Main Identity

From: "amol" <amol_p@vsnl.com>
To: "Soman Ravindra" <rssoman@hotmail.com>; "Narayan Ravi" <sochara@vsnl.com>; "Burte Aruna / Prakash" <burte@bom7.vsnl.net.in>; "Burte Poornima" <poornimaburte@hotmail.com>; "Sarkar PK" <fha@cal.vsnl.net.in>; "Prachi Patankar" <prachinoor@yahoo.com>
Sent: Monday, January 26, 2004 3:38 PM
Subject: Successful Thiyya !

The Successful *Thiyya Andolan* !

A few days ago we had posted an appeal for support for a *Thiyya Andolan* (indefinite 'Sit In') of the Pani Sangharsh Chalwal which started on the 19th of January in front of the Maharashtra Krishna Valley Development Corporation (MKVDC) Office here in Pune.

A *'Thiyya Andolan Sahayya Samiti'* consisting of most of the left and progressive organizations and unions was set up in Pune. However, since most of the leaders and activists from the left wing organisations were involved in the WSF not much support could be organised by these organisations. Much of the support therefore came from the remaining handful of activists who put pressure on the Pune Municipal Corporation to make arrangements for water supply and other basic amenities. The staff co-operated, thanks to the humanist appeal of the *Thiyya Andolan* and the influence of the Pune Municipal Kamamgar Union. A few articles in the Marathi press and news coverage helped to take the issue to a very wide circle of citizens. A good street play prepared by about a dozen motivated students of the Karve Institute of Social Service did it's rounds in various colleges and youth hostels to raise consciousness about the drought issue and about the *Thiyya*.

About 7000 people from the drought affected and dam affected areas of West Maharashtra participated in this struggle. This *Thiyya Andolan* was the largest indefinite 'Sit In' of the rural toilers in Maharashtra in many decades. It was also one of the most disciplined ones. People strictly followed the decision of not interfering with the working of the MKVDC office here in Pune. There was no violence or any untoward incident through the entire two days. For Punekars and especially the media it was a novel experience to see thousands of people eating and sleeping in the open on the roads.

It was quite a task to make arrangements for food for such a large number of agitators. Since the organisations in Pune could not undertake this responsibility the agitating organisations decided to make the food arrangements themselves. A team from Sangola taluka (Solapur district) took the responsibility of making about 30,000 *chapatis* and more than a quintal of *sabji* twice a day for the agitators! Leaders of some of the unions and organisations of the toilers in Pune like the LIC Union, Pune Municipal Kamgar Sanghatana, Molkareen Sanghatana (Organisation of the domestic workers), and state level leaders like N D Patil addressed the agitating farmers and pledged support for the *Thiyya Andolan*.

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Sent: Tuesday, January 13, 2004 9:55 AM
Subject: appeal !

Support the 'Thiyya Andolan' of the Drought and Dam Affected In the Krishna Valley!

This is an appeal to support the indefinite 'sit-in' *('Thiyya Andolan')* organised by the Pani Sangharsh Chalwal (a movement active in South Maharashtra) and Maharashtra Rajya Dharan va Prakalpgrast Parishad. About 20,000 people would be coming from 13 talukas of the drought and dam affected areas of Sangli, Satara, Solapur and Kolhapur districts to demand 'water for livelihoods'. This *'Thiyya Andolan'* has been planned in front of the *Sinchan Bhavan* on Barne Road in Mangalwar Peth in Pune.

The main demands of the Thiyya andolan are

- Immediate release of funds for eradication of drought
- Change in the priority allocation of water from industry to agriculture
- Equitable distribution of water- in proportion to the population
- Rehabilitation of the Dam affected

Maharashtra state is reeling under a severe drought, which is worse than the one that occurred in 1972. Apart from the stray news reports on the current drought in Maharashtra, the main reminders for the middle class have been when there was the news of artificial rains and when Pune's water quota was to be given to the drought affected Solapur. Almost 70 talukas in Maharashtra are affected by this drought. Thousands of cattle are being butchered because there is no fodder or water to keep them alive. If no serious programme is taken up to ameliorate the situation, then thousands of people-men women and children will be forced to leave their homes in search of livelihood- perhaps never to return home!

Amidst this fight for survival, people are forced to wage a struggle to force the government to act. The last one-year has seen such struggles in Sangli, Satara, Solapur, Kolhapur districts where people have come on the streets in large numbers to demand water for livelihoods. What a paradox this is! The toilers continue to toil for their survival and also wage a battle for the 'greater common good'- in this case measures for eradication of drought that in a few more years would engulf all of us in the cities too.

1/13/04

The Pani Sangharsh Chalwal

According to the Pani Sangharsh Chalwal priority must be given to harvesting local water

through watershed development. However the movement also argues that unless this local water is supplemented by 'exogenous' water from the dams, the drought prone areas in Maharashtra would remain deprived of water. This has to be done by taking into account, the average amount of dependable rainfall, nature of soil, terrain and population density. The movement also says, based on reliable information, that there is sufficient water in the existing dams to make this supplementary water available to all the drought-prone villages. However the main bottleneck according to the 'Pani Sangharsh' movement is the lack of a canal network. Much of the water remains unutilised today simply because of the incomplete canal work. The race to dam the Krishna waters to establish Maharashtra's right over the quota has meant that the state coffers are emptied on damming, leaving little or no resources for completing the canal work. The movement takes a position that if priority is given to the completion of this canal work and if water is distributed in an equitable manner a long-term solution to address the drought situation would emerge.

For over a decade, in the 13 drought-prone talukas in these 4 districts, the 'Pani Sangharsh Chalwal' and the 'Dharangrast Parishad' have been struggling for rights over water for all, including the landless. Over the last few years the movement has gained some unprecedented successes and is involved in significant struggles, which however have not been significantly reported in the state-level media. One of the significant contributions of this movement is that of joining together the interests of two groups, which are traditionally considered to be at loggerheads with each other- the dam affected and the drought affected-a situation the state exploits to its advantage.

In the last couple of months the movement waged successful struggles in Tasgaon and Mann talukas of Sangli district. Here the people launched indefinite 'sit ins' which lasted for a period of 6 and 14 days respectively. Their main demands were for ***equity in distribution of water***. The people withdrew their struggle only after getting written assurances from the government.

All these struggles have been able to achieve the demands partially or fully. However the movement realises the limitations of location-specific struggles and hence it decided to launch a massive struggle from the 19th of January 2004 which would demand to review the current water policy and specifically the water allocations within the Krishna basin to ensure equity in the basin and eradication of drought. Their slogan is 'Water for livelihood' (*Jagnyasathi Pani)* and 'Eradication of drought' (D*ushkal Bimod)*

'***Rehabilitation first, dam construction later'*** has been one of the major demands of the different successful struggles launched over the last few years. During January 2002 and 2003, more than three thousand dam-affected had launched an indefinite *'Thiyya Andolan'* in Satara for twenty days. The dam-affected withdrew the agitation only after getting written acceptance of their demands by the then Chief Minister. But even these written assurances have not been fully honoured. That is why they are joining this *'Thiyya Andolan'*.

In the last few months, apart from South-West Maharashtra, there have been struggles in other parts as well-- in Pavana, Malvandi, Panshet, and by people affected by the Tata dam, Narmada, Ujani, Vainganga projects. etc . All these struggles point to the growing discontent across the state which needs to be addressed in a much more holistic manner.

The *'Thiyya Andolan'* planned from the 19th of January 2004 in a way is the culmination of these various struggles.

- E-mail a letter of support to the Chief Minister of Maharashtra State at the following id chiefminister@maharashtra.gov.in

- Or phone him at the following numbers (Off) 22025151, 22025222 (Res) 23630408, 23634950

- As individuals and as organisations support the movement- send support letters, write articles, spread word etc. Support letters could be sent to any of the following addresses and they would be reached at the site of the *thiyya andolan*
amol_p@vsnl.com; joynagmans@vsnl.net; abhayseema@vsnl.com;

1/13/04

Though watershed development ; however the movement also argues that unless this local water is supplemented by 'exogenious' water from the dams, the drought prone areas in Maharashtra would remain deprived of water. This has to be done by taking into account, the average amount of dependable rainfall, nature of soil, terrain and population density. The movement also says, based on reliable information, that there is sufficient water in the existing dams to make this supplementary water available to all the drought-prone villages. However the main bottleneck according to the 'Pani Sangharsh' movement is the lack of a canal network. Much of the water remains unutilised today simply because of the incomplete canal work. The race to dam the Krishna waters to establish Maharashtra's right over the quota has meant that the state coffers are emptied on damming, leaving little or no resources for completing the canal work. The movement takes a position that if priority is given to the completion of this canal work and if water is distributed in an equitable manner a long-term solution to address the drought situation would emerge.

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In the last couple of months the movement waged successful struggles in Tasgaon and Mangalwedha talukas of Sangli district. Here the people launched indefinite 'sit ins' which lasted for a period of 8 and 14 days respectively. Their main demands were for equity in distribution of water. The people withdrew their struggle only after getting written assurances from the government.

All these struggles have been able to achieve the demands partially or fully. However the movement realises the limitations of location-specific struggles and hence it decided to launch a massive struggle from the 19th of January 2004 which would demand to review the current water policy and specifically the water allocations within the Krishna basin to ensure equity in the basin and eradication of drought. Their slogan is "Water for livelihood" ("Jagnyasathi Pani") and "Eradication of drought" ("Dushkal Nirmod")

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- E-mail a letter of support to the Chief Minister of Maharashtra State at the following id chiefminister@maharashtra.gov.in

- Or phone him at the following numbers (Off) 22022701 , 22022222 (Res) 23634950

- As individuals and as organisations support the movement- send support letters, write articles, spread word etc. Support letters could be sent to any of the following addresses and they would be received at the site of the thiyya andolan

amol_p@vsnl.com, joyeglitans@vsnl.net, abhayseems@vsnl.com.

- Support by giving financial donations either in cash or in kind. You could contact anyone of the numbers given below or the addresses mentioned above and get more details for donations.

Contact: Joy and Mani 9422505473, Seema Kulkarni- 020- 25465936, Anant Phadke- 020- 25460038

(Pani Sangharsh Samarthan Gat Pune)

A Thiyya Andolan Sahayya Samiti has been formed in Pune and consists of -

Hamal Panchayat. Sarva Shramik Sangh, CITU, Shramik Mahila Morcha, IFTU, Pune Mahanagarpalika Union, Kagad Kach Patra Sanghatana, Maharashtra Rajya Karmachari Union, Maharashtra Rajya Nurses Federation Pune, All India Democratic Women's Association, Ayurvima Karmachari sanghatana, National Railway Majdoor Union, Rashtra Seva Dal, PUCL, Pani Panchayat, Masum, Chowkashya,

Communist Party of India (M), Communist Party of India, Lal Nishan Party (L), Peasants Workers Party, Samajwadi Jan Parishad, Shramik Mukti Dal.

****

WISH YOU A MEANINGFUL, PEACEFUL NEW YEAR !

Anant & Sandhya Phadke,
8, Amey Ashish Co-op. housing society,
Near Kokan Express hotel, off Karve Road,
Kothrud, Pune 411029.
phone no. - 020 5460038

To,

The Chief Minister

Maharashtra State

Dear Sir,

As you are well aware Maharashtra has been severely affected by drought this year. In the light of this situation, the question of equitable distribution of the existing surface water gains significance. In the last few years the state has constructed a number of dams particularly in the Krishna basin. However this has not been supported by the construction of canals that would actually take this water to the fields. In fact the cavalier attitude of the state in this regard has meant that water just remains unutilised.

Pani Sangharsh Chalwal, a people's movement active in South Maharashtra takes the position that if the government takes up the work of the canal network on a war footing and ensures that water is distributed equitably (i.e. at least 3000^{m3}/household/year), long term solutions to eradicate drought would emerge. The movement makes a demand that all the necessary financial allocation for this must be made readily available. This has been a long-standing demand of the movement and it has led several successful local struggles on this.

1/13/04

The movement once again comes on the streets of Pune from the 19th of January with this very demand. We extend our support to the movement.

Cattle camps, employment guarantee scheme (EGS), provision of water tankers although necessary, are only temporary measures for mitigating drought and cannot be justified in isolation. The movement, based on a rapid assessment, shows that long term solutions to eradicate drought could emerge at a cost less than that incurred by the state on provision of tankers, EGS works etc.

Technological and social analyses have shown that failure of rains need not necessarily lead to a drought. However despite this we see that every failure of rains triggers a drought. This has largely been a result of the flawed policies with regard to water conservation and storage and use and distribution. Inequity in water distribution and policies that are leading to ecological crisis need to change. A pro- people policy in this regard has to be introduced. This too is one of our demands.

'Rehabilitation first, dam construction later' has been one of the major demands of the different successful struggles launched over the last few years. The Rehabilitation Act of 1978 was an outcome of these struggles. However due to the callousness of the state many of the demands of the dam affected still remain unaddressed. The last few years is marked with several struggles of the dam affected in different parts of Maharashtra. There have been some gains, however lack of funds is cited as the main cause for not honouring the assurances that the then Chief Minister himself made.

The dam affected are also therefore joining the Thiyya Andolan starting from the 19th of January 2004. We extend our support to them too.

We appeal to you to accept the demands of this thiyya andolan immediately and to implement them at the earliest.

Yours

1/13/04

DM 8.1

Social Issues

Human Health and Dams

Draft Final Report November 1999

Prepared for the WCD by:
World Health Organisation - Geneva

DRAFT (NOT FOR CIRCULATION OR CITATION)

For lib. after editing & finding authority

22/2/2000

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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

Disclaimer

This is a 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. The Commission's views, conclusions, and recommendations will be set forth in the Commission's own report.

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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

Good operation and maintenance	Delivering a reliable and cost-effective service

TABLE OF CONTENTS

Tables, figures and boxes

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 en 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 along side 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	Opistorchiasis 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, whereever 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 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 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.

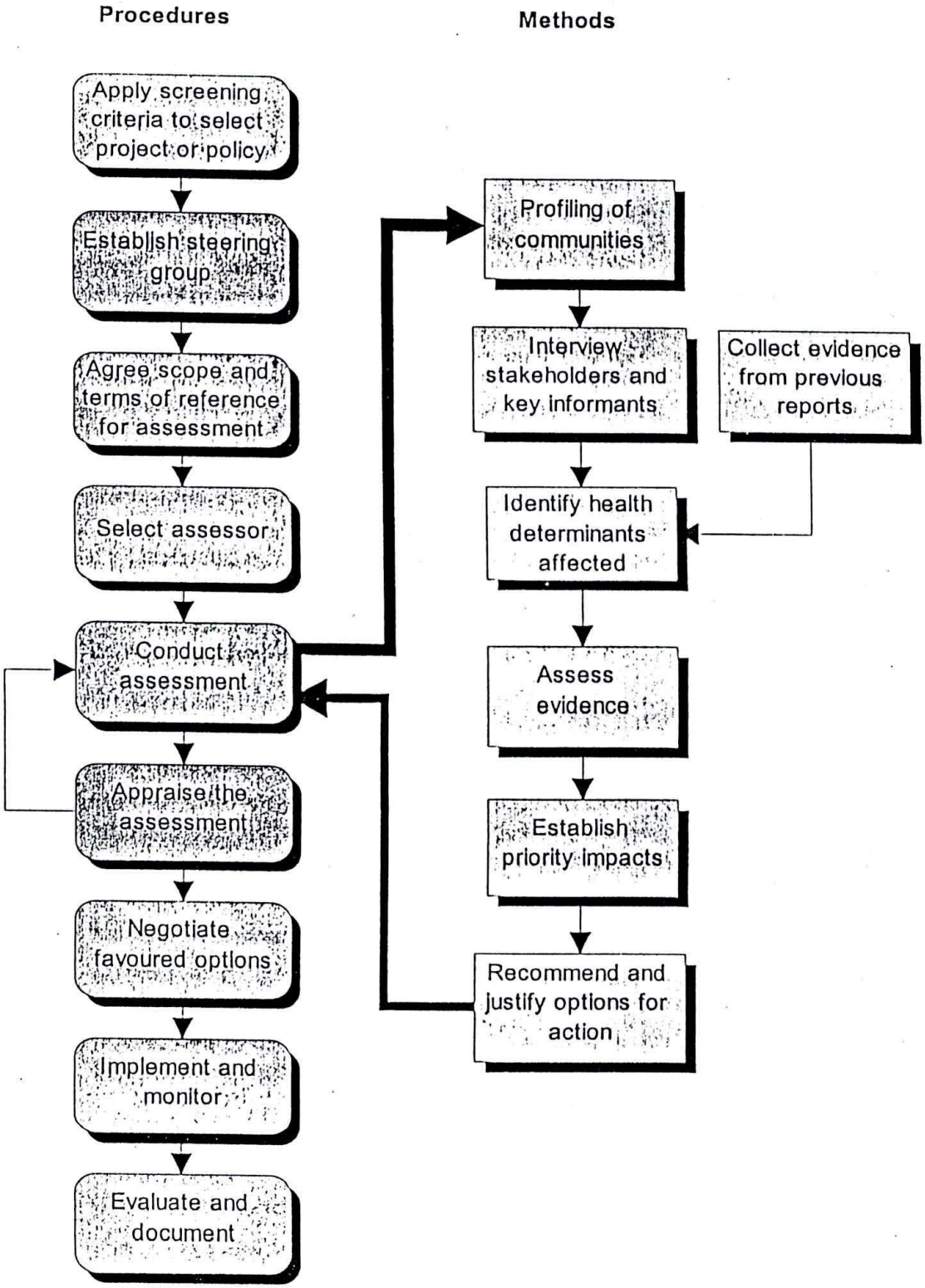
The various components of health impact assessment have been debated over the past 15 years especially in the context of water resource development. They can broadly be classified as policy, procedure and method. The policy context was described earlier in this document. The distinction between procedure 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 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 i 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 develope 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.

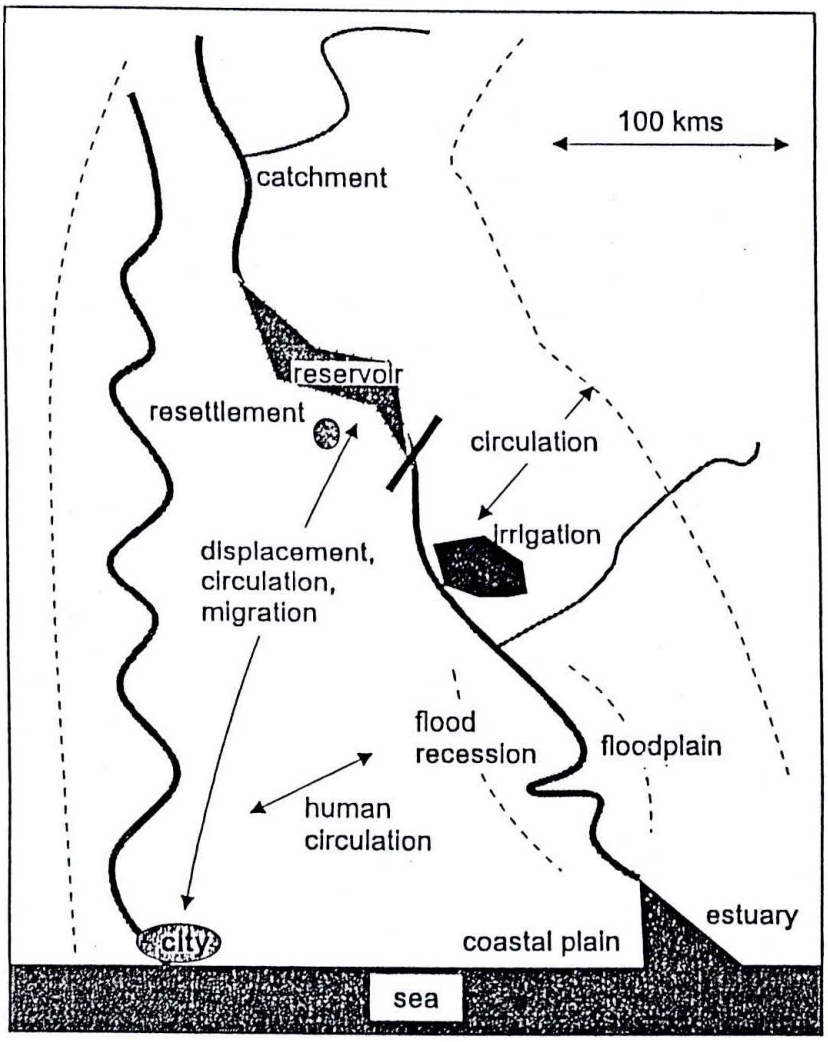


Figure 2. Spatial boundaries of dam health assessment

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

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[1]	Hunting[1]	Pastoralism[1,2]	Labouring[1,2]	Nomadism[1,2]	Resettlement[1,3]
Rural/urban	Commuting[1]	Trading[1,2,3]	Labouring[1]	Labouring[1,2,3]	Drought[1,2,3]	Labouring[1,2,3]
Urban/rural	Cultivating[1]	Trading[1]	Labouring[1]	Trading[1,2]	Refugees[1,2,3]	Retirement[1]
Urban/urban	Commuting[1]	Trading[1,3]	Trading[1]	Relocation[3]	Refugees[3]	3

1 communicable disease (e.g. vector-borne diseases, STDs)
2 malnutrition/injury
3 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

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

	Communicable disease	Non-communic-able 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 disempower ment
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	-
Decommission-ing	-	-	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.

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.

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.

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.

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

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.

	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

6. Acknowledgements

The World Health Organisation wishes to acknowledge and to express its appreciation in the preparation of this submission to the World Commission on Dams for the contributions and efforts of :

Dr M.H. Birley, Liverpool School of Tropical Medicine, Liverpool, UK

Dr M. Diop, Planification environnementale TROPICA, Dakar, Sénégal

Dr G. Jones, CSIRO Land and Water, Brisbane, Australia

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Also, the support and inputs provided by Dr J. Bartram (WHO), Dr G. Bergkamp (IUCN), Mr R. Bos (WHO), Mr P. Furu (DBL), Mr P. Murchie (USEPA), Professor S. Parasuraman (WCD), Dr T. Satoh (WHO), Dr J. Vapnek (FAO), Dr Y. Von Schirnding (WHO) are gratefully acknowledged.

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EXECUTIVE SUMMARY

DM 8.1

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:

i. 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.

ii. 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.

iii. 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 effectiveness of already implemented health risk management methods and 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.

iv. Action oriented research

Special funding should be directed towards action research in existing dam construction projects in order to strengthen existing knowledge bases, to improve health outcomes and to establish the effectiveness of health risk management techniques

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.

v. 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.

vi. 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.

vii. Prioritising dam projects for impact assessment

Screening procedures for HIA 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.

viii. 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**. (Tiffen 1991; Phillips *et al.* 1993). 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 (WHO, 1986). 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
Good operation and maintenance	Delivering a reliable and cost-effective service

STRATEGIC ASSESSMENT

Definition

1. Strategic Assessment (SA) aims to facilitate early comparison of impacts of development options, well in advance of project level impact assessment; consequently, it operates at the policy and programme level, in a cross-sectoral context. It is a process of integrating sustainability into strategic decision-making.

Responsibility

SA links the needs of economic development effectiveness to the needs of achieving optimal sustainability. The initiative and guidance for the SA process must, therefore, be the responsibility of national governments, shared by the highest authorities mandated to cover macro-economic development and environmental protection, respectively.

Scope

The scope of SAs will depend on the natural resource under consideration, either determined by geophysical boundaries (eg a river basin), or in a cumulative fashion (eg scattered mineral resources). The outcome should be the adjustment of the policy framework within which sectoral ministries implement their development activities.

Enabling condition for SA in the water sector

SA of the Water Resources sector must be a mandatory activity prior to consideration of individual projects. The multi-purpose nature of water resources development makes the formulation of a national water policy and strategy a first imperative.

Principles

2. SA must take into account the following principles:

- compatibility with the existing development policy frameworks
- opportunities and constraints analysis
- development needs and alternatives to meet those needs
- economic evaluation (eg costs and benefits)
- equitable distribution of benefits and risks
- social and cultural conditions, which determine the nature of the process and the potential scope of mitigation
- public awareness, involvement and acceptability, including prior informed consent
- the capacity of all partners to effectively participate in and contribute to the impact assessment process

SA attributes

3. SA must be revisited at appropriate intervals with periodic "state-of-the-sector" reporting; important variables determining the frequency and intensity of this on-going process include developments in the economy, in technology, in demography and in public opinion.
SA must apply to new development projects and the

rehabilitation of projects that are already operational. The SA process must be a transparent, involving stakeholder representation both interested and affected parties), and the results of the SA must be widely disseminated. Review of SA reports at the highest level of governance (eg Parliament) is a desirable procedure.

4. SA outcomes must provide a decision support system with clear policy directions for the selection of

SA outcomes and their attributes

- types of projects
- size of projects
- timing of projects
- ownership and financing of projects
- regional location of projects

The SA report must recognise the nature and magnitude of risks and rights of stakeholder groups, as well as opportunities offered to these groups by different development options.

5. The SA process and outcomes must be reviewed independently by a Panel of Experts, who are leading professionals in their field, designated in their personal capacity. The results of the SA and its review must subsequently be made public. In addition to the review of process and output indicators, this Panel should also identify possible synergies in the application of SA outcomes on different natural resources or for different sectors.

Independent review

6. No individual project can be considered (for study and implementation) unless a direct link with SA outcomes can be shown.

Conditionality of SA for project impact assessments

Strategic Assessment Parameters

1. multi-criteria decision making
2. macro approach (eg river basin scale)
3. cumulative assessment
4. identification of vulnerable groups and habitats
5. ranking of alternatives
6. Prior informed consent
7. others in accordance with local priorities

PROJECT ASSESSMENT

1. Impact assessment is a comprehensive planning tool which entails a process of identifying, predicting and evaluating the effects of development projects, with a view to preventing adverse effects, minimising risks, mitigating impacts that are not preventable and promoting additional development opportunities.

Definition

Impact assessment addresses both new development projects and plans for the rehabilitation/modernisation of existing ones; its outcomes include a risk management plan (for mitigating action during the detailed design, construction and operational phases, with measurable targets in a realistic time frame) and a Resettlement Action Plan (RAP).

Comprehensiveness

Outcome

Definitions

Environment in its broadest sense refers to biophysical, social, institutional, economic and health components of the world around us. Under this "umbrella" three types of impact assessment are conventionally distinguished.

Environmental Assessment (EA) or *Environmental Impact Assessment* the process of identifying, predicting, evaluating and providing a basis for the management of the biophysical, social, health and other relevar effects of development proposals before major decisions are taken and commitments made. As typically institutionalised, EA is applied primarily to minimise adverse effects that large scale development projects may have on natural resources and ecosystems. EA has developed into a broadly based planning tool to maximise developmer opportunities and options, ensuring that these are adjusted to environmental potentials and capacities.

Social Impact Assessment is the equivalent of EA on the human side, with a focus on the social and cultural effects of development initiative and decisions and their consequences for human populations, communities and individuals. Ideally, it should be oriented toward ensuring development meets the needs and priorities of people, with ar emphasis on their participation and inclusion. In the context of dams, resettlement issues occupy a prominent place in SIA, resulting in a Resettlement Action Plan (RAP).

Health Impact Assessment measures changes in health risks attributabl to a project, programme or policy. A health risk is the likelihood of a health hazard affecting a particular community at a particular time. EI which has health on its standard checklist, often results in a sector-limited, rather than a cross-cutting consideration of health status (recommendations would typically address strengthening of health services). Frequently, health is part of SIA. In fact, however, the heal status of communities results from both environmental and social determinants and HIA should therefore have a separate status, overlapping in method, procedure and outcome with EA and SIA. The outcome is a Health Protection and Promotion Plan.

Dam size

2. Large dams, as per de definition of WCD, should always be subject to a project specific impact assessment; the impact of small dams should be measured in a cumulative way under a Strategic Assessment.

Components

3. A generic approach to impact assessment methodology and procedure will facilitate the integration of Environmental Assessment (EA), Health Impact Assessment (HIA) and Social Impact Assessment (SIA) in the context of specific projects (See box previous page). The decision on the profile, relative weight and level of integration of the three components must be made at the scoping phase, based on clear criteria.

4. Scoping is the first step in the assessment procedure, and aims to:

Scoping: objectives

- establish the spatial and temporal boundaries for the assessment
- distinguish the key issues to be addressed in the assessment from the second-order ones
- ensure that the impact assessment proceeds from the framework provided by the Strategic Assessment
- define the balance between EA, HIA and SIA within the overall assessment and a mechanism for issues-driven interaction between the three during the entire process
- determine the composition of the IA team

Scoping: outcomes

The outcome of the scoping exercise is a set of detailed terms of reference for the contents, process and reporting of the impact assessment.

Scoping: timing

5. Immediately upon identification of a project, a scoping exercise must be carried out. It should involve appropriate public participation in an iterative process of identifying affected communities and starting a process of consultation. This implies that the scoping exercise must go beyond a desk study.

Steering Committee

6. A Steering Committee (SC), consisting of representatives of relevant government agencies and operating under the aegis of the environmental protection authority, guides the Impact Assessment process and monitors procedural vigour. The IA process should be further strengthened by the appointment of a Panel of Experts made up of leading professionals in their field, designated in their personal capacity. The Panel's function is to ensure that basic principles are adhered to, to provide guidance on assessment method, and verify the technical soundness, efficiency and social acceptability of recommended action.

Panel of Experts

Its first task would be to technically review the terms of reference of the IA and the profile of the consultants before the selection and start of the IA teams.

7. The outcome of scoping is the basis for the composition of the Steering Committee: all relevant ministries and other development partners must be represented. Each ministry should, as part of an impact assessment capacity building programme, develop human resources with intersectoral negotiating and decision making skills. Information sharing is a crucial function. Other key, minimal functions include: formulation of TOR based on the scoping outcome, review of the impact assessment for procedural vigour, adherence to the TOR and a secretariat role for the Panel of Experts. The Steering Committee operates in the policy framework set by SA, and is accountable to the highest environmental protection authority.

SC: modus operandi

8. The composition of the Panel of Experts should reflect the balance of issues considered by the impact assessment as determined by the scoping exercise. In the case of dams there should be minimally one impact assessment expert, one environmental expert, one resettlement expert and one health expert on the Panel. The Panel's essential functions include the technical review of the scoping outcome, of the TOR and of the impact assessment report(s), and the provision of technical guidance in the implementation of the environmental management, health protection and resettlement action plans. The Panel operates independently, serviced by the Steering Committee. The Panel reports to the highest environmental protection authority; thereafter, its reports should be made public.

Panel of Experts: modus operandi

9. The Impact Assessment is to be carried out by qualified consultants, in conformity with the TOR. It includes the following components:

Terms of Reference

- Review of IA reports of similar projects in the same setting
- Analysis of affected ecosystems
- Profiling/characterisation of all affected people and communities, with identification of vulnerable groups.
- Identification of environment, health and social determinants affected by the project.
- Identification of development opportunities offered by the project in terms of environment and health protection and promotion, and socio-economic progress.
- Analysis of the evidence of impacts and composition of a summary assessment. Recommend, justify and cost for action in the framework of environmental, and health management plans, and socio-economic development plans.

TOR components

Outcome of IA

The outcome of the Impact Assessment is a fully operationalised plan, defining roles and responsibilities of all partners, listing measurable products and delineating accountability. Typical outcomes include an Environmental Management Plan (EMP), a Health Protection and Promotion Plan (HPP) and a Resettlement Action Plan (RAP).

Impact assessment attributes

10. An assessment process that ensures optimal participation of stakeholders must, in its initial stages, allow for a comprehensive coverage of all real and /or perceived issues in the TOR through meetings with interested parties, engagement of relevant public sector institutions and public hearings.

It must include interviews with stakeholders and key informants as part of data collection. It must offer opportunities for review and improvement of the assessment report by all stakeholders. And, it must facilitate consultation with government bodies at all levels to agree on operational and regulatory responsibilities in the action plan of recommended measures.

Mechanisms to induce participation

A participatory assessment can be promoted with locally effective mechanisms, such as opening a local office of the developer or inviting the press to public hearings. The Steering Committee, which overviews the procedural rigour, should pay special attention to the participatory nature of the process. The Panel of Experts may advise on innovative participatory approaches.

Review

11. Formal review of IAs is considered an essential step in the decision-making process. It ensures the quality control of impact assessment. Review by competent authorities under prevailing laws and regulations (or in their absence, regulations established for this specific purpose) should be carried out keeping in mind the following criteria:

Review criteria

- independence
- objectivity
- comprehensiveness
- width of the range
- participatory process
- provision of clear guidance to proponents and decision makers

Biases

Identification of intentional or unintentional biases is a key component of review/appraisal; such biases may include:

- Consultants profile and independence (relevance and scope of expertise; social barriers –gender, language-, potential conflicts of interest)
- Timing (both methodologically -data collection on a seasonably transmitted disease should take place over a full 12-month cycle- and procedurally -work schedules of the various feasibility and impact assessment teams should be synchronised for optimal exchange of relevant information-)
- Adequacy of the TOR
- Adequacy of the resources allocated to the impact assessment.

12. The review of the IA documents can result in

Outcome of review

- outright approval
- conditional approval
- postponement of approval until differences have been effectively addressed.

IMPLEMENTATION OF THE PLAN

1. A legal framework supported by incentives and assurances is required to facilitate the transition from the impact assessment to the implementation of action plans aimed at prevention, mitigation and additional development opportunities. Instruments could include:

Legal framework and instruments

- negotiated contracts
- establishment of a trust funds
- percentage of power revenues
- performance guarantees through bonds
- improving the certainty level of the outcome by other means

2. Operationalise the Environmental Management Plan, the Health Protection and Promotion Plan and the Resettlement Action Plan. Firm up required funding, contractual and institutional arrangements. Establish roles and responsibilities, and determine the ultimate responsibility. Since a wide range of organisations will be included in the implementation tasks, appropriate coordination and management structures and procedures should be in place.

Start-up action plans

Principles

3. The principles of project implementation have been laid down in the attached organization chart.

4.

Implementation qualifyers

4. After the decision to proceed with the project has been made, the correct implementation of the mitigation management and development plans is of the highest priority. Funding of these activities must be assured and the institutional framework to implement must be clear and functional. Implementation includes government, private and non-governmental parties. It should work towards measurable indicators and include, whenever possible capacity building components.

Monitoring

5. Monitoring and evaluation procedures and arrangements should be in place. These can include:
   - internal monitoring and review
   - external independent monitoring
   - external independent evaluation
   - panel of experts

Re-dress

6. Redress procedures and arrangements should be in place. These can include:
   - a multi-level approach,
   - starting at the project, then through committees to the courts

Stakeholders

7. All stakeholders should remain actively involved throughout the implementation phase.

Time horizon

8. It must be recognised that the project is never completed.

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HUMAN HEALTH AND DAMS,

The World Health Organization's submission to the World Commission on Dams

Geneva, January 1999

Table of contents

Tables, figures and boxes

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 along side 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** the 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 Intersectoral 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 Organization, 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 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 institutionalization in Africa (Birley *et al.* 1996).

1.2 Equity and health

As already noted, the development and economic objectives of dams are often not fully comptaible with an equitable distribution of the benefits and stresses between different stakeholder and community groups. In the case of 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 at 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 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 (Ehiri and Prowse 1999).

Three main requirements need to be fulfilled 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 is intended 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 an appropriate policy framework for impact assessment means:

- lack of assessment of 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 Harare Declaration on Malaria Prevention and Control of the Organisation for African Unity 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 civil 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 the WCD from civil 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 particular communities. For example, farmers may be given subsidies to extract groundwater for irrigation with the result that a nearby community is paying 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 statements about health included in such instruments.

1.6 Integration 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 health problems of industrialised countries. In the case of dams, filariasis, malaria and schistosomiasis, are frequently cited. Other 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 little reference to human health (e.g. World Bank 1991; Department for International Development 1999), although the World Bank's environmental sourcebook has been updated on the issue of health (Birley *et al.* 1997). In most cases, health is addressed in a strictly "medical" sense rather than a wider cross-cutting view of community health. This then results in recommendations for the 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 mechanism 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.

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

Health issues	Examples	Knowledge base
Communicable disease	vector-borne, water-borne, sexually transmitted, zoonoses, other parasitic	large, reliable, ecosystem specific, some quantification
Non-communicable diseases	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
Malnutrition	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

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.

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 czanobacterial blooms, for example. Some of the more generalisable regional differences in health conditions throughout the world are described in Table 2.

Table 2 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. Examples include malaria, schistosomiasis and cholera. Toxic algal blooms are 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	Opistorchiasis is an example of a parasitic disease restricted to this region. 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 ration 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.

Table 8 provides examples.

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 search for procedures, methods and technical solutions that assist in achieving these objectives, many technical solutions can be found to the problem of negative impacts of dam construction - good practices -, as Table 3 and Table 10 illustrate.

Table 3 Examples of good and bad practice

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 the Tennessee Valley.
	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 linked to 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 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 remedial medical interventions (Bos, 1991; Rozendaal 1997).

As already noted, the key process driving this increased understanding is the integrated Health Impact Assessment (HIA). In he 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 these 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 usually be identified between the HIA and environmental (ecological) and social impact assessments. From a health perspective, it will 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, 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 of 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 that 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, and social and community planning. Some examples are:

- Multiple depth off-takes which allow the release of first flush inflows that may contain high levels of contaminants and nutrients, and allow a high level of control of

variation in operational water level (which can be advantageous in the control of disease vectors such as snails and mosquitoes).

- Double spillways in areas where onchocerciasis (river blindness) is endemic. Spillways have been shown to provide an appropriate habitat for the breeding of blackflies (*Simulium ssp.*), the vectors of the *Onchocerca* parasite causing the disease.
- A greater than standard diameter of off-takes will allow the rapid draw-down of reservoirs, allowing both a rapid drop in shoreline water levels (stranding and killing mosquito vectors, provided no pool formation occurs) and an artificial flood down stream that will flush out any vector breeding places in rock pools.
- Minimising low flow zones in artificial channel networks to minimise habitats for the propagation of disease vectors.
- Concrete lining of irrigation canals to reduce seepage, save water and prevent pools of standing water where mosquito vectors propagate.
- 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 to 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 perimeters) 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 (fisherman, women, 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 drinking water treatment may be less common or absent, and where exposure to toxic blooms may go unmanaged or unreported (see box 4).
- Careful settlement planning that ensures that, where ever 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 irrigated cropping systems to maintain wetting and drying cycles (while ensuring efficiency in water use), crop diversification and synchronisation of cropping patterns. Regular wetting and drying of flooded rice fields provides an important control of water associated vector-borne diseases such as malaria and Japanese encephalitis. In particular, there should be no agricultural advocacy or economic analysis carried out that encourages excessive multiple cropping within a single production year.
- Stages and planned control over population movements into and out of affected region, e.g. planned community infrastructure construction and culturally sensitive community planning.

- Well formulated dam environmental management plans that will support sustainable fisheries practices, sustain populations of natural predators of disease vectorsand minimise excessive growth of aquatic weeds.

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 off-site environmental management measures may also be considered.
Catchment management to minimise negative impacts on the impoundment, including population growth and agricultural development in the upper catchment and pollutants in-flow.

Adequate in-flow forecasting for disaster prevention because of increased settlement on the downstream floodplain and heavy livelihood dependence 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 irrigated areas that minimise long term salination and water logging and therefore impact on food security and scheme viability.

Sensitive management of flood plain wetlands and water resources to ensure wetland protection, while at the same time minimising excessive propagation of water-borne and water related vector-borne diseases. As with irrigated agricultural production systems, 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 degradation of the wetland and increased risks of vector-borne diseases.

4. Recommendations for improving good practice

4.1 Health Impact Assessment

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 climate cycle (see section 3.2).

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

4.2 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 health impact assessment to their full potential until there is a body of trained personnel, and this is clearly lacking throughout the world at the present time. A favourable policy climate is essential for this body of trained personnel to function optimally. Health sector personnel will benefit from training in impact assessment procedures and methods, and it 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 in inter-sectoral communication, collaboration and community participation. 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 is one of the indicated institutions to provide that support through its headquarters, Regional Offices and country representations. It can also provide the international framework for health impact assessments 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 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 Organization, 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 intersectoral 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 higly enhanced when simultaneously policy reform is promoted allowing for the trained staff to effectively engage in intersectoral collaboration (Birley *et al.* 1996)

4.3 Documentation of successes

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 effectiveness of already implemented health risk management methods and techniques.*

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

Examples of good health planning in dam and water infrastructure construction include: the Panama Canal, the Tennessee Valley Authority, Owens Falls in Uganda, small dams in Puerto Rico, simplification of the Gorgol irrigation project in Mauritania and remedial action on the Dez Irrigation 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 and the Manantali reservoir in Mali.

Evaluations of recent dam projects following construction (socalled *ex-post* evaluations) 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. (See sections 5.2.6 and 5.2.7 on HIA - boundaries).

4.4 Action oriented research

Special funding should be directed towards action oriented research in existing dam construction projects in order to strengthen existing knowledgebases, to improve health outcomes and to establish the effectiveness of health risk management techniques.

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. An action oriented research component on health risk management should be part of any future dam project.

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 the Department of Zoology of Peradeniya University and of 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 moments 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).

4.5 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. This represents the cost of

providing health care and medical support to communities for illnesses that arise because of unforeseen (though avoidable) consequences of dam construction. The health budget of a dam project, 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.

4.6 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 are positive health enhancements, while others will be negative health impacts that have to be prioritised for preventative action. Table 1 indicated the range of health issues that may be affected by a dam project. Development agencies are often aware of one or two 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 impact assessment procedures for dam construction.

In addition, there are often differences in perception of risk between subject experts (health specialists) and affected communities. Such differences in opinion cannot 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;
- determining the subjective perception of risk expressed by the stakeholder community;
- negotiation of opportunities for mutual gain;
- comparison with standards;
- reducing health inequalities.

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

In tropical, sub-tropical and arid regions of the world it is 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 input that accompanies the growth of towns and the development of 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 lethal to humans and animals if consumed in sufficient quantities. Additionally, some cyanobacterial toxins can promote live 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, 1999). A norm for drinking water concentrations 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 directly 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, 1999).

Box 5 Examples of health impacts form 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. (The World Bank, 1992.]

Water pollution

The impoundment 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, further downstream, Delhi itself seriously pollute 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).

4.7 Prioritising dam projects for impact assessment

Screening procedures for HIA must be a 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).

4.8 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 a critical source and repository of health knowledge and information.

5. Health impact assessment

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 mainly positive impacts and these include reductions in health risks as well as imporvement of the health status.

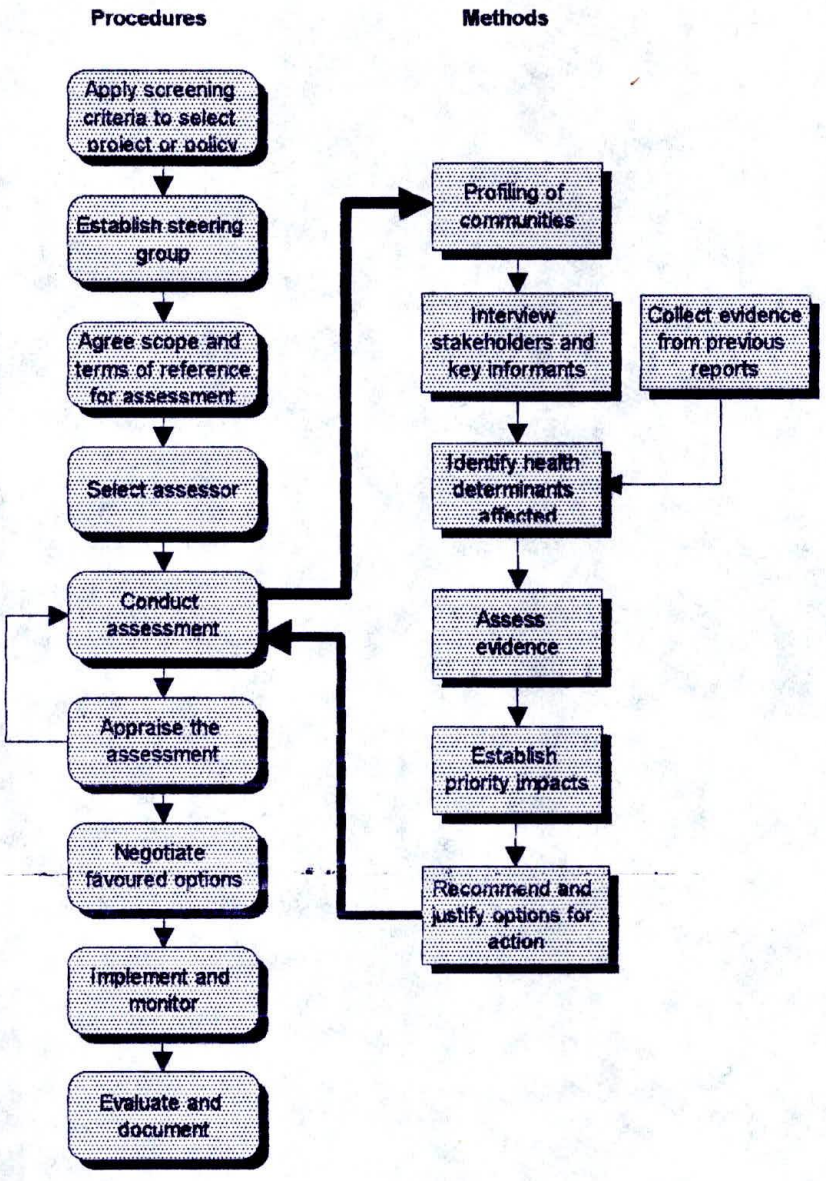
The various components of health impact assessment have been debated over the past 15 years especially in the context of water resource development. They can broadly be classified as policy, procedure and method. The policy context was described earlier in this document. The distinction between procedure 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 which aims to ensure that each stakeholder is informed of the framework in which the assessment should be carried out. See Figure 1.

5.2 Procedure

The procedure that is described 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 the following:

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 Illustration of some of the components of procedures and methods used in health impact assessment



5.2.1 Timing

Timing -when to start and when to complete athe 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. Whenever feasible, time should be allowed for the observation and recording of seasonal differences in health risks and baseline community health status. See also sections 3.2 and 5.2.7.

5.2.2 Screening

Screening procedures are used to decide which projects should receive a particular level of HIA, or whether, inded, an HIA is necessary at all (as discussed in section 4.7). It is, however, 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. As already noted, however, small dam developments need to be examined strategically and in a regional context. In particular in areas where several other such dams already exist, their 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 secion 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 asessment being determined to a large extent 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. The quality of the assessment is determined in part by the quality of 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 they should commission the HIA from. This is made more difficult by the general lack of availability of special training or expertise. In an ideal world, a team that encompasses all the requisite skills would undertake the assessment. In reality, some compromise will usually be necessary. The following list is provided for guidance. The person or team contracted to undertake the HIA of dam projects should ideally have the following qualifications, education and experience:

- Experience with prospective health/environmental/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 and issues of dam construction and operation.
- 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 (rather than laboratory, taxonomic or clinical expertise).
- Familiarity with technical assistance and how this differs from experimental scientific research.

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 section 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 assessments need to be integrated. Health impacts are sometimes associated with boundary problems and confusions over jurisdiction.

Figure 2 illustrates the various geographical components of dam projects. They include reservoir, upper catchment, irrigation scheme, floodplain, estuary, urban slums, 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 lateral zone of interest rather than any particular biogeographic zones (e.g. catchment boundaries). This includes seasonal movement of pastoralists, displacement to (peri-)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.

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 kms and the reservoir has a drawdown zone that may extend 5 kms laterally around the perimeter of the dam. At an even smaller scale, the local flight range of insect vectors between breeding and feeding sites ranges from 0.1-10km as Table 4 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 4 Flight range of insect vectors

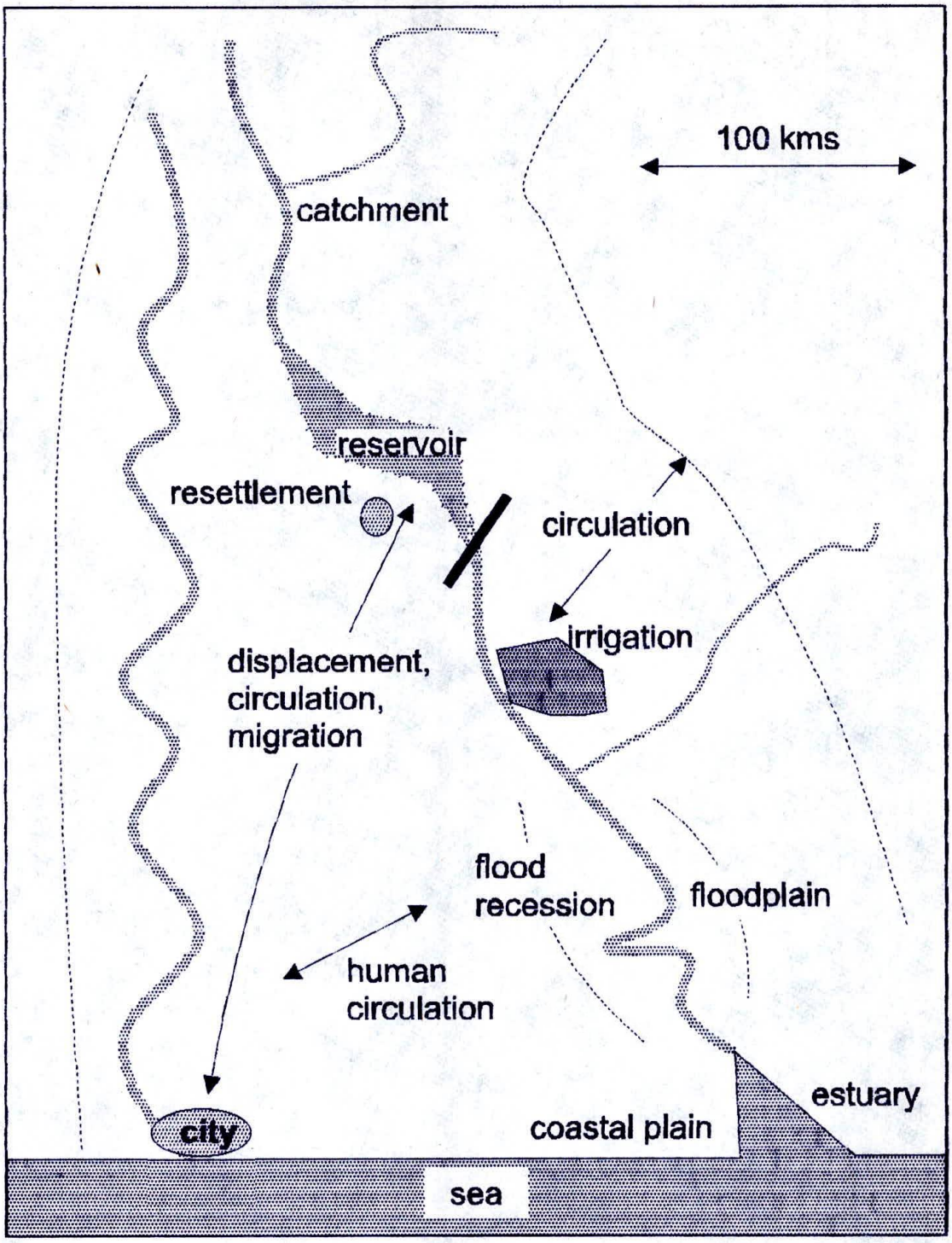
Vector	Local movement (km)	Migration (km)
Simuliid blackflies	4-10	400
Anopheline mosquitoes	1.5-2.0	50
Culicine mosquitoes	0.1-8.0	50
Tsetse flies	2-4	1

Table 5 Typology of human circulation (Birley 1995)

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

1 communicable disease (e.g. vector-borne diseases, STDs)
2 malnutrition/injury
3 psychosocial (e.g. alcoholism, stress, depression, violence)

Figure 2 Illustration of the spatial boundaries of a health assessment



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 is 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 6 and Table 7. 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.

Table 6 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 7 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

5.2.8 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 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 (which it usually will not).

5.2.9 Negotiation

The usefulness of the assessment lies in the weight of the arguments that it provides to the commissioners 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.

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).

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

Table 8 outlines some health impacts that 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 analyses of distributional effects and with health inequalities research.

5.3.2 Health determinants

Health determinants are the factors that are known or postulated to be causally related to health status. 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 9 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 attribute a change in health outcome to a change in health determinants. 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, and occupation. In seasonal climates vector-borne diseases often have seasonal changes in incidence. Hydrological changes may extend or reduce the transmission season.

Table 8 Examples of local stakeholder communities and some 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, problems of food entitlement within the household	dis-empowerment and uncertainty
Displaced	diarrhoeal disease		communal violence		stress, depression, suicide, , loss of tolerence and violence, divorce rates, drop-out from schools
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 and other vector-borne diseases	algal toxins	drowning		
Nomadic herders	zoonoses		communal violence	loss of grazing	stress
Various 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 teachers	vector-borne diseases				alienation
Seasonal labourers	STDs, vector-borne diseases	pesticide poisoning	agricultural and transport injury		

Table 9 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. It may not seem 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 with 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 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 and the movement of domestic animals so as to avoid zoonoses or to provide diversionary hosts; management of catchment effluents and pollution to minimise water quality degradation . See Table 10. 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 multifactorial; public policy and social norms are of equal importance to individual behaviour. Education is valuable because it is empowering and increases choice. Accessible health care is very important, but only as a last resort. Projects often provide too little health care and too late. For example, a dam resettlement project in S. E. Asia constructed the health centre more than a year after the community was already resettled and built a much smaller unit 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.

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 10 Examples of techniques for managing health risks

Poverty reduction	Poverty is probably the primary determinant of health. 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
Alternate 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 the capacity and capability of health service personnel
Water supply and sanitation	Helps to control diarrhoea, various intestinal parasites and schistosomiasis. Domestic water supplies such as wells 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 can 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 are health enhancers in themselves.
Communication	Early warning of critical events such as floods, health promotion
Dam design	Multi-point off-takes that release first flush inflows that may contain high levels of contaminants
	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 eutrophication and 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

Table 10 Examples of techniques for managing health risks

Poverty reduction	Poverty is probably the primary determinant of health. 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
Mosquito welfare 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 the capacity and capability of health service personnel
Water supply and sanitation	Helps to control diarrhoea, worm and intestinal parasites and schistosomiasis. Otherwise water supplies such as wells should be protected from contamination by flood waters
Vaccination	May be appropriate for certain epidemics
Treating mosquito breeding	Control of fish variety / type
Clearing	Involves clearing silted on elephant weeds, removing pollutants such as [illegible] debris, clearing or blasting away a rocky [illegible]
Community control	Increasing empowerment and reducing uncertainty are health enhancers in themselves
Communication	Early warning of critical events such as floods. Health promotion
Dam design	Multi-port oil takes that release that flush outlets that may contain high levels of contaminants
	Structures that enable extensive control of downstream 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
Options at planning	Shed new settlements away from vector breeding sites
	Adequate design of community water supply and sanitation, and solid [illegible] waste
	Shared responsibility linked to infrastructure development
	Culturally sensitive community training
Irrigation management	Management of cropping systems to provide wetting and drying cycles that [illegible]
	Minimise long term salinisation and water logging
Operation and control	Catchment management to minimise flood and pollution risks
In flow forecasting	Early warning of floods
Water use efficiency	To minimise floodplain productivity and hence mosquitoes
Cropping management	Prevent [illegible] and crop [illegible]
	Maintain shallow de-watered reservoir margins [illegible]
Protection	Strategic management of rainfall and water control
Flood protection and maintenance	Delivering a reliable and cost effective service

6. Acknowledgements

The World Health Organization wishes to acknowledge and to express its appreciation in the preparation of this submission to the World Commission on Dams for the contributions and efforts of :

Dr M.H. Birley, Liverpool School of Tropical Medicine, Liverpool, UK

Dr M. Diop, Planification environnementale TROPICA, Dakar, Sénégal

Dr G. Jones, CSIRO Land and Water, Brisbane, Australia

Dr P.V. Unnikrishnan, OXFAM, Delhi, India

Dr R. Zimmerman, Consultant Vector Biology and Control, Gainesville, Florida, USA

Also, the support and inputs provided by Dr J. Bartram (WHO), Dr G. Bergkamp (IUCN), Mr R. Bos (WHO), Mr P. Furu (DBL), Mr P. Murchie (USEPA), Professor S. Parasuraman (WCD), Dr T. Satoh (WHO), Dr J. Vapnek (FAO), Dr Y. Von Schirnding (WHO) are gratefully acknowledged.

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TEHRI DAM :

PROJECT
THAT
SPELLS DISASTER

By :

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Published by
The Tehri Bandh Virodhi Sangharsh Samiti
Tehri Garhwal

FORE-WORD

A freedom fighter Sri Virendra Datt Saklani is a well known personality and a leading lawyer in the Himalayan districts of Tehri Garhwal and Uttarkashi. He was born on 16th Nov. 1916 in Tehri town and it is natural that he should have profound attachment and love for his home town. After passing his B.A. degree he for some time worked as an honorary teacher in English language in Ghananand High School Mussorie, but later on he joined law and passed LL.B. degrees in the first division. In 1942 he joined the bar in Saharanpur judgeship at Dehra Dun. He was very closely associated with martyr Sri Deo Suman and was profoundly impressed with his national activities. When the father of the Nation Mahatma Gandhi gave the call for "Quit India" movement, Sri Saklani plunged in the Freedom of India movement. He was the first person to hoist the congress flag in Tehri Town on 10th of Sept, 1942, where upon he was immediately arrested and was lodged in Tehri jail on 12th Set. 1942. During the period of detention he was tortured in many ways. He was forbidden to get clothes to change, not provided to take bath, no facilities for cutting hair or shaving were allowed on account of which long hairs on head and beard grew. Similar treatment was meted out to other detenues, e.g. Sri Bansi Lal Pundir, Kushal

Singh Rangar, Prem Datt Do hal, Dinesh Chandra Saklani, Ram Chandra Uniyal a d all other who were arrested during the same peri d Sri Saklani was detained in jail for 390 days, a d, but for the last 30 days he was all through kept in solitary confinement and was tortured beyond des ription. During the winter, the only blanket given t him was taken away inspite of the clothes on his body were in tattered condition, and he was kept in h avy shakles simply to demoralize and torture and h was kept in that horrible position for 24 days.

These very shakles were l er put upon Sri Deo Suman who resorted to hunger trike for 84 days and sacrificed his valuable life at the alter of Independence, These shakles are preserved in Tehri jail for public view on Suman day which is a declared holiday Sri Jawahar Lal Nehru, then a a meeting at Srinagar Garhwal proclaimed that the T hri jail shall always be remembered as a symbol of errorism for all times to come.

Sri Saklani was released i Oct. 1943 from detention but was kept under h se arrest for one year more. After expiry of the per od of parole, he joined the Tehri Bar and started pra ticing law under the guidance of his father Sri Deve dra Datt Saklani, who himself was an eminent lawyer

In the year 1948, moveme t to free the princely state of Tehri Garhwal fr m feudalism began,

Sri Saklani together with Sri Shankar Datt Dobhal led the revolution. Both of them were at once arrested, kept for one night in Tehri Police Hawalat, and then together with sixteen other Prajamandal workers were transferred to Police Hawalat Narendra Nagar, where they were detained for 18 days. After his release from detention he and Sri Doval with blessings of late Sardar Patel, again organized the rebellion against the feudal system of Government in most peaceful and non-violent way. The Maharaja was not allowed to enter the Tehri town, and with great tact, the armed forces stationed at Tehri together with the commander of State Military Force Sri Nathu Singh were arrested and disarmed, all the state officials stationed at Tehri were arrested and lodged in Tehri jail. Whole of this movement was surprisingly peaceful except that at Kirtinagar, the state Police resorted to firing in which Sri Nagendra Datt Saklani and Molu Singh Bhardari lost their lives. So, ended the feudal system of Govt. in the princely state of Tehri Garhwal in 1948. A constituent assembly was formed and a popular democratic Govt. installed which functioned till the merger of Tehri Garhwal in Uttar Pradesh.

It is to the credit of Sri Saklani, that inspite of all persuation and oppurtunities given, he refused to join the Govt. or to accept any post of power and position. He resumed his practice and took part in social and development activities. For a number of years he remained President of the Zila Harijan Sewak

Sangh and General Secretary of Zila Nagrik Parishad During his tenure as President of hi Gaon Sabha and Chairman of Tehri Nagar Palika h carried out many works of public welfare and during t ie China aggression and Bharat Pakistan war his eff rts for the help of soldiers at the front were highly ppreciated by all concerned. Though entitled to F reedom Fighter's pension, he did not accept it holdin that he had only fullfilled his duty towards his mot ierland and could not accept compensation for it.

Sri Saklani has been in opposit on of Tehri dam from the very beginning. Agitation gainst the Tehri d m was going on under the leade hip of Sri Vidya Sagar Nautiyal, but the main mphasis was on reha bilitation of the people to be ou ted by the dam It was sometimes in January 197 3 that Sri Saklani and his colleagues came to know of ertain facts about the geological, seismological aspec s of project area and weak rock formations obtainir g at the dam site. It startled them and they were con inced that if this dam is built it is not only going to r in the h ll people but it is bound to fail and resu in a catastrophe unprecedented in the history of ma n. Obviously, if the dam bursts, the 2.62 million acre ft. water released from its 45 Sq K.M. lake will wipe (ut all habitations from Munikireti to Calcutta.

It was then that the Tehri Ba dh Virodhi Sangharsh Samiti was formed. Sri Sa lani being a non-party man was elected its president, a nd the presidents or Chairmens of all National Politic l parties (Distt.

Units) were elected, Vice Presidents of the Samiti. Representatives of all the concerned Gram Sabhas and prominent Social workers were elected as member of the Samiti. Many prominent persons were opted as its members and the first resolution to oppose the dam was unanimously passed on 24.1 78.

There after several big demonstrations were held, representation made to the Union and State Govt. which all fell on deaf ears. The vested interests in collaboration with the corrupt bureaocracy prevailed and the Govt. gave a green signal to go ahead with the project which forced the people to offer Satyagrah. When the work allotted to the contractors came to a stand still, the Govt. resorted to force, a large number of armed police force was called in and the Tehri town was virtually turned into a police cantonment. Sri Saklani together with his wife and many others were arrested on 1.6 78 They were released on the next day but Sri Saklani was rearrested the same day together with Sri Sawan Chand Ramola and many other prominent Satyagrahis were also arrested and sent to prison. There after, Sri Govind Singh Negi M.L A. together with many other persons specially village women were arrested and due to paucity of space in Tehri jail most of them were sent to Bareilly jail. Amongst the arrested persons were Smt. Nisa Rani wife of the President Congress (I) and the elder daughter of Sri Saklani. Smt. Sushila Gairola and thus after putting many persons behind the bar, the tunn-

Cont on last page.

Tehri Dam :

PROJECT THAT SPELLS DISASTER

(V. D. Saklani)

The Tehri Dam has become a project of fierce controversy in recent months, and serious objections have been raised to its construction on geological and ecological, humanitarian and other grounds.

The dam is proposed to be constructed on the Bhagirathi river near Tehri town in mid Himalayas. It is well known that the Tehri dam site lies within isoseismals VII and VIII of Kangra earthquake (1905) and it is subject to an earth quake whose intensity by M. M. scale can be up to VIII and IX falls. It has frequently experienced earthquakes of varying magnitudes in the past. A perusal of the report on seismic instrumentation for water resources development projects in Ganga and Yamuna Valley by the Roorkie University scientists goes to show that seismic activity is on the increase in this region in as much as before the year. 1971 While one or two earthquakes a year were experienced, at least 5 earthquakes in the year 1974 and 7 earthquakes in the year 1975 were experienced and many earthquakes originating from potential active features along which big earthquakes could occur in future remained undected as the seismological

instrumentation for monitoring the complete earthquake activity was formed to be inadequate and not well distributed over the whole region,

The Bhagirathi follows a weathered course and at the dam site weak metamorphic formations occur in the foundations and the river gorge are characterized by their shale structures as well as by their bent for intensive weathering and disintegration into separate blocks. The rock formations are of completely low strength (150–100 kg/cm) with completely low factor of shear resistance of rocks in foundation (0.5–0.6).

Heavy cracking of the rocks have been found on the exterior zone of the slopes of the river gorge. Thus the rocks on which the dam is proposed to be built are highly deformed and are most unlikely to be able to bear the weight of 2.62 million acre feet of water to be impounded in the lake, and it is well established fact that when deformed rocks under stress can no longer resist fracturing, earthquakes occur.

The water load of Marora dam reservoir, in Garhwal, was estimated to be 28 tons on one square inch and inspite of the fact that rocks at Marora were far more competent than the Tehri dam site rocks, the Marora scheme had to be abandoned due to existence of fault zones there. The water load of Tehri reservoir will be far greater than that of Marora, but inspite of the standing directions of the UNESCO to

that effect, no proper scientific inve tigation has been carried out to establishe the load bear ng capacity of the rocks at Tehri The matter does nc end there. The peculiar feature of the Tehri dam prc ect site is that it is strewn w th many major and minor faults which are all active and every sort of shear zones of varying width exhibiting considerable pinchin and swelling in thickness along their traces and thus roving that they are active and alive have been fou d to exist in the project area.

The authorities assume the rive bed fault to be in-active but the assumption is not s pported by any scientific investigation or data. It is in act controverted by the project report itself. The assu nption made is wholly uncalled for and is in disregard o the rule of prudence that in such cases, under no circu stances a factor should be assumed to be favourable unti the assumption is supported by all available data. I is well known that earthquake arise on fault surfaces v hen they come under stress. The tectonic peculiaritie in the Tehri dam project area are more than one The Dharkot thrust (Tons thrust) lies at a distance f only about a furlong from the project area and the main boundry fracture (thrust) of the Himalayan regio of U. P. state lies at about 20 K.M. from the Tehri lam site. It is known as krol thrust. and Nahan th ust, which is a branch of krol thrust, crosses the dam site itself and is known to be active. The Shrinagar t rust is located at a distance of 4 K.M. east of the da 1 site. It has

been found to be rejuvinated and activity in it is well established by displacement of terrace deposits across the fault and the presence of Nick points in the stream profiles across the trace of fault. A thrust is a horizontally dipping fracture (fault) along which mountains get tectonically transported for several miles.

Several tear faults are present in the Tehri dam project area for example, the Gadoliya tear fault, Tehri tear fault, Tehri river bed fault, Dewl tear fault and many other EW-NW SE-NE-SW trending tear faults are present A potentially dangerous tear fault is Mahar tear fault which is exposed 4 k.m. down stream of the dam site It runs parallel to the Dewal tear and by virtue of its upstream dip lies at a depth of 7 5 k m. beneath dam site It is admitted in the project report that in the event of future earthquakes, if release of stress takes place along this tear, there may be sudden fracturing and displacement along this fault. No one can predict that release of stress in the event of an earthquake cannot and will not take place along this tear, and if it occurs, as it is most likely to occur, no one can predict the extent of fracturing and displacement caused thereby It may result in wholesale fracturing causing overwhelming destruction.

The NW-SE, NE-SW tear faults are admittedly very dangerous from the point of view of seismic activity and according to the renowned geologist, Dr. K S. Waldia, the recipient of the Shanti Swroop

Bhatnagar award Head of the Deptt of Geology, Kumaon University, it is along such tear faults in the Himalayas that devastating earthquakes ccur. At the dam site itself a major fault of the wi lth of 5 metre has been proved by drill holes and the r ver bed fault has been found to exist from Tehri to Uppu at least. Dobata, Dobra and Uppu are respectivel at a distance of about 2.9 and 12 K M from the dan site. In fact, these sites were also investigated for co istruction of a high dam but were subsequently abando ed, primarily on account of the river bed faults there.

Tehri reservoir is to extend upto ab ut 45 k.m in Bhagirathi valley, and all these river ed faults from Tehri to Uppu will come directly under he water load of the Tehri reservoir. The water loac placed on the earth's crust by such man made lakes ha been respon-sible for triggering off violent earth uakes even in areas which previous to the lake filling ha l been earth-quake free The protagonists of this dam do admit that subsequent to the construction of a arge dam and impoundment of huge quantity of wat r in the reser-voir, seismic tremors are felt in the vici ity Construc-tion of high dams and impounding of l arge hydraulic heads seems to strain the rocks in the da n foundations and in the reservoir area to a large exte t and a conti-nuous process of settlement is known o be initiated: They maintain that such tremors are o low order and eventually die down. When confronted with the exte-nsive damage to such engineering structu es in U. S. A.

Japan etc. they vaguely assume and assert that they have invariably been related to well known fault systems which had an earlier record of movement or co-relation with earthquake focii. This averment of the dam champions is a blatant lie First they fail to make distinction between Isostatic and tectonic earthquakes and secondly they come to conclusions without considering the relevant scientific datas.

It is largely agreed now that the several earthquakes that occurred in the Koyna dam area (Maharashtra) were occasioned by water load or that the water load hastened their advent. The earthquake at Koyna which occurred on December 11, 1967 was of 6.7 intensity which caused large scale damage to the dam structure and immense loss of life and property. Not a single home was left habitable in Koyana nagar This happened inspite of the fact that Koyana is located in a stable and solid block of the Southern peninsular shield in India, which is a zone of minimum intensity and had no record of any earlier movement or any co-relation with an earthquake focii.

The report of the International Commission on Large Dams 1973 on lessons of dam accidents reveals that out of 10,000 dams constructed in various parts of the world, at least 166 suffered accidents and of these 140 were total failures The Baldwin reservoir site was only 300 meters from a fault line and only minor faults were found cutting the project site.

The reservoir lasted for 12 years and collapsed on December 14. 1963 within a few hour of warning. Due to seismicity of the region, it wa made a flexible structure, but the movement occurr d along the fault on December 14 when fu l pressur of the reservoir came on the fault surface, and the res rvoir gave way. The Frayle Arch Dam, Peru a 70 me res high structure, suffered a severe accident on A ril 13, 1961, due to an earthquake tremor. On Januar I. 1960 a severe crack develo ed in it and on its abut ents. The Vega Tera Dam, Spain was completed i 1957-58 but on January 9, 1 59, when the res rvoir wa at its maximum level for on y a few days, it collapse due to an earthqual e shock recorded at Coimbra, Por ugal, which was coincidental with the failure of the dam

The San Fernando earthquake, hich occured on February 9, 1971, destroyed the San Fernando hydraulic fill da a completely, causing im nense loss of life and property. It is said that if the s ock had lasted a few seconds longer, the Upper San Fernando dam, would have also failed. The Sheffie d earth-fill dam in the U. S A. failed due to earth quake shock of 6.3 magnitude on June 29, 1929, and imilarly several hydraulicfill dams failed in the U. S. A. due to earthqual e shocks, of 6.8 magnitude. A least 331 dams failed or suffered incidents in the U. S. A. uptil now. Out of the 54 dams in the U. S. S. R. f ur failed completely and three suffered incidents. I Japan 9 dams

failed completely and 7 suffered accidents and there are reports of very many dams failures from other countries of the world. The lower Suir Dam failed during construction in 1935. The reason for the failure of St. Francis High Dam on March 12. 1928 was the presence of a fault only 2 meters wide half way of the abutment. The fault surface got progressively weakend due to the action of water. The failure resulted in loss of 500 lives and property worth 10 million dollars. The Malapasset Dam France, collapsed, on December 2, 1959. The Dam was well designed, but a fault zone was present higher upstream of the dam structure, and movement on it caused the disaster Four hundred lives were lost and the town of Frejus was completely washed away.

The claim of the champions of Tehri Dam project that the lake load of the reservoir leads only to insignificant tremors which eventually die down is wholly false The presence of a fault one is certainly a sign of danger and huge engineering structure are not constructed on fault ones which are alive. No instances can be cited where a dam was constructed knowingly on an active fault zone. It is obvious that in the case of Tehri Dam the focus and epicentre of a violent earthquake can certainly be in the project area itself when pressure of such huge volume of water is artificially laid on the numerous fault surfaces and weak zones. It happened so in Kariba dam, Rhodesia. There was no report of any prior seismic activity in that area,

but when the reservoir began to fill n 1968, it was after six months of the filling that earthc ıake shocks began to be experienced and the great st of 5.8 magnitude occurred four years after the f lling was complete. The epicentre of the tremors was i the dam region itself, where some minor faults exis ed.

Several such examples have been cited by J. P. Rothe (1968) Faults are either ac ve or inactive, there are no dead faults and it has been f und that even those faults which have been inactive for thousands of years can become active by the lubrica ing action of water. The activity in such fault can b arrested by cement grouting, etc. but active faults can ever be adequately treated for the obvious reason tha the extent of future movement along them can never be precisely predicted. The faults in the Tehri Dam p roject are in fact all active, but the project report with out any justification assumes them to be inactive and goes on to say that the position of the nearest active fault is not known. If the position of the nearest active fault is not known, how can a plunge into unknown be made without locating their position ?

Treatment of faults is done generally to prevent large quantities of water reaching th subterranean fire. It can be done only at the dam site where the river bed can be dried up by diverting the ri er water elsewhere, but it is impossible to treat th faults existing on the riverbed upstream or down strea n of the dam site.

Explorations have established that apart from many other shear zones, a shear zone varying in thickness from 7 m to 20 m is present in the river course for a length of about 900 m. (300 m. down stream and 600 m. upstream) of the dam axis. The project report admits that it is part of younger fault systems in the valley and can not be considered free from adjustment in the event of future earthquakes in the region. If it so happens, what will be the fate of this dam ?

It is true that mere seismicity of a region may not be sufficient ground for not constructing a dam there, the question will always be whether there are geological faults there and whether the faults are active or not and further the rocks are competent or not. The Nurek Dam, a 1040 ft. high structure, is being constructed in a highly seismic region in Central Socialist Russia, but rocks there are a thousand times more competent than those of Tehri Dam site. It is being constructed for experimental purposes.

It is thus clear that in view of the potential presence of many major and minor faults at the Tehri Dam site, in its vicinity and along the river bed upstream and downstream, the epicentre of an earthquake shall be in the project area itself and the enormous water load artificially laid over fault surfaces will hasten its triggering off and then it can be of any magnitude. Its intensity can be 12 balls by m. m. scale and the result will be wholesale destruction.

The project report admits that the triggering off of a tectonic earthquake by the water load of the Tehri reservoir cannot be ruled out and if that possibility can not be ruled out, there can be no question of constructing this dam. Even in India distress has occurred in as many as 41 dams and more than 14 failed totally. The Kadam dam failed in 1958, Nanak sagar in 1967, Chikahole in 1972, Dantiwala in 1973, Aran in 1978. The Panchet dam which failed in 1961 is said to be the biggest dam disasters in this country. The Hinglo v dam failed in August 1978 which led to the destruction of hundreds of villages in Birbhumi, Bardwan & Murshidabad in West Bengal and took a heavy toll of human lives and cattle. The Morvi dam disaster of August 1979 is still a-fresh in the memory of all

The seepage from the Tehri Dam reservoir even in to the dam's rockfill is bound to be alarming, specifically from the right side abutment where the hillside is highly fissured and fissile and shear zone cross the whole width of it from the right bank of the Bhagirathi to the left bank of the Bhainto i rivulet. The Tehri Dam project report admits that the weak metamorpbic formations occurring in the foundations and on the sides of the river gorge are characterised by their shale structures as well as by their lent for intensive weathering and disintegration into separate blocks, and that under such complicated tectonic geological characteristics at the site of the Tehri dam located in a zone where the seismic effect can reach VIII–IX by

m. m. scale, the problem of any type of dam construction of 250 metres, will be very serious and complicated.

Thus the great risk is involved in the project is made clear, by the project report itself But the project authors opine that if the fault zone in the river bed can prove to be not active then while studying and analysing all the peculiarities of the site in a detailed way as well as by means of special observations and model investigation solution of this problem safe and economical **to a sufficient extent** can be found. This is technologists over-optimism.

All the faults and thrusts in the Himalayas are active and alive and it can not be denied that the river bed fault is not active. Assuming it to be inactive the project authors give a guarantee of the safety of the dam **to a sufficient extent alone**, where as in such a matter a guaranteed security is needed for the obvious reason that if the dam bursts, it will result in a catastrophe unprecendented in the history of man. Whole of the Ganga basin from Munikireti to Calcutta will be wiped out of existenee. And, if the river bed fault zone be active, then there can not be even one percent security of this dam. It is so obvious from the project report itself.

Sri Y. K. Murti Ex. fellow Chairman of the central water commission of India in his paper read at the 54th Annual Session of the Institute of Engineers

(India) at Banglore, Nov. 3, 1978 admi ed that the dam at Tehri would not only be the high st structure of its kind in the world but would call for tackling complex technical problems involved ir a rockfill dam of such a height for which th re is little precedence available else where in the v orld." He further admitted that "despite thorough i vestigation and adequate design it is not possible to limi nate all possible hazards. . . .. Despite all advance i technology and improvement in dam Engineering c er the last decades, the surprises in the course of e: ecution and operation of Dams & reservoir cannot b eliminated altogether". The question is can we take this risk by building such a dam in the Himalayas, and let the Democles sword hang over the head o the Ganga basin for all days and nights ?

Henry H Thomas an Engineer of w rld fame in his book "The Engineering of large dams" as advised that the Engineer should not hesitate o overrule academic calculations. however positive they might seem to be if there is any element of doubt abou the safety of the reservoir. He is a great protagon t of large dams, but frankly admits that we know of failure, is undoubtedly true in all phases of life but it i a method we can not afford to adopt in buildin of dams, undue boldness in design might ultimat ly end in disaster..... The statics of failur of dams are some what alarming..... The cost of security can be ascertained with reasonable accurac if proper

investigation have been done, the cost of failure is immesureable. Damage to property may be assessable, damage to environment is less tangible but no less real but loss of life is a matter of personal suffering. Water can lubricate clay seams, it can adversely affect the physical properties of most rocks, it can act as colossal hydraulic ram, it can erode and corrode, it may induce earthquakes, and if the dam should fail it will devastate and destroy .... Cost is of vital importance, but security must always be paramount.

It is thus clear that if guaranteed security of the dam may not be available, it will be a case for rejection of the proposal rather than a case to go ahead with it. The project report of Tehri Dam does not give any guarantee of security of the dam. It says that the safety of the dam can be assured **to a sufficient extent alone** and no further, and that too if the river bed fault be found to be inactive. The project champions, assume the river bed fault to be inactive without any rhyme and reason ignoring the opinions of Geologists, scientists and all tenats of common-sense.

As I have stated above, the Tehri Dam site is risk laden to the extreme The project report itself leaves no doubt about it. The complicated tectonic and seismic activity of the site, the presence of fault zone of width of 15 m in the river bed, completely low strength of rock formation, high deformity of the rock differences in the properties of rock formations in the

side of the gorge, comparitively low fac or of shear resistance of rock in foundation, heavy c acking and large number of fault zones in the exterio zone of the slopes of the river gorge have been well e tablished by exploration apart from other dangerous t ct onic peculiarities found in the whole of the project a ea.

While the project report categorically admits that the lake load of Tehri reservoir can trig er off a tectonic earthquake, it is amazing that the da n champions make groundless assumption on the bas s of unwarranted comparisions They maintain that the quantity of water proposed to be stored in Te ri reservoir will transmit to the foundations a load f nearly 3 2 billion tons and as that will be only 30% c the Govind sagar, nearly 6% of lake mead and c ly 40% more than that of Shivsagar (Koyana), there ore the water load of Tehri reservoir will be too sma l to cause any large scale earthquake. In making t is ass mption they conviniently ignore the fact that n two dam site in the world are the same nor have he rocks same properties. It is admitted by Sri Y. . Murti and even by Henry H. Thomas and it is bvious that no two dam sites are exactly alike any st ndardisation is neither desirable nor possible. The ntensity of the earthquake always depends on the dep h and distance of the focus and epicentre, the nature of the rocks, the sub-structure and solidity of the structu e.

Technologist's over optimism ma think to build a dam over an inconceivable site, bu common sense

may dictate that it is too risky and unwise to do so. Universities confer degrees and some persons become technologists, but common sense is a gift from God. The common sense of the people of Teton, who were opposing the vast Teton dam, did prevail over technocrates assertions, when the Teton dam broke on 5 June 1975. Three town were completely washed away and property worth more than Nine bilion dollars destroyed. There cannot be a standard set of guide lines for ensuring the safety as problems vary from project to project and so no two dams have failed in the same way and that exact evaluation of short term and long term changes in dam and its foundation which will pose ultimately a threat to its safety is still and shall always remain an excercise in the domain of uncertainty. We can not put an implicit faith on technology which is basically improvisional. It treats the symptoms but does not provide any lasting cure. Technology in fact is becoming itself a problem for mankind.

There can be no room for any doubt that the chances of the failure of Tehri dam do exist in abundance and it will be unwise to ignore them on the assumption that it is a bare or remote possibility or that the evil may possibly be avoided by recourse to remedial measures. The people have to be guarded against such risks which no prudent and reasonable man will incur, even if there may be no absolute certainty of its occuring The rule of prudence demands that we balance

the magnitude of the evil with the chances its occuring, and even if there be less imminent probability of it, the risk can not be taken for the simple reason that if the evil does occur at any time, i. e. if the dam bursts the resultant mischief will be vast and overwhelming.

Tehri dam is an unwarranted attempt to disturb the fragile eco-system of the Himalayas which is the youngest mountain chain in the world and which has not yet attained isostatic equilibrium. A little excercise of reason can foresee the immense likelyhood and potential of Tehri Dam ending in a national disaster. The scientists have been warring mankind of the dangers involved in such projects, They are warnings not just of difficulties but of a major disaster.

Must we demand the evidence of catastrophe before we act ?

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elling work of the dam was started under the protection of helmeted armed police.

Before starting the movememt against the dam the Samiti decided to file petition in the petition committee of the Parliament. But, unfortunately due to the dissolution of the Parliament the petition lapsed, and a new Govt. formed at the centre. Dialogue is now going on between Sangharsh Samitee and the Govt. In the mean time before taking the final and decisive action, the Samiti resolved to publish in small booklets all the materials available to create awareness amongst the people about the evil consequences of this dam, and the present booklet is one of them. Sri Saklani has very deeply studied, the Geological, seismological and ecological aspects of this dam which if constructed is bound to prove baneful to the Nation.

I hope that in this booklet and in many other booklets, articles and letters written in this respect, the readers will get a complete idea as to why this project is being opposed, and I very much hope that they will make a common cause with the Tehri Bandh Virodhi Sanghrash Samiti in turning down this project.

Sardar Prem Singh
General Secretary
Tehri Bandh Virodhi Sangharsh Samiti

Pundir Printing Press, Tehri.

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SEVENTH ANNUAL MEETING
Rome, 7-11 September 1987

PEEM/7/87.7
ENGLISH ONLY

EPIDEMIOLOGICAL PATTERNS ASSOCIATED WITH AGRICULTURAL ACTIVITIES IN THE TROPICS

D.J. Bradley and R. Narayan

EPIDEMIOLOGICAL PATTERNS ASSOCIATED WITH AGRICULTURAL ACTIVITIES IN IN THE TROPICS WITH SPECIAL REFERENCE TO VECTOR-BORNE DISEASES.

David Bradley[1] and Ravi Narayan[2]

Introduction

For most rural populations of the tropics agriculture is the normative occupation. Therefore our picture of the health and diseases of tropical communities consists of the epidemiological patterns associated with agricultural activities. The patterns are complex and diverse. Tropical peasant agriculture is usually characterized by a high infant and child death rate, malnutrition which may be seasonal, acute respiratory infections and diarrhoea as the main causes of death, particularly of children, frequent tuberculosis and skin infections, trauma and disability, and infection by a variety of endemic parasitic worms and protozoa at high prevalence but showing much regional variation. They will include many vector-borne diseases among which malaria, filariasis, arbovirus infections, schistosomiasis and the other human trematode infections, and the haemoflagellate infections are of particular importance (Table 2). Typically, the subsistence farmer will live with his family on or near to his fields and there will be no sharp boundary between his occupational and general health.

To separate the two is neither feasible nor particularly useful. The person's health problems are experienced as a whole and they are the concern of the Ministy of Health. Some diseases may be linked to specific components of life and of activity and may be open to change, but in general there will be a health care system concerned with all the local diseases and health problems and the agriculture-related diseases can only be approached by observing health changes if the people migrate to a city and nothing else changes in the environment. Even then, the multiplicity of changes is so great that to relate all the differences to loss of agricultural activity will be clearly mistaken.

While it is difficult in the subsistence situation to separate agricultural occupational health problems from the remainder of the community's health, once changes in agricultural activity take place the consequent health changes may be more readily identified and measured. We now therefore concentrate on the health consequences of changing agricultural activity. Health problems may get worse or better - too often different factions of those who study the problem only focus on one of these aspects. We first analyse the types of agricultural change and their health effects, then illustrate the effects of common groupings of changes, and thirdly review a set of particularly important types of agricultural change and their epidemiological implications.

We present a broad rather than a detailed picture, both because of space limitations and also because many of the papers that follow will describe particular aspects of the problem or specific examples.

Agricultural change tends primarily to involve alterations in the basic environment, domestic plants and animals, and farming methods (Table 1). The two main types of environmental modification are the provision of increased, or more controlled, water for vegetation growth and the opening up of additional land.

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Water resource developments

Water resource developments have been much studied and may comprise impoundments of water in artificial lakes, sometimes of huge size, and irrigation systems to bring the water to the fields and plants. The resulting increase in availability and diversity of surface water both in area and in duration through the year tends to lead to increased populations of still-water vectors, particularly mosquitoes and water snails. The torrent-breeding Simulium vectors of onchocerciasis may have their habitats destroyed by inundation. The converse aspect of water management, drainage of swamps and waterlogged areas, will reduce breeding of mosquitoes and the amphibious snail hosts of Schistosoma japonicum. While increased surface waters with more vector habitats and increased vector populations will tend usually to more mosquitoes biting man, contact between snail parasites and man will be dependent on the detailed changes in water availability - man/vector contact may even be reduced due to a dilution effect.

Land Use Extension

Extension of land use brings different vector hazards, chiefly resulting from man's intrusion into new ecosystems with disturbance of parasite life cycles maintained as zoonoses in the undisturbed environment. Leishmaniasis provides a clear example, both in the deforestation on the Amazon region where agricultural settlers are exposed to Leishmania braziliensis causing muco-cutaneous disease and in the southern USSR where cutaneous leishmaniasis, transmitted by sandflies between huge populations of the colonial burrowing gerbil Rhombomys opimus is a major hazard to farming settlement (Lainson et al., 1963). More lethal problems from sleeping sickness have resulted from agricultural resettlement or patchily cleared secondary forest in South Busoga, Uganda. Audy has emphasized the importance of eco-tones in the epidemiology of vector-borne zoonoses and land use extension creates extended ecotones, edge-effects between different ecosystems (Audy, 1968). Malaria outbreaks in Thailand due to Anopheles dirus (formerly called A. balabacensis), and to be described by Sornmani, are of this type also.

An ecologically comparable situation is where man enters a habitat for some form of agricultural activity of a more hunter-gathering type and thereby enters a zoonotic life cycle habitat. The chewing-gum collectors of Honduras are exposed to Leishmania mexicana, which mutilates their external ears, in this way (Garnham, 1971). Another example is Kyasanur Forest Disease, an arboviral infection in Karnataka State, South India where affected men and cattle have previously come in contact with Haemaphysalis spinigera, a monkey biting hard tick during excursions into the forest (Singh, 1971).

Domestic animals and cultivated plants

Changes in plants and animals for domestic use may affect vector-borne diseases, usually because they require changed cultural practices. Many of the high-yielding varieties of rice and wheat, which are the key feature of the "green revolution" have requirements for water and fertilizer that prolong the period of available surface water for vector breeding.

The time scale of health impacts on agricultural change are both variable and complex. A common effect of water resource developments is to decrease seasonal effects, to make irrigation water available in the dry season. So vector presence changes from seasonal to perennial. Often the loss of seasonality will be accompanied by increased vector populations, but this is not always so. The seasonal malaria of the savannah may be at

least as harmful as the perennial transmissi(n of the forest zone in West Africa. The degree of persisting seasonali(y will depend on small scale decisions. For example, with the multiple (ropping of irrigated rice the fields may be planted synchronously, or they may be totally staggered with the consequence that there will always be ric(e present at the particular growing stage that provides the best habitat for a particular vector. The loss of seasonality may also remove the 'hungry period" and its accompanying seasonal overwork and synchronou(s malaria transmission - that lethal combination which so raises the s(easonal death rate in the savannah of West Africa and elsewhere.

Some changes will be of a secular type o(n a very long timetable. Thus the eutrophication sequence of lake Volta in Ghana is now settling after some 15 years, during which there were massiv(e increases and now falls in the submerged macrophytes which acted as habi(tats for the snail intermediate hosts of urinary schistosomiasis (Bulinus tru(ncatus rolfsi) (Obeng, 1975).

The trend towards multiple cropping whic(h depends on both irrigation and appropriate crop varieties can, in the ca(se of rice, increase the period when the ricefields provide breeding habitats threefold in the absence of measures to restrict mosquito larval survival. However, selection of crop rotations within the year can reduce the time when free surface water is present.

Changes in livestock may affect vector-b(orne disease patterns in complex manner. Increased animal population may direct mosquito biting activity away from man, especially if the liv(estock pens are sited between the breeding sites and human settlements. On the other hand, the stock may act as amplifier populations, allowing the gr(eat proliferation of arboviruses normally transmitted at a lower l(evel among wild birds or mammals. Subsequently the infection may spi(l over into the human population, as may occur with Japanese enceph(alitis virus, amplified in domestic pig populations. Livestock populat(ions, by increasing food supplies for mosquitoes and tsetse, may also (encourage larger vector population than otherwise would be the case, (but little quantitative data are available. In the case of schistosomias(is in East Asia, domestic animals are susceptible and may play a role i(n maintaining the parasite life cycle in the Philippines and elsewhere.

Farming methods

Changes in agricultural methodology, such as increased mechanization and the use of pesticides, herbicides and fer(tilizers, will often affect vector-borne disease transmission but it is di(fficult to generalize about the precise consequences. For example, insect(icides applied for agricultural purposes may initially also reduc(e vector insect populations substantially, they may select insecticide-res(istant strains, and they may continue to reduce natural populations of othe(r invertebrates that limit the vector breeding success. The outcome after a time may be more rather than less disease transmission, but the time scale (of such changes may vary greatly. Herbicides may render the irrigatio(n channel less suitable for vector breeding (or more so for other species), they may be lethal to snail hosts of trematodes, and the medium-term ecosy(stem changes may influence the vector populations in complex ways. Eutrophi(cation from fertilizers may indirectly increase snail breeding and have co(mplex effects on the balance of aquatic organisms.

Increased mechanization, to be discussed (fully by Service, has both direct effects through changes in the ricefiel(d or other agricultural environment that may decrease snail population by better clearing of

vegetation from canals, for example, and indirectly may lead to larger fields, better levelling, drainage of marshy areas, and a sharper separation of land and water which will generally tend to decrease vectors of disease.

Most forms of mechanical equipment will also tend to reduce personal contact of farm workers and the aquatic environment. Thus, schistosomiasis transmission will be reduced, so will leptospirosis with its rodent reservoirs, but no invertebrate vector. Where mechanical means are used to harvest crops or cut sugar-cane there will be a decreased risk of snake-bite (a substantial hazard in some part of Asia). Increased sophistication of methods short of mechanisation may also reduce schistosomiasis in those working in water while better clothing will decrease leech bites and insect bites among plantation workers such as tea-pluckers.

As agricultural activity and culture methods become more sophisticated and higher yields are systematically sought, a more evenly cultivated landscape will result. The ecotones, patches of waste land and water will be reduced and many disease vectors will decrease. There may however be larger populations of a few vectors whose ecological preferences happen to coincide with the spreading pattern of agriculture.

Changes in people, agents of disease and vectors

Types of agricultural change are outlined above. Either in order to achieve them or following their introduction, substantial human population changes frequently occur. The most obvious are immigration of farmers to newly opened up or newly irrigated lands. Often they may come from over-populated hill areas where endemic malaria and other primarily warm climate diseases are uncommon. Such immigrants suffer heavily - "malaria of the tropical migration of labour" is, for example, a well-known and named entity. The malnutrition which often occurs in the first years in a new site takes its toll and may exacerbate other diseases. The immigrants may precede the provision of health services. Unplanned immigrants, especially fishermen invading water resource developments, may suffer from vector-borne diseases such as schistosomiasis but benefit in economic terms (Pesigan, 1958). Even more unfortunate are indigenous inhabitants displaced by the agricultural innovations of the water resource developments undertaken to provide them. Their health problems are compounded by poverty and upheaval. Resettlement is usually inadequate and a health service to take particular care of new disease hazards is unavailable.

Where the agricultural shift is to cash crops from subsistence, family nutrition usually suffers, at least in the short run, from the loss of local cereals and pulses, sometimes from increased labour demand and less time for child-rearing. The effect of malnutrition on vector-borne diseases is complex and agent-specific, they are not always made worse.

Patterns of settlement often change from scattered homesteads to compact villages. Health care can be made more accessible but some forms of disease transmission - hookworm and other gelhelminths, the childhood virus fevers, and other infectious conditions may become more frequent. Common source disease outbreaks will be larger.

Many activities, and their health consequences, will tend to become less seasonal than before, and the "hungry season" that coincided often with maximal transmission of vector-borne disease, may become less pronounced.

New pathogenic organisms may infect man new in the sense that they were previously unknown in the locality. This may be because of the environmental changes in agricultural practice described above, introduction by immigrant farm workers, or amplification of zoonotic viruses by introduced livestock. Infections already present may become more prevalent, and in the case of helminthic infections the parasite burden may be increased, with a resulting risk in overt disease. Thus the Egyptian transition from annual flood irrigation to perennial irrigation in the Nile valley haa led to a changed balance between schistosome species and a greater intensity of infection.

Vector populations may increase in numbers, or in a few cases decrease, have an extended season of activity and undergo the many complex changes to be described in subsequent papers at this conference.

The emphasis in the above summary has been oo the health effects of agriculture as mediated by change in the natural and biological environment. But agricultural change has social and economic effects and their effect on human health may be yet more important. Effective agricultural development will raise aggregate income, with potential health benefits, but it often also increases disparities of income and the poor, usually landless labourers, may become yet poorer and marginal farmers become worse off, with consequences for nutritional status and access to health services. Consequential inevitable urbanization of the poorest farmers, with its different health hazards, may be a consequence of agricultural change.

A further group of indirect health effects follow from the various types of seasonal migration related to agriculture, from the regular traditional transhumance of mountain pastoralists to the much larger scale seasonal labour requirements for planting and harvest of sugarcane in Thailand, cotton in the Sudan, and various crops in Asian Turkey. In the last case, problems of welfare taxation greatly complicated control of malaria; both there and in Thailand, as is often the case, migrant labour chiefly suffers from the endemic malaria even though local perception may be reversed, with the migrants being blamed for the malaria which they have in fact contracted only on arrival. Housing for such temporary migrants is not only often very bad, but the transient structures may lack proper walls ans be difficult to spray with residual insecticides against mosquito vectors. Permanent agricultural housing over large tracts of South America is liable to colonization by reduviid bugs, which by their nocturnal blood feeding on inhabitants may transmit Chagas' disease.

Where livestock shares the farmers' dwelling at night, other vector-borne disease problems are locally significant. Cattle ticks of the genus Ornithodorus in Tanzania will travel up the bedposts, especially if they are fixed into the ground, and transmit relapsing fever among the inhabitants. In areas of sheep herding domestic dogs become important in the transmission of hydatid disease to man while rabies is a hazard also.

The patterns of disease observed in different agricultural communities will depend upon the specific agricultural variables listed in Table 1 together with the local features of climate, degree of socio-economic development, and cultural variables. Certain broad patterns may emerge, in different geographical regions, though the vector-borne diseases in particular will tend to show micro-geographical variations in both the types and prevalences of diseases encountered.

Implications of agricultural types

Asian rice cultivation will be dominated by malaria, schistosomiasis and Japanese encephalitis, with smaller contributions from gastro-intestinal and hepatic flukes. But all these diseases are patchily distributed and in many areas malaria is prevalent but unrelated to agricultural activity. Similar problems occur with irrigated rice elsewhere, though different arboviruses will replace the Japanese encephalitis, especially in the Americas, and the filariases will play a variable role.

The problems of extending cultivable land into forested areas are likely to include zoonoses such as leishmaniasis, sleeping sickness and some arbovirus infections while some Asian malaria vectors flourish in such ecotones as does scrub typhus.

Plantation agriculture has usually followed control of malaria, and particular health hazards are related to labour-intensive activity in close contact with trees and shrubs where insect stings, leeches and snakebite may be frequent. A range of vector-borne diseases may occur but are more easily controlled than in the unorganized rural agricultural sector of contiguous areas.

The move to highly mechanized advanced agriculture is accompanied by massive falls in the farming population, larger plots and more capital-intensive methods than usually tend to reduce the hazards of vector-borne disease. Contact with vector snails will tend to fall, even if they are present in the water bodies, and the main residual problems will be vector mosquito breeding if rice or similar crops are grown and health hazards from seasonal labour migrants where these are needed for harvesting. Mechanization and/or sophistication of technology are invariably involved with greater capital intensive production reducing labour demand and hence increasing rural unemployment, especially if alternative employment through rural or urban industrialization cannot keep pace. This could further complicate the situation of poverty and disease.

Particular issues of agricultural change.

Various Arcadian memories or dreams exist concerning healthy agricultural practices and environments in the past, and hunter-gatherers seem to often have lighter levels of parasitic infections that do those in settled agriculture. The ancient hydraulic agricultural communities of Sri Lanka were said to have a relatively low incidence of vector-borne disease as a result of having a network of small units serving limited populations, without use of pesticides and fertilizers but with careful maintenance of tanks and canals and carefully followed cycles of seasonal flooding and drying out of the channels. Similarly, in more recent times the Sudan Gezira Board achieved good control of schistosomiasis and of malaria by a complex of environmental and behavioural measures enforced with an iron hand in the earlier years of that irrigation scheme. It is far from clear how far, in the absence of coercion or very strong other incentives it is possible to have an environmentally and behaviourally determined relatively safe agricultural programme in the tropics involving water resource development but certainly this area needs further study.

The practical issues of attempting a return to this Arcadia are raised by considerations that have increased since the availability of greater evaluated experience of "the green revolution" and the awareness of an increasing range of detrimental effects that have accompanied the increased food availability - not the least of which are the pesticide "treadmill" effect, pesticide hazards, and the socio-economic effects mentioned earlier.

The quest for sustainable agriculture - tha produces higher yields but with very limited fertilizer and other mode n sector inputs has been gaining ground through experiments in Japan, India, USA and UK. This situation may be good for environmental control of vecto s but little directly relevant research is yet available and needs to be p anned for.

Development strategies involving both gricultural and industrial interventions are increasingly beginning to focus on those sections of society who do not adequately participate o benefit from the existing modes of development. While environmental and s cio-economic changes in the community have been adequately documented, nly in some limited specific cases has data about the health and nutriti n effects of agricultural development been applied in impact evaluati n. Much more needs to be done.

The analysis of health consequences of agricultural change has predominantly considered one disease at a t me and traced the biological and behavioural determinants of transmission. Less often, a single change in agriculture or a single intervention has be n considered in relation to all its health consequences, as when the effect of increasing irrigated rice fields or introducing piped water are consi ered. But the farming family see their health as a whole in relation to hemselves rather than a single agricultural change or occupational hazard. Moreover the farming community is essentially a stratified community divid d into different groups by socio-economic status, land ownership and w ge relations. Agricultural change whether single or multidimensional, ffects different groups in different ways - quantitatively and qualita ively. There is a need for community based epidemiological studies tha will consider agriculture as one of the many determining variables for h alth and measure its impact on the stratified agricultural community. Th s is not only to give a sense of proportion but also to view the problems an thus seek solutions from the viewpoint of the farmer and the agricultura community.

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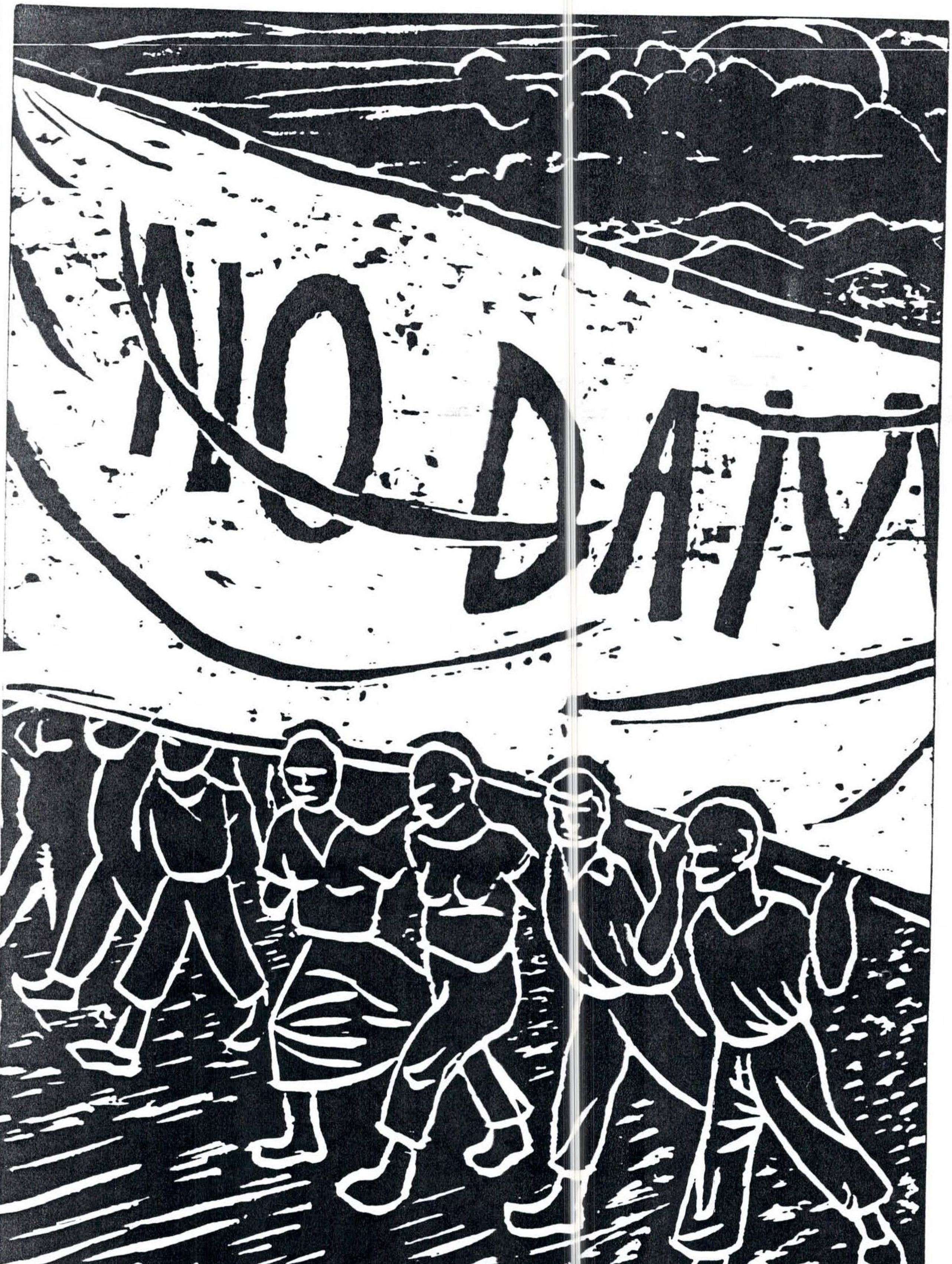
TABLE 1: Epidemiologically Relevant Aspects of Agricultural Change

	New or Qualitatively Changed	Increased Quantitatively
PRIMARY AGRICULTURAL CHANGES		
ENVIRONMENT		
Water resources development	Reservoirs, dams. Land drainage. Irrigation schemes	Irrigation canals
Land use extension	Clearing, deforestation Extensive ecotones	
ORGANISMS		
Plants	New High-yielding varieties Move to cash crops Intercropping	Multiple cropping
Livestock	New breeds	Increased animal husbandry
CULTURAL METHODS		
Chemicals	Pesticides Herbicides	Fertilizers
Machinery	Mechanization	
SECONDARY EPIDEMIOLOGICAL CHANGES		
People	Settlement Changes in Seasonal Patterns Nutritional status	Immigration
Vectors	Species changes	Population changes
Disease agents	Species changes New introductions New hosts acquired	Amplification by stock

Table 2. Major vector-borne diseases that may be related to agriculture

Protozoa	
Malaria	Anopheline mosquito vector may breed in standing water
Sleeping sickness	Tsetse-borne disease related to extending land use into forest
Chagas' Disease	Transmitted by bugs living in walls of houses, especially when livestock there
Visceral leishmaniasis	Sporadic, sometimes epidemic in semi-arid regions, sandfly transmitted
Cutaneous leishmaniasis	Rodent reservoirs disturbed in Asian land use
Muco-cutaneous leishmaniasis	Forest zoonosis of Amazon forests, to man during deforestation
Trematodes and Cestodes	
Schistosomiases	Major irrigation problems spread by aquatic and amphibious snails
Hydatid	Dog tapeworms larva usually in sheep, harmful to man in sheep-herding areas
Other tapeworms	Problems where undercooked beef and porc concerned
Other trematodes	Transmitted by snails through undercooked freshwater animals
Nematodes	
Guinea-worm	Transmitted through defective water supplies by water-flea type crustacean. Big effect on agriculture
Filariases	Transmitted by anopheline and culicine mosquitoes
Oncherciasis	Transmitted by fast-water breeding *Simulium* flies
Other microbes	
Relapsing fever	Tickborne problem where stock and man share accommodation
Yellow fever	Hazard at forest edge (and in urban areas)
Dengue Japanese encephalitis Other encephalitides Other arbovirus infections	Viruses transmitted by mosquitoes, mainly culicines, breeding in irrigated fields and standing water
Scrub typhus	Mite-borne zoonosis of the forest edge
Non-vector-borne diseases	
Leptospirosis	Especially problem of marshy and irrigated agriculture
Rabies	Hazard of pastoral areas where dogs used
Snakebite, leeches	Hazard in forest plantation agriculture


NO DA

The Social and Environmental Effects of Large Dams

by

Edward Goldsmith and Nicholas Hildyard

Volume One: Overview

A Report to
The European Ecological Action Group (ECOROPA)

(1984)

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CONTENTS PAGE

A Ballad of Ecological Awareness

The cost of building dams is always underestimated -
There's erosion of the delta that the river has created,
There's fertile soil below the dam that's likely to be looted,
And the tangled mat of forest that has got to be uprooted.

There's the breaking up of cultures with old haunts and habits loss,
There's the education program that just doesn't come across,
And the wasted fruits of progress that are seldom much enjoyed
By expelled subsistence farmers who are urban unemployed.

There's disappointing yield of fish, beyond the first explosion;
There's silting up, and drawing down, and watershed erosion.
Above the dam the water's lost by sheer evaporation;
Below, the river scours, and suffers dangerous alteration.

For engineers, however good, are likely to be guilty
Of quietly forgetting that a river can be silty,
While the irrigation people too are frequently forgetting
That water poured upon the land is likely to be wetting.

Then the water in the lake, and what the lake releases,
Is crawling with infected snails and water-borne diseases.
There's a hideous locust breeding ground when water level's low,
And a million ecologic facts we really do not know.

There are benefits, of course, which may be countable, but which
Have a tendency to fall into the pockets of the rich,
While the costs are apt to fall upon the shoulders of the poor.
So cost-benefit analysis is nearly always sure,
To justify the building of a solid concrete fact,
While the Ecologic Truth is left behind in the Abstract.

Kenneth E. Boulding

(From T. Farvar and J. Milton, The Careless Technology, Tom Stacey, London, 1973).

Chapter Twenty-Seven

Recommendations

In the light of today's knowledge, it is clear that the building of large-scale water development schemes can only be justified to an electorate and to the world at large by systematically covering up - as governments and their advisers have shown themselves adept at doing - their true implications.

Unpalatable as it must undoubtedly be to the dam-building industry, there is clear evidence that building large dams is not an appropriate means of feeding the world's hungry, of providing energy, or of reducing flood damage.

For it to be so, we would have to accept as largely expendable the human and non-human population of the whole area affected by the dam simply in order to further the political and financial interests of a very small minority.

To persuade Third World governments to abandon plans to build water-development schemes, to which they are often totally committed, is a lost cause. The only way to prevent their construction is to appeal directly to donor governments, to development banks and to international agencies without whose financial help such schemes could not be built. It is not that the latter are more responsible, only that they operate in the industrialised world where public opinion can be mobilised more readily against the pursuance of their present policies.

We thereby call upon those organisations, herewith, to cut off funds from all large-scale water-development schemes that they may plan to finance, or are involved in financing, regardless of how advanced those schemes might be.

The vast concrete hulk of a three-quarters finished dam may not provide irrigation water or electricity - but then, nor will it drown ancient villages, precious forests or stretches of fertile bottomland.

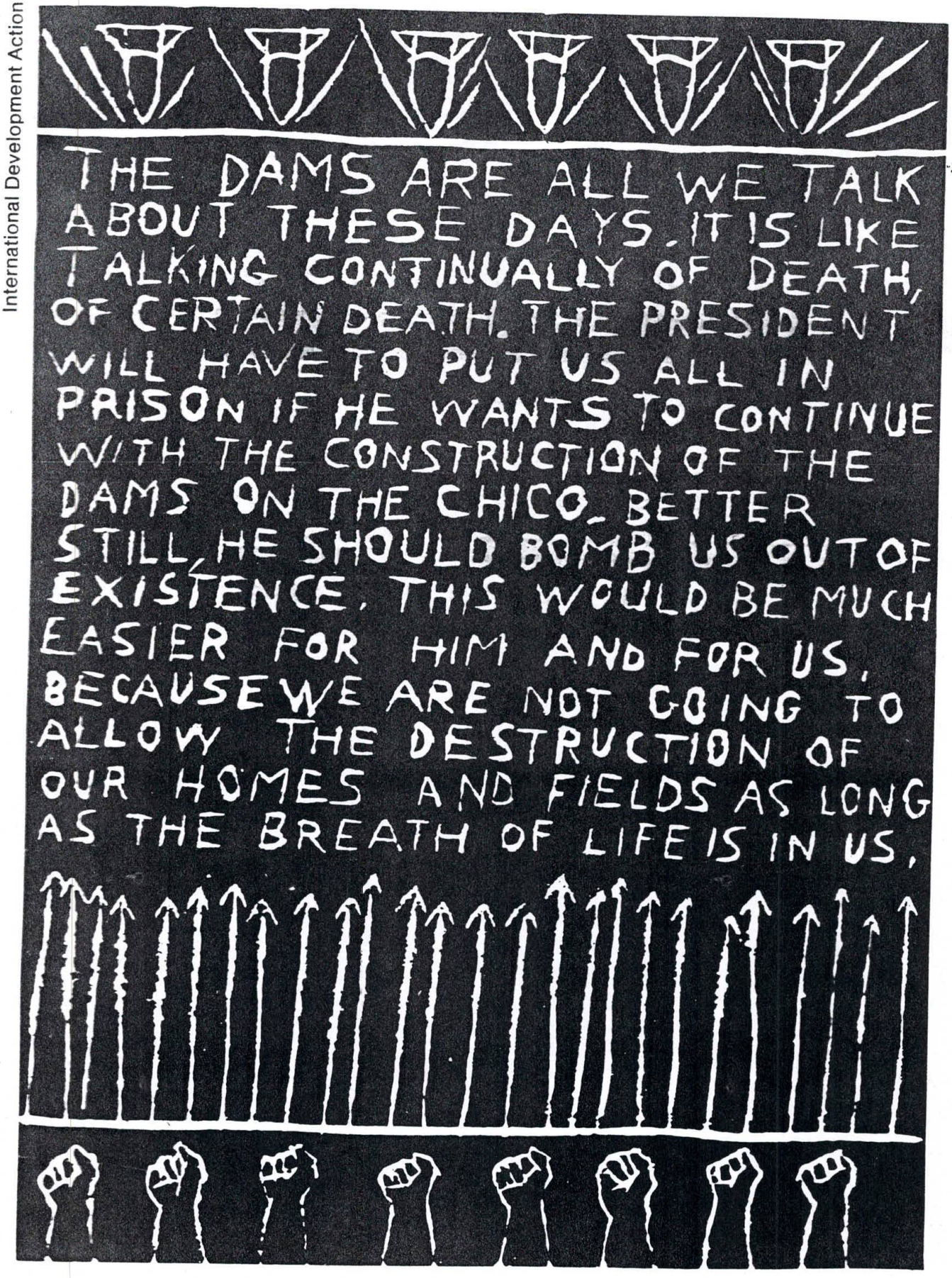
Nor will it uproot tens, if not hundreds, of thousands of rural people, condemning them to eke out a miserable existence in the degraded environment to which they will have been forcibly consigned.

Nor will it condemn those inhabiting the irrigated areas to see their children ravaged by malaria and schistosomiasis to which many of them must inevitably succumb.

Nor will it systematically transform much of their remaining agricultural land into a waterlogged and salt-encrusted desert, nor cause it to be progressively made-over to large plantations geared to the export of food to foreign lands, or to large factories which manufacture goods which the local population cannot conceivably afford.

Nor will it deprive local inhabitants of their water supply in order to satisfy the unquenchable thirst of the plantations, the factories and the new urban conurbations that dams support.

On the other hand, if the project is completed and all this destruction is allowed to occur, we will eventually be left with a silted-up reservoir and the vast concrete hulk of an abandoned dam. All that we can then hope for is the ruins of that dam may serve a salutary function as a permanent monument to the folly, or to the cynicism, of those who now direct the organisations which have financed so much destruction and so much misery throughout the world - a monument set in a vast muddy wasteland where once the fertile soil nourished happy and sustainable communities.



I congratulate the authors on writing a fine report. I agree with their views. The report should be widely circulated and translated at least into Hindi and Punjabi. Its findings are applicable as much to Karnataka as to Punjab and Haryana. I find that large projects everywhere follow the same trajectory. In many respects what is happening in our irrigation projects is even more serious than in the case of Bhakhra and Nangal. Hence the need to disseminate the findings of this report widely in Karnataka also.

On a personal note, I grew up at a place which is about 60 miles down-stream of Bhakhra-Nangal [redacted] (though not irrigated by the Bhakhra canal). The project is a part of my childhood. Memories of the visits to the sites under construction are indelible. But I never visited Bhakhra after completion of the dam. [redacted] The impact of the changes brought about by the policies of the govt. consequent upon completion of the project was no less drastic in my village also. From more than twenty crops we have come down to four or five.

...2

Having built dams all over, the question now is what do we do with them; how do we minimize the damage. This requires serious thought. Unfortunately no one in govt. is seriously concerned about it.

I would add one more point to the excellent report: Punjabi folklore is replete with references to navigation down the rivers to the sea. All these irrigation projects have cut Punjab, and even upper Sindh, off from the sea. As the rivers dried up, the culture became impoverished. How does one put an economic price on that?

Lastly, I am happy that the author discovered Surinder Kaur and Asa Singh Mastana. Indeed, there is more to Punjab than "balle balle". And Bhakhra-Nangal; though electricity from the project made my homework easier than the kerosene lamps from the sixth class onwards and brought songs of Surinder Kaur home on the radio. I remember how happy I was when the lights came on the first day and we bought the radio.

Chiranjiv Singh

A Journey Int the Realm of Bhakra

OUR JOURNEY INTO THE BHAKRA-LAND BEGAN ITH THIS AWESOME DISPLAY of the green revolution in its full visual glory. As we t velled through Haryana, and then Punjab, this sight was to be repeated day after day. As e moved through the country, we heard stories of how the waters had transformed virtual de erts into lush green fields. We saw the big *pucca* houses in villages, the large number of trac ors – and not a single bullock cart. We crossed numerous small and big canals as we drove n the excellent road network. The most spectacular sight of the journey was our first view f the Bhakra dam. It was nothing short of stunning. Seen coming up the mountain from the wnstream side in the late evening, the wall of the dam rises up steeply, suddenly from the epths of the gorge to a sheer 200 meters, the lights at the top illuminating it. As an eng neer, I could only marvel at this testimony to the skills of our profession. We saw at the dam site exhibition the photos of visiting dignitaries like Ho-Chi-Minh, Bulganin, Khrusc v – images from the heydays of "socialist" India.

Our physical journey was paralleled by another, a metapl rical, journey – a journey through the facts and figures, through the documents, through the story, geography, science, politics of the project. A journey through the minds and memories f people, a tour that accompanied the people on their experiences of the dam, of the agricul re of the two states. This journey was equally, if not more, fascinating as the physical journe

The mesmerising display of the green revolution in th fields of Haryana and Punjab is matched by the spectacular statistics of agricultural g wth. In Punjab, the foodgrains production went up from 3.389 million tons (m tons) in 1 5-66 to 17.221 m tons in 1985-86 – an increase of five times in 20 years, or an annual co pounded growth of 8.47% for 20 years running! In 1999-2000 it stood at 25.197 million ton 12.1% of the all India production. In Haryana, in the same period, foodgrains production incr ased from 1.985 m tons to 8.147 m tons, a four times increase. In 1999-2000,it stood at 13.065 illion tons, or 6.2% of All India.

There is an old saying – I believe it exists in some form or e other in every language – which states "Appearances can be deceptive". Our journey, our f scinating journey into the realm of Bhakra was to prove the truth of this saying many times ver, in many different ways. Our journey was a discovery of this, of how long held popular eliefs and perceptions were mostly just that – beliefs. It was also a revelation of the hidden, r not so hidden, but often swept-under-the-carpet side of the story.

The first revelation came with our very first visual encou er with Haryana described above. As we soon found, the lush green fields from Panipat to ansi had little to do with Bhakra[1]. This area, along with other large areas in Haryana receiv waters from the Western Jamuna Canal (WJC) and have been doing so since over 100 ye s.[2] The WJC is a diversion canal taking off from the Yamuna river near Tajewala. This version is from a weir and not a

[1] Throughout this report, unless the context so indicates, or it is specified therwise, the term "Bhakra" or "Bhakra project" will refer to the entire Bhakra-Nangal project.

[2] The WJC was irrigating small areas as early as the 16th Century – durin the rule of Akbar. In 1832 it was remodelled for extensive irrigation.

storage dam. In fact, the gross command area of Bhakra in Haryana is about 30% of the state geographical area. In Punjab, the gross commanded area of Bhakra is about 18.6% of the state area. *Punjab and Haryana are much more than Bhakra.*[3]

It is often said that before Bhakra, Punjab (and Haryana) were just semi-arid, dry regions with little irrigation and / or highly problematic agriculture. We found this to be far from the truth.

As we traced the history of irrigation in the two states, we had to go back to pre-partition India, the pre-partition Punjab. Pre-partition Punjab included not only the Pakistan part of Punjab, but also today's Indian states of Punjab and Haryana. *Punj* (Five) *Aab* (Waters) – the land of the five rivers – Sutluj, Beas, Ravi, Chenab, Jhelum - and of course the mighty Indus whose tributaries these five are – forms an area endowed with the most lavish water resources. While irrigation was being used in the Indus basin since the days of Harappa and Mohen-ja-daro, it really developed during the 19th Century and by the early 1900s, Punjab[4] had an extensive, highly developed irrigation system based on diversions from the major rivers.

A large part of this system was in what is today Pakistan. But the irrigation developed in the Indian part was not small or insignificant. The Western Jamuna Canal,[5] we have seen, was serving large parts in today's state of Haryana. The Upper Bari Doab system from Ravi that serves much of Amritsar and Gurudaspur districts in Punjab was opened in 1859.

The Sirhind Canal, taking off from the Sutluj at Ropar in Punjab, was opened in 1882. It was irrigating, and still does, large areas of Punjab. Apart from these, there was significant irrigation from wells.

Overall, the situation in Punjab (including Haryana[6]) around 1950 - before the Bhakra project - was as follows.

In percentage terms, in 1949-1950, Punjab[7] had 35.3% of its sown area irrigated and the figure for PEPSU (Patiala and East Punjab States Union)[8] was 42.6%. This was the highest in the whole country! Together, PEPSU and Punjab accounted for 13% of the country's irrigated area, while it had 5.89% of the country's total sown area[9]. Thus, it was way ahead in irrigation as compared to the rest of the country – even after losing the lion's share to Pakistan. In absolute terms, the areas irrigated were 4.9 million acres in Punjab and 2.04 m acres in PEPSU.

Similarly, Punjab at that time was the leading producer of wheat, maize and gram in the country.

Against this background, the decision to build Bhakra was a very interesting one. As we explored the planning and decision making process around Bhakra project, we found that the

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[3] Note that the gross command area gives the maximum possible reach of the project.

[4] Punjab here means the Pre-partition Punjab. The readers will do well to keep in mind the following. The British Province of Punjab included much of what is today Indian Punjab, Indian Haryana, small part of Indian Himachal and the Pakistan Punjab. Some areas that are in Punjab or Haryana today were not in the British province of Punjab but were princely states. These included Patiala, Jind, Bhatinda, Faridkot etc. and went by the name PEPSU – Patiala and East Punjab States Union. In 1947, the partition created West Punjab (in Pakistan) and East Punjab (in India) – later called simply Punjab. This Indian Punjab (of 1947) included parts of today's Punjab, today's Haryana and some parts of Himachal. In 1956, PEPSU merged with Indian Punjab. In 1966, this combined Punjab was reorganised into Haryana and Punjab, with a few districts going to Himachal. We will use the following terminology. Pre-partition Punjab for before 1947, Unified Punjab for Punjab between 1947 and 1966 and simply Punjab for post 1966. However, we will use these qualifications *only when the context does not make it clear which Punjab we are referring to.*

[5] Though not a part of the Indus basin

[6] See footnote 4 on what constituted Punjab during various periods.

[7] Punjab at this time also included Shimla and Kangra districts of Himachal, but these had very limited amount of irrigation.

[8] See footnote 4

[9] R.L. Anand; *Punjab Agriculture Facts and Figures*; Economic and Statistical Adviser to Government of Punjab; 1956 Page 57 Table 20

real reasons behind advocating the project had much more) do with the interstate disputes of the (then British) provinces of Sind and Punjab and later I dia-Pakistan, than the interests of taking water to dry areas.

We learnt that the Bhakra dam was an over designed dan Even after the Sutluj flows were augmented by the transfer of Beas water to the Bhakra rese oir, the reservoir has not filled up in most of the years.

We found that as in most other dam projects, the figures p t forward for areas to be irrigated by the Bhakra project were highly exaggerated. Indeed, ev the areas that it could ultimately service, it was able to do so by virtually drying up the riv and cutting off areas previously irrigated. *The startling finding was that Bhakra did not add ny new areas under irrigation – it only transferred or shifted the irrigation from one set of eas to another - from areas that were already irrigated to other areas.*

The Bhakra project did not produce any dramatic impact o the country's foodgrain situation. Irrigation from the Bhakra-Nangal project began in 1954, i reased rapidly, and reached close to its full potential by 1963. Yet, India's foodgrain positio had continued to deteriorate, and food imports reached an all time high in 1966. While in orts fell subsequently, they rose sharply again and in 1975 touched a high once more.

20 years after irrigation deliveries started from a project tha is supposed to have brought food self-sufficiency to India, we were still importing huge quant ies of food.

One of the more absorbing and educative part of our jou ey has been the history of food policy and programs in India.

Independent India's quest for feeding its millions began w a conflict of approaches. In the late 40s and early 50s, there was a lot of focus on land refo ns[10] as a necessary component of addressing the food problem. Further, there was emph is on minor irrigation and the community was seen as both, the vehicle of implementing rograms on the ground and as a basis for planning. The sum total was a central place for a decentralised approach. The First Five Year Plan (1951-56) was deemed a success with resp ct to food production. Rationing, control on interstate movement of foodgrains and all such re raints were removed.

The Second Plan (1956-61) shifted the focus from agricultu to industry and was a disaster in terms of foodgrains production. From the Second to Third P n and beyond, the focus also was shifting away from the decentralised approach, towards l ge-scale schemes. Land reforms were not going ahead beyond the abolition of *zamindari*. T strategy of concentrating inputs and resources on selected areas to attain higher production v s coming into prominence.

One of the important reasons for this shift was the bias tow ds interpreting the food problem in terms of "market deficits". The market deficit – the short ll of market supply over market demand - has little role to play for the millions who are no connected to the market for their food needs. Even for those who depend on the market for food needs, it needs to be emphasised that market demand, and hence "deficit" also d pends on the price of foodgrains and purchasing power of the millions. If people do not hav purchasing power, their need to fill their stomachs would not be translated into market dema d and hence the deficit would be less. The focus on market deficit led to an emphasis on in reasing the "procurable surplus" from the farmer to meet the market needs. This approach m nt the food problem was defined in terms of the "visible" demand of those who could pay. corollary was that the approach shifted to an "intensive" and "selective" one, where bett endowed areas would produce

[10] The term Land Reforms encompasses a range of measures from abolitio f *zamindari*, land to the tiller and land to the tenant, land ceiling and redistribution of land, to the security of te ncy and ensuring reasonable conditions for tenancy etc. It is also used sometimes to include land consolidation.

higher "surpluses" which could be procured for the market,[11] since it was easier to produce and procure more surplus from smaller, better endowed areas. This meant that inputs would have to be concentrated there.

However, there was another approach. In this, it was argued that the real solution was (1) For the producers – increase the security of and access to land (land reforms) and increase the productivity of such lands (2) For the millions of "non-producers" increase their purchasing power through sustainable employment. It was also realised and argued that the only way in which the purchasing power of the millions spread all over the country could be increased, and increased in a non-inflationary manner was if the investments used for (1) were also supporting (2). In other words, a massive, decentralised program that would make use of the country's huge human resources to create infrastructure that would increase the productivity of vast areas of lands.

In today's discourse, this is essentially a wide-spread, decentralised rainwater-harvesting, watershed management, soil-water conservation, groundwater recharge program.

It is often said that if India has to feed its millions, there is no alternative but to build huge dams to "harness" the waters of the rivers. Considerable evidence has now accumulated that a decentralised rain-water harvesting program can improve dramatically the productivity of land even in the most scanty rainfall areas. It is argued that this evidence is *now* available, but at the time of independence, the efficacy of such an approach was not established and hence this was not an option at all.

One of the important things we discovered during the course of our study was that such watershed management, rainwater harvesting programs were not only being carried out in the country, but that impressive results from these had been noted and proposals to implement these country wide had been forcefully put forward. For example, the report of the All India Congress Agrarian Reforms Committee of 1949 had noted the results of the soil-water conservation works in Bijapur and its objectives, which were to " keep all the rain-water that fell on the land as near the place at which it fell" and that such a program "could well be expanded to all of India."

Further, from time to time, various experts had proposed precisely the kind of schemes that today are being undertaken for decentralised rainwater harvesting and watershed management – to be implemented all over the country. *Significantly, a very important advantage presented for these schemes was that of generating employment on a huge scale and using India's wealth of human resources.*

However, for a number of reasons, including the reasons of vested interests in large schemes and the blocking of land reforms by the rural elite, the policies shifted decisively towards the strategy of large projects, selectivity and intensification. But we discovered an important thing – that there were very concrete alternatives being proposed to the large projects-based-strategy even in the early years of Independence.

Around 1967 came the Green Revolution (GR). It must be understood that while the GR *strengthened* the intensification, the strategy of intensification and the advent of GR were two separate phenomena. The GR itself was a virtually unforeseen development. The GR took place primarily with the advent of a new variety of seeds, called High Yielding Varieties (HYV). However, they should more appropriately be called High Response Seeds, since their basic quality was that they could take up and withstand much higher levels of fertilisers than even the "improved" seeds in use till then.

The HYV demanded, and got, huge increases in the inputs. These included not only chemical fertilisers, pesticides, but also machinery, cheap credit, minimum support prices and

[11] The Public Distribution System was to be the means for addressing the issue of distribution, especially the needs of the poor.

procurement, extension services and of course water. It sh ld be emphasised that the performance of the HYV was critically dependent on this whc package. All this involved huge public subsidies, the cost of which was borne by the nation .

The spectacular growth in the foodgrains production in Punjal and Haryana came with the advent of the HYV. It is sometimes argued, conceding that the Bhakra project by itself may not have increased production in a dramatic manner, that it was ne key in enabling the Green Revolution. It is also said that the Bhakra project helped inc ase production by allowing hitherto wasteland being brought into cultivation.

We found the ground realities to be quite different. The only s stantial increase in the areas cultivated brought about by the Bhakra project lie in the dry b t of Haryana – in the Hissar tracts. But the contribution of this to the foodgrains production vas limited. Against this, we need to see the costs – financial, social, ecological and economi – of the project. Further, the agriculture of these very areas now faces serious problems – eco gical and economic.

Irrigation was a crucial component of the green revolution. E t Bhakra itself has played a limited role. We have already seen that Bhakra commanded are form less than a third of the area of Haryana and less than a fifth in Punjab. The rest of the c al irrigation in these states is from projects that are over a century old and are based only on d ersion structures.

However, far far more important than the canal irrigation – whe er from Bhakra or anywhere else – has been the role of groundwater. There is not an iota o doubt that it is the explosive growth in the groundwater use – especially with tubewells, that as been the real driving force behind the green revolution and agricultural production in these vo states.

The HYV seeds are highly sensitive to the timing and quantity f watering. It is the tubewells that allowed the farmer to achieve this control. Tubewell pro ictivity is documented to be more than one and half times canal productivity.

The number of tubewells in Punjab jumped from 20,066 to c er 450,000 from 1965-66 to 1975-76. In 1997-98, this figure was 910,000. In Haryana, the number of tubewells jumped from 25,311 in 1965-66 to 204,736 in 1975-76, and in year 200(stood at 583,705.

The areas irrigated by wells/tubewells also increased dramatic ly. By the late 60s, tubewell irrigated areas equalled and soon outstripped canal irrigated ar is in Punjab. In Haryana too, tubewell irrigation grew rapidly till it now equals canal irrigat n. This enormous growth in tubewell irrigation is the major factor behind the agricultural pr uction in the two states.

It is often argued that the tubewell irrigation in the two states w made possible by the canals. It is argued that the waters that the tubewells are lifting are e entially the waters that have seeped in from the canal and this is given as a major contributic of Bhakra. But this is widely off the mark. Large part of the water being drawn out by the ubewells in the two states is actually water that is being mined – in other words, water that not being recharged. This is water that has accumulated over generations or even centurie and is being taken out in a matter of years. Obviously, this is highly unsustainable.

Our calculations show that in Punjab 43-46% of all agricu ural production is based on unsustainably mined groundwater. For Haryana, the figure is 5%.[13] This is the production of the two states that has nothing to do with any canal seepag has nothing to do with canal irrigation and has nothing to do with groundwater recharged r rmally through rain. In other words, a sizable part of the "miracle" of Punjab and Har na is purely and eminently unsustainable. And on the verge of collapse as groundwater lev s are falling rapidly.

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[12] The point is not about subsidies *per se*. This author at least believes that sub lies will be necessary for agriculture. The issue here was the concentration of the subsidies in limited areas of the untry.

[13] Haryana figures for the Year 1998-1999. Punjab figures are for year 1989-9

It may be added that the figures for Punjab above are for the year 1989-90, when the canal irrigated area was 1.467 m ha and tubewell irrigated area 2.44 m ha. By 2001-02, the canal irrigated area in Punjab had fallen sharply to 0.987 m ha – that is, even less than what it was in 1954 before the Bhakra project - and tubewell area gone up to 3.068 m ha. This means that the percentage of production dependent on the mined groundwater should be even higher today.

This is the shocking reality of the miracle of Punjab and Haryana's agriculture.

What is the contribution of Bhakra? The same calculations show that the production that can be attributable to canal irrigation is about 43% in Punjab- *this includes the recharge of groundwater through canals (17%)*[14]. For Haryana, the figure is 48%.

An analysis of the Command area shows that in Punjab, the areas irrigated by Bhakra are very limited and the even the figure we saw earlier of the GCA (Gross Commanded Area) for Bhakra is misleading. The areas that were proposed to be irrigated by Bhakra were either areas that were already irrigated, or were well-endowed areas. Even these planned areas are irrigated not so much by canal as by tubewells. Most of the canal irrigated areas in Punjab are in the Sirhind area or the UBDC area. Out of the 43% of Punjab's production attributed to canals, we find that about 11% is due to Bhakra canals[15]. In Haryana, since Bhakra canals service about 50% of the total canal irrigated areas, we find that Bhakra is responsible for about 24% of Haryana's production. These are conservative calculations.

What is equally important to note is that Haryana is the senior partner as far as Bhakra is concerned (it has much more area irrigated from Bhakra than Punjab), but in terms of food production Punjab is the senior partner. Punjab's foodgrains production is double that of Haryana, even though the cultivable area of the two states is comparable.

In other words, in the best analysis, contribution of Bhakra to India's foodgrains production and Punjab / Haryana's agricultural prosperity has been limited, and nowhere near what is the perception. Bhakra happened to be in the right place, at the right time, and has been given the credit for things it never did.

However limited the production from Bhakra, the question can be asked – was there any other way to achieve this? In particular, the areas of Hissar tracts in Haryana, which were dry and semi-arid area, with much of the groundwater of poor quality – and today boast of lush green fields – is there any other way that these areas could have been served?

We found that the answers are an emphatic yes – and also that the answers have several dimensions.

There are two ways the question could be posed – was taking the waters of Sutluj to Hissar, Sirsa, Fatehbad, Jind, Kaithal etc. districts in Haryana the only, or even the most optimal, way to meet India's food needs? This is from the point of view of the country. From the point of view of these areas themselves the question is whether there was any other way to meet their developmental needs.

About the needs of the areas themselves: purely in technical terms, we found that it would have been possible for these areas to be irrigated with Sutluj water even without the Bhakra dam. Indeed, such a scheme had also been proposed in the late 19th Century. In fact, many parts of these areas were already being irrigated with the WJC.

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[14] To elaborate – the production attributable to the canal irrigated areas is 26%. This is the direct contribution of canals. However, about 60% of the *recharged* groundwater in Punjab is said to come from the recharge due to canals. We have included this as the indirect contribution of the canals and this works out to be 17% of production. Hence, total contribution of canals – direct and indirect is 43%.

[15] Due to the non-cooperation of the Government, we were not given the exact areas irrigated in each of the systems. We have worked out these figures from the district-wise irrigation data.

There is a larger issue here. What is the appropriate (agricu ural) development for this area? From the Second Irrigation Commission (1972) to the new National Water Policy, planners espouse that development of an area should be appropriate its eco-climatic conditions. But the practice has been to implement the same agricultura model in all zones – growing sugarcane even in deserts[16], so to say. So long as sugarcane cultivation pays much more than say a livestock based economy (which may be more suited t such zones), there is little doubt that the people will demand water to grow sugarcane. The d cussion on this issue is crucial to the agricultural strategy in the country, but it is clearly be ond the scope of our work. We would only like to state that in our undertaking, we found ar ple evidence of the desirability of tailoring development strategies to the eco-climatic and loca conditions.

As for the first question – was the Bhakra (or similar projec) the only and optimal strategy to meet the country's foodgrains needs – it was clear th there were real and tangible alternatives, alternatives that could have served the untry better. These were the decentralised wide-spread schemes that were being propos d, which would have spread the inputs, resources, investments and the outputs – and put pu hasing power in the hands of the people. Such alternatives had been proposed, we found, but ad been ignored.

Choosing these alternatives could have also meant avoi ng many of the serious social, environmental, financial costs and impacts of the Bhakra roject. In evaluating the limited benefits of the Bhakra project, we must not forget this other ide of the balance sheet.

One of the most serious issues has been the waterloggi ; and salinisation in the Bhakra command. What is important is that much of the area in B akra command that is in Haryana (and this is the main irrigated area of the project) is und lain with saline and bad quality waters. It is virtually impossible to control waterlogging nd salinisation in this situation, unlike in areas with good quality water where pumpin can help. The twin dangers of waterlogging and salinisation of the lands lead to sharp de line in productivity, even making the lands totally uncultivable. When we visited the are s affected by waterlogging and salinisation, we were shocked by the impacts. Farmers to us stories of lands going out of production and farmers migrating from the village. We aw costly experiments trying to recover salinised lands which are meeting with only limite success. We saw the Master Plan prepared by the Haryana Government to address the probl n of waterlogging- the cost – Rs. 2000 crores.

Waterlogging has also badly affected the infrastructure. number of houses have fallen, buildings have been affected due to differential sinking c foundations. Long stretches of a National Highway have had to be lifted for the same reason

All evidence available to us shows that the problem of aterlogging and salinisation will continue to become more serious. This is a classic examp of short-term benefits and long-term disastrous impacts.

There have been severe impacts of the dam itself. The iver downstream of the dam has become virtually dry. We have not been able to estimate t impacts of this since it is almost 50 years since this has happened and getting baseline ata has been very difficult. But meticulous research will be able to get this, and we feel th this will be a very important area for researchers to explore.

There have been no detailed studies of the environmental npacts of the dam except possibly the issue of waterlogging. We feel that these would have b n important and should have been done since Bhakra has been projected so much as a model. ut we came across many pieces of information which indicate that there have been serious i pacts of the project. Diversion of most of the water at Nangal and Ropar has meant serious onsequences downstream. Similar

[16] In Kutch, Gujarat, for example, sugarcane is growing in the semi- arid eas, while neighbouring villages have serious problem of even drinking water.

impacts are also seen below Pandoh in Beas basin. The traditional, much sought after fish, *masheer* has virtually disappeared from the reservoir, being replaced by the silver carp which is a low valued fish. There have been several health impacts of the project especially in the reservoir area. About 10% of the live capacity of the reservoir has been lost to siltation and a hump formation in the reservoir is preventing the silt from going into the dead storage. Given the importance attached to the project, it is very important that these be thoroughly investigated.

By far the most poignant moments for us have been when we met the oustees of the project. Almost fifty years have gone by after their displacement. And yet, they have not been fully settled. The communities living on the periphery of the reservoir – literally a reservoir of water – do not have proper supply of drinking water. Those who were settled in the command area of the project, in district of Hissar far away from their homes and culture, were allotted bad quality lands, overgrown with bushes and undergrowth. An entire generation spent its life in backbreaking work to try and make these lands cultivable. Fifty years after displacement their lives are not yet back on track, and they are still fighting to get themselves properly established. Many of them have not got titles to their lands or house plots. Many of the house plots are still under the encroachment of local people. The oustees do not find political representation as they are in the minority, and their grievances are not properly heard for the same reasons. They find themselves cut off from their relatives and culture, and feel like aliens in a strange land even after so many years. They are still dersogatorily called *bilaspuriyas* (as they came from Bilaspur district) by the locals. Since large number of them have small land holdings, they are hard hit by the worsening economy of agriculture.

Their voices still convey the pride they had felt, in the days when the country was just independent, that they had been called on to serve the country through giving their lands and *watan* (homeland). This has been replaced by a deep sense of being betrayed by the nation.

Now there is another set of people who are being pushed headlong towards displacement – economic displacement. These are the farmers of Punjab and Haryana. And therein lies one of the biggest tragedies of this chronicle.

Wherever we went in Haryana or Punjab, we hardly heard exuberant voices extolling the virtues of the project. In Punjab this was understandable since the Bhakra project has little in terms of contribution to the state. In Haryana, we went across the command area of the project. At places people told us about the transformation brought about by the project. Yet, the voices were weighed down by distress; the eyes were full of apprehension about the future. Everywhere we went, people told us that after the first 15-20 years of progress, the problems began. They pointed out to us that much of what is being seen around (the houses, the tractors, the prosperity) is the gift of those early years. And things are crumbling now. There is little doubt about it – there is a deep crisis in the agriculture in the two states.

Ironically, the roots of the crisis lie in the same factors that brought in the much envied, much referred to prosperity.

The groundwater that has been the real driving force behind the agriculture growth is declining rapidly. Farmers with 5 H.P. motors have had to shift to 10 and then 20 H.P. motors, and now have to go for submersible pumps. Canal irrigation is leading to large-scale problems of waterlogging and salinity. Prolonged use of fertilisers and chemicals has dramatically reduced the fertility of the soil, and higher and higher levels of inputs are needed to get the same output. The yields have stagnated, and in some cases – like rice – are going down. Pests have increased, and crops like cotton have been devastated. The two states have been locked into virtual mono-cropping of rice and wheat. Attempts to change the cropping pattern are not working due to a combination of economic, ecological and political reasons. The farmer is caught in a pincer as the costs of inputs are mounting, and the price of the output is not keeping pace. Indebtedness is rising among the farmers and the small farmers are hardest hit.

There is pressure on the Government to cut the subsidie that manage to support much of the system. The crisis is so serious that number of farmers i Punjab have resorted to committing suicide. Suicides of farmers in the state where farming supposed to be most prosperous in the country is an indicator of the gravity of the situation a d an omen.

At one village, we asked to talk to the landless families. We were again and again brought to people with lands. When we repeated our request – we ere told that these people have only 1-2 acres of land, and hence are as good as landless. To , there could be no bigger indicators of the crisis of agriculture than the suicides of farmers an this.

One would have thought that in states considered o be the pinnacle of agricultural achievement and prosperity, in the land of Bhakra, agric lture would be so rich that 1-2 acres would be enough for a person to live well. But it is not s

There is little doubt that the agriculture and the farmer of the two states are paying a high price for the short burst of prosperity. Agriculture in the tate has lost the resilience to take on new challenges. Both the economic, and ecological oundations of the agriculture have become shaky. The system has become highly vulnerabl to outside shocks. Ecological shocks are already being felt, as are economic. And the WTO s waiting in the wings to administer blows which will be impossible for this system to take In both states, farmers, analysts and social activists expressed grave fears that if the mini ium support prices were withdrawn under the pressure of WTO, and they were forced to ell at market price, lakhs of farmers would be rendered bankrupt.

This of course, is a part of the larger crisis of agricultur Punjab and Haryana are the furthest down *this* path to agricultural "prosperity", and hen have reached the end of the path earliest. Others on the same path can but reach the sam end. But if the "magnificent" Bhakra project has not protected the two states against this, then his is food for thought. Our study has shown that in this model, there will be a short-lived bur of prosperity, followed by long-term, permanent devastation. Somewhat like a supernova.

Unfortunately, at the official level, there seems to be li le understanding of, or willingness to address the root causes. The Punjab Government set up committee to address the agricultural crisis in the state which gave its report in the year 2002 It is known after its Chair as the Johl Committee. The main thrust of the report is that the pr blem of Punjab is that of plenty. It is locked into the wheat-rice cycle and produces such a undance that it is difficult to find a market for it. The proposed solution? State subsidy to ie farmers to stop growing wheat and rice on about 1 million ha – to be given even if they do ot grow anything.

The report exposes one of the most important dimen ions of the food problem in India. It reveals the reason behind the fact that even as we tru pet that we are now self-sufficient in food, that we now export food, millions still go hungry the country. We quote:

> "India has accumulated huge stocks of foodgr ns that are not finding market and are proving to be a heavy drain on the state exch uer and the government is obliged to purchase substantial new arrivals at higher an higher prices every season under the system of Minimum Support Prices. Althoug as per the nutritional requirements of the Indian population, these stocks may not considered in excess, yet due to the lack of purchasing power with the poor, suppl exceeds demand...."

This lack of the purchasing power is the main reason f the perversity of huge food stocks, of exports at subsidised prices even as millions go h ngry. And the roots of the lack of purchasing power go deep to the strategy of selectivity intensification and centralisation. The roots go back to the strategy of the separation of the eans to achieve the two objectives of increasing production and the subsequent equitable di ribution- the strategy of concentrating inputs, resources and investments in small areas to inc ease production and then hope that the rest can buy this production. But buy with what? nce this approach creates purchasing

capacity only in pockets. Big dams like Bhakra exemplify the unfolding of this strategy on the ground, as they concentrate benefits in selected areas.

Unfortunately, we are not learning from these developments in Punjab; a similar situation is rapidly developing in the economy in the other sectors. Under the policies of globalisation, liberalisation and privatisation, we are having high rates of growth – but without growth in employment. The same mistake – of jobless growth; we should be ready for the same results.

Fortunately, we also found a number of people in Punjab and Haryana thinking along more fundamental lines. And therein lies hope. We found groups worrying about the impacts of the large-scale use of chemicals and pesticides. We found people who are concerned about the soil degradation due to excessive chemical input and are trying to create a shift to organic agriculture. We found people trying to document and revive traditional water resources, tanks and ponds. Villages like Sukho Majri show how local water harvesting, diversity of cropping and use of organic inputs can lead to high yields and minimum debts for the farmers.

When we travelled in Punjab and Haryana, we heard the desperation in the people's voices. Some farmers also told us – when the country needed us, we were there to help the country produce food. Now that we are in trouble – will the country not help us? Even if our report just leads to an answer in affirmative to this question, we will feel that our efforts have not been in vain.

It would be incomplete to end the tale of this journey without a word about the other discoveries we made – almost as a sort of a by product but probably equally valuable.

The first thing we came across, and something that was a constant all along the way has been the wonderful, warm and generous hospitality of the people of Punjab, Haryana and Himachal. And this is not just our friends but everyone. Complete strangers welcomed us into their homes, fed us superbly, and shared their life experiences with us. The latter especially has been a privilege.

We discovered why the simple traditional meal of *makke-ki-roti sarson-da-saag* ranks among the most wonderful food in the world – even though the *makka* may no longer be growing so much, replaced by wheat and rice. We realised the true meaning of the *lassi* and *paratha* – and that what we called by these names back home were poor country cousins.

We found out that music in Punjab is much more than "*balle balle*" or the more recent "*Tunuk Tunuk*" as we were introduced to the mellifluous songs of Asa Singh Mastana, Surinder Kaur and others.

We also came across some not so pleasant facts – the low female: male ratio in Punjab to name one. Or, the striking absence of women in the markets of the small towns of Haryana – an indicator of their role and status.

We found the obsession with "*foreign*" in the Doab region to be just as the stories have it. Almost every family from this region of Punjab seems to have a member abroad. It was also later given to us as a reason why the farming families are able to make ends meet here.

Two stops on our journey are particularly memorable. One was at Khatkad Kalan – a brief stop on the way from Ludhiana to Bhakra, to pay a visit to the birth place and home of Shahid Bhagat Singh. The other was at the Gurudwara at Anandpur Sahib, where, apart from other things, the lunch at the *langaar* reminded us that the generosity and hospitality of the Sikhs is not restricted to individuals but extends to the community.

All these not only made our journey so much more enjoyable and pleasant, it also offered to us insights into famous entrepreneurial spirit of the Punjab (and Haryana) farmer, and the culture and society in which the subject of our study is placed.

Yet, we have come away with a sense of despondency. The c sis we saw in the agriculture is very real, and deep. And it is not just going to be restricted t the two states, but is likely to engulf much of the country. No farmer we met was untouche by it, and no one could refrain from referring to it. Before we embark on the details of t s journey of ours in the next chapters, as a reminder of our mission, of what we found, we can do no better than end with two quotes – one, from an official, the other from a farmer.

Report of the S.S. Johl Committee, Government of Punjab, Oc 2002:

> "On the other side, continuous production of wheat a d rice in annual rotation in the irrigated areas of Punjab is having a deleterious effec on soil, water, environment and social fabric of the state. Soils of Punjab have beco e virtually a laboratory culture that requires higher and higher doses of fertilisers, icronutrients, insecticides and pesticides to produce same level of wheat and /or ric This has resulted in declining total factor productivity. The situation is becoming ery serious day by day which can very soon proved to be economically disastrous, s cially untenable and politically unsustainable, which can turn into man-made nati al calamity if not dealt with judiciously."

Sardar Gurmail Singh, Village Bada, District Ropar:

> "All that you can see around in Punjab [the prosperit] all that you have heard about it, please do not believe it. Things are not what they em. Punjab is on the brink..."

UNRAVELLING
BHAKRA

ASSESSING THE TEMPLE OF RESURGENT INDIA

Report of a Study by
Manthan Adhyayan Kendra
Badwani (M.P.)

Study Team
Shripad Dharmadhikary
Swathi Sheshadri
Rehmat

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Report of a Study of the Bhakra Nangal Project

Published By:	Manthan Adhyayan Kendra, Dashera Maidan Road, Badwani (M.P.) 451 551 Ph: 07290-222 857 Email: manthan_b@sancharnet.in
Study Team:	Shripad Dharmadhikary Swathi Sheshadri Rehmat
Layout & Maps:	Rehmat
Photographs:	BBMB, Government of Rajasthan, Rehmat, Mukesh Jat, Alok Agrawal, Shripad Dharmadhikary and several others.
Production Support:	Eklavya Bhopal
April 2005:	1000 copies
Suggested Contribution:	Individuals: Rs. 150.00 Institutions: Rs. 300.00

Printed at Adarsh Printers and Publishers, Bhopal, Phone: 2555442

UNRAVELLING BHAKR
Assessing the Temple of Resur ent India

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A Journey Into he Realm of Bhakra

OUR JOURNEY INTO THE BHAKRA-LAND BEGAN WI H THIS AWESOME DISPLAY of the green revolution in its full visual glory. As we trav led through Haryana, and then Punjab, this sight was to be repeated day after day. As we noved through the country, we heard stories of how the waters had transformed virtual dese into lush green fields. We saw the big *pucca* houses in villages, the large number of tractor – and not a single bullock cart. We crossed numerous small and big canals as we drove on he excellent road network. The most spectacular sight of the journey was our first view of he Bhakra dam. It was nothing short of stunning. Seen coming up the mountain from the dov stream side in the late evening, the wall of the dam rises up steeply, suddenly from the dep hs of the gorge to a sheer 200 meters, the lights at the top illuminating it. As an engine r, I could only marvel at this testimony to the skills of our profession. We saw at the da n site exhibition the photos of visiting dignitaries like Ho-Chi-Minh, Bulganin, Khruschev – images from the heydays of "socialist" India.

Our physical journey was paralleled by another, a metaphori l, journey – a journey through the facts and figures, through the documents, through the hist ry, geography, science, politics of the project. A journey through the minds and memories of eople, a tour that accompanied the people on their experiences of the dam, of the agriculture of the two states. This journey was equally, if not more, fascinating as the physical journey.

The mesmerising display of the green revolution in the fi ds of Haryana and Punjab is matched by the spectacular statistics of agricultural grow . In Punjab, the foodgrains production went up from 3.389 million tons (m tons) in 1965- 6 to 17.221 m tons in 1985-86 – an increase of five times in 20 years, or an annual compo nded growth of 8.47% for 20 years running! In 1999-2000 it stood at 25.197 million tons, 1 1% of the all India production. In Haryana, in the same period, foodgrains production increase from 1.985 m tons to 8.147 m tons, a four times increase. In 1999-2000,it stood at 13.065 mil on tons, or 6.2% of All India.

There is an old saying – I believe it exists in some form or the her in every language – which states "Appearances can be deceptive". Our journey, our fasci ting journey into the realm of Bhakra was to prove the truth of this saying many times ove in many different ways. Our journey was a discovery of this, of how long held popular belie s and perceptions were mostly just that – beliefs. It was also a revelation of the hidden, or r t so hidden, but often swept-under-the-carpet side of the story.

The first revelation came with our very first visual encounter ith Haryana described above. As we soon found, the lush green fields from Panipat to Hans had little to do with Bhakra[1]. This area, along with other large areas in Haryana receive wa rs from the Western Jamuna Canal (WJC) and have been doing so since over 100 years.[2] he WJC is a diversion canal taking off from the Yamuna river near Tajewala. This diver on is from a weir and not a

[1] Throughout this report, unless the context so indicates, or it is specified other se, the term "Bhakra" or "Bhakra project" will refer to the entire Bhakra-Nangal project.

[2] The WJC was irrigating small areas as early as the 16th Century – during the r e of Akbar. In 1832 it was remodelled for extensive irrigation.

storage dam. In fact, the gross command area of Bhakra in Haryana is about 30% of the state geographical area. In Punjab, the gross commanded area of Bhakra is about 18.6% of the state area. *Punjab and Haryana are much more than Bhakra.*[3]

It is often said that before Bhakra, Punjab (and Haryana) were just semi-arid, dry regions with little irrigation and / or highly problematic agriculture. We found this to be far from the truth.

As we traced the history of irrigation in the two states, we had to go back to pre-partition India, the pre-partition Punjab. Pre-partition Punjab included not only the Pakistan part of Punjab, but also today's Indian states of Punjab and Haryana. *Punj* (Five) *Aab* (Waters) – the land of the five rivers – Sutluj, Beas, Ravi, Chenab, Jhelum - and of course the mighty Indus whose tributaries these five are – forms an area endowed with the most lavish water resources. While irrigation was being used in the Indus basin since the days of Harappa and Mohen-ja-daro, it really developed during the 19th Century and by the early 1900s, Punjab[4] had an extensive, highly developed irrigation system based on diversions from the major rivers.

A large part of this system was in what is today Pakistan. But the irrigation developed in the Indian part was not small or insignificant. The Western Jamuna Canal,[5] we have seen, was serving large parts in today's state of Haryana. The Upper Bari Doab system from Ravi that serves much of Amritsar and Gurudaspur districts in Punjab was opened in 1859.

The Sirhind Canal, taking off from the Sutluj at Ropar in Punjab, was opened in 1882. It was irrigating, and still does, large areas of Punjab. Apart from these, there was significant irrigation from wells.

Overall, the situation in Punjab (including Haryana[6]) around 1950 - before the Bhakra project - was as follows.

In percentage terms, in 1949-1950, Punjab[7] had 35.3% of its sown area irrigated and the figure for PEPSU (Patiala and East Punjab States Union)[8] was 42.6%. This was the highest in the whole country! Together, PEPSU and Punjab accounted for 13% of the country's irrigated area, while it had 5.89% of the country's total sown area[9]. Thus, it was way ahead in irrigation as compared to the rest of the country – even after losing the lion's share to Pakistan. In absolute terms, the areas irrigated were 4.9 million acres in Punjab and 2.04 m acres in PEPSU.

Similarly, Punjab at that time was the leading producer of wheat, maize and gram in the country.

Against this background, the decision to build Bhakra was a very interesting one. As we explored the planning and decision making process around Bhakra project, we found that the

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[3] Note that the gross command area gives the maximum possible reach of the project.

[4] Punjab here means the Pre-partition Punjab. The readers will do well to keep in mind the following. The British Province of Punjab included much of what is today Indian Punjab, Indian Haryana, small part of Indian Himachal and the Pakistan Punjab. Some areas that are in Punjab or Haryana today were not in the British province of Punjab but were princely states. These included Patiala, Jind, Bhatinda, Faridkot etc. and went by the name PEPSU – Patiala and East Punjab States Union. In 1947, the partition created West Punjab (in Pakistan) and East Punjab (in India) – later called simply Punjab. This Indian Punjab (of 1947) included parts of today's Punjab, today's Haryana and some parts of Himachal. In 1956, PEPSU merged with Indian Punjab. In 1966, this combined Punjab was reorganised into Haryana and Punjab, with a few districts going to Himachal. We will use the following terminology. Pre-partition Punjab for before 1947, Unified Punjab for Punjab between 1947 and 1966 and simply Punjab for post 1966. However, we will use these qualifications *only when the context does not make it clear which Punjab we are referring to.*

[5] Though not a part of the Indus basin

[6] See footnote 4 on what constituted Punjab during various periods.

[7] Punjab at this time also included Shimla and Kangra districts of Himachal, but these had very limited amount of irrigation.

[8] See footnote 4

[9] R.L. Anand; *Punjab Agriculture Facts and Figures*; Economic and Statistical Adviser to Government of Punjab; 1956 Page 57 Table 20

real reasons behind advocating the project had much more t do with the interstate disputes of the (then British) provinces of Sind and Punjab and later I lia-Pakistan, than the interests of taking water to dry areas.

We learnt that the Bhakra dam was an over designed dam Even after the Sutluj flows were augmented by the transfer of Beas water to the Bhakra reser ɔir, the reservoir has not filled up in most of the years.

We found that as in most other dam projects, the figures pu forward for areas to be irrigated by the Bhakra project were highly exaggerated. Indeed, eve the areas that it could ultimately service, it was able to do so by virtually drying up the rive and cutting off areas previously irrigated. *The startling finding was that Bhakra did not add a y new areas under irrigation – it only transferred or shifted the irrigation from one set of a as to another - from areas that were already irrigated to other areas.*

The Bhakra project did not produce any dramatic impact on he country's foodgrain situation. Irrigation from the Bhakra-Nangal project began in 1954, in eased rapidly, and reached close to its full potential by 1963. Yet, India's foodgrain position ad continued to deteriorate, and food imports reached an all time high in 1966. While imp rts fell subsequently, they rose sharply again and in 1975 touched a high once more.

20 years after irrigation deliveries started from a project that supposed to have brought food self-sufficiency to India, we were still importing huge quantit s of food.

One of the more absorbing and educative part of our journ y has been the history of food policy and programs in India.

Independent India's quest for feeding its millions began witl a conflict of approaches. In the late 40s and early 50s, there was a lot of focus on land reform[10] as a necessary component of addressing the food problem. Further, there was emphas on minor irrigation and the community was seen as both, the vehicle of implementing p ɔgrams on the ground and as a basis for planning. The sum total was a central place for a c centralised approach. The First Five Year Plan (1951-56) was deemed a success with respec to food production. Rationing, control on interstate movement of foodgrains and all such rest ints were removed.

The Second Plan (1956-61) shifted the focus from agriculture o industry and was a disaster in terms of foodgrains production. From the Second to Third Pla and beyond, the focus also was shifting away from the decentralised approach, towards lar -scale schemes. Land reforms were not going ahead beyond the abolition of *zamindari*. The trategy of concentrating inputs and resources on selected areas to attain higher production wa coming into prominence.

One of the important reasons for this shift was the bias towar interpreting the food problem in terms of "market deficits". The market deficit – the shortfa of market supply over market demand - has little role to play for the millions who are not c nnected to the market for their food needs. Even for those who depend on the market f food needs, it needs to be emphasised that market demand, and hence "deficit" also dep nds on the price of foodgrains and purchasing power of the millions. If people do not have rchasing power, their need to fill their stomachs would not be translated into market demanc and hence the deficit would be less. The focus on market deficit led to an emphasis on incr sing the "procurable surplus" from the farmer to meet the market needs. This approach mea the food problem was defined in terms of the "visible" demand of those who could pay. A ɔrollary was that the approach shifted to an "intensive" and "selective" one, where better ndowed areas would produce

[10] The term Land Reforms encompasses a range of measures from abolition of *amindari*, land to the tiller and land to the tenant, land ceiling and redistribution of land, to the security of tenan and ensuring reasonable conditions for tenancy etc. It is also used sometimes to include land consolidation.

higher "surpluses" which could be procured for the market,[11] since it was easier to produce and procure more surplus from smaller, better endowed areas. This meant that inputs would have to be concentrated there.

However, there was another approach. In this, it was argued that the real solution was (1) For the producers – increase the security of and access to land (land reforms) and increase the productivity of such lands (2) For the millions of "non-producers" increase their purchasing power through sustainable employment. It was also realised and argued that the only way in which the purchasing power of the millions spread all over the country could be increased, and increased in a non-inflationary manner was if the investments used for (1) were also supporting (2). In other words, a massive, decentralised program that would make use of the country's huge human resources to create infrastructure that would increase the productivity of vast areas of lands.

In today's discourse, this is essentially a wide-spread, decentralised rainwater-harvesting, watershed management, soil-water conservation, groundwater recharge program.

It is often said that if India has to feed its millions, there is no alternative but to build huge dams to "harness" the waters of the rivers. Considerable evidence has now accumulated that a decentralised rain-water harvesting program can improve dramatically the productivity of land even in the most scanty rainfall areas. It is argued that this evidence is *now* available, but at the time of independence, the efficacy of such an approach was not established and hence this was not an option at all.

One of the important things we discovered during the course of our study was that such watershed management, rainwater harvesting programs were not only being carried out in the country, but that impressive results from these had been noted and proposals to implement these country wide had been forcefully put forward. For example, the report of the All India Congress Agrarian Reforms Committee of 1949 had noted the results of the soil-water conservation works in Bijapur and its objectives, which were to " keep all the rain-water that fell on the land as near the place at which it fell" and that such a program "could well be expanded to all of India."

Further, from time to time, various experts had proposed precisely the kind of schemes that today are being undertaken for decentralised rainwater harvesting and watershed management – to be implemented all over the country. *Significantly, a very important advantage presented for these schemes was that of generating employment on a huge scale and using India's wealth of human resources.*

However, for a number of reasons, including the reasons of vested interests in large schemes and the blocking of land reforms by the rural elite, the policies shifted decisively towards the strategy of large projects, selectivity and intensification. But we discovered an important thing – that there were very concrete alternatives being proposed to the large projects-based-strategy even in the early years of Independence.

Around 1967 came the Green Revolution (GR). It must be understood that while the GR *strengthened* the intensification, the strategy of intensification and the advent of GR were two separate phenomena. The GR itself was a virtually unforeseen development. The GR took place primarily with the advent of a new variety of seeds, called High Yielding Varieties (HYV). However, they should more appropriately be called High Response Seeds, since their basic quality was that they could take up and withstand much higher levels of fertilisers than even the "improved" seeds in use till then.

The HYV demanded, and got, huge increases in the inputs. These included not only chemical fertilisers, pesticides, but also machinery, cheap credit, minimum support prices and

[11] The Public Distribution System was to be the means for addressing the issue of distribution, especially the needs of the poor.

procurement, extension services and of course water. It sh uld be emphasised that the performance of the HYV was critically dependent on this wh le package. All this involved huge public subsidies, the cost of which was borne by the natio[12].

The spectacular growth in the foodgrains production in Punja and Haryana came with the advent of the HYV. It is sometimes argued, conceding that th Bhakra project by itself may not have increased production in a dramatic manner, that it wa he key in enabling the Green Revolution. It is also said that the Bhakra project helped in ease production by allowing hitherto wasteland being brought into cultivation.

We found the ground realities to be quite different. The only s ostantial increase in the areas cultivated brought about by the Bhakra project lie in the dry b lt of Haryana – in the Hissar tracts. But the contribution of this to the foodgrains productio was limited. Against this, we need to see the costs – financial, social, ecological and economi – of the project. Further, the agriculture of these very areas now faces serious problems – eco gical and economic.

Irrigation was a crucial component of the green revolution. E t Bhakra itself has played a limited role. We have already seen that Bhakra commanded are form less than a third of the area of Haryana and less than a fifth in Punjab. The rest of the c al irrigation in these states is from projects that are over a century old and are based only on d ersion structures.

However, far far more important than the canal irrigation – whe er from Bhakra or anywhere else – has been the role of groundwater. There is not an iota o doubt that it is the explosive growth in the groundwater use – especially with tubewells, that as been the real driving force behind the green revolution and agricultural production in these o states.

The HYV seeds are highly sensitive to the timing and quantity watering. It is the tubewells that allowed the farmer to achieve this control. Tubewell pro ctivity is documented to be more than one and half times canal productivity.

The number of tubewells in Punjab jumped from 20,066 to o r 450,000 from 1965-66 to 1975-76. In 1997-98, this figure was 910,000. In Haryana, the umber of tubewells jumped from 25,311 in 1965-66 to 204,736 in 1975-76, and in year 2000 tood at 583,705.

The areas irrigated by wells/tubewells also increased dramatica y. By the late 60s, tubewell irrigated areas equalled and soon outstripped canal irrigated are s in Punjab. In Haryana too, tubewell irrigation grew rapidly till it now equals canal irrigati n. This enormous growth in tubewell irrigation is the major factor behind the agricultural pro uction in the two states.

It is often argued that the tubewell irrigation in the two states wa made possible by the canals. It is argued that the waters that the tubewells are lifting are es entially the waters that have seeped in from the canal and this is given as a major contributio of Bhakra. But this is widely off the mark. Large part of the water being drawn out by the bewells in the two states is actually water that is being mined – in other words, water that i not being recharged. This is water that has accumulated over generations or even centuries and is being taken out in a matter of years. Obviously, this is highly unsustainable.

Our calculations show that in Punjab 43-46% of all agricul ral production is based on unsustainably mined groundwater. For Haryana, the figure is 3 %.[13] This is the production of the two states that has nothing to do with any canal seepage, as nothing to do with canal irrigation and has nothing to do with groundwater recharged n mally through rain. In other words, a sizable part of the "miracle" of Punjab and Hary a is purely and eminently unsustainable. And on the verge of collapse as groundwater level are falling rapidly.

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[12] The point is not about subsidies *per se*. This author at least believes that subsi s will be necessary for agriculture. The issue here was the concentration of the subsidies in limited areas of the co ntry.

[13] Haryana figures for the Year 1998-1999. Punjab figures are for year 1989-90.

It may be added that the figures for Punjab above are for the year 1989-90, when the canal irrigated area was 1.467 m ha and tubewell irrigated area 2.44 m ha. By 2001-02, the canal irrigated area in Punjab had fallen sharply to 0.987 m ha – that is, even less than what it was in 1954 before the Bhakra project - and tubewell area gone up to 3.068 m ha. This means that the percentage of production dependent on the mined groundwater should be even higher today.

This is the shocking reality of the miracle of Punjab and Haryana's agriculture.

What is the contribution of Bhakra? The same calculations show that the production that can be attributable to canal irrigation is about 43% in Punjab- *this includes the recharge of groundwater through canals (17%)*[14]. For Haryana, the figure is 48%.

An analysis of the Command area shows that in Punjab, the areas irrigated by Bhakra are very limited and the even the figure we saw earlier of the GCA (Gross Commanded Area) for Bhakra is misleading. The areas that were proposed to be irrigated by Bhakra were either areas that were already irrigated, or were well-endowed areas. Even these planned areas are irrigated not so much by canal as by tubewells. Most of the canal irrigated areas in Punjab are in the Sirhind area or the UBDC area. Out of the 43% of Punjab's production attributed to canals, we find that about 11% is due to Bhakra canals[15]. In Haryana, since Bhakra canals service about 50% of the total canal irrigated areas, we find that Bhakra is responsible for about 24% of Haryana's production. These are conservative calculations.

What is equally important to note is that Haryana is the senior partner as far as Bhakra is concerned (it has much more area irrigated from Bhakra than Punjab), but in terms of food production Punjab is the senior partner. Punjab's foodgrains production is double that of Haryana, even though the cultivable area of the two states is comparable.

In other words, in the best analysis, contribution of Bhakra to India's foodgrains production and Punjab / Haryana's agricultural prosperity has been limited, and nowhere near what is the perception. Bhakra happened to be in the right place, at the right time, and has been given the credit for things it never did.

However limited the production from Bhakra, the question can be asked – was there any other way to achieve this? In particular, the areas of Hissar tracts in Haryana, which were dry and semi-arid area, with much of the groundwater of poor quality – and today boast of lush green fields – is there any other way that these areas could have been served?

We found that the answers are an emphatic yes – and also that the answers have several dimensions.

There are two ways the question could be posed – was taking the waters of Sutluj to Hissar, Sirsa, Fatehbad, Jind, Kaithal etc. districts in Haryana the only, or even the most optimal, way to meet India's food needs? This is from the point of view of the country. From the point of view of these areas themselves the question is whether there was any other way to meet their developmental needs.

About the needs of the areas themselves: purely in technical terms, we found that it would have been possible for these areas to be irrigated with Sutluj water even without the Bhakra dam. Indeed, such a scheme had also been proposed in the late 19th Century. In fact, many parts of these areas were already being irrigated with the WJC.

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[14] To elaborate – the production attributable to the canal irrigated areas is 26%. This is the direct contribution of canals. However, about 60% of the *recharged* groundwater in Punjab is said to come from the recharge due to canals. We have included this as the indirect contribution of the canals and this works out to be 17% of production. Hence, total contribution of canals – direct and indirect is 43%.

[15] Due to the non-cooperation of the Government, we were not given the exact areas irrigated in each of the systems. We have worked out these figures from the district-wise irrigation data.

There is a larger issue here. What is the appropriate (agr ultural) development for this area? From the Second Irrigation Commission (1972) to the r w National Water Policy, planners espouse that development of an area should be appropria to its eco-climatic conditions. But the practice has been to implement the same agricult al model in all zones – growing sugarcane even in deserts[16], so to say. So long as sugarca e cultivation pays much more than say a livestock based economy (which may be more suite to such zones), there is little doubt that the people will demand water to grow sugarcane. The discussion on this issue is crucial to the agricultural strategy in the country, but it is clearly eyond the scope of our work. We would only like to state that in our undertaking, we found mple evidence of the desirability of tailoring development strategies to the eco-climatic and lo l conditions.

As for the first question – was the Bhakra (or similar proj ts) the only and optimal strategy to meet the country's foodgrains needs – it was clear hat there were real and tangible alternatives, alternatives that could have served the country better. These were the decentralised wide-spread schemes that were being prop sed, which would have spread the inputs, resources, investments and the outputs – and put p rchasing power in the hands of the people. Such alternatives had been proposed, we found, b had been ignored.

Choosing these alternatives could have also meant av ding many of the serious social, environmental, financial costs and impacts of the Bhak project. In evaluating the limited benefits of the Bhakra project, we must not forget this oth side of the balance sheet.

One of the most serious issues has been the waterlogg ng and salinisation in the Bhakra command. What is important is that much of the area in hakra command that is in Haryana (and this is the main irrigated area of the project) is ur erlain with saline and bad quality waters. It is virtually impossible to control waterloggin and salinisation in this situation, unlike in areas with good quality water where pumpi g can help. The twin dangers of waterlogging and salinisation of the lands lead to sharp c cline in productivity, even making the lands totally uncultivable. When we visited the a as affected by waterlogging and salinisation, we were shocked by the impacts. Farmers t d us stories of lands going out of production and farmers migrating from the village. W saw costly experiments trying to recover salinised lands which are meeting with only limit l success. We saw the Master Plan prepared by the Haryana Government to address the prob m of waterlogging- the cost – Rs. 2000 crores.

Waterlogging has also badly affected the infrastructure A number of houses have fallen, buildings have been affected due to differential sinking f foundations. Long stretches of a National Highway have had to be lifted for the same reaso

All evidence available to us shows that the problem of waterlogging and salinisation will continue to become more serious. This is a classic exam e of short-term benefits and long-term disastrous impacts.

There have been severe impacts of the dam itself. The river downstream of the dam has become virtually dry. We have not been able to estimate e impacts of this since it is almost 50 years since this has happened and getting baseline data has been very difficult. But meticulous research will be able to get this, and we feel th t this will be a very important area for researchers to explore.

There have been no detailed studies of the environmental mpacts of the dam except possibly the issue of waterlogging. We feel that these would have b en important and should have been done since Bhakra has been projected so much as a model. But we came across many pieces of information which indicate that there have been serious mpacts of the project. Diversion of most of the water at Nangal and Ropar has meant serious consequences downstream. Similar

[16] In Kutch, Gujarat, for example, sugarcane is growing in the semi- arid reas, while neighbouring villages have serious problem of even drinking water.

impacts are also seen below Pandoh in Beas basin. The traditional, much sought after fish, *masheer* has virtually disappeared from the reservoir, being replaced by the silver carp which is a low valued fish. There have been several health impacts of the project especially in the reservoir area. About 10% of the live capacity of the reservoir has been lost to siltation and a hump formation in the reservoir is preventing the silt from going into the dead storage. Given the importance attached to the project, it is very important that these be thoroughly investigated.

By far the most poignant moments for us have been when we met the oustees of the project. Almost fifty years have gone by after their displacement. And yet, they have not been fully settled. The communities living on the periphery of the reservoir – literally a reservoir of water – do not have proper supply of drinking water. Those who were settled in the command area of the project, in district of Hissar far away from their homes and culture, were allotted bad quality lands, overgrown with bushes and undergrowth. An entire generation spent its life in backbreaking work to try and make these lands cultivable. Fifty years after displacement their lives are not yet back on track, and they are still fighting to get themselves properly established. Many of them have not got titles to their lands or house plots. Many of the house plots are still under the encroachment of local people. The oustees do not find political representation as they are in the minority, and their grievances are not properly heard for the same reasons. They find themselves cut off from their relatives and culture, and feel like aliens in a strange land even after so many years. They are still dersogatorily called *bilaspuriyas* (as they came from Bilaspur district) by the locals. Since large number of them have small land holdings, they are hard hit by the worsening economy of agriculture.

Their voices still convey the pride they had felt, in the days when the country was just independent, that they had been called on to serve the country through giving their lands and *watan* (homeland). This has been replaced by a deep sense of being betrayed by the nation.

Now there is another set of people who are being pushed headlong towards displacement – economic displacement. These are the farmers of Punjab and Haryana. And therein lies one of the biggest tragedies of this chronicle.

Wherever we went in Haryana or Punjab, we hardly heard exuberant voices extolling the virtues of the project. In Punjab this was understandable since the Bhakra project has little in terms of contribution to the state. In Haryana, we went across the command area of the project. At places people told us about the transformation brought about by the project. Yet, the voices were weighed down by distress; the eyes were full of apprehension about the future. Everywhere we went, people told us that after the first 15-20 years of progress, the problems began. They pointed out to us that much of what is being seen around (the houses, the tractors, the prosperity) is the gift of those early years. And things are crumbling now. There is little doubt about it – there is a deep crisis in the agriculture in the two states.

Ironically, the roots of the crisis lie in the same factors that brought in the much envied, much referred to prosperity.

The groundwater that has been the real driving force behind the agriculture growth is declining rapidly. Farmers with 5 H.P. motors have had to shift to 10 and then 20 H.P. motors, and now have to go for submersible pumps. Canal irrigation is leading to large-scale problems of waterlogging and salinity. Prolonged use of fertilisers and chemicals has dramatically reduced the fertility of the soil, and higher and higher levels of inputs are needed to get the same output. The yields have stagnated, and in some cases – like rice – are going down. Pests have increased, and crops like cotton have been devastated. The two states have been locked into virtual mono-cropping of rice and wheat. Attempts to change the cropping pattern are not working due to a combination of economic, ecological and political reasons. The farmer is caught in a pincer as the costs of inputs are mounting, and the price of the output is not keeping pace. Indebtedness is rising among the farmers and the small farmers are hardest hit.

There is pressure on the Government to cut the subs lies that manage to support much of the system. The crisis is so serious that number of farme s in Punjab have resorted to committing suicide. Suicides of farmers in the state where farm g is supposed to be most prosperous in the country is an indicator of the gravity of the situati n and an omen.

At one village, we asked to talk to the landless fami es. We were again and again brought to people with lands. When we repeated our request – e were told that these people have only 1-2 acres of land, and hence are as good as landless. o us, there could be no bigger indicators of the crisis of agriculture than the suicides of farmer and this.

One would have thought that in states consider d to be the pinnacle of agricultural achievement and prosperity, in the land of Bhakra, a riculture would be so rich that 1-2 acres would be enough for a person to live well. But it is nc so.

There is little doubt that the agriculture and the far ers of the two states are paying a high price for the short burst of prosperity. Agriculture in ne state has lost the resilience to take on new challenges. Both the economic, and ecologic l foundations of the agriculture have become shaky. The system has become highly vulner ble to outside shocks. Ecological shocks are already being felt, as are economic. And the W O is waiting in the wings to administer blows which will be impossible for this system to t te. In both states, farmers, analysts and social activists expressed grave fears that if the m imum support prices were withdrawn under the pressure of WTO, and they were forced o sell at market price, lakhs of farmers would be rendered bankrupt.

This of course, is a part of the larger crisis of agricul re. Punjab and Haryana are the furthest down *this* path to agricultural "prosperity", and h nce have reached the end of the path earliest. Others on the same path can but reach the sa ne end. But if the "magnificent" Bhakra project has not protected the two states against this, th n this is food for thought. Our study has shown that in this model, there will be a short-lived b rst of prosperity, followed by long-term, permanent devastation. Somewhat like a supernova.

Unfortunately, at the official level, there seems to be ittle understanding of, or willingness to address the root causes. The Punjab Government set o a committee to address the agricultural crisis in the state which gave its report in the year 20 2. It is known after its Chair as the Johl Committee. The main thrust of the report is that the roblem of Punjab is that of plenty. It is locked into the wheat-rice cycle and produces such abundance that it is difficult to find a market for it. The proposed solution? State subsidy t the farmers to stop growing wheat and rice on about 1 million ha – to be given even if they d not grow anything.

The report exposes one of the most important dim nsions of the food problem in India. It reveals the reason behind the fact that even as we t mpet that we are now self-sufficient in food, that we now export food, millions still go hungr in the country. We quote:

> "India has accumulated huge stocks of food ains that are not finding market and are proving to be a heavy drain on the state exc equer and the government is obliged to purchase substantial new arrivals at higher d higher prices every season under the system of Minimum Support Prices. Althou n as per the nutritional requirements of the Indian population, these stocks may no be considered in excess, yet due to the lack of purchasing power with the poor, supp y exceeds demand...."

This lack of the purchasing power is the main reason or the perversity of huge food stocks, of exports at subsidised prices even as millions go ungry. And the roots of the lack of purchasing power go deep to the strategy of selectivi , intensification and centralisation. The roots go back to the strategy of the separation of th means to achieve the two objectives of increasing production and the subsequent equitable stribution- the strategy of concentrating inputs, resources and investments in small areas to in rease production and then hope that the rest can buy this production. But buy with what? ince this approach creates purchasing

capacity only in pockets. Big dams like Bhakra exemplify the unfolding of this strategy on the ground, as they concentrate benefits in selected areas.

Unfortunately, we are not learning from these developments in Punjab; a similar situation is rapidly developing in the economy in the other sectors. Under the policies of globalisation, liberalisation and privatisation, we are having high rates of growth – but without growth in employment. The same mistake – of jobless growth; we should be ready for the same results.

Fortunately, we also found a number of people in Punjab and Haryana thinking along more fundamental lines. And therein lies hope. We found groups worrying about the impacts of the large-scale use of chemicals and pesticides. We found people who are concerned about the soil degradation due to excessive chemical input and are trying to create a shift to organic agriculture. We found people trying to document and revive traditional water resources, tanks and ponds. Villages like Sukho Majri show how local water harvesting, diversity of cropping and use of organic inputs can lead to high yields and minimum debts for the farmers.

When we travelled in Punjab and Haryana, we heard the desperation in the people's voices. Some farmers also told us – when the country needed us, we were there to help the country produce food. Now that we are in trouble – will the country not help us? Even if our report just leads to an answer in affirmative to this question, we will feel that our efforts have not been in vain.

It would be incomplete to end the tale of this journey without a word about the other discoveries we made – almost as a sort of a by product but probably equally valuable.

The first thing we came across, and something that was a constant all along the way has been the wonderful, warm and generous hospitality of the people of Punjab, Haryana and Himachal. And this is not just our friends but everyone. Complete strangers welcomed us into their homes, fed us superbly, and shared their life experiences with us. The latter especially has been a privilege.

We discovered why the simple traditional meal of *makke-ki-roti sarson-da-saag* ranks among the most wonderful food in the world – even though the *makka* may no longer be growing so much, replaced by wheat and rice. We realised the true meaning of the *lassi* and *paratha* – and that what we called by these names back home were poor country cousins.

We found out that music in Punjab is much more than "*balle balle*" or the more recent "*Tunuk Tunuk*" as we were introduced to the mellifluous songs of Asa Singh Mastana, Surinder Kaur and others.

We also came across some not so pleasant facts – the low female: male ratio in Punjab to name one. Or, the striking absence of women in the markets of the small towns of Haryana – an indicator of their role and status.

We found the obsession with "*foreign*" in the Doab region to be just as the stories have it. Almost every family from this region of Punjab seems to have a member abroad. It was also later given to us as a reason why the farming families are able to make ends meet here.

Two stops on our journey are particularly memorable. One was at Khatkad Kalan – a brief stop on the way from Ludhiana to Bhakra, to pay a visit to the birth place and home of Shahid Bhagat Singh. The other was at the Gurudwara at Anandpur Sahib, where, apart from other things, the lunch at the *langaar* reminded us that the generosity and hospitality of the Sikhs is not restricted to individuals but extends to the community.

All these not only made our journey so much more enjoyable and pleasant, it also offered to us insights into famous entrepreneurial spirit of the Punjab (and Haryana) farmer, and the culture and society in which the subject of our study is placed.

Yet, we have come away with a sense of despondency. Th crisis we saw in the agriculture is very real, and deep. And it is not just going to be restrict d to the two states, but is likely to engulf much of the country. No farmer we met was untou hed by it, and no one could refrain from referring to it. Before we embark on the details this journey of ours in the next chapters, as a reminder of our mission, of what we found we can do no better than end with two quotes – one, from an official, the other from a farmer

Report of the S.S. Johl Committee, Government of Punjab Oct. 2002:

> "On the other side, continuous production of whe and rice in annual rotation in the irrigated areas of Punjab is having a deleterious ef ct on soil, water, environment and social fabric of the state. Soils of Punjab have b ome virtually a laboratory culture that requires higher and higher doses of fertilise , micronutrients, insecticides and pesticides to produce same level of wheat and /or ce. This has resulted in declining total factor productivity. The situation is becom g very serious day by day which can very soon proved to be economically disastrou , socially untenable and politically unsustainable, which can turn into man-made r tional calamity if not dealt with judiciously."

Sardar Gurmail Singh, Village Bada, District Ropar:

> "All that you can see around in Punjab [the prosp rity] all that you have heard about it, please do not believe it. Things are not what th y seem. Punjab is on the brink..."