SOCIO-ECONOMIC CONSEQUENCES OF HEALTH IMPACTS FROM WATER RESOURCES DEVELOPMENT PROJECTS

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This thesis is dedicated to my husband, Zhizhong,
my son, Xiao Hua,
and my parents.

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ABSTRACT

Water resources development projects have been undertaken in large numbers, especially in developing countries, because of their obvious economic and social benefits and contributions to development. While many of the effects are positive and anticipated, others are negative and often are overlooked or even ignored in the early stages of project planning. The impact on human health due to the spread of water-borne diseases is a typical example of such negative consequences. It has also been one of the least investigated aspect of such projects.

This study attempts to develop an analytical framework with which the socio-economic consequences of health effects on local communities from water resources development projects can be examined. The concept of forgone output is employed to represent the health impact. It is applied to the disease of schistosomiasis associated with the Volta River Project in Ghana. It is demonstrated that the framework is useful in assessing health effects associated with water resources development projects.

The results of this study suggest that health effects impose a heavy economic burden on the local population living within the project area; and that disease control programs are very cost-effective in controlling water-borne diseases. It is recommended that health impact assessment should be conducted before the project is carried out; and that disease prevention or control programmes be incorporated into early stages of project planning.

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CHAPTER 1. INTRODUCTION

1.1. The Impacts of Water Resources Development Projects

The needs in response to economic, industrial and agricultural expansion for a country's modern development have spurred the construction of tens of thousands of large-scale hydropower, irrigation, navigation or multipurpose water resources development projects in the past few decades. Today, water resources projects are still an essential feature of integrated national and regional economic development plans all over the world. With funding now available from such institutions as the International Bank for Reconstruction and Development (i.e., the World Bank) and the various international aid agencies, the pace of dam construction has accelerated dramatically since the Second World War. The World Bank by itself has lent over one billion dollars to more than 20 countries in connection with dam construction projects. It is further estimated that, to ensure continued development, over 15 billion US dollars would be required to finance power expansion programmes in non-industrialized countries (Goldsmith and Hildyard 1984).

Brazil is a typical example. It intends to build 15 large dams in the Amazon basin to produce 66,000 megawatts of electricity. The Itaipu Dam on the Parana River between Paraguay and Brazil alone will generate 12,600 megawatts of electricity- the equivalent output of 13 large nuclear power stations- at an estimated cost of 16 billion US dollars (Deudney 1981). Still more ambitious is the proposed Three Gorges Dam on China's Yangtze River. With a planned generating capacity of 25,000 megawatts or an equivalent output of 25 large nuclear power stations, the project may produce 40 per cent of China's total current electricity output. The Three Gorges Project is estimated to cost up to 12 billion US dollars (Hamil 1980). In South-East Asia, plans are under way to build a complex of dams on the Mekong River Basin at a cost of eight billion US dollars at 1970 prices (Goldsmith and Hildyard 1984).

In the Philippines alone, an estimated 39 large dams are already in operation, 12 are under construction and 177 are awaiting construction (Hunter 1982). By 1990, the total number of dams worldwide over 150 meters in height is expected to have reached 113, of which 49 would have been built during the 1980s (Mermel 1982). For the future, many large-scale schemes are planned worldwide, some of which involving the diversion of whole rivers, the transfer of water from one river basin to another, and even the reversal of the river flows. It is expected that decisions made on dam projects in the next decade will affect most of the world's last remaining free-flowing rivers.

The building of large-scale water resources development projects is an exceptionally expensive business.

In order to implement such projects, many developing countries have to borrow large amounts of money from international lenders, including banks in the private sector. A combination of factors, including, among others, high interest rates, deteriorating markets for their products, reduced international aid flows, and falling investment, has rendered many developing countries incapable of repaying even the interest on such loans. These problems have raised many controversial issues over the impacts of aid projects and programmes, particularly large-scale water resources development projects, on Third World development. Goldsmith and Hildyard (1986), for example, questioned the real contribution of dam building to the development in the developing countries:

> "Few Third World governments are able to lay their hands on such vast sums of money. They must therefore borrow. But the loans that are made to them are made on the assumption that the dams will provide a net return on investment. In all too many cases, however, the dams have turned out to be economic white elephants. The Itaipu Dam has not brought the economic development which its backers were promised. The Sri Lankan Government is now having difficulties in meeting the interest payments on the loans it raised to pay for the Mahaweli scheme. In India, according to a recent report, every single large dam built since the Second World War has proved an economic disaster: not only have the dams cost more than estimated but they have failed to provide their expected benefits. The Republic of Guatemala is already in trouble over paying for the Chixory Dam, which was originally expected to cost $341 million but which ended up costing $630 million. In Honduras, the construction of the massive EI Cajon Dam is expected to cost $90 million more than the

> government estimated- a sum which will have to be borrowed by a regime which is already in dire economic straits."

The concern over the effects of large-scale water resources development projects on Third World development is not confined to the economic impacts at the national level. In recent years, the undesirable effects on the natural and social systems have also been critically scrutinized (Lagler 1969; Hunter 1982; Goldsmith and Hildyard 1984, 1986). Monosowski (1985) maintained that the social and environmental costs of water projects have very often outweighed their economic benefits. Drawing on the ecological and social effects of the Volta Dam in Ghana, Johnson (1971) argued that "large dams may create far more problems than they could solve".

It is well-documented that large-scale water resources development projects may have enormous impacts upon the natural environment, both directly by flooding valleys upstream, and indirectly, by altering the productive riparian, estuarine and coastal ecosystems hundreds of miles downstream. They may also accelerate social change (e.g., from subsistence agriculture to a cash economy), to the effects of transforming the social life of local residents, and indigenous and traditional cultures. This very ability to engineer ecological and social environments makes this type of projects attractive to governments and development agencies alike. Yet, the radical environmental and social changes accompanying such a project may result in the destruction of local ecosystems and communities (Williams 1986).

Large-scale water resources development projects have been widely reported to create negative impacts on the physical, biological and chemical processes. Sterling (1972) described that when a large dam is built, the rising waters may flood several thousand square miles of land. Resultant changes may range from climate, erosion, sedimentation, water quality, fish, and wildlife habitats. On the human side, serious deleterious effects on public health may also occur (Goodman 1984).

1.2. Health Problems Associated with Water Resources Development Projects

Water resources development projects usually induce significant changes in the environment by flooding large areas of land for storing water and by introducing water for irrigation into once dry farming lands. One of the consequences of these ecological changes is the breeding and spread of water-borne diseases, thus creating a number of risks to the human health of local population. Among the commonly-reported diseases associated with water resources development projects are schistosomiasis, malaria, onchocerciasis, trypanosomiasis, filariasis and sleeping sickness (Laçler 1969; El-Zarka 1973; Kalitsi 1973; Raheja 1973; Chen *et al.* 1980; Goldsmith and Hildyard 1984, 1986). Table 1-1 summarizes the major water-borne diseases reported in selected water resources development schemes around the world. These diseases affect the health of millions of people in developing countries in a variety of ways, such as, creating illness, disability and death, etc.

Water-borne diseases are a particularly added problem for water resources development in tropical Africa. In Upper Egypt, the malaria epidemic of the 1940s causing 130,000 deaths was seen as a consequence of water development (Farid 1977). At the Kariba Dam Project area, an outbreak of human sleeping sickness caused by tsetse fly led to the death of 41 children within a single 3-month period (Scudder 1966). For over half a century, the tsetse fly has prohibited agricultural development in large parts of the Kariba reservoir area (Magadza 1986). In the Lusitu area below the dam, dysentery killed over 153 of the about 6,000 relocatees in less than two years after the relocation (Scudder 1966). Among them, schistosomiasis is unquestionably the most serious (IFIAS 1973). In Kenya, for instance, schistosomiasis affected almost 100 per cent of school children in the areas around Lake Victoria (Biswas 1978). In Ghana, the prevalence of schistosomiasis in some communities rose from 10 per cent to nearly 100 per cent

Table 1-1. Health Effects of Selected Water Projects (WHO/EURO 1983)

Date of Completion	Project	Health Effects
1933	Tennessee Valley Project, USA	Increase in malaria
1958	Kariba Hydropower Scheme, Zimbabwe	Increase in schistosomiasis. Sporadic increases in trypanosomiasis
1960	Gezira-Managil Irrigation Scheme, Sudan	Increase in schistosomiasis. Short increases in malaria
1963	Ord River Dam, Australia	Increase in arboviruses
1965	Soe Dam, Ghana	Increase in onchocerciasis
1966	Volta Dam, Ghana	Increase in schistosomiasis
1968	Sugar Estate Irrigation, Tanzania	Increase in schistosomiasis
1969	Kainji Dam, Nigeria	Increase in schistosomiasis
1969	Aswan High Dam, Egypt/Sudan	Increase in schistosomiasis
1970	Ubolratana Dam Complex, Thailand	Increase in intestinal parasitic infection: helminths and protozoa. Increase in opisthorchiasis
1970	Kisuma Rice Irrigation Scheme, Kenya	Increase in malaria. Increase in arbovirus infections
1970	Nagarjunasagar Dam, India	Increase in genu valgum
1974	Guyama, Guajataca and Lajas Valley Water Development Schemes, Puerto Rico	Increase in schistosomiasis
1974	El Bir and Foum Gleita Reservoir Schemes, Mauritania	Increase in schistosomiasis
1975	Tana River Basin, Kano Plains, Yala Swamp and Teveta Irrigation Schemes, Kenya	Increase in schistosomiasis
1978	Malumfashi Agricultural Development Project, Nigeria	Increase in schistosomiasis
1978	Srinagarind Dam, Thailand	Increase in malaria
1979	Gambia Estuary Barrage, Gambia	Increase in schistosomiasis, malaria, filariasis and enteric diseases. Possible linkage to introduction of trypanosomiasis

among the inhabitants around Lake Volta, within five years of the impoundment (Leisinger 1983). Increased incidence were also reported in many countries other than Africa, suchas the United States, China, and Brazil (Chen et al. 1980; Budweg 1980).

In 1947, an estimated 114 million people in the world suffered from schistosomiasis. It was noted in the report of the Nobel Workshop on Schistosomiasis, held in Stockholm in 1973, that schistosomiasis affected between 100 and 200 million people in 71 countries. Unlike most other public health problems, this disease had been spreading and remained largely uncontrolled (Wright 1968; IFIAS 1973). Up until 1977, schistosomiasis still affected a total of 200 million people (Obeng 1977). It was estimated by the Special Tropical Research Programme of the United Nations Development Programme (UNDP)/World Bank/World Health Organization (WHO) that 180-250 million persons in tropical regions had schistosomiasis (UNDP/World Bank/WHO 1981).

The spread of schistosomiasis has a strong linkage with water resources development projects, which serve to extend habitats for the intermediate snail host of the disease. Although schistosomiasis is the subject of a large and expanding research effort aimed at finding efficient control methods, the human costs in connection with the disease are not well understood (Baldwin and Weisbrod 1974).

It is generally understood that the effects of the so-called water-borne diseases on the local population concerned are multi-dimensional, encompassing mainly three direct components: illness, disability and death, (Ghana Health Assessment Project Team 1981), which in turn result in output lost. In addition to intangible "subjective" losses, these effects also exert enormous economic and social burdens on local population through increased costs of hospitalization and pain suffering, etc.. People in the project areas are usually impoverished as a direct result of the project instead of becoming better off.

This led Stanley *et al.* (1975) to argue that the justification for building dams in the first place was usually based on economic grounds but should be- if it is a big dam- political ones as well. Human health impacts are important for their own sake. Failure to attend to the health aspects of large artificial lakes or reservoirs may lead to a social catastrophe in so far as the local population are concerned. This renders it necessary that health planning must be built into the project from its inception, long before anything is built, and continued long after the lake has filled, until the health provisions are fully incorporated into the public health structure of the country concerned. Even if dams are among the greatest human triumphs to human engineering, critical analyses of the effects of water resources development projects are seriously needed.

1.3. Objective of This Study

Traditionally and even recently, decisions on water resources development projects have been based exclusively on economic-engineering criteria. Cost-benefit analysis, which usually is restricted on the analysis of national, regional or provincial level, has been the principal tool in the decision making process. Planning for new projects has always accounted for their direct costs and benefits. It is often the case that decision-making is usually based on the assumption that a water development project can generate great benefits for national and regional economic development. In some cases, planners and decision makers are seldom aware of the "hidden costs" associated with the adverse impacts on local communities, in particular, those resulting from water-borne diseases induced by water development projects. But, in many instances, they are well-informed about the risk, yet remain ignorant. Whatever is the case, water resources development projects are built at the expense of local people by localizing environmental and human costs for the benefits of national and international interests.

The primary objective of this study is to develop an analytical framework with which the socio-economic consequences of health effects on local communities by water resources development projects can be examined. The framework has been applied to a water resources development project- the Volta River Project in Ghana- for testing. The results have demonstrated that the project had enormous impacts on the human health of local population. The results have also indicated that the framework can be used as a reference tool in assessing the health effects associated with water resources development projects and the cost-effectiveness of disease prevention or control programmes (DPPs or DCPs).

This study focuses on the disease of schistosomiasis. One of the major reason for choosing schistosomiasis is that it is the most serious health hazard associated with the Volta River Project, and can be expected to occur in almost all water resources development project in the tropic and subtropic countries. Meanwhile, a large amount of epidemiological data is ready available in the Volta Lake area on a before-and-after-project basis.

CHAPTER 2. LITERATURE REVIEW

There is a growing volume of literature from different perspectives with regard to the analysis of public health effects with development projects (see, for example, Popkin 1982; Stock 1986). Most of the attention has been devoted to three interrelated issues. The first issue is the ecological transmission of water-borne diseases among the population in question. The second issue is centred around the socio-political economy of such effects (see, for example, Hughes 1970; Hunter 1982; Popkin 1982; Stock 1986). The third issue is concentrated on the economic analysis of water-borne diseases (see, for example, Barnum 1987; Ghana Health Assessment Project Team 1981; Olivares 1986; Prescott 1979; Taylor 1970; Weisbrod *et al.* 1973).

2.1. Ecological Changes in Promoting Water-Borne Diseases

In the past few decades, Africa has witnessed many large-scale water resources development projects, resulting in significant and drastic modifications of the existing ecological environment. It is generally believed that these unintended environmental modifications, particularly those related to water resources development, have played a particularly important role in the spreading of water-borne diseases. Dubos (1965) stated that "it is environmental changes, especially the greatest changes, that are chiefly responsible for diseases".

A water resources development project can change the environment and cause health threat in a number of interrelated pathways. The first pathway is the flooding of large areas of land. Most water projects, whether they are for hydro-electric generation, improvement of navigation or expansion of irrigation, require the storage of water. As such, flooding of land is an inevitable consequence. Kainji Lake, for example, flooded an area of 1,250 square kilometres (Adekolu-John *et al.* 1978). Another large artificial lake in Africa- Lake Kariba- inundated an area of 5,364 square kilometres at its normal operating level (Balon 1978). This large-scale flooding always dramatically alters the ecology of the project area. As such, some biological species, for example, will thrive in the lake, or in the irrigation channels. Plants, fungi, protozoa, bacteria and other micro-organisms will be affected. Many of those species play an important part in the transmission of infectious diseases (Goldman 1979).

The second pathway is the introduction of water into once dry-farming areas for irrigation use. Many disease vectors may be brought into the newly-irrigated areas. If people in the project areas do not have the knowledge of how to use water properly, as is usually the case, the increased frequency of contact with water can serve as a source of spread of water-borne diseases amongst the population (Odei 1961).

Flooding inevitably results in the reduction of land. This, in turn, creates a higher concentration of people, which represents a third pathway for disease transmission. In many instances, population density may double or even triple in the project area. The increase in population density and crowding, whether in houses, village settlements, markets or other gathering places, may promote the transmission of many parasitic diseases. Coupled with a lack of sanitation facilities, the local water supply may quickly become contaminated with human wastes. Under such circumstances, chances for the rapid transmission of water-borne diseases will inevitably increase (Fernea and Kennedy 1966).

The fourth pathway is human movement. Many water resources development projects, particularly artificial lakes, usually serve as a tourist attraction. Increased traffic as the tourism industry booms may increase the movements of diseases in and out of the area (Tikasingh 1979). The situation is particularly aggravated by the in-flow of large numbers of labour force in search for better opportunities. The labour force may carry various infectious diseases and introduce them into new areas where the infectious vectors may not exist and the population are non-immune. On the other hand, the labour force may also expose to a locally endemic disease for the first time (Fernea and Kennedy 1966; Goldman 1979).

Among the Ashanti in Ghana, for example, there is a clear illustration of the role of population movement in the dissemination of infectious diseases and re-infecting of controlled areas:

> "From the 1920's into the 1940's many labourers from the savanna areas of northern Ghana, and from other northern countries such as the Upper Volta Republic, Mali, and Niger, moved into southern Ghana for work. As they migrated, they passed through the tsetse belt immediately north of the forest, where they picked up the infection. Upon reaching their destination-Ashanti country in central Ghana, they became the source for spreading the disease, to such an extent that Ashanti foci began to have higher rates than the north. At the same time, eradication campaigns in the northern areas were somewhat effective in reducing the incidence of infection there. With the periodic return of migrant labourers from the south, however, the process of re-infection began. Such migratory movements continue today, one consequence being that trypanosomes are being cycled back to the northern savanna." (Scott 1965).

Water pollution is another pathway for transmission. As water serving both as a transfer medium and as a habitat for vectors and intermediate hosts, water itself can carry toxic chemicals and many communicable diseases. For example, the establishment of an irrigation scheme may render a region more vulnerable to diseases. The chemical pollution affecting irrigation populations may originate upstream and endanger the health of the downstream inhabitants. It may also occur in the irrigation scheme itself through the indiscriminate use of chemicals and pesticides, which in turn accumulate in plants and fish ultimately consumed by human or domestic animals, causing serious, acute or chronic toxication (Worthington 1977).

If proper sanitary measures are not taken, water used for drinking and domestic purposes may be polluted by human and animal wastes. Once contaminated, the water will provide a habitat for vector of disease and infect all drawers of water from that source. Consequently, an epidemic of water-borne diseases may occur within a relatively short period of time, affecting not only public health but also production (IDRC 1981).

The sixth pathway concerns social and cultural or behavioral factors. A community's socio-cultural patterns can influence the prevailing ecology of health and diseases. Wellin (1958) claimed that communities have their customary patterns of activity and characteristic relations with their environment. These cultural patterns are among the determinants of whether, when, how often, and with whom disease agents will interact, and what the outcomes of the interaction will be. For example, in a water project area, people may increase their water-contacting activities. This may have played a crucial role in transmission of schistosomiasis. Cline (1989) observed that behaviourial changes related to bathing, recreational activities of children, clothes washing, and occupational practices of the population concerned increase the exposure of local residents to schistosomiasis.

It was found by Goldman (1979) that the stress associated with resettlement of people living in water project sites in Africa also plays a significant role in increased morbidity and mortality, particularly among the very young and the very old. In addition, a water resources project usually involves the construction of transportation systems. The building of new roads, rail connections and bridges, often results in changes in the environment and causes population redistribution. These kinds of secondary activities may encourage movement and mixture of people and goods, which may disturb parasite vectors and can thus affect the local distribution of diseases (Goldman 1979; Thomson 1967; Scott 1957).

In Nigeria, for example, transmission of diseases has increased sharply along the main JosWamba road, a road used by migrant labourers going to the tin workings on the plateau (Thomson 1967). Another illustration of a human-induced transmission site is also from northern Nigeria- the area of Kanawa. In 1961, when it was surveyed for prevalence of sleeping sickness as a precautionary measure for labourers working on the Bornu railway extension, it was found to be free of the diseases. Later, however, there was a sharp outbreak of sleeping sickness. Subsequent investigation indicated that it was human induced: a small forest reserve deliberately planted along the banks of a stream at the point where it was crossed by the main road- a place where people gathered to wash, drink and relax. In this case, the trypanosome strain was one of high transmissibility.

Although water-related diseases are among the most widespread infectious diseases associated with water resources development, there is little reliable information on which the planning and implementation of disease prevention and control measures could be based (Iarotski and Davis 1981). Previous studies on this subject were characterized by a lack of consideration of the various steps among the disease transmission, functional impacts, variations in physical performance (Popkin 1982). A comprehensive or fuller review of the ecological changes in promoting transmission of water-related diseases as well as their prevention and control methods is still in short (Iarotski and Davis 1981).

2.2. Development for Whom? At What Price?

In many developing countries, it is often the case that water resources development projects are designed to produce energy, cash crops for the international market in the industrialized nations or for domestic markets in urban centres. It is undoubtedly true that certain groups within the economy can benefit enormously from water development projects. But the main beneficiaries appear to be the urban population, the wealthy "westernised" elite class, the politicians, construction companies and their consultants, bureaucrats, and industrialised countries. The local people, the traditional farmers, the indigenous or minority groups, etc., who happen to be in the way of progress and who are usually politically and economically marginal, are forced to give up their livelihood, their home, and their communities. They also have to bear the consequences of ecological, economic and social destruction.

Williams (1986) maintained that development projects, particularly water resources projects, usually mean the exploitation of resources for the benefits of one group at the expense of another. This can involve taking lands from tribal people for the benefits of nearby industrializing cities. In a country like India, for example, the construction of the Bhopalpatnam and Inchampalli Hydroelectric Projects, has effectively resulted in a direct assault on the country's tribal population. According to official figures, these two projects have inundated some 140,000 hectares of land, about 45,000 tribal people were displaced and resettled. As their dependent surrounding nature is degraded and resources is appropriated by the more powerful people in society, the tribals are forced to the verge of social, cultural and economic collapse. They become further impoverished (Colchester 1986; Morris 1983).

In the case of the Senegal River Scheme, 16,430 people had to leave the areas flooded by the project. Over 300,000 people had to change their way of life as a result of the change in location of agricultural areas, the disappearance of fishing areas, the destruction of local craft industries, the erection of new urban ship-building and food-processing centres, and the large influx of people towards the project area. Inevitably, the traditional social structure would not be able to withstand the pressures. Social breakdown would eventually follow. As people are now committed the whole year round to irrigated farming, they are becoming more dependent on imported goods (Mounier 1986). It is still a myth that the construction of the billion dollar Aswan High Dam has made Egypt wealthier. The silt that has made the Nile Delta the most fertile land is settling to the bottom of Lake Nasser (Sterling 1972). A local resident once said, "Before the dam, our life was good. It was bountiful. Everything- fish, shrimp, good water. Now all we have is the consequences of the dam and that's it: hunger and polluted water" (Dwyer 1989). For local people, electricity supply is still a promise and any water supplies are seldom derived from the project itself.

The beneficiaries are cities or industrial centres far away (Rosenfield 1979; Waddy 1975). Monosowski (1986) criticised that the distribution of the beneficial economic effects of water development projects do not correspond to the distribution of its ecological and social costs, including negative health effects, upon local communities. The needs of those people, who have least political power, have not been sufficiently taken into account in the national policy objectives. The water resources development will therefore only serve to exacerbate the country's internal inequalities.

Balon (1978) cited another typical example, the Kariba Dam Project, as the roots of external inequalities in developing countries. He demonstrated that the project had led to widespread environmental damage. Once able to support a dignified population, the area now needs outside help to survive. He argued that in their rush to clamber into the industrialized world, developing countries allowed their environment to be exploited for short-term gains. The electricity generated at Lake Kariba only simply accelerated the exploitation of non-renewable resources, so that the industrialized Western world could maintain its high standard of living. Few or no benefits have reached the local communities.

The Cabora Bassa dam, which was built in the Tete Province of Mozambique when it was under Portuguese colonial rule, provides a very large amount of electricity, more than twice as much as the Volta dam. Such a quantity of electricity is of no immediate use to a poor country like Mozambique. In fact, 90 percent of the electricity generated from the dam was exported to South Africa (Bolton 1986). The Bakolori scheme in Nigeria produced no revenue for the country but provided substantial benefits for the transnational Fiat-manufacturers (Beckman 1986). Adamson (1971) argued that the project is simply a reinforcement of the economic power of their oppressors. All these are closely linked to the term of international neo-imperialism (Palmer 1974).

In the Philippines, the situation is the same. Water resources programmes are usually designed to favour the large foreign corporate consumers, while the basic needs of the country's poor receive short shrift. The programmes strongly stress electrification for the demands of industrial consumers. The Filipino government claims that generating more electricity, through projects like the Chico Dams, would foster rural development; it would allow farmers to irrigate their land with electric pumps, grind their rice and corn in electric mills, and develop cottage industries. These claimed benefits, however, are rationalisation rather than realities. Rural Filipinos, by and large, lack the capital to invest in electric equipment and appliances; the majority cannot even afford basic connection charges and fees. On the contrary, most of the electricity use is concentrated in heavy, primary industries, such as mining, refining, and manufacturing, the majority of which are foreign-owned or foreign-controlled (Anti-Slavery Society 1983).

In summary, development often does not occur in a vacuum. It is often the case in the developing world that development acts in favour of some groups in society and at the expense of others. Development can in fact be described as the process by which the rich and more powerful reallocate the nation's natural resources in their favour and modern technology (Agarwal, 1982; Rifkin and Kaplinsky 1975). The construction of huge dams is no exception. Human health impacts upon local communities are just part of the development process.

2.3. Poverty, Diseases, Health Care and Development

A vast amount of research has been produced on the development and health theme. Researchers have continued to explore health problems within a developmentalist framework, considering the impacts of disease burden on development and the effects of development on health. Hughes and Hunter (1970), for instance, examined the "hidden costs" of development to human health. They concentrated primarily on how the transmission and impacts of diseases, such as malaria, trypanosomiasis and schistosomiasis, had been affected by development. The authors argued that health impacts are seen as essentially side-effects of development. The health effects are part of its social costs. Water-borne diseases are, therefore, very much a disease of development (Heyneman 1982).

In developing countries, the short-term economic benefits of resources development generally carry more weight in political decision making than the adverse health effects (Bos and Miller 1987). As the majority of the population in developing countries are deprived and poor people, they have little voice, limited political influence and they are often inaccessible to development programmes. It is their poverty which breeds disease, which reinforces poverty. Historians of public health (Ackernecht 1965; Brockington 1958; Dubos 1959; Rosen 1958; Sigerist 1945) have extensively documented the dilemma that the poor are sicker, and the sick are less able to do anything about their poverty.

Thus, the WHO (1981) has described the health status of the poorer groups in the developing countries:

> "Nearly 1,000 million people are trapped in the vicious circle of poverty, malnutrition, disease and despair that saps their energy, reduces their work capacity and limits their ability to plan for the future. The depth of their deprivation can be expressed by a few statistics. Whereas the average life expectancy at birth is about 72 years in the developed countries, it is

> about 55 years in the developing countries: in Africa and southern Asia it is only about 50 years. Whereas only between 10 and 20 out of every 1,000 infants born in the developed countries die during their first year, the infant mortality rate in most developing countries ranges from nearly 100 to more than 200 per 1,000. Whereas the death rate for children between 1 and 5 years old is only about 1 per 1,000 in most developed countries, it averages about 20 in many developing countries and more than 30 in Africa south of the Sahara. Of every 1,000 children born in poverty in the least developed countries, 200 die within a year, another 100 die before the age of 5 years, and only 500 survive to the age of 40 years."

The poor health status for most people in the developing countries is a main obstacle to development, because the status of health of an individual determines his or her productivity, earnings and thus living standards. Low health status and diseases affect physical and intellectual capabilities- which again are long-run determinants for productivity and earning capacity. With reference to Africa, Kimble (1960) eloquently summarized some of the intertwined relations as follows:

> "In the African social drama sickness has a strong claim to being arch-villain. It is bad enough that a man should be ignorant, for this cuts him off from the commerce of other man's minds. It is perhaps worse that a man should be poor for this condemns him to a life of stint and acheming, in which there is no time for dreams and no respite from weariness. But what surely is worst is that a man should be unwell, for this prevents his doing anything much about either his poverty or his ignorance."

The literature on African health problems has continued to grow since the publication of "Disease and Development in Tropical Africa" by Hughes and Hunter in 1970. But a surprising amount of research on African disease ecology has showed little or no evidence of having been informed by these two authors. Stock (1986) observed that development and underdevelopment are dimensions essentially absent from the research agenda. In some cases, this is a function of a highly-focused research design, or reflects the choice of an isolated study area. There are other examples, however, of too narrowly-conceived research designs, which have ignored integral relationships between underdevelopment and health hazards. Health and underdevelopment cannot be studied merely in relation to the environment and/or human behaviour, but must be situated in the correct historical, political economic context, which is the historical experience of capitalist expansion, and the articulation of capitalist and indigenous modes of production in most developing countries.

Navarro (1983) argued that health and diseases in developing countries can be seen to be rooted in imperialist and capitalist relations. It is these class relations and exploitation, of which the capitalist metropolis and the dominant classes on the one side and the impoverished population on the other, that result in underdevelopment, poverty, and disease of the majority of the world's population. The communicable diseases are, therefore, social problems. That is, they reflect the ability of dominant classes to define what is important and what is not (Gregory and Piche 1983).

In an article on the problems of health care in Khartoum/Omdurman, Sudan, Herbert and Hijazi (1984) wrote that there were significant variations in disease prevalence and the provision of basic public health and health care services. These variations predictably reflected levels of wealth, with the poorest areas having the most ill-health and the fewest health-related services. The authors explained that the ill-health they had described was a product of "underdevelopment and ultimately of an unequal distribution of resources and wealth".

Studies by Sandbach (1975) and Leisinger (1983) indicated that the highest prevalence usually occurred in rural areas where the population had no access to safe water and adequate sanitation. As a result, their health was inevitably poor. According to WHO figures, 1233 million people in the Third World (excluding China) had no adequate clean water in 1975. In many areas, many people today still have to walk long distances every day to collect water, so they use as little water as possible. In 1975, 1350 million people in the Third World had no adequate sanitation. In 1980, the figure stood at 1730 million. The percentage of the population covered by sanitation services in developing countries declined from 33 percent in 1975 to 25 percent in 1980 (WHO 1981). The lack of safe water and sanitation is the cause of 80 per cent of the world's diseases. It is estimated that 10 to 25 million people die from diseases caused by unclean or inadequate water, and by insanitary conditions per year, that is about 30,000 to 70,000 per day (Agarwal *et al.* 1985).

But in the developing countries, 85 per cent of health spending goes to curative care for 10 per cent of the people, while only 15 per cent goes to primary health care for 90 per cent of the people. Health programmes stress cure rather than prevention, and delivery systems are hospital-based, hi-tech and specialized medicine. They favour the needs of the relatively rich and relatively skilled urban minority at the expense of the relatively poor and unskilled rural majority (Aidoo 1982; Navarro 1983). In India, 80 per cent of the doctors practise in urban areas where only 20 per cent of the population reside (Lipton 1968).

It is important to see other additional information on political commitment, which is revealed if expenditures on health compared with those on military spending (see, Table 2-1). Military spending always seems to enjoy a higher priority than health. The low priority given to health has remained constant. For public health in developing countries, few governments have implemented

Table 2-1. Public Health, and Defence Expenditure of Selected Countries, 1978 (1975 Dollars)

	Health	Defense
Low-Income Countries	2	7
eg - Somalia	2	7
- Burma	1	5
- Mali	1	4
- Burundi	1	3
- Upper Volta	1	4
- Sri Lanka	5	2
- Tanzania	4	7

Source: World Development Report, 1981.

comprehensive programmes to combat ill health among their population. Public expenditures on health programmes are often limited and undertaken on an *ad hoc* basis without the benefit of detailed information on the extent of particular problems and the efficacy of the measures and administrative arrangements to achieve health objectives. Official expenditures on health seldom exceed 3 per cent of GDP. In a group of 72 countries for which such data are available, slightly over one half have per capita expenditures on health of less than $5 a year. The bulk of official outlays on health are often concentrated in urban areas and on expensive hospital facilities, while rural population usually have limited access to modern health services (Measham 1986; Stock 1986).

Rosen (1958) noted that the appalling inequalities in health conditions that existed throughout the world were directly and intimately connected with the fundamental problems of wealth and poverty. They usually not only suffer from poor health but also receive poor health care from a system offering very little in the way of health resources. Whereas these medical consequences of the uneven development of health care are readily interpreted within the underdevelopment paradigm, they are less easily accommodated within a developmentalist framework concerned about the side effects of development initiatives (Stock 1986).

Only recently have developmental economists begun to consider health services as an important area of overall development strategy in developing nations, the literature on the relationship of healthy policy to economic development is still sparse, and few plans have explicitly recognized the need for integrating the health system into the strategies for development. The consequences of these developments for the health of the underdeveloped world's population have not yet been studied in detail. Some professional health administrators and doctors continue to argue the need for integrated health and economic policies (Bryant 1969; King 1966; Worth and Shah 1969).

2.4. Current Economic Analysis of Health Problems

For exploring the relationship between water resources development projects and health problems, most attention is concentrated on the mechanisms of transmission of water-borne diseases or socio-political issues. Less work has been done to evaluate the impacts of diseases on economic development. Many authors have realized the need for the quantification of the health impacts of water resources development on the belief that such data would be very useful informing the decision makers the 'hidden costs' associated with health impacts. Such information is also useful in evaluating the cost-effectiveness of disease prevention or control programmes.

A recent study in Ghana has proposed a conceptual framework for quantifying the "healthy days of life lost" through illness, disability and death as a consequence of individual diseases (Ghana Health Assessment Project Team 1981). The method may be used as a tool to aid in the planning of a health care system and to decide the priorities for the allocation of resources to alternative procedures or programmes by calculating the amount of healthy days of life, which may be saved by different approaches and then relating these savings to the costs (Morrow 1984). But they stopped short of quantifying these healthy days of life lost in monetary terms, which is of more relevance to policy making.

Since the central issue in Third World development is to maximize the benefits from resources allocated to the health sector in a given expenditure, the choice between different activities should reflect a systematic comparison between the benefits they produce and the costs they create. The disease problems as described above are insufficient to determine priorities for health services. Priorities should be determined on the basis of procedures, which most reduce the burden of illness, disability and death for a given unit cost. That is to reduce the incidence rate, the case fatality rate, and/or the extent of disability and sickness. But, practically this approach has had little application in the health sector in any country. Without proceeding further to evaluate those effects, there is an unavoidable limitation and entailing policy responses and establishing priorities among different programmes in the allocation of limited resources (Creese 1985; Olivares 1986).

According to Kamarck (1976), Director of the World Bank's Economic Development Institute:

> "Governments and international development agencies had agreed that action against disease in the less developed countries is an important component of any programme to help economic development. A number of expenditures were initiated, but only a beginning, Practically nothing has been done in the way of systematic economic analysis of the various specific obstacles to economic development posed by disease, and of the economic and social costs and benefits of projects to remove them. Without this basic information, it is impossible for a government or aid agency to allocate investment optimally between disease control as such and other more conventional investment projects. In the meantime, it is highly improbable that the existing distribution of resources is anywhere near optimal."

In principle, the benefits of different types of health improvement, such as prevention and control programmes, should be conceived in terms of their contribution to the objective of improving health status, although little has been done to try to quantify it (Ghana Health Assessment Project Team 1979). But it is deserved to be noticed that improved health prevention and disease control programmes may help to raise aggregate output by increasing the effective supply of labour. Reduced death rates increase the number of potential labourers. Reduced disability (sufficient to prevent work) increases the potential number of working days per labourer. Reduced illness (sufficient to impair efficiency at work) increases the potential efficiency of working days per labourer (Prescott 1979). Kitron (1989) claimed that control of tropical diseases can demonstrate a more cost-effective use of resources, even though they may appear expensive, especially, during the initial stages. Taylor (1970) also asserted that every individual in a community could benefit from any action which a person takes to reduce his or her own likelihood of an infectious disease. A reduction in the incidence of an infectious disease, thus, creates benefits to those directly saved from the disease.

A number of other studies have examined labour force participation behaviour and have either explicitly or implicitly recognized the importance of health status (Rice

1966; Bowen and Finegan 1969; Berkowitz and Johnson 1971). They provided estimates of the aggregate losses of earnings due to various diseases through both morbidity and mortality.

According to data in conjunction with the substantial assumption, the elimination of mortality due to schistosomiasis would have increased the expectancy of life at birth of Zanzibar males in 1960 by approximately 1.8 years, and would have extended the life of the average male in Zanzibar in 1960 by 2.3 years (Cohen 1974). Farooq (1963) assumed that when individuals were sick, infected with Schistoma *japonicum*, they lost 25 per cent of their working capacity. He estimated an equivalent of 5.4 days of total disability per person infected with S. *japonicum* in the Philippines.

A study by Luft (1975) indicated that an average disabled man aged 18 to 64 years would suffer a 37 per cent reduction in yearly earnings. It was estimated in an unpublished paper that an individual with schistosomiasis *hematobium* in Egypt "would lose from 4 to 20 per cent of his energy and working power" (Watson 1959). In China, it was reported that "on the average, the disease causes a 40 percent loss in the patient's capacity to work" (Yang 1960). In Jiashan County, China, it was noted that in 1949 when the People's Republic was founded, 76 per cent of those infected "were unable to work" (China's Medicine 1968). A major study of the effects of schistosomiasis in St. Lucia showed that banana plantation workers suffering from schistosomiasis had lower daily earnings (Barlow 1977). These health effects pose a major obstacle to development in endemic areas, principally because of the impact on labour's output (Goldsmith and Hildyard 1984).

Adversely, improved health status can increase labour's output. From the study by Steven (1977), it indicated that reduction of malaria in a Malaysian rubber estate caused output per worker to rise 17-fold. A research by Conly (1975) on the impact of malaria upon agricultural output, measured before and after an eradication programme, showed that malaria could, in fact, result in a substantial reduction in output, and the lost output could be saved from its eradication. In a study of the impact of Schistosome *mansoni* infection, Fenwick and Figenschon (1972) found that an infected group of workers, when treated, recovered from their output decreases.

Although a number of studies have asserted dramatic costs of disease and benefits of improved health in developing countries, the lack of hard evidence has limited scientific use (Weisbrod *et al.* 1973). Grosse and Harkavy (1980) argued that in spite of the fact that the development and health literature contained a variety of such plausible speculations as to the beneficial effects of improved levels of health on output, there was little rigorous empirical evidence. Muller (1976) also contended that there was little, if any, systematic information concerning the effects of diseases on output in the traditional agricultural sector in which the major share of the labour force of the developing countries is employed. The specifics of diseases in a given area have inhibited the development of generalizations about the direct impacts of health on total output. Health workers are faced with the difficult task of estimating the economic benefits of improved health.

In general, there is one major weakness in their analyses. That is, little work has been done to quantitatively evaluate the losses from health impacts incurred to local residents. Previous studies on this subject were also characterized by a narrow conceptualization of the economic and social factors representing consequences of outcomes; and by a lack of consideration of the gross or net impact on the ill, disabled and deceased individuals and the whole community (Popkin 1982). It is obvious that a quantitative analysis of the health effects on local residents affected by water resources projects is desirable. Its results can be used to attain a better understanding of the social and economic costs of diseases, or more appropriately, the nature of the benefits which will accrue to the individuals, as well as to the communities, when human health can be improved by eliminating or mitigating the effects of these diseases.

CHAPTER 3. THE DISEASE OF SCHISTOSOMIASIS

3.1. The Transmission of Schistosomiasis

Schistosomiasis is one of the most wide-spread parasitic infections on the human. It can be expected in almost all water resources development projects in the tropic and subtropic countries, as these types of projects provide new habitats for the snails that are the intermediate hosts of the schistosomiasis (Derban 1984; Learmouth 1988). They may have done as much in the past decade to spread schistosomiasis infection around the world than any other human action (Canter 1969; Carley 1970).

In 1947, there was about 114 million cases of schistosomiasis worldwide. It was estimated that approximately 12.5 million persons were infected in 1972 in 71 countries, among them 9.1 million in Africa, 0.2 million in South-West Asia, 2.5 million in South-East Asia, and 0.6 million in the Americas (Wright 1972). By 1977, schistosomiasis affected the health of 200 million people in Asia, Africa, the Caribbean and Latin America (Obeng 1977).

Shown in Figure 3-1 is a world map of the several forms of schistosomiasis (Ree 1977; Well and Kuale 1985). Schistosome *mansoni* is found in Africa and the Arabian Peninsula, Brazil, Surinam and Venezuela in South America and in some Caribbean islands. Schistosome *haematobium* is

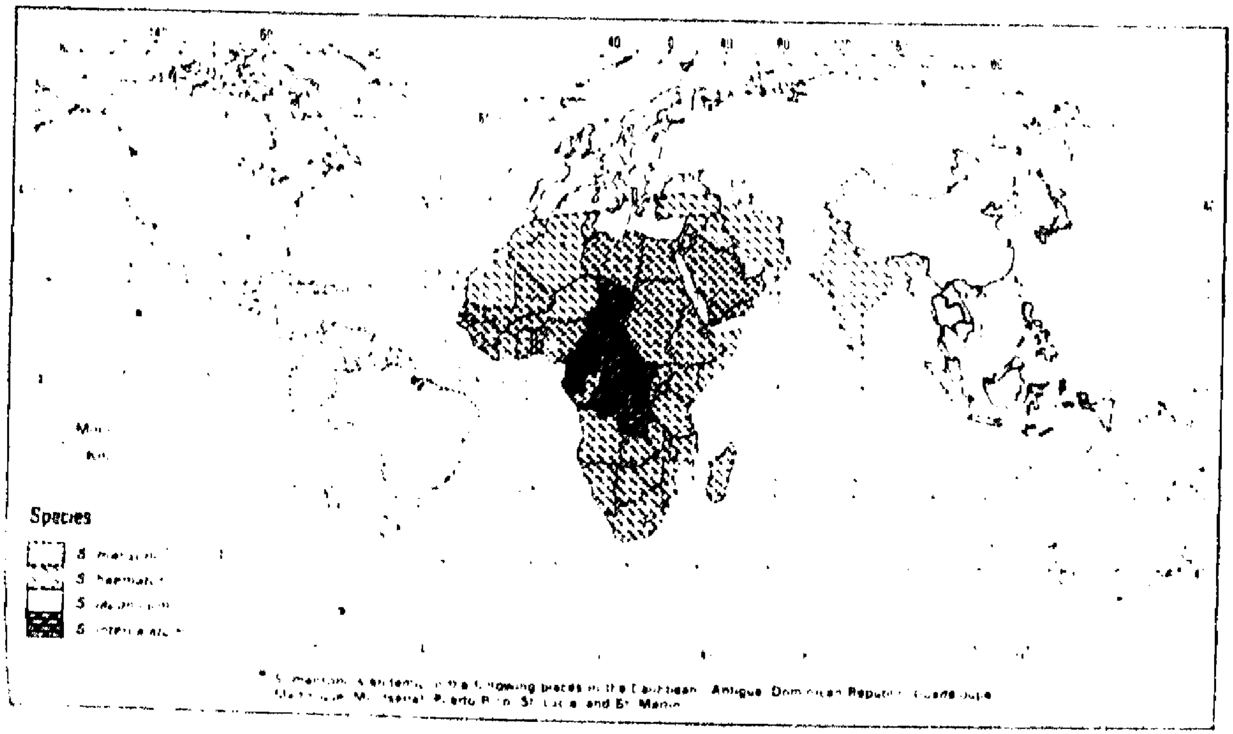

Figure 3-1. World map of the three important forms of schistosomiasis (Ree 1977; Weil and Kuale 1985).

found in Africa and the Middle East. Schistosome *japonicum* is found in China, Japan, Philippines and Sulawesi. Schistosome *mekongi* is found in the Mekong River area of Laos and Kampuchea and in Thailand. Schistosome *intercalatum* occurs in parts of west Africa, including Cameroon, Central African Republic, Chad, Gabon and Zaire (Benenson 1985).

The construction of water projects has facilitated the dramatic spread of schistosomiasis in regions where it was not found earlier. Irrigation canals and artificial lakes usually provide a suitable shallow water habitat for the snails and their parasite, often made ideal by extensive growths of floating aquatic plants. As human population tend to increase and concentrate along the shorelines, the growing untreated sewage produced by villages and discharged into reservoirs will provide nutrients for floating plants, organic material for the snails, and a vehicle for the schistosome to complete its life cycle (Barbosa and Oliver 1958; Agarwal et *al*. 1985).

There is little doubt that it is water which transmits many epidemic diseases serving both as a transfer medium and as a favourable habitat for diseases. If no precautions were to be taken, it could rationally be expected that schistosomiasis might be freely transmitted along the lake border, and that this might become an extremely important centre for its distribution. In tropical or subtropical countries where schistosomiasis existed at a relatively modest prevalence of, say, 10-15 percent of the population, and with a correspondingly low intensity of infection, it is common to see prevalence grow quickly to 80-90 percent after a water development project (Worthington 1977).

The risks are particularly exacerbated by the fact that a large proportion of local people or newly arrived fishermen, if they did not suffer from it previously, are bound to become heavily infected (Waddy 1975). In the case of Egypt, the building of the Aswan Low Dam caused the incidence rate of schistosomiasis amongst the population in some areas to rise from 21 to 75 per cent. Once the Aswan High Dam had been completed, the incidence of the disease increased still further. In some communities, it reached an estimated infection rate of 100 per cent (Lanoix 1958).

In Kainji Lake, the snail intermediate hosts of both Schistosome *haematobium* and Schistosome *mansoni* were in evidence, and transmission of the parasites in settled areas was taking place. After 2 years of the closure of the dam, the prevalence rates of the two schistosome infections in 1970 being 31 and 1.8 per cent, these observations were only established when the snails were still confined to scattered foci. Elsewhere the story is the same. In the Volta Lake, the increase in schistosomiasis was also one of the most serious side-effects of the development (Johnson 1971; Obeng 1975).

Schistosomiasis can spread very easily. Its worms develop in a complicated life cycle involving an aquatic snail intermediate host, the human definitive host, and their mutual presence in a common environment where transmission occurs. As indicated in the cycle of transmission (Figure 3-2), the miracidium needs the snail host for the continuation of its life cycle. Once infected by a miracidium, the snail can shed several hundred thousand cercariae (larvae) within a six-month period, which are then dispersed by wind action on the lake's surface. Unbroken human skin is readily penetrable by the cercariae, and children are normally infected first because of their greater contact with water. The cercariae travel to the heart, lungs, and liver, and then mature, mate, and produce eggs. On the other hand, the human host retains some eggs in body tissue, resulting in a reaction and pathological changes. Other eggs are released in urine. With poor sanitary conditions and/or direct urination into the lake, the eggs re-enter the lake, where they immediately hatch into miracidia and repeat the cycle (Benenson 1985; Jordan 1975).

A water project usually results in an increase in permanent habitats for the intermediate snail host, such as, misuse of water; poor maintenance of the hydraulic system; canals with stagnant water; and non-operating drains, invaded by weeds and forming marshes. In addition, it brings

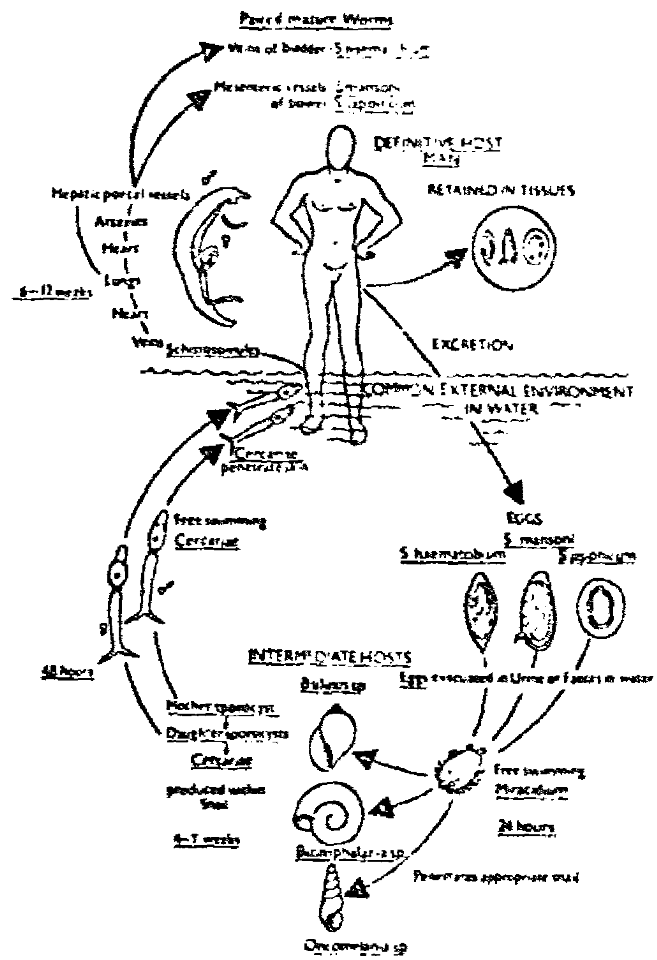

Figure 3-2. The Life Cycle of Schistosomiasis (Homans 1945)

a greater number of people in contact with infected water. For example, farm work and fisheries require frequent contact with water; concentration of people in new settlements encourages people to use the same infectod contact sites for bathing, clothes washing, drinking water and other domestic purposes, thus maintaining the continued transmission of the parasite (Davey and Lightbody 1956; Sandbach 1975; Worthington 1977; Goldman 1979; Learmouth 1988). In Epe of West Nigeria, 90 per cent of school children were infected, presumably from use of lagoon for washing, laundering and swimming (Okpala 1961). The research by Taylor and his colleagues (1987) in a rural community in Zimbabwe showed that water courses posed a threat of schistosomiasis transmission made up 70.8 per cent of sites, where washing activities took place.

Chu *et al*. (1981) observed that water resources development projects increased the water-loving habitats of the people living alongside the lake. The intensity of water contact was high for lakeside residents, not only because the villagers were mainly fisherfolk, but also because the lake was attractive as a water source. Additionally, children often used the open beaches for swimming and playing during hot season. With such intensive water contact in villages, a correlation between snail infection rates and the epidemiological index of the disease in the villages would be expected. Listed in Table 3-1 are human activities associated with artificial lakes that can lead to possible schistosomiasis exposure.

The symptoms of schistosomiasis include abdominal pains, weight loss, headache, lassitude, chills, fever, coughing, painful liver, blisters on the skin and blood in the faeces and urine. The infection, especially in chronic cases, usually causes weakness, anaemia, bloody urine or stools, diarrhoea, and painful micturition. These are generally debilitating- refers to a health impairment that

Table 3-1. Human Activities Resulting in Possible Exposure to Schistosomiasis in Artificial Lakes (Rosenfield 1979)

Human Activities	Human-Snail Habitat Contact Points
Fishing in Boats	Entering or leaving boat; putting hands in water while in boats
Transportation (boating, fording)	Entering or leaving boat; crossing stream
Washing (personal, laundry, dishes)	Lakeshore sites, lagoons, streams
Recreation (swimming)	Lakeshore sites, lagoons, streams
Obtaining drinking water	Lakeshore sites, lagoons, streams
Waste disposal (personal, garbage)	Lakeshore sites, lagoons, streams
Watering domestic animals	Lakeshore sites, lagoons, streams

prohibits or restricts gainful activity or paid employment). A person may develop cirrhosis of the liver, cancer of the bladder, central nervous system disorders and kidney infections. The victim can rarely put in more than three hours' work a day (Jordan and Webbe, 1969; Sterling, 1972). A study also showed serious physiological impacts among the Sudanese, whose blood haemoglobin levels had been reduced to such an extent that oxygen flow to the muscles and brain was limited (Karim and Collins 1978).

Reports have indicated that up to 12 percent of the people died of schistosomiasis in hospitals in parts of South America. In some regions of Tanzania, around 20 percent of people have what in Western countries would be considered serious damage to the urinary tract and a proportion of these would be expected to live only a few years. These changes, in Tanzania, Zanzibar, Nigeria and Egypt, are seen commonly in children and would be expected to produce their most serious results in adolescent and early adult life (Macdonald and Farooq, 1973).

In the early of 1960s, Farooq (1963) has divided the disease into mild, moderate, severe and very severe forms, the assumed loss of working capacity are also shown in each of the four classifications:

Class I. Mild: occasional abdominal pain, occasional diarrhoea or dysentery; no absence from work. About 25 per cent of working capacity will be lost in this category;

Class II. Moderate: anaemia or weakness; reduced capacity for work. The assumed loss of working capacity is 50 per cent.

Class III. Severe: recurring attacks of diarrhoea and dysentery; frequent absence from work. 75 per cent of working capacity is assumed to be lost.

Class IV. Very severe: ascites and emaciation; total absence from work. 100 per cent of working capacity will be lost in this situation.

Recently, the Ghana Health Assessment Team (1981) has demonstrated that an increased disease on local population within a water project area can increase the health effects of illness, disability, and death. These effects reduce the 'days of healthy life' of the affected population, thus reducing their potential output.

3.2. Medical Treatment

For those people who are infected with schistosomiasis in a community can be treated immediately with one of the recommended drugs which are most frequently used, as shown in Table 3-2 (also see, Davis *et al.* 1979; Ishizaki *et al.* 1979; Katz *et al.* 1979; Santos *et al.* 1979).

Table 3-2. Recommended Treatment of Schistosomiasis (Mott 1984)

Schistosome species	Drug to be used	Dosage per kg body weight
All species	Praziquantel-tablet 600 mg	40 mg, single dose
S. *haematobium*	Metrifonate-tablet 100 mg	7.5 mg, 3 doses (1 every 2 weeks)
S. *mansoni*	Oxamniquine-capsule 250 mg	15-60 mg, single dose

But practically, mass medical treatment by drugs in the developing countries is not yet feasible. They are expensive and have unpleasant side effects. Meanwhile, medical supervision is required. In most countries, routine treatment of schistosomiasis is conducted at dispensary or hospital level. In particular, treatment may be prohibitingly expensive where the possibility of re-infection is high. It tends to be reserved either for members of the elite groups or for the broader population in areas where snail control programmes can be carried out simultaneously. If nothing is done to prevent transmission, drugs will be useless in condition where the affected population are going to be re-infected soon after the treatment (Iarotski and Davis 1981; Muller 1976).

Delegates to an international conference in Cairo noted that "available drugs are not ideal with regard to efficacy, ease of administration and safety". Optimum strategies for treating infected communities are currently lacking. So a more intensive search for new anti-schistosomiasis drugs has been recommended. Additionally, promising advances towards vaccine development have been reported, but immunisation against schistosomiasis is still only a distant possibility (Cline 1989).

3.3. Prevention and Control Methods

For controlling the disease of schistosomiasis, many different methods have been used around the world. The common techniques and strategies to control schistosomiasis involve chemotherapy, molluscicides, insecticides, snail control (chemical, biological and environmental), the participation of local population, health education, and provision of safe water supplies and latrines. Among them, the long-scale use of chemotherapy may bring about a dramatic reduction in transmission as well as a reduction in prevalence and incidence in the human population. But in some endemic areas, the intensity of transmission is constant all the year round. At such a high level that without a campaign against the snails, chemotherapy may have no lasting effect on prevalence. Its application alone rarely succeeds in permanently interrupting transmission (Mott 1984).

Although molluscicide is another good method of breaking the disease cycle, it is used sparingly. Its usage is limited by expensive cost and adverse side effects-resistance to snails, as well as its requirement for long-term commitment which it is beyond the means of most developing countries where the disease is endemic (Jelnes 1977). Therefore, It has been recommended to be used in conjunction with other measures (Obeng 1977).

Changes in farming practices can also be of vital importance. An obvious example is a switch from paddy cultivation to intermittent irrigation which incidentally removed a large snail habitat. New canals or irrigation systems, if properly designed and maintained, are easier to keep snail free than old marshes. An interesting project was implemented on Leyte Island in the Philippines to drain marshes and improve the irrigation in important rice growing areas. Particular attention should be given to the construction of channels, which may deny snails habitat and consequently reduce the incidence of schistosomiasis (Muller 1976).

To facilitate disease control in medically under-served rural areas, in 1978, the Alma-Ata Conference on Primary Health Care of WHO/UNICEF recommended that overall disease control become one of the essential elements of primary health care, and should be integrated into primary health care strategy. In addition to the technical usages, such as chemotherapy and molluscicides, those measures that might permanently halt human contact with snails should be stressed. Additionally, the improvement of domestic water supplies, waste disposal and treatment facilities, improved housing, alternative employment possibilities, and health education are also important. These measures, often considered as economic development investments, have the secondary effect of controlling schistosomiasis (Rosenfield 1979).

The construction and utilization of latrines and of appropriate waste disposal protects the environment against contamination, and at the same time hinders the transmission of diseases. Provision of safe water supplies can inhibit transmission of numerous diseases through drinking polluted water and also avoids the skin penetration of schistosomes (Jordan *et al.* 1982; Lagler 1969). Research from St. Lucia reported that the provision of piped water, public washing facilities and modest swimming pools in rural villages had a dramatic impact on the incidence of the disease (Jordan *et al.* 1982).

Basic health education has been realized to be the key to improved community hygiene. Without establishing broad contact with the population through mass education in public health, little may be expected from a programme of disease prevention and control. The primary health care worker can tell people about the part they play in the transmission of schistosomiasis, about the long-term effects that the disease could have on their health, and what they should do to eliminate the disease. The people should be educated how to use and maintain the water sites, washing facilities and latrines; to improve the domestic management of water; and to change nutritional habits. They should learn the danger signs of infection, circumstances and contact points, and how to avoid them (Mott 1984). These can be conducted through various media- radio broadcasts, posters, movies, exhibits, lantern slides, and dramatic performances. Public awareness of the serious implications of the disease and popular community participation in strategies to combat the disease, are believed to be pre-requisites for successful plans to relieve human of schistosomiasis (Obeng 1977; Buck 1989). All schistosomiasis control programmes should aim to inform, motivate, train, and encourage the community and its leaders to play a part in improving their own health.

3.4. Integrated Approach

Owing to the usual difficulties of controlling schistosomiasis and no single method alone is efficient against the disease, integrated schistosomiasis control is increasingly recommended. Nearly 50 per cent of endemic countries around the world use more than three different methods simultaneously to control schistosomiasis.

The national programmes in Brazil, Egypt, Iran, Japan, Puerto Rico, and Venezuela provide examples of the combined approaches. These programmes include: 1) chemotherapy of patients; 2) mollusciciding; 3) environmental and sanitary improvements; and 4) health education. In Puerto Rico, biological control of snails is also used. The first two methods form the basis for integrated control of the disease and considerable success can be achieved using just these techniques. In Egypt, molluscicides used in combination with drug therapy in the oasis region of Fayum have reduced the prevalence of infection among the 1 million people of this area from 45.7 per cent in 1968 to 8.1 per cent in 1975 (Mobarak 1978).

Many researchers convinced that the long term maintenance of schistosomiasis control should also be based on improvements in basic living conditions and education as well as improved access to health care for people in endemic areas. In particular, improved water supplies, better sanitary facilities, changes in human behavior, as well as improved irrigation design and drainage canals can have a significant impact on schistosomiasis control (Macdonald 1965). Whenever possible, the three interdependent components, safe water, waste disposal systems, and programmes of health education at the community level, should particularly be developed together (Jordan *et al.* 1982; Lagler 1969). The overall prevention and control programmes should be integrated into both large-scale control operations and the primary health care system.

When all methods of control are not feasible or affordable, appropriate control measures must be selected for each endemic population based on local characteristics of transmission, available resources, and other health priorities. A specifically designed strategy is needed, whether for prevention, reduction of prevalence, or complete interruption of transmission. These strategies must be based on epidemiologic investigations in carefully selected and statistically appropriate population samples to determine cause distribution, prevalence or incidence, dynamics, and severity of disease in the community. Because monitoring is an integral part of the planning process, objective and continuous evaluation of a control project are essential (Buck 1989).

In all water development projects, it is desirable that early advice be taken and, wherever possible, prevention measures be built into each project (Lagler 1969). These measures should be taken in the design, maintenance, and operation phases of a project to prevent or reduce health impacts (Hayes 1976; Biswas 1980). It has been widely realized that well designed interdisciplinary studies involving anthropologists, geographers, sociologists and other social scientists can facilitate the selection of appropriate control strategies and contribute to the long-range success of control programmes.

CHAPTER 4. METHODOLOGIES

4.1. Theoretical Issues

A water resources development project can change the health status of local people by increasing the incidence and prevalence rates of diseases, which, in turn, affect the physical capacity, time allocation, work intensity, and general activity levels of the individuals. As a result, a decline in output and income is expected for the affected population (see, Bowen and Finegan 1969; Berkowitz and Johnson 1971; Creese 1985; Popkin 1982; Weisbrod et *al*. 1973).

For a long time, economists have attempted to attach monetary value to human life in evaluating health programmes by the use of the popular technique of cost-benefit analysis, focusing on national and regional levels, as a tool to assist decision-makers (see, for example, Dublin and Lotka 1946). The concept of valuation of life, generally used to estimate the benefits of disease prevention or reduction, is the "human capital approach". This approach views a human being as a productive asset, who can generate output and income through future years. Any health projects, which generate benefits outweighing or offsetting its costs, are worth undertaking. The human capital approach has been widely used as a standard procedure in cost-benefit analysis to measure the benefits of health programmes (Vinni 1983; Weisbrod 1968).

The Ghana Health Assessment Team (1981) has recently assumed that the health effects of an increased disease on local population have three components: 1) illness; 2) disability; and 3) death. The increases in illness, disability and death reduce the "days of healthy life" of the affected population, thus reducing their output. The foregone output is assumed to equate the aggregate lost "days of healthy life", which has been successfully applied to 48 commonly reported diseases in Ghana. Olivares (1986) recently proposed that, if the estimated number of healthy days of life lost is multiplied by the average output of labour, or by the market wage rate, the value of output lost through increased disease burden or the salaries foregone can be computed or added to the project costs, and, therefore, included in the assessment of the project's economic worth. Further, the cost-effectiveness of various health improvement programmes (HIPs), can be measured and compared using the criterion of forgone output that can be saved as a result of the application of the procedures. This constitutes an important motivation for the development of techniques of quantitative assessment, stemming from the need for a measure of cost-effectiveness that can be used to establish priorities towards the local population who are affected by water resources development projects.

From a water resources project, local population may suffer the direct "objective" costs from health effects. First, lost output due to decreased efficiency during work; and lost output due to the extinguishment of working lives. Second, resources, such as inputs of medical, administrative and human resources, etc., would have been used to prevent the healthy from getting illness, disability and death (Prescott 1979; Weisbrod *et al*. 1973). In reality, it turns out that these economic burdens of diseases is by far the biggest component of output forgone for local communities. In addition, diseases also precipitate emotional costs to the individuals, and their families and friends.

It is, of course, in the interest of society to minimize the costs of ill health, disability, and death. Various health programmes can generate direct "objective" benefits for the communities from the saved costs. However, in practice, this human capital approach has drawn some criticism over the exact procedure to use in calculating benefits from the reduction in mortality and disability (see, for example, Titmuss 1971; Mishan 1971; and Jones-Lee 1976). First, it is argued that saving a life usually directly benefits the person who is saved. The person may contribute to the economy's output during his or her extra years of life, and so benefit the rest of us. But this has to be set against the demands he or she makes on the world's resources from his or her own consumption. Since life saving uses up resources, people on the whole will be worse off in the region where lives are saved. Second, In using this approach, one is primarily interested in the net gains for the target population of health project. It may lead to rejecting all health programmes toward children, the poor and the old. It can be seen that the approach involves a narrow concept of health status, concentrating, as it does, on the work-related physical capacity component rather than social and mental aspects of well-being (Creese 1985). Wiseman (1963) has made it clear that those with the most favourable cost-benefit ratios would be permitted to eat those whose contribution to growth was negative- that is, the old, the poor and perhaps some of the children. Third, this approach is primarily interested in the net gains for the target population of a health programme, in many cases, a health project has also external or indirect effects. For example, a person who directly benefit from a health programme, but also indirectly benefit other persons who care about him or her.

In response to the above mentioned problems in the application of human capital approach, however, several points are worth raising. First, the main interest of this study is the effects of a disease on the local population, instead of the national population as a whole. The rationale is that, while water resources development projects are built to benefit the nation as whole, the local communities are usually harmed and impoverished as a result of the outbreak of water-borne diseases. Using the national economy as the accounting stance, as it does in the use of mainstream cost-benefit analysis, often tends to fail to inform policy-makers about the environmental and human costs imposed on local population.

Second, the contribution of children, the poor and the old to net output may be negative and have no immediate economic benefits. Yet, society may attach a certain value to the so-called unproductive for a variety of reasons. For the children, they can be assumed to grow into productive labour, and can thus make a contribution of output to their communities in the future as everyone else does. If they die or are disabled by a particular disease, the entire potential productive life and future earnings will be lost. So it is reasonable to assume that a child's disability or death has the same effect to the society as the adults (Barnum 1987; Basch 1990).

Even if a person doesn't directly participate in the labour force, such as a spouse. But from a household point of view, they are still a part of the working unit. For example, in fishing community in Newfoundland, Canada, although women do not directly go out fishing, they are an integral part of family-based household output for fish processing, like salted, sun-dried, which required group effort and considerable time expenditure. Although these women do not get paid for their labour, their fish processing efforts account for up to forty percent of the earning power of the family unit (Antler 1982). If a husband or wife loses the spouse, he or she may lose the support from the spouse to share household work for efficient output and additional income contribution and suffer the bitterness of losing a family member.

One may argue that poor or elderly people shouldn't be saved, and that the resources, which are used to save them, could be used and benefit other productive people. This is equal to saying that let all of these people die, because they have less productive capacity. But, one may miss the fact that the meaning of life is existence. From development and moral points of view, all of the people, no matter who they are and how much output they can produce, are an existence in society. Society has to keep them alive. An individual may value a health improvement because the likelihood of occurrence of an undesirable effect to himself or herself, or anyone who cares about. In essence, human beings are averse to the consequences of the death of other people and to death *per se*. As Taylor (1970) contended:

> "As for the widespread acceptance of the idea that nothing should be spared in the effort to save a life that is in danger, I believe it represents a kind of tacit "insurance agreement"

> among us all. It is not so much that we gain a lot if the lifesaving attempts are successful on somebody else, but rather the possibility that we might be in a similar situation some day in the future. If we are, we want everything possible done for us. The way to ensure that this all the case is to make it a basic rule of our society."

Further, the total value of a health programme for poor people may include the value attached to it by the rich as well as by the poor people themselves. The rich may attach value to the consumption of health services by the poor for a number of reasons. First, providing medical care to those who cannot afford it may satisfy a sense of moral obligation of the rich. Second, improving the health of the poor may increase their earning ability, thus, reducing the burden of welfare on the rich. Third, reducing illness among the poor may make the society a better place for the rich to live in. Finally, the provision of medical care with other anti-poverty efforts may lessen the possibility of riots and revolution that could threaten the property, patterns of living, and lives of the rich. Because of such indirect benefits, the value that the rich attach to health programmes toward the local population may be substantial. The total value may well exceed the cost. Therefore, measuring value by the dollar worth to people by no means implies that all health programmes for the redistribution well-being toward the poor are worth less than their cost (Taylor 1970). Thus, it is possible that society wants to incorporate distributional objectives into the cost-benefit analysis (Carrin 1984). It is true that almost all projects will harm some individuals as well as benefiting others. In other words, a specific project is not characterized merely by some total benefits but by a distribution of costs and benefits across the individuals of a society. Further, it is now commonly accepted in our society that government in a country should ensure that everyone is provided with the basic needs of life, including medical care. Even further, medical care has become one of the major weapons employed in the attack on a country's poverty. Thus, the government of a country is sponsoring care to the poor not simply for its own sake but as part of the campaign to reduce the health problems which are the incidence of poverty, and its effects on the rest of society.

Finally, there is the argument that "Good health is worth as much as people are willing to pay for it" (Taylor 1970). People seek medical care for many reasons. They may include: 1) to reduce pain and suffering for enjoying life; 2) to reduce fear and anxiety about the seriousness of diseases; 3) to hasten recovery from illness; 4) to improve appearance; 5) to reduce risk of future disability; 6) to reduce of time lost from work for hospital visits; and 7) to prolong life (Jones-Lee 1976; Carrin 1984). These reasons of seeking care promise no monetary gain- the cost of care may exceed any gain in the present value of future income. When these "subjective" costs can be avoided from a health programme, the "subjective" benefits can be generated. Although output gain and cost saving constitute an appromixation to the direct "objective" benefits. The "subjective" benefits are also a very significant component for the local communities and society. Although the quantification of these benefits proves to be extremely difficult and they are usually left out of cost-benefit calculations, it is important for us to acknowledge their real existence.

4.2. Hypotheses

A number of hypotheses concerning the health effects of water resources development projects will be tested in this study. It is hypothesized, first that the construction of water resources projects will cause the ecological and social changes in the project region, which result in increased incidence or prevalence of endemic water-borne diseases to local population. Second, without health programme for disease prevention or eradication, the increased incidence of diseases increases the rates of illness, disability and death, which will result in losses to the local population in terms of forgone output. Finally, disease prevention and control programmes for water-borne diseases from water resources development projects are cost-effective in preventing and reducing those socio-economic losses. Some of the hypotheses may be subject to quantitative testing. Others may only be testable on a qualitative basis. These qualitative hypotheses are included, for they are essential to the integrity of analytical framework and reference for decision making.

4.3. Calculation of Number of People Affected

The number of people affected by a particular disease can be calculated as the population size in a particular year in the geographical boundary multiplied by the incidence rate of that disease in that year. The mathematical formula is as follows:

$$N_t = P_t \times I_t$$

where, N_t = number of people affected by the disease in year t (t = 1, 2, ..., n) after the project;

t = 1 represents the year when the lake was formed;

t = n represents the present year

P_t = population size in year t in the geographical boundary; and

I_t = incidence rate of the disease in year t.

4.4. Calculation of Illness, Disability and Death

The number of people affected by a particular consequence (illness, disability and death) of a particular disease in a particular year can be calculated as the number of people affected by the disease multiplied by the percentage of the particular consequence. It can be calculated from the following formula, which comes from the formula developed by Ghana Health Assessment Team (1981):

$$N_{t,j} = N_t \times R_j$$

where, $N_{t,j}$ = number of people affected by consequence j (j = 1, 2, and 3, representing illness, disability and death) from the disease in year t; and

R_j = percentage of consequence j.

4.5. Calculation of Lost Days of Healthy Life

In calculating the lost days of healthy life for 48 commonly reported diseases in Ghana, Ghana Health Assessment Project Team (1981) used the following formula:

$$L = (C/100) \times [E(A_o) - (A_d - A_o)] \times 365.25$$

:premature deaths

$+ (C/100) \times (A_d - A_o) \times (D_{od}/100) \times 365.25$

:disability before death

$+ (Q/100) \times E(A_o) \times (D/100) \times 365.25$

:chronic disability

$+ [(10-C-Q)/100] \times t$

:acute illness

Where, L = the average number of lost days of healthy life to the communities by each patient with the disease;

A_o = average age at onset;

A_d = average age at death of those who die of the disease;

$E(A_o)$ = expectation of life (in years) at age of A_o;

C = case fatality rate (expressed as percent);

D_{od} = percent disablement in the period from onset to death among those who die;

Q = percent of those affected by the disease who do not die of the disease but are permanently disabled;

D = percent disablement of those permanently disabled;

t = average period of temporary disablement (days) among those who are affected but neither die nor are permanently disabled, multiplied by the proportion disablement of those temporarily disabled.

The quantitative assessment is derived from an essential accounting approach that uses estimates of incidence rate, case fatality rate, average ages at onset and death from the disease and expectations of life at these ages, and extent and duration of disability and illness to calculate the number of healthy days lost from the disease. Their data are from a variety of sources, including: the National Census- age, sex, and region-specific death rate estimates from a special sample of the census (Gaisie 1976); cause of death from death certificates (available on about 12 per cent of all deaths in Ghana- mostly deaths in hospitals and therefore a biased but useful sample); in-patient and out-patient statistics; special surveys and published studies; and interviews with experienced clinicians. By the use of these estimates, it was possible to approximate the amount of healthy life lost through illness, disability and death as a consequence of each disease (Morrow 1984).

4.6. Gross Forgone Output

The gross forgone output of the population as a whole from a particular consequence of a particular disease in a particular year can be computed as the total lost days of healthy life multiplied by average forgone output for each lost day of healthy life (see, Olivares 1986). The following mathematical expression is used:

$$Q_{t,j} = L \times H_j$$

where, $Q_{t,j}$ = gross forgone output of the population as a whole from consequence j of the disease in year t;

L = average number of lost days of healthy life from the disease; and

H_j = average forgone output for each lost day of healthy life, which is represented by GNP per capita divided by 365 days.

It is worth mentioning that in this study, I will use gross, instead of net output. Because, for a country like Ghana, it is possible that net output will be equal to or less than consumption. If we use net output, the benefit from health programme is zero or negative, which may mean that nothing should be done to improve their health status. As has been discussed earlier, this is neither practical or desirable from a societal point of view.

A further consideration is that, if people are sick or disabled, their future consumption will not be extinguished, they will keep consuming resources. Other members of society are imposed with the burden of sharing the remaining total output with these persons in order to meet his or her consumption requirements (Prescott, Prost and Berre 1984). Thus, without medical care, society will lose more. In the case of death, although the victim's future consumption is extinguished, nobody can grantee if his or her present value of lost output exceeds the present value of extinguished consumption. Especially from a long-term perspective, an individual's lifetime consumption discounted in some appropriate way to a present value may be less than the present value of his contribution to national output. That is, the individual may make a net contribution to output. If it is the case, the local communities and society suffer a net loss of output. Since the individual concerned is "still alive". As he or she is alive and able to enjoy that consumption, the individual's consumption should not be deducted when assessing the benefits of preventing or controlling diseases. This view is coherent with the aim of GNP maximisation. This means that the value of life is the same as lifetime earnings (see, for example, Dawson 1971; Taylor 1970).

4.7. Discount Rate

It is evident that any projects may have future benefits and future costs. Economic value of a healthy life can be described in terms of present and future earning power. When dealing with such calculations involving a long time span, economists always consider both the present and discounted monetary values (Barnum 1987).

In making present-worth calculations, it is difficult to choose the most appropriate discount rate. Health economists have often used several parameters to indicate the sensitivity of results to the choice of the discount rate (Weisbrod 1968). For the purpose of comparison of the discount result here, however, three different discount rates (4%, 6% and 8%) are used. Then, the current value of total forgone output over the years since the project was constructed can be computed as follows:

$$TFP=\sum_{t=1}^{n} TFP_t(1+r)^{t}$$

TFP_t = current total value of gross forgone output as a result of health effects in the region affected by the project since it was constructed.

TFP = Total value of gross forgone output at 1989 US dollars.

r = Discount rate.

4.8. Selection of Case Study and Disease

The Volta Lake of Ghana is chosen as the case study of this research. This selection is based on the following reasons. First, the Volta Project provides a typical example of large-scale water resources development and resultant health problems. Second, a large amount of data is readily available with regard to the health effects of the lake on a before and after basis. Finally, socio-economic data of Ghana are also abundant.

Schistosomiasis, which is the most serious health hazard associated with the Volta River Project, and can be expected from water resources project in the tropical and subtropical regions, will be used to test applicability of the framework of this study.

4.9. Geographical Boundary, Time Horizon and Data Collection

The study area includes the communities within 10 kilometres from the water body. It was observed by Waddy (1975) that 10 kilometres is the maximum radius which the water body can affect. The time horizon is set at the year when the lake was formed until up to 1990 on a yearly basis. It covers a time span of 25 years which is commonly used in engineering and economic analyses. This study uses secondary data. The data are collected from existing published and unpublished materials from Ghana, international organizations such as WHO, FAO, World Bank and National Research Council Canada as well as local libraries in Halifax. Information sources include newspapers, magazines, journals, reports and books.

4.10. Methodological Limitations

Like any other study, this study has its own limitations. First, only one type of disease (schistosomiasis) is used to test the analytical framework. Second, "subjective" factors concerning illness, disability and death are excluded from the analysis. Third, the analysis is based primarily on secondary information which, although cross-examined with various sources, should have been verified by field data should time and financial resources have permitted. However, the study results have indicated that this is a line of inquiring worth pursuing.

CHAPTER 5. SETTING FOR THE VOLTA PROJECT

5.1. Physical and Engineering Settings

The Volta River Project (VRP) is located in southeast areas of Ghana in West Africa (Figure 5-1). The construction of the project started in 1962 and was completed in 1965. The dam, often called the Akosombo Dam or the Volta Dam, is at latitude 6'15''N, and longitude 0'5''E. It impounds the water of Volta River and forms. Lake Volta, which is still the largest artificial lake in Africa (Moxon 1969).

The total shoreline of Lake Volta is nearly 4,800 kilometres. The lake occupies the centre of the riverine system of Ghana and drains most of the country's rivers. It covers an area of approximately 8,500 square kilometres- about 4 per cent of total land area of Ghana- and contains 148,080 million cubic meters (120 million acre-feet) of water. It is about 80 kilometres in its widest point and 400 kilometres in its maximum length. The depth ranges from 19 to 75 metres, with the estimated maximum depth being 905 metres at Akosombo. It begins to decrease from south to north and from mid-lake to shore. The lake has a highly dendritic shape due mainly to the rivers which flow into it (Kaplan *et al.* 1971; Obeng 1977; Taylor 1973).

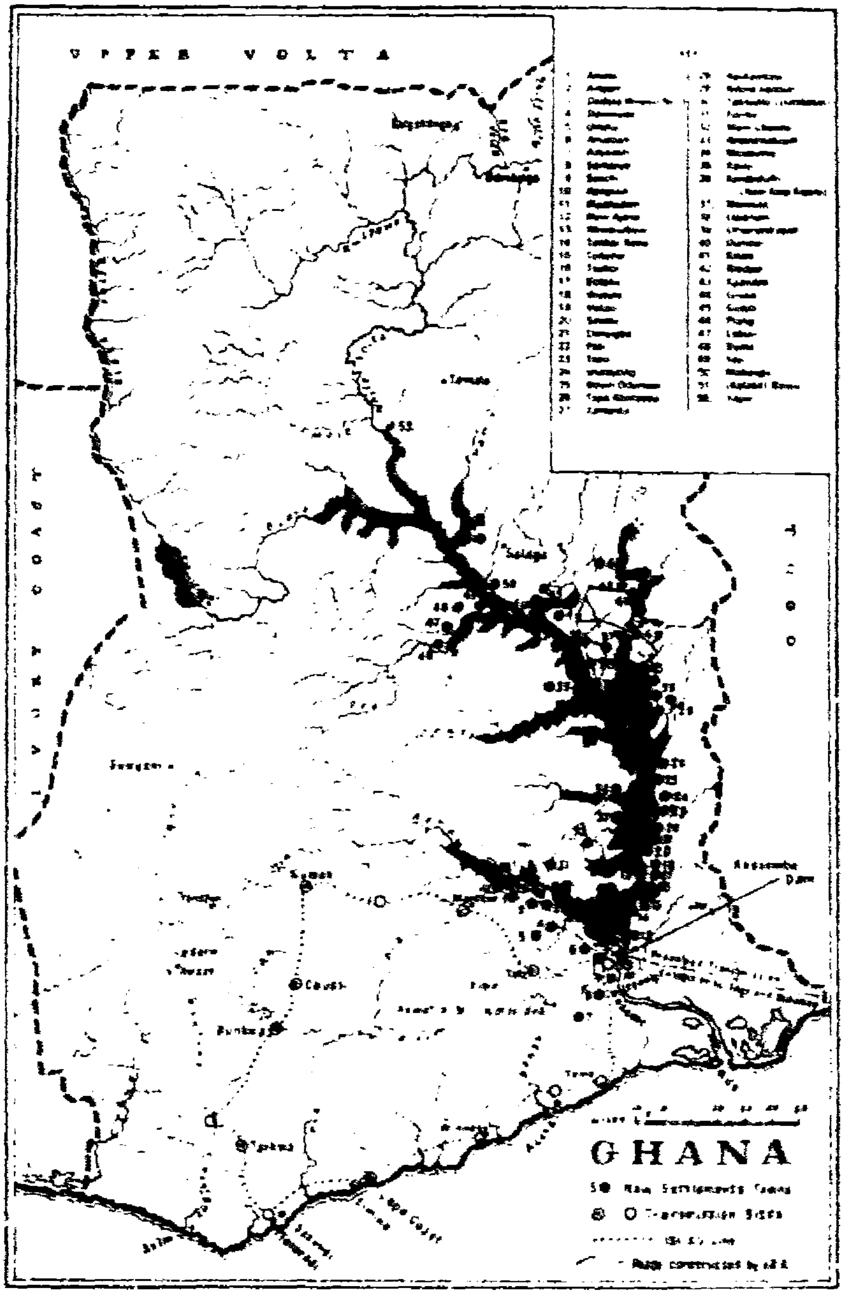

Figure 5-1. The Volta River Project in Ghana (Moxon 1969)

The legal and financial arrangements of the VRP were settled in February, 1962. The construction of the project immediately followed. By July 1963, the scheme to resettle those people living in the area affected by the lake started. Construction of the aluminium smelter at Tema began in June, 1964. One and a half years later, the first commercial power became available from the dam and the formal inauguration of the VRP took place in January, 1966. The smelter came into operation in April, 1967. The project was to provide 830 million watts of electric power for the big aluminium smelting plant on the coast, the electrification of Southern Ghana, and textile and mines near the dam (Rosenfield 1979). The users of the electric power generated from the Volta Dam are listed in Table 5-1.

Table 5-1. The Users of Volta-Generated Electricity

	million kWh	% approx.
VALCO	2518	67
Accra/Tema Area	583	15
Mines	271	7
Togo and Benin	137	4
Kumasi	90	2
Takoradi	73	2
Akosombo Township and Textile Factory	34	1
Others	66	2

Source: VRA and ECG Annual Reports, 1975.

As can be seen from Table 5-1, the largest proportion of the electricity generated from the Volta Dam was supplied to VALCO (the Volta Aluminium Corporation). The urban consumers in the Accra/Tema area represent the second largest user. The next largest amount was consumed by the mining companies in their gold, diamond and manganese operations, and so on. Less or no electricity is provided to local communities.

5.2. Financial Features

The Volta Project was financed by means of external loans and equity investment on the part of the Ghana Government. The World Bank granted a major loan for the project. Other loans were provided by the US and UK governments. The government of Ghana provided the rest of the cost of the project through an investment valued at $98 million, most of this actually being in Ghanaian cedis. The sources of funds are summarized in Table 5-2.

The foreign loans were tied to the purchase of goods either from the donor countries or from acceptable member countries of the World Bank (Moxon 1969). A lower profitability than expected on the part of the VRP reduced ability to pay off the loans. By the end of 1976, only $70 million of these loans was paid (Hart 1980). In referring to the Volta Project, Sterling (1972) commented that all the

Table 5-2. Sources of Finance for the Volta Project (US $million)[a]

Source of Finance	Period (in Years)	Interest (% p.a.)	Amount (million)
World Bank	25	5.75	47
USAID	30	3.5	27
US Export-Import Bank	25	5.75	10
UK ECGD[b]	25	6	14
Ghana Government	--	--	98
Total	--	--	196

Source: Seven-Year Development, p.204.
[a]U.S. $1.00 = 1.23 cedi at 1972-1973 exchange rates
[b]UK Export Credits Guarantee Department

Table 5-3. Construction Costs of Volta Lake and Associated Projects

Items	Costs (Million US$)
Power-related expenses	
Dam and powerhouse	86
Transmission network	20
Akosombo network	2
Other land and buildings	1
Generating plant and machinery	7
Other equipment	2
Other expenses	
Resettlement villages	13
Roads	3
Total	134

Note:
(1) Grand total does not include costs of planning and scientific studies.
(2) Source: Volta River Authority pamphlet on Volta Lake project.

rich countries offer is hard currency, technicians, and equipment, on loan and at interest. In the end it is the poor countries who pay, and pay. Table 5-3 shows the construction costs of the VRP. It should be noted that no budget was allocated to disease prevention.

5.3. Socio-Political Background of the Project

During World War II, the United Kingdom had rapidly expanded the exploitation of Ghana's bauxite deposits in order to satisfy a dramatically increased need for aluminium. They did not pay any attention to what benefits Ghana would receive, and to whether Ghana actually benefits from the scheme as proposed. No concern was expressed for developing Ghana's bauxite or hydroelectric potential. No mention was made of the possible deleterious side-effects of the scheme. Although the VRP envisaged by the United Kingdom involved the output of 564 million watts of electric power from the dam, 514 million watts would go to the smelter and only 50 million watts to other users in Ghana (Hart 1980).

The participation of the United States in the VRP arose paramountly from the political considerations. The United States government primarily desired greater political influence in the newly independent African nations. Ghana represented the first of the new independent African states and the United States was anxious to be involved. The Volta Project was the ideal opportunity (Jackson 1964). There were also economic reasons for the U.S. involvement. The U.S. government was frantically stockpiling one of the world's most strategic materials- aluminium. New U.S. companies were being encouraged to enter the industry to guarantee the future supply of aluminium. The fact that the United States and other leading industrial nations had almost exhausted their domestic bauxite and hydro-power resources made the task all the more urgent. Eugene R. Black, the Executive Director, President and Chairman of the World Bank between 1947 and 1962, stated that:

> "...our foreign aid programmes constitute a distinct benefit to American business. The three major benefits are:
>
> 1) Foreign aid provides a substantial and immediate market for U.S. goods and services.
>
> 2) Foreign aid stimulates the development of new overseas markets for U.S. companies.
>
> 3) Foreign aid orients national economies towards a free enterprise system in which U.S. firms can prosper." (Magdoff 1969).

By involving in the VRP, the U.S. government was therefore able to gain access to cheap hydroelectricity, and to place itself in a strategic position to obtain some of Ghana's large supplies of bauxite. It is obvious that the US interest was on aluminium output rather than Ghana's desire for electricity (Goodwin 1976).

With regard to Ghana itself, the country produced 35 per cent of the world production of cocoa in 1960. Cocoa exports accounted for 60 to 70 per cent of Ghana's total exports, and duties and taxes on cocoa represented approximately 35 per cent of the government's revenue. The price received for exported cocoa tended to vary inversely with the amount exported (Birmingham *et al.* 1966). Ghana, was always in danger of being the world's largest producer of cocoa, saturating the world market, so there appeared to be little hope of gaining extra resources through increased output. Thus, one of the underlying objectives of Ghana's development programmes was to reduce this overdependence and to diversify the economy by changing the commodity structure of agriculture and industrialization. The Volta River Project was one of the most important instruments of this policy.

The primary purpose of the VRP was to produce electric power to support the industrialization programme, to start the specific industry of aluminum, as well as to provide electric supply to other industries and towns of southern Ghana. All those ambitions were at variance with the idea of Third World development through multinational-led growth. The artificial lake was also supposed to create a wide range of other development possibilities through multi-purpose uses, including fisheries, transport, agriculture, wildlife, and tourism (Chambers 1970).

The rational behind the VRP was that it would provide abundant supplies of electricity. This electricity was seen as a necessary requisite for industrialisation. Thus, the production of electricity had over-riding priority. The Volta Project was aimed, therefore, at industrial development as opposed to rural development. There was a much greater outlay on the development of the industrial community than on the resettlement of the rural communities that had to be moved. The immediate benefits of the project were to be channelled only to the small sector of the Ghanaian population receiving housing and employment, and to overseas suppliers of capital equipment. On the other hand, there was a deliberate policy of minimizing their involvement of the people of Ghana as participants in any significant way. Moxon (1969) claimed that if there were admirable social and physical reasons for developing the natural resources of the country, there were strong political reasons as well.

Although the Volta River Project was initially described as a generally successful development scheme, the end result is that the project did not seem to have assisted Ghana's development. David Carney (1952), one West African economist, stated:

> "Some persons tend to regard the scheme as one of the first fruits of the country's recent successful political tournament. Nothing could be further from the truth. The scheme cannot be

> expected to make any substantial contribution to the secondary industrialisation of the country in the sense of a shift of resources away from agricultural and mining activity to manufacturing industry. In essence it is just another of those enterprises which have characterised and continue to characterise the economy of West Africa as a raw materials economy. It is a plan for winning aluminium, in most part by private enterprise, and exporting it to other countries which will use it in the manufacture of useful articles."

5.4. Effects upon Industry, Agriculture and Economy

It was hopped that the Volta Project could help Ghana to diversify her economy and broaden her range of export earnings by aluminium production. In fact, this happened only in a limited way. Aluminium was first exported in 1967 and, soon after, was making a substantial contribution to the total value of exports, about 5 or 6 per cent (Hart 1980). But, apart from this, there does not appear to have been any change in the structure of Ghana's export earnings (Table 5-4). It shows that the VRP's provision of electricity has made no difference to the nature of Ghana's export economy.

Furthermore, as a result of the VRP, Ghana is now tied into the world aluminium industry in a unsatisfactory manner. That is, Ghana exports bauxite at a fairly low price, but imports alumina; exports primary aluminium, but imports rolled aluminium to be fabricated into aluminium

Table 5-4. Diversification of Ghana's Exports*.

Year	(a)	(b)	Year	(a)	(b)
1959	95.9	-	1968	87.6	95.1
1960	94.5	-	1969	84.5	95.0
1961	97.1	-	1970	89.0	95.5
1962	96.0	-	1971	84.7	92.4
1963	93.3	-	1972	83.8	92.9
1964	91.5	-	1973	84.6	90.2
1965	n.a.	-	1974	92.8	96.6
1966	92.6	-	1975	85.2	88.3
1967	91.1	94.0			

Note: *Percentage contribution of cocoa, timber, gold, diamonds and manganese: (a) to the total value of all exports; (b) to the total value of all exports excluding aluminium.

Sources: Bank of Ghana, Annual Reports;
Bank of Ghana, Quarterly Economic Bulletin, July/Sept. 1976.

products. Owing to the nature of its involvement in aluminium, Ghana lacks control over all aspects of its aluminium industry. As primary aluminium is a basic resource, the production of aluminium could not make Ghana move away from a raw materials economy. Thus, Ghana merely serves the world aluminium industry as a source of cheap bauxite on the one hand, and as a source of cheap electricity for aluminium production on the other (Hart 1980).

Beyond the provision of electricity, the government's aim in setting up the project was to achieve a significant measure of industrialisation. This does not seems to have occurred. Up till the middle 70s, the provision of electricity had not led to the expected beneficial industrialization and giant leap forward in national wealth. One of the major reason is that until the loans were repaid, Ghana could not dictate the terms under which the electricity was sold (Goodwin 1976).

E.A.K. Kalitsi, formerly Chief Resettlement Officer and later Director of Finance for the VRA (Volta River Authority), admitted:

> "The Volta Project is the most adventurous event in the life of Ghana. Its construction was the boldest step taken by Ghana to diversify her economy and underpin the newly independent country's industrial development. It was conceived to develop the total resources of a river which runs into the heart of a small country for the benefit not only of its riverine dwellers but the entire population.
>
> Nevertheless, implementation concentrated on power as the direct economic objective and important work to achieve socio-economic objectives and ensure desirable biological conditions were left in abeyance resulting in problems more difficult to solve than would have been case." (Kalitsi 1973).

It was planned that these settlement villages could be used as a mass demonstration for improved agricultural output. It had been intended that sufficient land be cleared to provide every farmer with 12 acres. But by 1966, when the inexorable deadline of dam construction had been reached, only 15,000 acres had been cleared from a target of 54,000 acres (Graham 1986). With improved seed and fertilizers that were to be made available, it was expected that the average farmer would have an annual income of 700 cedis per year. But, the programme failed because of encountering practical difficulties in implementation. For the entire programme to succeed, systematic planning, marketing organization, and other things were required. But the human resources, the skills, and the experience needed were not available in adequate quantities. The result was that initial progress was very poor (Kalitsi 1973). By 1966, the disruption of existing social, cultural and economic relations was almost complete. Yet, the incorporation into new way of mechanised farming, or forced cooperation had not, as yet, taken hold. The rejection of self-help and the absence, or inadequacy, of the new government-sponsored initiatives left the resettled in a social and economic vacuum (Graham 1986). Between 1964 and 1970, the settlers had to be given free food relief by the UN/FAO World Food Programme (WFP) with $7 million worth of food supplies (Johnson 1970).

Ghana also has long been interested in the potential of the Volta Lake for irrigation. It considered delivering irrigation water, by gravity from Volta Lake and by pumping from the Volta River, to 440,000 acres of the Accra Plains south of the dam site. Large-scale mechanised agricultural methods were to be used on plots. Fertilisers and pesticides were to be liberally used. It was hopped that the development of individual land tracts that would "yield the highest profitability" (Kaiser Engineers 1965), but the cost of the scheme was worked out in terms of a maximum debt. By the tenth year after the start of construction, the accumulated debt of capital costs, interest charges and operating costs has amounted to more than 28 million cedis. In fact, the scheme as a whole appeared to be even more inappropriate than the resettlement agricultural scheme. No moves were made to implement this scheme so that the idea of irrigating the Accra Plains remained in abeyance (Hart 1980).

The development of a fishing industry on the Volta Lake has frequently been described a success story. It was estimated that optimum output would be 20,000 metric tons. The fish population in the lake, however, exploded due to higher than expected nutrient levels. In 1969, over 60,000 metric tons of fish were harvested (Ackerman *et al.* 1973). However, those in the resettlement areas were not the major beneficiaries of this harvest, since their villages were located some distance from the shore and they were mainly farmers. Migrant fishermen from the lower Volta area constructed fishing villages along the shore and reaped the benefits of the excellent fishing opportunities (Rosenfield 1979).

The Kaiser Report estimated that by 1970, over

150,000 tons of fish per year would be transported up and down the lake. Ghana has not and could not be expected to reach these levels. Expensive plans were submitted for a comprehensive rail-road-lake transport scheme at a time when the economy was experiencing a decline. The proposals were considered too expensive and inappropriate to the needs of the country. Instead, a small pilot system was introduced. Although carrying over 20,000 tons by 1976, it was continually plagued by acute shortages of capacity, spare parts, maintenance facilities and cargo handling equipment. In 1979, the company was handed over by the government to a private West German enterprise in the hope that the scheme could be revitalised (Graham 1986). At the end, many of the multipurpose aspects of the VRP, comprehensively outlined in previous proposals, were either scaled down or scrapped completely.

5.5. The Resettlements of Local Residents

The damming of the Volta River produced a direct difficult problem to the people, their homes and lands. Many local residents had to lose their homes, traditional surroundings, burial grounds, shrines and general environment. Approximately 80,000 persons- about 1 per cent of Ghana's population- in 14,657 households from 739 villages were affected by the flooding (Chambers 1970). Most of them were subsistence farmers. The people were resettled in larger population units to form 52 new communities at different distances from the lake to specialised farming and fishing. Most units were between 2,000 and 5,000 in population (Johnson 1971; Kaplan 1971; Graham 1986).

The relocates had to adjust themselves to new and different environments and living conditions. The traditional social and behaviour patterns were disrupted. This created enormous socio-cultural impacts on the people (Harinasuta *et al.* 1970). The resettlement, according to Derban (1975), were "bleak and featureless with no familiar market days for buying, selling and social contact. The settlers had exchanged a place of comfort for a place of insecurity."

A slightly larger number, some 60 thousand Ewe fishermen with their families with affected schistosomiasis from the lagoons lying along the lower part of the Volta River and from the delta at its mouth, were attracted to the lake by rich fish harvests in the early years of impoundment (Hart 1980). They settled at random along the lake shore creating about 1,000 new communities, many of which were accessible only by boat. Their village population usually ranged from 50 to 337 (Senker 1979; Scott *et al.* 1982).

In the early phases of the resettlement, a large number of relocates were moved in such a rush and harsh manner that they were confronted by a shortage housing, cleared land, money and food. Few of the planned villages were completed by the time when the people arrived. Many of the new towns consequently began life without many of the basic facilities on which the people had come to depend-markets, stores, transport facilities, patrol stations, health clinics, schools and churches (Graham 1986). The resettlement programme was described by Moxon (1969) as "the character of a national disaster".

For the relocates, most families were crowded into small houses. The type of resettlement housing was called a "core" or "nuclear" house, consisting of a concrete floor, landcrete block walls and a corrugated aluminium roof. Although sufficient floor space was provided for two rooms and two porches, only one room was to be constructed before the settlers moved in; the rest of the house was to completed by the settlers themselves. In theory, the settlers were to have been given the materials necessary for house extension but in practice this did not occur. The cost of obtaining items like cement and bitumen was prohibitive in terms of attainable family incomes (Chamber 1970; Goodwin 1976). Outwardly, the resettlement houses appeared to be superior to the traditional mud and thatch dwelling. But in many respects, they were inferior, that is, the mud and thatch house tended to be cooler than the ambient temperature during the day and warmer than ambient at night. Complaints were often expressed to the physical discomfort because of the cold at night in the resettlement houses (Chamber 1970).

Compensation for the land, and for buildings and other assets could have proved to be a vital stimulus in the regeneration of the new villages and the rebuilding of hope for the future. Yet, by 1970, only 1.1 million cedis had been paid out for crops destroyed while no compensation at all had been paid for lands submerged or for lands acquired from the original communities (Graham 1986). Also the housing provision and compensation payment associated with the settlement scheme proved very unsatisfactory, it can be said the resettlement scheme was not "used as an opportunity to enhance the social, economic and physical conditions of the people" (Chamber 1970).

In addition to the promise that "no one would be made worse off" as a result of the creation of the lake, the VRA Resettlement Division wished to "offer the people of Ghana a better way of living". However, the end result was that the Resettlement Division was unable to bring its words to reality for lack of funding and resources, because it was accountable to the government and not to the relocates (Jopp 1965). To those people whose land and homes were flooded by the new lake, they were robbed and victialized.

A most relevant aspect of the VRA resettlement scheme in terms of health problems was that water supplies and sanitary facilities in the new villages were not satisfactorily handled. Although the villages had been provided with community water supplies and latrines, the drinking water was a problem as pumps and pipes broke down frequently. Communal latrines soon ceased to function. Sewage collection and disposal systems also broke down (Derban 1975). Of six villages in 1973, only one system was still working (Boland 1974). Although the villages were located some distance from the lake shore, the villagers had to turn to the snail-infested lake for water. This increased the chances of infection by water-borne diseases.

5.6. Health Care System in Ghana

The health care services in Ghana were initially characterized by the colonial health planning, which emphasizes curative rather than preventive, and urban-based instead of rural-based practices. Intra-regional disparities, urban-rural inequalities, intra-urban differentials, and intra-district skewness in the distribution of health care facilities were quite evident. According to statistics, in 1953, approximately 90 percent of all hospital beds were in the south. Population and bed ratios ranged from 478:1 in the south to 35,000:1 in the north (Gold Coast Medical Department 1954).

The urban population were generally better served by hospitals, health centers, and clinics (Adarkwa 1981).

Over 80 percent of a sampled 1,000 government-salaried physicians worked in the larger towns and cities, which accommodated only 15 percent of the country's population (Nimo 1982). For the majority of people, only the most seriously ill was hospitalized, which usually requiring trips of more than one day's duration (Fosu 1986; Patterson 1981). The colonial regime had built a very weak foundation for the health care structure of the country. Over the years, the pattern of health care in Ghana has remained basically the same.

According to the result of the 1984 census, Ghana's population had increased by 43 percent since 1970. Expectation of life at birth for male is 50, for female is 53.8. Statistic data indicate that both fertility and mortality are high in Ghana, about 210.9 per 1,000, and 98.3 per 1,000, respectively. The high proportion of deaths in the 25-45 age group is noteworthy (see, Jain 1982; Patterson 1981). The high infant and maternal mortality rates, as well as communicable disease rates, have reflected the prevailing poor health situation in Ghana.

The service coverage of water supply and sanitation remains poor. Such a situation has serious repercussion for health problems in Ghana because several diseases are caused by unsafe drinking water, contaminated food, poor fecal disposal facilities, poor drainage facilities, and overcrowing (Anyinam 1989).

Other equally important determinants of health are also poor. Daily per capita calorie supply as percentage of requirement declined from 101 percent in 1974 to 86 percent in 1983. Over 60 percent of the rural population are estimated to be below the absolute poverty line. In spite of the phenomenal increase in the number of physicians and nurses, these health workers have been trained for and deployed mainly to hospital positions. Those trained for environmental health, epidemiological services, health education, nutrition and community health nursing together constituted less than 25 percent of all trained health workers in the early 1980s (Morley *et al.* 1983).

The adjustment programmes of the Rawling administration, with emphasis on economic recovery procedures gave almost no consideration to the improvement of the conditions of the people, especially the poor and vulnerable. One significant result to the economic recovery was the introduction of user fees for all public health care facilities. In the 1983 budget, the nominal fee of 0.5 cedis per day for outpatients was increased to 7.50 cedis for adults and 5.00 cedis for children, while inpatients were asked to pay 25.00 cedis per day instead 10.00 cedis (Ghana News 1983). The drug situation and other essential services had greatly improved in the economic recovery period, but, accessibility of public health care services for low-income urban and rural dwellers was considerably reduced. Hospital attendance declined drastically in many areas when new fees were introduced (Anyinam 1989). It is ironic that, in spite of the cost-recovery ethic of the government, more than 250 million cedis of public money was paid to private clinics and private medical practioners to provide health care for workers of some 13 state enterprises, boards, and corporations between 1984 and 1986 (West Africa 1987). Poor conditions of service resulted in a continuous loss of medical personnel from the public health care sector. Of the 1,700 doctors working in the public health care sector in 1982, only 665 were at their posts in 1987 (Green 1987).

Onmen (1981) contended that the notion of economic development being desirable insofar as it offers improved conditions of life to the majority of the population, in fact, seldom comes true. The relative success of a development project in turning the economy around is, however, not reflected in the socio-economic life of the people. The economic improvement, if there is any, is usually achieved at the expense of the people's welfare, stardard of living, and quality of health, through the removal of government's subsidy on all social services on which people depend most- especially health and education.

5.7. Thirty Years after VRP

About thirty years after the Volta Lake, Ghana's "life blood" or the "mainstay of her economy" remains cocoa, in spite of the fact that the rationale behind the project is to diversify the country's economy. Cocoa still accounts for 70 per cent of her foreign exchange earnings and 30 per cent of national revenue (West Africa 1975). From above facts, it is fair to say that the project hardly help Ghana's economy at all. On the other hand, it has created many long-term ecological, as well as socio-economic problems for the local communities or for the nation as a whole.

Today, the manufacturing sector remains under-developed and heavily reliant on state subsidies and on imported raw materials and components. Plans to utilize the large bauxite deposits at Kibi for the VALCO aluminium smelter at Tema have failed to materialize because of funding difficulties and opposition from the Kaiser Aluminium Co, which currently still imports bauxite from Jamaica for use at the Tema plant. And a drastic fall in the level of the Volta Lake, which resulted in considerable reductions in the availability of water and in the production of electricity for domestic use as well as industrial and commercial purposes (Hackett 1988).

For the country, the infrastructure is weak, adequate marketing, storage and distribution facilities are in short. Development planning has been sporadic and uneven, while increased spending on imports, regular budget deficits and persistent overseas borrowing have led to spiralling inflation and a large external debt. In addition, political instability and general mismanagement have had a disastrous effect on Ghana's economy.

In 1981, inflation was more than 100 percent per year, and world cocoa prices had fallen to their lowest level for 10 years. The situation worsened in 1982, owing to the effects of a severe drought and chronic shortages of foreign exchange. In many areas of the country, especially rural areas, a high level of deprivation is obvious, which mainly resulted from government policies draining rural resources for the development of the urban sectors and maldistribution of resources.

To improved the situation, policies reformed, supported by IMF and the World Bank, were introduced within a three-year Economic Recovery Programme, covering the period 1983-86, in an attempt to restore economic growth through the rehabilitation and restructuring of key export industries. But a reduction in price subsidies and a cut in real wages substantially reduced living standards, combined with the continued damaging effects of the drought, the cocoa crop continued to constrain economic growth.

During the period 1986-88, the second three-year Economic Recovery Programme was carried out. Its aim included improved financial incentives for producers; structural reforms in the agricultural, industrial and energy sectors; reductions in balance-of payments and budget deficits; the 'privatization' of certain state-owned enterprises; and growth in export earnings and investment expenditure. GDP rose by an estimated 5.3 percent in 1986. Continued recovery has been helped by an international agreement on cocoa prices, but remains dependent on support from the IMF and aid donors. Despite the reduction in inflation, the upturn in business activity and increased food supplies, real incomes remained some 60-70 percent below their 1975 level (Hackett 1988).

In the past, people had money but nothing to buy, today they lack the money to buy the goods available in large quantities on the market (Duodu 1987). Imported goods that have flooded the markets are priced beyond the pockets of the people. A typical is chicken. The price was 70 cedi each in 1981, but is now more than 800 cedi (Anyinam 1989). To date, the impacts of the economic recovery programmes on incomes, jobs, and cost of living has been unfavorable. The stabilization and adjustment programmes have not succeeded in making life more bearable for the ordinary Ghanaian than before the revolution (International Monetary Fund 1988). Ghana is still characterized by physical and social insecurity, corruption, ethnic conflicts, regional inequalities, and state violence.

CHAPTER 6. THE HEALTH IMPACTS OF STUDY AREA

6.1. Health Status before the Volta Project

Before the Volta project, the incidence of schistosomiasis transmission was rare along the Volta River and its main tributaries as big rivers were usually unsuitable habitats for the vector snails (Onori *et al.* 1963). Surveys conducted in 1955 and 1956 by the Medical Field Units (MFU) revealed that infection rates in the project area had been 1 to 5 per cent before the formation of the Volta lake. That is, maximum of five out of 100 people had shown symptoms (Onori *et al.* 1963; Rosenfield 1979).

Paperna (1970) reported that infection with Schistosome *haematobium* was not endemic at the period of 1959-1961 in riverside communities. The incidence rate ranged from 1 to 8 per cent. Here in this present study, a baseline of 3 per cent on average is used. It is also consistent with the data of WHO/EURO (1983).

6.2. Health Status after Project

Many previous studies revealed that the formation of the Volta Lake posed a great threat of health problems on the local population in the project area (Hunter 1982). In particular, there were two diseases of major incidence: schistosomiasis and onchocerciasis. To date, very little literature has been produced on the subject of onchocerciasis; moreover, few reliable statistics are available on the prevalence of the disease in Ghana. It is believed that the Volta River Project has caused no drastic change in the number of people affected by onchocerciasis and that it has merely altered its geographical distribution (Hart 1980).

When the Volta Dam was closed, the water level rose rapidly and started a whole series of hydro-biological changes. After the lake reached full size in 1968, the variety of aquatic weeds in the lake increased through the addition of many new species- a phenomenon that has occurred repeatedly in other artificial African lakes. These changes included a population explosion of aquatic plants, fish, and other aquatic organisms (Kalitsi 1973).

Within the project areas, a large number of aquatic and semiaquatic plants became established in bays and inlets in the vicinity of villages and resettlements where the forest or savannah had been cleared. The aquatic vegetation was also fast establishing itself in areas which were previous swampy or flooded annually by the Volta River (Obeng 1975; Paperna 1969). The presence of aquatic plants has favoured the development of snail populations and the transmission of the disease.

With the inadequately planned and implemented resettlement schemes, and a lack of water supplies and sanitary facilities in the new villages, the lake itself has posed a severe health threat to surrounding residents. Heavy concentrations of snails and the incidence of schistosomiasis at the Volta Lake had been established in the vicinity of villages and resettlements along the lake where the natural vegetation has been mostly affected. They tended to be closely associated with inhabited shores where submerged and marginal vegetation and the host snails co-exist (Paperna 1969; 1970).

A study by Chu *et al.* (1981) indicated that infected snails were more often found in water-contact sites sheltered by emergent plant growth, where families carry out all their water-related activities: collection of water, washing clothes, swimming, bathing, playing, landing fish catches, cleaning nets, and mooring their canoes. These water-contact sites are particularly attracted to the children. With such intensive water contact in all villages, the increase of snail infection rates was expected (Chu *et al.* 1981; Scott et al. 1982).

A sharp increase in schistosomiasis transmission was observed after the impoundment at Volta. It has been reported by several authors that twelve months after the impoundment, in 1963, the incidence of schistosomiasis rose to 20 percent (Jordan 1975; Edington and Edington 1977). The work by Paperna (1969, 1970) indicated that schistosomiasis transmission occurred widely during the period of 1968-1969 and reached an incidence rate of 90 per cent around the lake. In some localities, the prevalence of schistosomiasis in school children increased from 5 percent before the dam to 90 percent in children aged 10-14 years old in a few years after formation of the lake (Hunter 1982; Basch, 1990).

Paperna (1969, 1970) also reported that there is a rapid spreading of urinary schistosomiasis transmission during the 1968-1969 period around the lake. The transmission rate slowed down by 1970, probably because the fish stocks had approached near-equilibrium with the aquatic weed on which the snail vectors fed. The incidence rate of urinary schistosomiasis in the total population surveys in 1973 and 1974 was 73 per cent (Chu *et al.* 1981; Scott *et al.* 1982). In light of those research findings, the entire dynamics of the post-project incidence rate can be reconstructed as is shown in Figure 6-1. The detailed incidence rate for each year after impoundment can be seen in Table 6-1, which is tabulated from various data sources as well as interpolation and extrapolation from Figure 6-1.

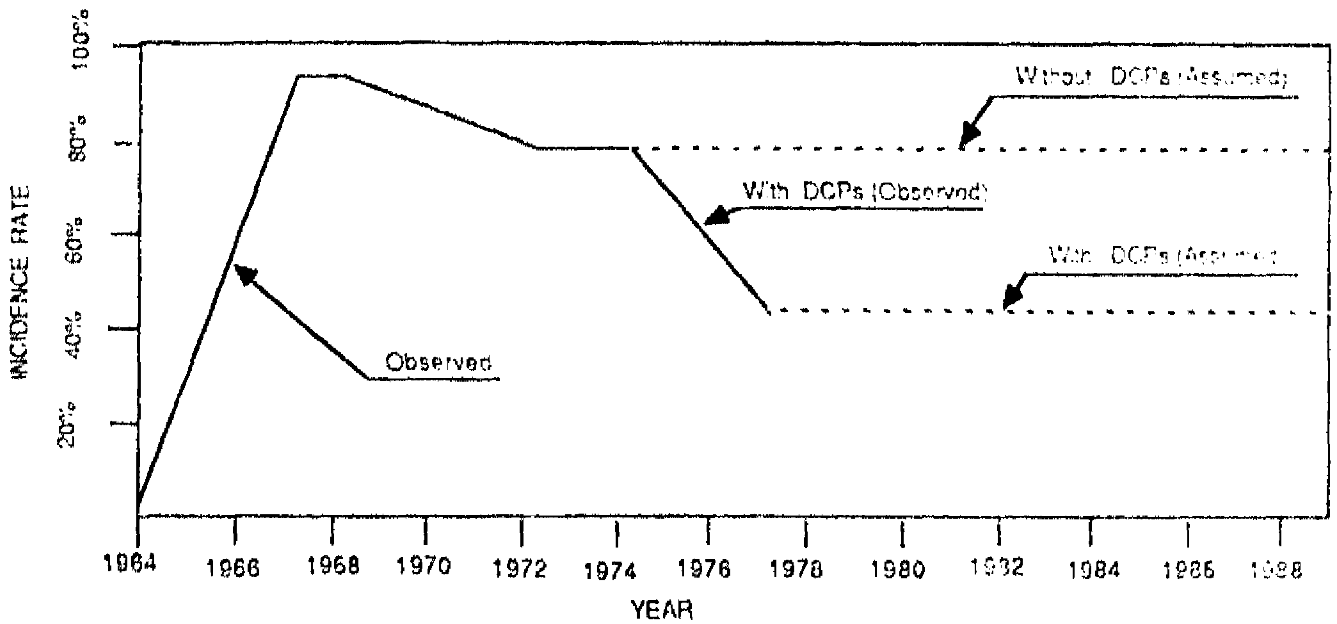

Figure 6-1. Longitudinal Dynamics of Schistosomiasis Incidence in the Volta River Project Area

Table 6-1. Incidence Rate after Impoundment

Year	Incidence	Remarks
Baseline	3%	Onori *et al.* 1963
		Rosenfield 1979
		Paperna 1970
1964-65	20%	Jordan 1975; Edington *et al.* 1977
1965-66	46%	Interpolated
1966-67	64%	Interpolated
1967-68	81%	Interpolated
1968-69	90%	Paperna, 1969, 1970
1969-70	88%	Interpolated
1970-71	84%	Interpolated
1971-72	79%	Interpolated
1972-73	75%	Interpolated
1973-74	73%	Chu *et al.* 1981; Scott *et al.* 1982
1974-75	73%	Extrapolated
1975-76	68%	Interpolated
1976-77	57%	Interpolated
1977-78	46%	Interpolated
1978-79	41%	Chu *et al.* 1981
1979-80	41%	Extrapolated
.	.	.
.	.	.
.	.	.
1988-89	41%	Extrapolated

6.3. Number of People Affected

When the Volta Lake began to fill, some 60,000 fishermen with their families from outside the project area were attracted to the lake for the flourished fish harvest (Scott *et al.* 1982). This figure has been reported by many authors over the years (see, for example, Obeng 1969; Rosenfield 1979; Hart 1980; Hunter 1981). The fishmen population seemed quite stable in the years following the formation of the lake. One possible explanation might be that the newly-created lake can only support a fishing population of 60,000. Should it occur that the capacity of the lake was exceeded, some fishmen would be put out of business. Since they are immigrants, they are relatively mobile. Those who could not catch enough fish to support their families would be expected to return to their original fishing villages or move to other fishing grounds outside the over-crowded lake area. The immigrant fishing population are, therefore, assumed to be constant over the study period.

The Volta project area had a farming population of 80,000 and a resident fishing population of 2,100 in 1964. In light of the statistics of the World Bank (1977), the average increase rate of 2.6 per cent in Ghana is used in this study in calculating the numbers of people living in the study area.

In summary, the population in project area can be derived from the following formula:

P_t = original population before impoundment x (1 + increase rate of population)^t + immigrant fishermen population.

Where, P_t = population size in year t in the lake area; and t = the present year after impoundment

Thus, the calculated population sizes in the project area after impoundment are presented in Table 6-2.

The increase in schistosomiasis incidence rate (see, Table 6-3) in a particular year is calculated by deducting the baseline rate (3%) from the observed incidence rate in that year (Refer to Table 6-1). The increases in the numbers of people affected by schistosomiasis in each year can be calculated by multiplying the increase in incidence rate with the population living in the study area at present year (refer to Table 6-2 and 6-3). The results are prerented in Table 6-4.

Table 6-2. Population Sizes in the Volta Project Area after Impoundment (Rounded to 100)

Year	Population
1964-65	82,100
1965-66	144,200
1966-67	146,400
1967-68	148,700
1968-69	151,000
1969-70	153,300
1970-71	155,700
1971-72	158,200
1972-73	160,800
1973-74	163,400
1974-75	166,100
1975-76	168,900
1976-77	171,700
1977-78	174,600
1978-79	177,600
1979-80	180,600
1980-81	183,800
1981-82	187,000
1982-83	190,300
1983-84	193,700
1984-85	197,100
1985-86	200,700
1986-87	204,400
1987-88	208,100
1988-89	212,000

Table 6-3. Increase in Schistosomiasis Incidence Rate after Impoundment in Volta River Project Area

Year	Increase in Incidence Rate
1964-65	17%
1965-66	43%
1966-67	61%
1967-68	78%
1968-69	87%
1969-70	85%
1970-71	81%
1971-72	76%
1972-73	72%
1973-74	70%
1974-75	70%
1975-76	65%
1976-77	54%
1977-78	43%
1978-79	38%
1979-80	38%
.	.
.	.
.	.
1988-89	38%

Table 6-4. Increase in Number of People Affected by Schistosomiasis after Impoundment in Volta River Project Area (Rounded to 10)

Year	Increase
1964-65	13,960
1965-66	62,010
1966-67	89,300
1967-78	115,990
1968-69	131,370
1969-70	130,310
1970-71	126,120
1971-72	120,230
1972-73	115,780
1973-74	114,380
1974-75	116,270
1975-76	109,790
1976-77	92,720
1977-78	75,080
1978-79	67,490
1979-80	68,630
1980-81	69,840
1981-82	71,060
1982-83	72,310
1983-84	73,610
1984-85	74,900
1985-86	76,270
1986-87	77,670
1987-88	79,080
1988-89	80,560

6.4. Calculation of Forgone Output

Using this formula developed by Ghana Health Assessment Team as included in Table 6-5, it is estimated that the average lost days of healthy life for the incidence of schistosomiasis are 624 per thousand population per year when incidence is 1%. The final results of total days of healthy life due to increase in incidence rate of schistosomiasis in the Volta Project area can thus be derived (Table 6-6), which result from increase in number of people affected by the disease after impoundment in the project area in each year multiplying by average lost days of healthy life from the disease.

Further, using the yearly productive capacity of each person affected which is equal to GNP per capita of Ghana in that year (GNP per capita in Ghana over the study period is presented in Table 6-7), the gross output lost in each year can hence be calculated by multiplying total lost days of healthy life in that year with GNP per capita of that year divided by 365 (refer to Table 6-6). The value of aggregate output forgone each year over the period of 25 years for the entire project area is included Table 6-8. At 8% discount rate, the total value for the period amounts to approximately $3,368 million (1989 US dollars). At 6% discount rate, the figure stands at approximately $2,534 million (1989 US dollars). At 4% discount rate, it is about $1,923 million (1989 US dollars).

Table 6-5. Schistosomiasis in Ghana Measured in Terms of the Days of Healthy Life Lost (Per Thousand Population per Year) (Ghana Health Assessment Team 1981)

Average age at onset (A_o)	5
CFR % (C)	4.0
Average age at death (A_d)	30
% Disablement to death (D_{od})	4
% Perm. Disab. (Q)	96
% Disablement (D)	1
Days of temp. Disab. (t)	-
Incidence (I)	7.0
% due to premature death	67.4
Days of life lost	436

Table 6-6. Lost Days of Healthy Life due to Increase in Incidence Rate of Schistosomiasis in Volta River Project Area (Rounded to 1,000)

Year	Lost Days of Healthy Life (x 1000)
1964-65	8,711
1965-66	38,694
1966-67	55,723
1967-68	72,378
1968-69	81,975
1969-70	81,313
1970-71	78,699
1971-72	75,024
1972-73	72,247
1973-74	71,373
1974-75	72,552
1975-76	68,509
1976-77	57,857
1977-78	46,850
1978-79	42,114
1979-80	42,825
1980-81	43,580
1981-82	44,341
1982-83	45,121
1983-84	45,933
1984-85	46,738
1985-86	47,592
1986-87	48,466
1987-88	49,346
1988-89	50,269

Table 6-7. GNP per capita in Ghana, 1964/65-1988/89

Year	GNP per capita
1964-65	207
1965-66	220
1966-67	216
1967-68	230
1968-69	225
1969-70	240
1970-71	260
1971-72	265
1972-73	260
1973-74	275
1974-75	285
1975-76	280
1976-77	290
1977-78	325
1978-79	360
1979-80	385
1980-81	400
1981-82	385
1982-83	355
1983-84	350
1984-85	365
1985-86	380
1986-87	390
1987-88	390
1988-89	390

Source: World Tables of World Bank, 1974-89

Table 6-8. Gross Forgone Output due to Increase in Incidence Rate by Schistosomiasis in Volta River Project Area (Rounded to 1,000 and in current US dollars)

Year	Forgone Output (x 1000)
1964-65	4,940
1965-66	23,322
1966-67	32,976
1967-68	45,608
1968-69	50,533
1969-70	53,466
1970-71	56,060
1971-72	54,469
1972-73	51,464
1973-74	53,774
1974-75	56,650
1975-76	52,555
1976-77	45,969
1977-78	41,716
1978-79	41,537
1979-80	45,172
1980-81	47,759
1981-82	46,771
1982-83	43,885
1983-84	44,045
1984-85	46,738
1985-86	49,548
1986-87	51,779
1987-88	52,726
1988-89	53,712

6.5. Evaluation of Cost-Effectiveness of Health Improvement Measures

In order to make the best use of available resources, it is necessary to determine the best methods of controlling diseases in various conditions (WHO 1973). In the area of the Volta Lake, a WHO/UNDP project was established in 1971 to study the epidemiology of schistosomiasis. In 1975, a control programme was carried out, which costed US$1.09 per capita. After three years of cercarial transmission control using focal application of niclosamide and weed removal in Water Contact Sites (WCSs) in the project area of the Volta Lake, the number of WCSs infested with cercariae and infected snails was reduced by over 90 per cent in areas of both high and low endemicity. This, combined with selective population chemotherapy, reduced the incidence of Schistosome *haematobium* infection by 72 per cent in the area of low endemicity and 40 per cent in the area of high endemicity. The incidence rate had continually declined to 41% during the period from 1978 to 1979 (Chu *et al.* 1981).

In calculating the cost-effectiveness of the DCPs proposed and practised by WHO/UNDP in the Volta Lake, the reduction rate of 56 per cent is used for the year of 1976 (WHO 1973). Data after 1979 are unavailable. It is assumed that the disease would be controlled at the same level as in 1978 under the same financial inputs. The effect of the DCPs is shown in Table 6-9. The days of healthy life saved in each year (Table 6-10) as a result of DCPs are calculated by population in the Volta Project Area after impoundment multiplying with incidence reduction as DCPs in the same year and average lost days of healthy life for each incidence (624), refer to Table 6-2 and Table 6-9. Then, the gross output saved as a result of DCPs can be derived from the days of healthy life saved as DCPs multiplying by GNP per capita and divided by 365 days (see Table 6-11). At 6% discount rate, the saved value is approximately $724 million (1989 US dollars).

Table 6-9. Outcome of DCPs

Year	Incidence Rate	Reduction	Remark
Baseline	73%	0	Interpolated[a]
1975-76	68%	5%	Interpolated
1976-77	57%	16%	Interpolated
1977-78	46%	27%	Interpolated
1978-79	41%	32%	Chu *et al.* 1981
1979-80	41%	32%	Projected[b]
.	.	.	.
.	.	.	.
.	.	.	.
1988-89	41%	32%	Projected

Note: [a,b]From Figure 6-1.

The analysis indicates that the benefit of controlling schistosomiasis appear to be greater than the cost. This can be seen from Table 6-11 and Table 6-12 that for a total cost of $4.53 million (1989 US dollars) on DCPs over the period from 1975 to 1989, the output saved in the same period as result of DCPs totalled $724 million (1989 US dollars). The benefit/cost ratio is, therefore, 724 / 4.53 = 160. That is, for each dollar spended on DCPs, a benefit of US $160 can be produced in terms of output saved that might have been forgone if the DCPs had not been implemented.

This finding proves that the claim by WHO (1978, 1979) is true that the multilateral cooperation in research and control activities around Lake Volta in Ghana has been particularly effective. The strategy developed has resulted in the achievement of an acceptable level of disease control in the project area. Eventually, this strategy may be useful to other areas of the lake and to major water bodies in other African countries.

Table 6-10. Days of Healthy Life Saved as A Result of DCPs

Year	Days of Healthy Life Saved (x 1000)
1975-76	5,182
1976-77	17,143
1977-78	29,417
1978-79	35,463
1979-80	36,062
1980-81	36,701
1981-82	37,340
1982-83	38,398
1983-84	38,678
1984-85	39,357
1985-86	40,076
1986-87	40,815
1987-88	41,553
1988-89	42,332

Table 6-11. Gross Output Saved as Result of DCPs in Current US Dollars (Rounded to 1,000)

Year	Output Saved (x 1000)
1975-76	3,975
1976-77	13,620
1977-78	26,193
1978-79	34,977
1979-80	38,038
1980-81	38,712
1981-82	39,386
1982-83	37,346
1983-84	37,088
1984-85	39,357
1985-86	41,723
1986-87	43,611
1987-88	44,399
1988-89	45,231

Note: At 6% discount rate, the value is approximately $724 million (1989 US dollars).

Table 6-12. Spending on DCPs in Current US Dollars

Year	Spending
1975-76	184,101
1976-77	187,153
1977-78	190,314
1978-79	193,584
1979-80	196,854
1980-81	200,342
1981-82	203,830
1982-83	207,427
1983-84	211,133
1984-85	214,839
2985-86	218,763
1986-87	222,796
1987-88	226,829
1988-89	231,080

Note: At 6% discount rate, the value is approximately $4.53 million (1989 US dollars).

CHAPTER 7. CONCLUSIONS AND RECOMMENDATIONS

Development projects, such as water resources development projects, have the potential of disturbing environmental, and social balances. This may, in turn, create favourable conditions for increasing the incidence rates of water-borne diseases on local population, particularly in tropical and subtropical countries. The comments given in a WHO document is most relevant here: "The incidence of schistosomiasis has increased but it is man's doing. As he constructs dams, irrigation ditches, etc., to alleviate the world's hunger, he sets up the ideal conditions for the spread of the disease to pose many health problems" (WHO 1961). Since planners and decision makers usually base on the rational rather than reality that a water resources development can vitalize their national and regional economic development, the "hidden costs" of health effects on local population are seldom taken into project consideration.

As water resources development projects are constructed in the developing world today, people living in urban areas as participants in the wider national economy enjoy electricity, wage employment and other economic benefits generated through those projects. On the other hand, people at the lakeside, whose well-being has not been sufficiently taken into account in the national objectives, are suffering from the increases of water-borne diseases and bearing the unproportionate costs. By the unequal distribution of ecological, social and economic costs, water projects have deteriorated the living standards of local people and have made them even worse off than before. Together, this type of projects have exaggerated social and economic disequilibrium in a country. The adverse effects of water resources development projects have been clearly articulated in a paper on India's Narmada Valley Project:

> "The process we have embarked on is not only ecologically non-sustainable, it is socio-culturally destructive- it has increased inequalities, concentrated power in the hands of a few, swamped valuable traditional cultures and knowledge systems, destroyed the spiritual part in us, broken integrative social relationships and isolated individuals from each other and from nature. Most damagingly, our fixation with this 'Western' model has meant the neglect of all alternative forms of change including the possibility of developing on traditional time tested, ecologically-sound practices like organic farming." (Kalpavriksh and the Hindu College Nature Club 1986).

This study of the disease of schistosomiasis in connection with the Volta Lake in the African continent has provided one typical example that the critical health problems are closely related to water development problems and have the potential of increasing the social predicament in the project area and decreasing local people's output and earnings. It has been clearly demonstrated that owing to the increase in the incidence of schistosomiasis, the local population as a whole suffered the consequences of illness, disability and death, which resulted in a direct loss of about US $2,500 million (1989 US dollars, 6% discount rate) over the 25 years since the project was built. If the indirect "subjective" costs are included, the social and economic burdens on local people are believed to be much greater.

The profoundly negative effects of the Volta Project on the socio-economic and health conditions of the local population as a consequence of water-borne diseases have clearly demonstrated the need for appropriate measures to control these health hazards, in order that full benefits can be derived from water resources development undertakings. In the design of a water development project, every effort should be made to ensure that the problem of transmission of diseases is carefully considered. It is, however, usually the case that no efforts are made to control disease until too late- until, in fact, the dams and associated irrigation works have been built and all problems created. In Volta Lake area, it is only after 11 years later in 1975, a schistosomiasis control programme was initiated.

Yet, the results of this study have shown that the belated control programme has reduced the incidence of the disease to a large extent. The total saved output due to reduced incidence of schistosomiasis amounted to approximately $700 million (1989 US dollars, at 6% discount rate), which would have been forgone without the introduction of the health improvement programmes. Given the cost allocation of US $1.09 per capita, the total cost of the DCPs is estimated at about $4.5 million (1989 US dollars). This gives a cost-effectiveness ratio of 160 approximately, implying that, for each dollar spent, about 160 dollars were generated. It is clearly demonstrated that schistosomiasis can substantially impair labour output and that its elimination is cost-effective and can reduce the losses of output substantially. Should the intensity of management and health prevention spending have been higher, a greater reduction in schistosomiasis incidence rate would have been possible.

In the less-developed tropical and subtropical countries, the balancing of economic efforts with the establishment of priorities in the planning of development programmes is of paramount importance. The value of health in increasing productive power, economic growth and human well-being is doubtless. An estimate (even if only approximate) of the economic benefits that would accrue to the community is a powerful argument in favour of granting a higher priority to the control of specific health hazards. The measurement of the economic consequences of a disease is therefore highly relevant, and control measures can be advocated as they are likely to generate a large amount of social benefits.

The principle in relation to disease and socio-economic development has already been enunciated many years ago, when the Prime Minister of Thailand bluntly pointed out that a healthy economy could be built only on a healthy community. Today, it is more widely recognized that economic development for a country is closely linked with individual and public health. The improved health is essential to sustained economic and social development and may make a contribution to a better quality of life in developing countries. Therefore, health programmes must be seen as part of a nation's economic strategy. The more this is accomplished at both the global and local levels, the easier it will be for progress towards providing acceptable standards of living and health towards the poor people in the developing countries.

It is also true that water resources development projects are important for the development of a country. With proper management, it is possible that water resources development projects can bring much greater benefits by preventing many of the negative health impacts. In fact, many water-borne diseases are human-induced in nature (Hunter *et al.* 1982). The implication of this conception is that they should and can be solved by improved project planning exercises. It is important that the prevention of the transmission of water-borne diseases should be considered at the early planning stages of a water resources project. The project areas must be dealt with as an integrated whole. Even though the primary objective may be hydroelectric, the impacts on human ecology, on human health and on socio-economic structure of the local systems must be considered and included in the project planning process to minimize the spread of infections and to ensure that health protection measures are included.

It is essential to realize that water development projects should take into account health protection through the stages of project design and operation. The health of local population should be covered from beginning to end. Their health status should be monitored not only during the building operations, but afterwards, as power production and industrialization, or irrigation, or both, come into full effect and the communities are rehoused and resettled. Only in this way, it is possible to ensure that developmental interventions be evaluated in their ecological entirety so as to avoid or minimize the negative consequences to human health.

Inasmuch as health problems of water resources development projects are dependent on project planning, design, operation and management, their prevention and solution may be found only in close cooperation between staff from multi-disciplinary fields such as public health specialists, planners, hydrologists, engineers, agronomists, economists, geographers, sociologists and agriculture extension experts. This cooperation should begin with the planning phase and continue through the life of the development scheme. As the World Health Organization noted with respect to the need for interdisciplinary cooperation in controlling this pervasive health threat in the planning (and therefore preventive) phase:

> "The successful attack on the disease will be accomplished by a team: the engineer, the malacologist, the parasitologist, the sanitarian, the physician, and the chemist, widely divergent in training, speaking in the beginning different technical language, but with a common purpose in mind." (Odei 1961).

As soon as a water resources development project is proposed and the decision has been made, it is desirable to organize a public health survey for the project area and for regions from where people might be likely to move. This would estimate and quantify as far as possible the prevailing disease pattern, the diseases which could appear or spread, their human, social and economic effects, and the costs and benefits of the health programme.

As health problems vary from place to place or from one country to another, it is necessary to predict the health impacts affected by water resources projects. The predictions can be order-of-magnitude estimates that are based on statistical inference. The framework for this analysis is shown in Figure 7-1. It is likely that the analysis of the risk of increasing the incidence and prevalence of water-borne diseases after the introduction of water and people through a water resources development project may prove to be a complicated task. But after time and effort were put to the task, a lot of use could be made out of this type of health information. The health consultants could estimate the likelihood of increases in incidence and prevalence of water-related diseases in question.

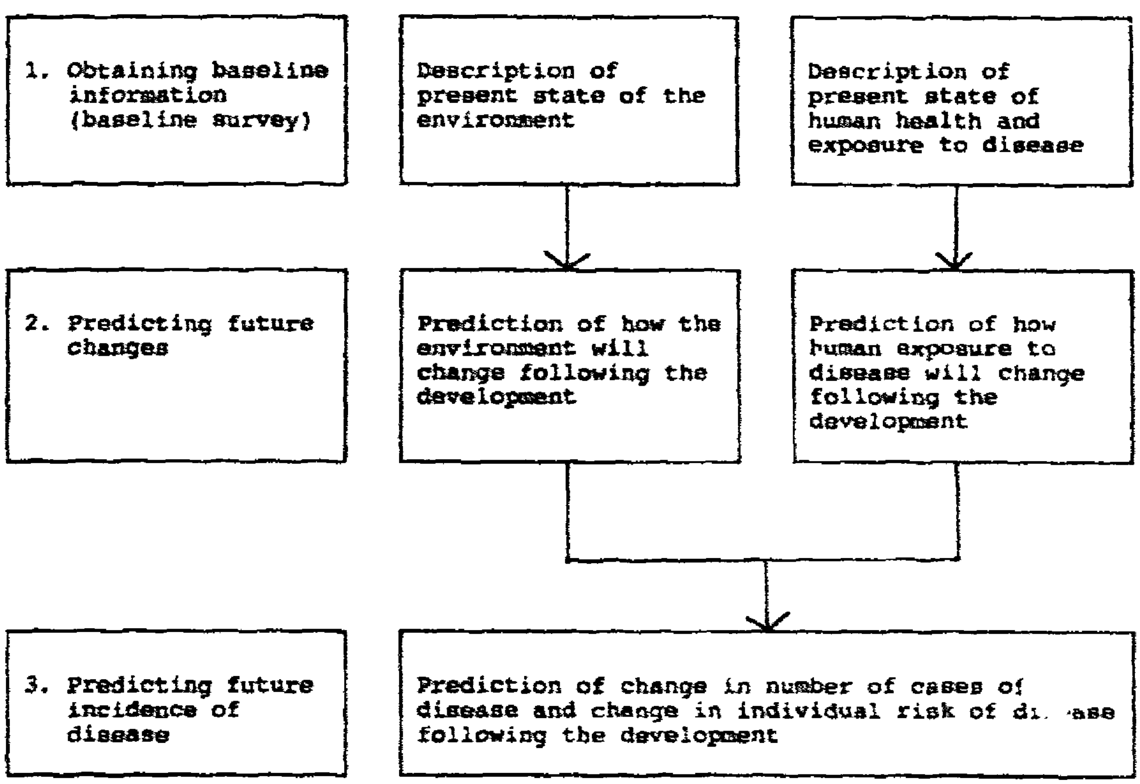

Figure 7-1. Steps in Predicting Health Effects (WHO/EURO 1983)

Retrospective studies of the experiences of past developments are essential to assess the scale of potential health impacts. Similarly, it is possible to indicate the health risks for each project associated with its possible implementation (Olivares 1986). Health agencies should give particular attention to the need for post project monitoring and assessment in order to build an epidemiological database to guide future health impact analysis.

Further, good preliminary surveys and planning should make it possible to foresee the potential health risks before beginning a water resources development project. In analyzing the health effects of water resources development projects, factors including demographic, physical, environmental, health, social and economic elements should also be given equal attention. The probable effects of the ecological changes, the creation of new communications, the movement of labour and local population, new settlements and the resettlement of people displaced by the developments themselves must all be considered and projected in planning, not only as social and economic problems but as a background for possible redistribution of local communicable disease or the introduction of environmental health hazards.

To significantly improve the health conditions requires the formulation of a comprehensive policy that gives priority to the improvement of the socio-economic conditions of the people concerned. It also requires the involvement of the general public in the planning, design and implementation of health improvement pro·rammes, directly addressing the diseases on communities which are likely to occur. In addition, it is necessary to restructure the existing health delivery system to support primary health care activities to ensure more equity and appropriateness in the distribution of health resources between different geographical areas or population groups. Only in this way that improved health services and health status can represent the real signs of progress of a society. To achieve this, it will depend upon the change in the reform of development policies.

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