance, rejection or requirements for report modification. The accepted report is deemed to have met a quality standard and that standard and the content of the final HIA report should be agreed to by all stakeholders as the basis for further negotiation, whether or not it represents a consensus opinion.

Table 7. Examples of association of health issues with timing

	Acute or rapid onset	Chronic or delayed onset
Communicable disease	Malaria	schistosomiasis
Non-communicable disease	acute poisoning such as during pesticide application, algal toxins	chronic poisoning such as dust-induced lung disease, algal toxins
Injury	drowning, trauma	hearing loss of construction workers
Nutrition	wasting	stunting
Psychosocial disorder / social well-being	communal violence	depression



Table 10. Examples of local stakeholder communities and important health issues

Stakeholders	Communicable disease	Non-communicable disease	Injury	Nutrition	Psychosocial disorder / well-being
Construction workers	STDs, lung diseases, vector-borne diseases	deafness	occupational injury		alcoholism
Camp followers	STDs, diarrhoeal disease		communal violence		alcoholism
Settlers	vector-borne diseases	pesticide poisoning, algal toxins	communal violence, agricultural injury	Transitional malnutrition, food entitlement problems in household	dis-empowerment and uncertainty
Displaced	diarrhoeal disease		communal violence		stress, depression, suicide, loss of tolerance, violence, divorce, school drop-outs
Recipient communities of the displaced			communal violence	Decreased access to natural resources	Loss of tolerance and increase in hostilities and violence over a period of time.
Peripheral communities		algal toxins		Decreased access to natural resources	
Downstream floodplain dependent communities		poisoning from contaminated water	drowning	loss of subsistence	
Fishing folk	schistosomiasis, other vector-borne diseases	algal toxins	drowning		
Nomadic herders	zoonoses		communal violence	loss of grazing	stress
Professional groups associated with project management	vector-borne diseases				
Project beneficiaries, such as electricity consumers	Improved water supply	Reduced air pollution	Reduced fire risks	Improved cooking fuels	Improved quality of life
Service staff such as	vector-borne diseases				alienation



such as teachers	diseases				
Seasonal labourers	STDs, vector-borne diseases	pesticide poisoning	agricultural and transport injury		

Table 11. Examples of health determinants and their classification

Principal categories	Fields	Examples of health determinants
Individual/family	Biological	Genetics, age, senses, gender, immunity, nutritional status
	Behavioural/Lifestyle	Risk acceptance and behaviour, occupation, education
	Circumstantial	Poverty, empowerment, family structure
Environmental	Physical	Air, water and soil media, infrastructure, vectors, housing, energy, land use, pollution, crops and foods, traffic
	Social	Community structure, culture, crime, discrimination, social cohesion
	Economic/Financial	Unemployment rate, investment rate, interest rate, inflation rate
Institutional	Health services	Primary care, specialist services, access, drug supply
	Other services	Police, transport, public works, municipal authorities, local government, project sector ministry, local community organisations, NGOs, emergency services, access
	Public policy	Regulations, jurisdictions, laws, goals, thresholds, priorities, standards, targets

### 5.3.3 Weight of Evidence

The HIA assembles evidence from many sources about the changes in health determinants. The evidence may be qualitative and based on key informants and community opinion. It will often be incomplete, inconclusive, imprecise, and will usually be probabilistic rather than absolute. At first it may not seem totally credible to bio-medical scientists and engineers who are used to working with hard facts and numbers. Because of the uncertainties and difficulty of dealing with large and highly variable human populations, the type of information that will be gathered has more in common with legal evidence than scientific evidence.

Nonetheless, the analysis seeks to establish a chain of inference between the project, the health determinants and health outcomes. Assumptions have to be made, but if these are explicit, readers can make their own judgements about the chain of inference. The priorities assigned to the changes in health outcomes and the associated perceptions of risk are a political matter and outside the judgement of the assessor.



### 5.3.4 Management of health risks and enhancements

The final stage of the assessment is to recommend and budget socially acceptable measures to safeguard, mitigate and promote human health. These measures are designed to influence the direction of change of some of the health determinants. The budget can be negotiated as part of the project loan agreement. Decisions about which recommendations to implement are then an outcome of the negotiating stage.

The most important principle for health promotion is dialogue between project proponents, health professionals and stakeholder communities at the planning stage. The technical recommendations for managing health risks are diverse. A broad classification is:

- Appropriate health regulations and enforcement;
- Modifications to project plans and operations;
- Improved management and maintenance;
- Supportive infrastructure such as domestic water supply;
- Timely provision of accessible health care including diagnosis and treatment;
- Special disease control operations;
- Individual protective measures;
- Redistribution of risk through insurance schemes.

Some general principles for managing health risks include poverty reduction, community empowerment, removal of uncertainties, multiple barriers to safeguard health, accessible and functional primary health centres and a series of environmental measures. Projects that deliver a reliable and cost-effective service are likely to be health enhancing. The environmental measures used to mitigate health risks include manipulation of the timing and duration of the flood to flush vector breeding sites; the movement of domestic animals so as to avoid zoonoses or to provide diversionary hosts; management of catchment effluents and pollution to minimise the water quality degradation (see for more details). Many environmental measures are site specific. It is inappropriate to rely exclusively on curative medicine or pesticides as the mitigating measure. Drugs and pesticides are expensive and resistance seems inevitable.

The most appropriate safeguards improve the project outcome as well as improving human health - the "win-win solution". In some cases this can be achieved without additional project costs by simply improving communication between stakeholders during the early planning stages. Recommendations to change individual behaviour are unrealistic. They are also based on a model of individual responsibility for health. Health determinants are multi-factorial; public policy and social norms are of equal importance to individual behaviour. Education is valuable because it is empowering and increases choice. Accessible medical care is very important, but only as an additional protective barrier rather than as an alternative to preventative community health. Projects may often provide too little health care and too late. For example, in one dam resettlement project in S.E. Asia, the health centre was constructed more than a year after the community was already resettled, and was then built much smaller than planned because of cost overruns. Health centres should be operational, accessible and stocked with drugs before important events take place, not afterwards. They should be of an appropriate size for the projected population and staffed and equipped accordingly.



Table 13. Examples of techniques for managing health risks	
Poverty reduction	Poverty reduction empowers and enables people to make choices and to safeguard themselves and their families from many environmental hazards
Zooprophylaxis	There is a possibility of using livestock as diversionary hosts to protect people from malaria
Wetting and drying of floodplains or streams	Controls some mosquito species
Health centres	Ensuring that health centres are equipped and functional before dam construction, and building capacity and capability of health personnel
Water supply and sanitation	Reduces diarrhoea, intestinal parasites and schistosomiasis. Domestic water supplies should be protected from contamination by flood waters.
Vaccination	May be appropriate for certain arboviruses
Handling moribund animals	Control of Rift Valley Fever
Canal or river flushing	Floods have a flushing effect on stagnant waters, removing pollutants such as human waste, clearing drains or flushing away mosquito larvae.
Community control	Increasing empowerment and reducing uncertainty enhance health
Communication	Early warning of critical events such as floods, health promotion
Dam design	Dam off-takes that release first flush inflows with high levels of pollutants
	Structures that enable extensive control of operational water levels
Irrigation channel design	Minimising low flow zones to prevent vector breeding
Dam siting	Siting dams in areas that require minimum population and livestock displacement
Settlement planning	Siting new settlements away from vector breeding sites
	Adequate design of community water supply and sanitation, including careful management of wastes
	Staged resettlement linked to infrastructure development
	Culturally sensitive community planning
Irrigation management	Management of cropping systems to enable wetting and drying cycles and to use water efficiently
	Minimise long term salinisation, siltation and water logging
Upstream management	Catchment management to minimise flood and pollution risks
In-flow forecasting	Early warning of floods
Water release schemes	To enhance floodplain productivity and hence nutrition
Reservoir management	Prevent excessive growth of aquatic weeds and toxic cyanobacteria



	Maintain shallow de-weeded reservoir margins near settlements
Floodplain	Sensitive management for habitat and vector control
Good operation and maintenance	Delivering a reliable and cost-effective service



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There are a number of books and reports on the health impacts of dams stretching back many years. In addition to the references below, recent texts include the following.

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