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REPORT ON THE SEMINAR ON THE PREVENTION AND CONTROL OF VECTOR-BORNE DISEASES IN WATER RESOURCES DEVELOPMENT PROJECTS

Alexandria and Egypt, 21-27 March 1978
The Sudan, 28 March - 6 April 1978

CONTENTS

PREAMBLE

The Seminar on the Prevention and Control of Vector-Borne Diseases in Water Resources Development Projects, the first on this subject to be organized by WHO, was opened on Tuesday 21 March 1978 in the Conference Hall of the WHO Regional Office for the Eastern Mediterranean.

The main purpose of the Seminar was to highlight the importance of these projects for the socio-economic development of the countries; the inadequate attention given to the health aspects of these projects and their impact, and to discuss and recommend measures and action that should be taken by the national administrations and international and bilateral agencies involved.

The Seminar brought together over 40 participants including medical officers, engineers, biologists, entomologists and administrators from the Ministries of Health, Agriculture, Water and Power, Planning, etc. and from bilateral and international agencies (see Annex 4).

Some working papers were submitted, presented and discussed. The questionnaires on water resources development projects, and the requests for information on legislation and the cost of canal lining which had been sent previously to participating countries were received and the information compiled (Annexes 6 and 7).

The agenda of the Seminar (Annex 1), the presentation and discussions covered a whole range of health and environmental problems associated with the development of water resources; an analysis of these problems and the measures for their prevention and control, and finally the principles and major steps to be followed for inclusion of health safeguards in planning, design, construction, operation and maintenance of these projects.

The programme of work of the Seminar consisted of five days' (21 - 25 March) presentations and discussions in Alexandria followed by a one day (27 March) field visit to irrigation and drainage projects in the Nubaria and Damanhour provinces (Egypt) and 8 days' (28 March - 5 April) field observations and discussions in Khartoum and the Gezira province in the Sudan.

During the visit to the Gezira Province, the participants were divided into four multidisciplinary groups and were assigned to a case study area where the health problems and facilities and services were assessed by the groups during field investigation. Groups then formulated their proposal plans which were presented and discussed during 5 April 1978. During the same day the Seminar discussed and approved the recommendations made and thereafter the meeting was closed.

THE OPENING SESSION

The Seminar on the Prevention and Control of Vector-Borne Diseases in Water Resources Development Projects was opened at 09.00 a.m. on 21 March 1978. Dr A.H. Taba, Regional Director, WHO, Regional Office the the Eastern Mediterranean, while inaugurating the Seminar, welcomed the participants from the Ministries of Health, Agriculture, Water and Power, and Planning and from universities as well as from international and bilateral organizations. He emphasized that the Seminar was important both from the socio-economic point of view and from the health development aspects. If proper measures at the planning stage of water resources projects are not taken, it is likely that the water will become infested, polluted and contaminated and that the vectors and intermediary hosts of diseases may find suitable conditions for breeding, multiplication and dispersion. In order to make water resources development schemes fully beneficial to mankind, the planners, engineers, and the public health officials all have to contribute, with respect to their specialized professional knowledge and experience, in a collaborative effort to prevent diseases and their health hazards. Every endeavour should be made by all the agencies concerned to plan, design, implement and operate the water resources development projects in such a way that the schemes do not leave a trail of vector-borne diseases jeopardizing the health of the human population and their socio-economic development.

Mr H.A. Rafatjah, Chief, Equipment Planning and Operations, Division of Vector Biology and Control, WHO, and the Secretary of the Seminar, thanked Dr A.H. Taba for taking such a keen interest and for his support in organizing the Seminar. He expressed that the developing countries, in order to improve the socio-economic conditions of their masses, are extending irrigation by developing their water resources; frequently at the cost of the health of the population which is supposed to benefit from such projects. He cautioned that sometimes certain measures advocated against one health problem create other problems. It was, therefore, of paramount importance that all the concerned agencies should collectively plan and implement the water resources development projects while giving due consideration to health. He also pointed out that the objectives of these projects would not be achieved unless the national, bilateral and international agencies establish and follow realistic guidelines for the correction of existing problems and to prevent the creation of health problems in future projects.

Dr L. Kaprio, Regional Director, WHO, Regional Office for Europe, while highlighting the importance of the Seminar, said that the subject was very important for the developing countries. Similar problems exist in the European Region, particularly in South-East Turkey where extensive irrigation and agriculture development has caused a return of malaria in epidemic form involving over one hundred thousand cases. He said that success in controlling vector-borne diseases in water resources development projects would lie in the joint approach of various concerned professionals of diversified disciplines and the collaboration of international agencies with national administration.

Mr G.L. Pennacchio, Resident Representative, UNDP, thanked Dr A.H. Taba, Regional Director, for his words of welcome and greeted the participants on behalf of Mr Doo Kingue, Assistant Administrator of the United Nations Development Programme. He said that UNDP places considerable importance on the prevention and control of vector-borne diseases in water resources development projects. Several projects have been and are being supported through UNDP financing in various parts of the world. He wished the participants in the Seminar success in their deliberations and Dr Taba personally a happy new Iranean year (Nou Rouz).

THE REPORT OF THE SEMINAR

Part I - Presentations and discussions, Alexandria, 21 - 27 March 1978

1. The purpose and objectives of the Seminar

The group noted that there was a pressing need to examine the present situation in water resources development in view of:

(a) an increasing number of projects planned and executed for water resources development;
(b) the drastic adverse effects on health that have been observed in some of these projects, and the difficulties faced in the correction of such effects;
(c) the need for forecasting the health implications of projects being planned or prepared and for giving early attention to their prevention.
(d) the need for stressing the importance of disease prevention and control measures in existing projects.

The principal objective of the Seminar was therefore to bring the attention of the planners, designers, engineers, etc. to the health implications of their work and to the need for the incorporation of features and procedures for the prevention and control of disease transmission and prevalence from the initial-stage surveys, planning and design, and throughout the periods of construction and operation of the projects.

The Seminar must review basic information of the most important vector-borne diseases associated with water, their influence on socio-economic development and on the achievement of the objectives of water resources development projects. This includes a review of the present available measures (environmental,management, chemical and biological) for the prevention and control of the most common disease vectors (mosquitos, snails and flies) and their application to the various components of water resources development projects (reservoirs, irrigation schemes, communities).

It is noted that the Seminar offered the opportunity for discussing the way these prevention and control measures could be incorporated into the planning and design of water resources development projects and the means required for their effective implementation at the various phases of execution of the project e.g. construction, operation and maintenance.

2. Water-associated vector-borne diseases in the Eastern Mediterranean Region

2.1 Major water-associated vector-borne diseases

During the last decade factors such as industrialization, urbanization, population movement and agricultural and engineering developments have been responsible for much variations in the patterns and distribution of diseases. Some of the changes and variations have been associated with large-scale development schemes based on the utilization of water, which have been frequently responsible for the spread and intensification of water-associated and water-borne diseases, which interfere with the normal human life and activity and thus reduce considerably the social and economic benefits expected of water resource projects.

Water is a favourable medium for the spread of bacterial and viral diseases in man; its role is even more important in the transmission of a number of parasitic diseases. Some of the parasitic diseases do not require vectors* for transmission to man; others require vectors of which the most important are mosquitos, flies and snails. Water and irrigation works facilitate the breeding of vectors and provide a suitable environment for their proliferation.

*The term vector is used in its broadest sense to represent vectors, animal reservoirs and intermediate hosts of human and animal diseases.

Malaria is a top priority health problem in the Region; filariasis is a parasitic disease of public health importance; schistosomiasis is a chronic parasitic infection and is becoming a growing problem in many developing countries in the world. The complications that arise from chronic infections are frequently serious and can be fatal. Malaria and schistosomiasis have particularly serious adverse socio-economic effects on water resources development projects.

Malaria is widely prevalent in the Eastern Mediterranean Region. Filariasis, caused by Wuchereria bancrofti, is also largely widespread.

Onchocerciasis is prevalent in several areas of the Sudan and limited foci have been identified in the Yemen Arab Republic and Somalia.

Schistosomiasis is widespread in the Region. S. haematobium and S. mansoni species are both prevalent. The prevalence in irrigation areas is in general very high. In spite of the control measures applied there is everywhere a tendency for the disease to spread particularly in association with irrigation schemes.

Governments have adopted various health measures to control water-borne and water-associated diseases. For malaria, the preventive and control measures have included vector control, drug prophylaxis, active discovery and treatment of cases, but many technical problems have arisen among which vector resistance to insecticides remains one of the most important. For schistosomiasis, governments have instituted important control programmes particularly where there have been water development projects and where the control of the disease has priority. The situation for the control of filariasis is very difficult due to the high toxicity of the commonly used drugs and vector resistance to most insecticides. It is, nevertheless, gratifying to note that governments are showing a growing interest in the prevention and control of diseases associated with irrigation schemes and water development works.

It is at the planning phase of the projects that the health risks should be assessed and considered and preventive measures organized. There is a need for close collaboration of engineers, public health workers, educators, agronomists, veterinarians and social scientists to devise and apply adequate and realistic measures to ensure that water, the source of life, does not become, by negligence, a cause of disability and death and thus retard agricultural and socio-economic development.

(a) Malaria

Malaria is a disease caused by parasites of the genus Plasmodium found in the blood of infected persons.

Anopheline mosquitos transmit the disease from man to man. Not all anophelines can be vectors, but only those that are genetically susceptible to the infection, feed on human blood and live long enough to permit the development of the parasite into their bodies.

Mosquitos require water for their development.

Man may influence the degree of malaria transmission in an area through his own behaviour. Of particular interest to the Seminar was the creation of extensive breeding places for the mosquitos through incorrectly planned and operated water development schemes.

In arid and semi-arid areas mosquito breeding is very limited and breeding places normally dry out during a part of the year. Such areas are particularly vulnerable to man-induced environmental changes and increased malaria transmission may follow badly managed water resources development projects.

Following the discovery of residual insecticides and the spectacular success which followed their application for the control of malaria, the concept of malaria eradication was evolved and applied in many countries all over the world. The concept of eradication was based on the fact that if all intra-domiciliary resting places of the vector are sprayed with a residual insecticide, the Anopheles iskilled before it is able to transmit malaria. In the absence of transmission,malaria could disappear within a few years with the disappearance of the parasite from human hosts.

The initial success of these applications could not however be maintained because of an increasing number of technical and administrative problems such as resistance of vectors to insecticides, increasing cost of basic commodities, inadequacy of general health services' support to antimalaria programmes, etc. Many countries have, therefore, reoriented their programmes towards a control of the disease. Malaria eradication programmes, nevertheless, protected not less than 800 million people from malaria risk while nearly as many are living in areas where the risk has been greatly reduced.

The control of malaria and the selection of antimalaria measures must be adapted to each specific situation. What, however, is to be emphasized is that permanent solutions are to be preferred and lie in the prevention and permanent elimination of vector breeding. Temporary control measures, especially the use of pesticides must be done with caution and selectively and as an intermediary to a permanent solution.

(b) Schistosomiasis

Schistosomiasis includes a group of diseases caused by trematode worms of the family schistosomatidae and which are prevalent in 72 countries and islands in Africa, West and South-East Asia, Latin America and the Caribbean area. It is estimated that more than 200 million people are actually infected and more than 600 million are at risk. Four species of schistosome are normally parasitic in the circulatory system of man namely S. haematobium, S. mansoni, S. japonicum and S. intercalatum. The first species cause urinary bilharziasis and the eggs are excreated in the urine and occasionally in the faeces, while the other three are the causes of intestinal bilharziasis.

By the time the eggs are passed in the urine or faeces, the miracidium contained within the ovum has reached maturity and is ready to hatch if the eggs reach water. The miracidium moving in water by means of its cilia, seeks out and attacks the suitable intermediate host which is a fresh water snail. In the event of failure to contact the intermediate host the miracidium dies in less than 24 hours.

The intermediate host of S. haematobium,S. intercalatum and S. mansoni belong to the molluscan family Planorbidae, genus Bulinus (for the first two) and genus Biomphalaria (for the third). The intermediate host of S. japonicum belongs to genus Oncomelania.

After penetrating the snail intermediate host, the miracidium transforms and migrates to the digestive glands and develops into cercariae and emerges from the snail after about a month to attack the mammalian host. It usually dies in 48 hours in water if failed to penetrate a host.

After penetration of the skin of the definitive host the cercariae get into the blood stream, the heart, lungs and then through arterial circulation to various parts of the body. Those cercariae reaching pelvic plexuses (S. haematobium) and mesentric veins (other species) reach sexual maturity and lay eggs which begin to recover in urine or stool 30-40 days after skin penetration.

The transmission of the disease and the consequent establishment of endemicity is dependent upon the access of schistosome eggs to water, the presence of the snail intermediate host or hosts in water and human contact with infested water once the extrinsic cycle is completed.

It is thus evident that human behaviour plays a dominant role in the aetiology and epidemiology of schistosomiasis. Furthermore the introduction of new irrigation schemes has unfortunately provided the creation of new habitats for vector snails, and has thus lead to the spread and intensification of endemicity of the disease.

As early as 1938, Khalil in Egypt reported that a change from basin to perennial irrigation had increased enormously the prevalence of the disease within a few years viz. (from 5% to 60 and 80%). Nevertheless, during the past two decades many water resources development programmes were implemented in countries where schistosomiasis was known to be present. The available report for man-made lakes in Africa shows that transmission of schistosomiasis is taking place in practically every major lake and in the related irrigation systems.

Schistosomiasis control concentrates on two parameters, namely, control of snails and mass treatment of infected individuals. There are many limitations to the application of either of these two approaches. In addition to the difficulty of detecting all infected individuals through the use of the known diagnostic methods and their treatment, the available drugs are not devoid of toxicity and as yet a safe and effective drug for mass treatment has not been developed. Moreover, there is no prophylactic drug, and the availability of an effective vaccine is not foreseen in the near future.

The use of molluscicides may be most cost effective in arid areas where transmission is seasonal and where the volume of water to be treated per person at risk is small. In large irrigation schemes, the use of molluscicides is expensive and requires proper assessment of their acute and chronic effects on the biota.

Environmental management and engineering methods including

- reduction of snails through habitat management,
- reduction of human contact with infective water through provision of safe, adequate and convenient water supply for drinking, recreation and other domestic uses especially for children who represent 60-80% of the potential of transmission of the disease, and through the installation of barriers, site selection etc.
- prevention of access of schistosome eggs to snail habitats, by construction of excreta disposal systems, health education etc.

Environmental control measures have more lasting effects but may be more expensive. In the light of their longterm health benefits and efficacy against other endemic diseases, the implementation of these measures in water development projects where technical skill and possibly funds are available, could be justified. In addition environmental management measures are usually beneficial to agriculture.

(c) Mosquito-borne viral diseases

Viral diseases transmitted by mosquitos can either be classified according to the clinical picture which they cause on man or according to biochemical or biophysical properties of the pathogen. The clinical picture may vary from a benign fever with polyarthritis and rash to severe encephalopathy or haemorrhagic syndromes such as yellow fever or eastern equine encephalitis.

The mosquitos responsible for the transmission of viral diseases are mainly *Culex*, *Anopheles* and *Aedes*. The longevity and density of these vectors is directly correlated to the rate of reproduction of the viral disease. Mathematical models defining such relationships can be developed to estimate the size of the risk of an epidemic when factors favouring longevity and density of the potential vectors are introduced in the area by a water development project. The introduction of water bears as a consequence the increase of the relative humidity. The first factor (increase of breeding) is a determinant for increased density. The second factor (humidity) is conducive to an extended duration of life of the mosquito (longevity). The cycle of transmission of viral diseases includes an extrinsic incubation period within the body of the mosquitos which is in on average about 10 days. If the life-span of the mosquito could be reduced to a number of days less than the extrinsic incubation period there would be little likelihood of transmission of the disease. Control operations are therefore based on reduction of breeding sources and shortening of the life-span of the mosquito through insecticides.

Prevention and control are based on a detailed knowledge of the epidemiology of the viral diseases and of the bionomics of the vectors. A detailed study of the ecosystem of the area for the purpose of knowing how the introduction of water shall influence the environment is essential at the planning stage of the water development project.

(d) Filariasis, Onchocerciasis and Trypanosomiasis

Mosquitos are the main vectors of human filariasis and because they depend on water for their breeding, their vectorial capacity increases proportionately with the availability of human hosts. The Culex pipiens complex is the main vector of urban filariasis in countries of the Eastern mediterranean Region (Egypt, Sudan, Somalia, Iran and Oman). It breeds in polluted water of cisterns, cesspits, wells, ditches, wastewater drains, etc. and can tolerate high concentrations of organic matter. Source reduction of breeding sites, environmental sanitation and health education are primary tools in filariasis control.

The vectors of Onchocerciasis are members of the black fly genus Simulium which are found in and affect two countries of the Eastern mediterranean Region, Sudan and parts of the Arab Republic of Yemen. The vector flies breed in rapids of flowing water and therefore are influenced only by hydroelectric schemes entailing the construction of large dams which while eliminating breeding places upstream, may create breeding sites in the spillway of the dams and in the downstream water passage. Chemical control has been the only successful control measure tried which could be from air or ground depending upon accessibility of the breeding sites.

The vectors of sleeping sickness are members of the tsetse fly genus Glossina all of which are nowadays confined to tropical Africa between latitudes $15^{\circ}N$ and $30^{\circ}S$. Unlike mosquitos, tsetse flies are not directly dependent on water for the completion of their life cycle, but are associated with dense, humid, tropical forest, gallery forests in the moist savannah and the low woodlands of the savannah of East Africa.

Water development resources schemes influence or contribute to the spread of vectors of sleeping sickness in as much as they provide resting shelters in the vegetation that develops along reservoirs and main irrigation canals, newly forested areas and similar schemes. In the Eastern mediterranean Region, only in the southern parts of two countries, namely the Sudan and Somalia, has this disease been reported to prevail.

Effective control of tsetse flies can be obtained by the application of insecticides to which no resistance has yet been detected.

2.2 Vector-borne, water-associated diseases of man/animals

Fascioliasis affects cattle, buffaloes, sheep, goats and man. Two species of Fasciola are incriminated i.e. F. gigantica and F. hepatica. The former predominates in the northern parts of the Delta and Nile Valley. The vector of which is the snail species, Lymnaea cailliaudi. The second is localized to the oases where the vector snail Lymnaea truncatula is prevalent. Control measures depend mainly on massive and regular treatment of animals and the use of molluscicides in certain areas. Treatment of man has not yet been carried out.

Heterophyes affects dog, cat, fox and man. The parasite Heterophyes heterophyes requires two vectors; one is a species of fish (Talapia and mugil) and the other is a snail of brackish water, Pirenella conica. The disease is localized in the northern parts of the Delta around the lakes Borollos and Manzala.

Dracunculiasis is caused by a nematode parasite called Dracunculus medinensis, which affects man, dog and horse. The vector is a species of cyclops.

Rift Valley Fever is a viral disease which affects sheep, cattle and man. It has been recently recorded in Egypt in Sharkia Province. The vectors are mosquitos.

Paramphistomiasis affects cattle, buffaloes, sheep and goats especially in areas south of Aswan. The causative agent is a trematode parasite called Paramphistomum cervi which requires snail vectors of the species Bulinus and Biomphalaria.

Filariasis is caused by a nematode parasite known as Dipetalonema evansi which affects only camels with serious results. The vector is the horsefly of the genus Tabanus.

Setariasis is caused by a nematode parasite called Setaria equina which affects internal organs of the horse. The vectors are Aedes aegypti and Culex mosquitos.

Two species of nematode parasites are responsible for onchocerciasis in animals. The first is Onchocerca reticulata and the second is O. cervicalis. They both affect tissues of the horse with unfavourable results. The vectors are species of culicoides to both species in addition to Anopheles mosquitos for the second species.

Many participants explained the problems experienced in their countries, e.g. Iran, Sudan, Syria and Egypt in relation to water-borne diseases and particularly schistosomiasis. They pointed out that in many countries canals and drains get choked due to lack of adequate equipment for clearing silt and weeds. This determines conditions favourable to the breeding of vectors of vector-borne diseases. Moreover, in certain projects, canal banks are wide enough and thus prevent seepage as is the case in the Gezira area of the Sudan. In others the water may percolate through the banks causing water logging, which in turn creates ideal breeding places for anopheline mosquitos.

It was further pointed out that sample survey of urine carried out in 1977 in Khusistan, Iran, showed 1800 positive cases.

3. Socio-economic aspects of water-associated diseases

It is implicitly accepted that by reducing diseases that cut short a life or reduce chronic disability, productivity and economic and social advancement was assisted and stimulated.

For the assessment of the economic value of health, the money value of increased productivity and therefore of income, has been singled out as the most readily quantifiable consequence of disease control. Other values associated with health, social, cultural, psychological, etc., which are clearly appraised by individuals but not easily measured, are ignored as unquantifiable in cost/benefit analysis.

Some workers have based their assessment of benefits on (a) loss of income to society; (b) cost of medical care, and (c) prevention of suffering. Income (or production) is lost when a disease prevents labour force working or compels it to work at a reduced efficiency. Medical costs are incurred for the treatment of illness, hospital care, control and surveillance programme. Finally, prevention of suffering is the consumption benefit, the ultimate goal of all economic activity. Consumption benefits exceed in importance the other benefits of avoided loss of income and the cost of medical care, but are unfortunately non-measurable.

The loss of income or production can be calculated for a disease using data on mortality, morbidity and the absenteeism. The cost of medical care can also be calculated using similar data. The results, however, should be taken as impressionistic. Data are usually incomplete and for the most part unreliable. Also the existence of a large number of unemployed affects the validity of this calculation of productivity.

For this reason, studies of benefits of disease control are incomplete; they give underestimated and distorted results that are easily misinterpreted. Under these circumstances any comparison among competing interest will be biased against health and other programmes where "intangible values" may be of a greater importance to the welfare of the population than well-quantified money profits.

Assessments based on personal perception, feeling and judgement of incommensurable values are useless for statistical analysis. Nevertheless, disability, impairment and early death caused by diseases are too much in evidence in developing countries to be pushed aside as being of any importance to the socio-economic development of the country. It is incongruous to believe that a country can move forward to social and economic prosperity while the vast majority of the population drags behind in sickness, ignorance and destitution.

If the lack of quantifiable parameters makes it difficult to determine the value of health in money terms, this does not mean that valid indications cannot be obtained to demonstrate the magnitude of the adverse impact of disease on socio-economic development.

The group felt that at the time of planning a water resources development project, well-planned studies should be carried out to obtain adequate and pertinent basic data for establishing the socio-economic level of the population; the results of these studies can be used as a baseline for future comparison and evaluation.

The analysis of influences that have intervened in changing the socio-economic status of the population after several years of project operations will point out the importance of health, or the lack of it, in producing such changes.

The group recognized that the effects of health on socio-economic development cannot be analysed separately from those that are produced by improvements in other fields. This is not an argument against their evaluation; on the contrary the fact that various fields of activities, all aiming at improving the quality of life, are so closely related, should encourage the undertaking of collective studies and assessment of their joint impact on socio-economic development.

4. Health aspects of water resources development projects.

Water, one of the elements indispensable to the survival of man and to the promotion of health, sustains the life of other organisms as well and besides contains a number of chemicals. Some of these organisms and chemicals can be harmful and even lethal to man and more frequently their presence in water comes from the interference of man.

It depends on these organisms and chemicals whether water is an asset or an injury to health. The adverse role of water and its connexion with water resources development is evident when the four main roles of water related to health of man are examined:

(a) Water as the source and vehicle of disease

A number of communicable diseases, called water-borne, mainly of the gastroenteric system are caused by micro-organisms that reach the water, live and move in it until they are ingested. Direct human interference through the pollution of water is largely responsible for the introduction of these micro-organisms. They cause killing diseases, largely responsible for high mortality rates, particularly among children. A safe water supply and proper excreta disposal system are effective means for the prevention of water-borne diseases.

(b) Water as the habitat of disease vectors

A number of communicable diseases of man are caused by parasites and viruses that cannot affect the human unless there is another organism that acts as a vector or intermediate host. Indirect human interference, by producing environmental conditions favourable to the propagation of the vectors and hosts, assists in the introduction, spread and intensification of these types of diseases. These diseases are commonly known as vector-borne diseases. They include malaria, schistosomiasis, onchocerciasis, yellow fever and a dozen more of the most common diseases that afflict mankind. These are mainly debilitating diseases that lower the resistance of the sufferers to contracting other infections and reduce their working potential. They are easily transmitted and widespread endemicity is common. As such, they cause serious problems to socio-economic development and affect adversely the cost/benefit relation in water resources development projects.

(c) Water as a man-made health hazard

Here, water is referred to as the carrier of organic and inorganic deleterious wastes that may reach it through such activities as mining exploitation, industrial development, etc. Chemical and radio-active contaminants discharged into water as wastes have produced serious problems in developed countries and there is much concern about their physiological and carcinogenic effects. Water resources development projects, with their availability of water and, in many instances, electricity may stimulate the establishment of industries carrying with it the problem of the disposal of their wastes.

(d) Water as a means for promoting personal and community hygiene

The lack or shortage of water discourages the adoption of personal cleanliness and hinders community hygiene and sanitation. Such situations promote the spread of the so-called "diseases of filth" which include trachoma, scabies, louse-borne typhus. These diseases, which affect mostly children, are always associated with insufficient water for washing, bathing and domestic use. It is a paradox that in many water resources development projects where water for electric power, irrigation, fish culture, etc. is stored in millions of cubic metres, often little or no provision is made for the hundred litres of safe water that a human being needs daily for keeping himself clean and healthy.

The group noted that water resources development projects exert a predominant influence on the prevalence and spread of a number of diseases of man. Of these, diseases where a vector or an intermediate host is an essential link in the transmission chain, are most widespread and have gravest socio-economic consequences and thus their prevention and control must be given high priority in water development schemes. Most of the environmental changes introduced by the project lead to the spread and increase of the existing diseases by producing habitats most suitable for the rapid and intensive multiplication of vectors and hosts while influx of labour or settlers from areas where these diseases are endemic, may increase the intensity of the transmission or introduce new diseases. On the other hand, correctly designed, constructed and operated projects may not only prevent occurence of vector-borne disease but also cause a reduction or elimination of those already endemic in the project or surrounding areas. In practice, however, rare is the major water resources development project in tropical and sub-tropical zones where the problem of malaria or schistosomiasis has not grown from being non-existent or insignificantly mild to acquiring the magnitude of a disaster that puts in jeopardy the success of the project.

The group noted that the development of water resources is launched with the aim of greater and faster development and improvement of socio-economic conditions in the countries concerned. High productivity must thus be preserved and hence the health of populations involved should receive greater consideration.

5. General review of experience of the health impact of water resources development projects

It may be said that wherever water goes, diseases follow in its wake; this is the sad experience that occurs once and again when man impounds and conveys water for his own purposes.

Epidemiological studies carried out among new settlers on the margins of "man-made lakes" indicate the introduction and rapid intensification of malaria and schistosomiasis. Reports from Ghana, Nigeria, UAR and Zambia show that Lakes Akosombo, Kainji, Nasser and Kariba are becoming centres of high endemicity, where malaria and schistosomiasis has affected or may soon affect the surrounding populations.

In most of these projects health hazards were studied to assess their impact, but either these studies were incomplete or untimely for their inclusion in plans and designs, or the recommended measures were not adequate or fully incorporated in the planning and construction designs.

A typical example is Lake Akosombo on the River Volta in northern Ghana. Urinary schistosomiasis was practically absent or mildly present in well identified and restricted foci in the region when the reservoir began to be filled in 1964. By 1967, when the reservoir was full for the first time, the rates of infection among school children in 3 selected sites were 9%, 38% and 42% respectively. One year later an identical survey of these localities carried out by the same team showed that the rate of infection had raised to 99%, 99% and 74% respectively; in one year the disease had spread to practically all children. The original population of 80,000, who had to be displaced from the reservoir area in 1964, has increased to about 140,000 mainly from outside migration.

What is happening on the margins of the major reservoirs is repeated in most of the river basin development projects. In the Awash Valley in Ethiopia, where urinary schistosomiasis introduced by migrant workers affects about 60% of the population; in the Gezira irrigated area in Sudan where after more than 25 years of molluscicide application no apparent improvement in controlling schistosomiasis is recorded and malaria receptivity remains high despite many years of control operations at the yearly cost of about US$1,000,000.

As a result of the construction of the Aswan High Dam ecological changes have taken place along the course of the Nile from Lake Nasser to the Delta. These changes have been propitious to the settlement and multiplication of the snail host of schistosomiasis in regions where snails were absent, and it is predicted that the high infection rate that before was limited to the Nile Delta will spread to all the new reclaimed and irrigated lands. Similar examples were given of Indus river basin in Pakistan and its role in the spread of malaria, the Helmand and Nangarhar valley in Afghanistan, the Jizan Dam in Saudi Arabia, etc.

The Indus Basin covers 70% of the gross areas of the country. The basin is traversed by 5 large perennial rivers and numerous seasonal rivers. Nearly 14 million hectares in the basin are being irrigated by 5 large and medium dams, 20 small dams, 18 river diversion works, 62000 kms of canals, 6,000kms of surface drains and 161,000 table wells. The basin can be classified as a hot bed of malaria. Ample evidence exists that the areas that had low incidence of malaria, become hyperendemic regions after the construction of water development projects.

In Afghanistan two major irrigation projects have considerably increased the local malariogenic potential, one in the Eastern Province of Nangarhar and the second in the South Western Province of Helmand.

Nangarhar Province consists of a large basin stretching from West to East on both sides of the Kabul River. The valley is about 100 kms long and the settled rural population is about 483,000 and is mainly concerned with agriculture and livestock while the town of Jalalabad is a trade centre with a population of 63,000.

The construction of the irrigation project started in 1960 and completed in 1964. The main irrigation canal, with a capacity of 50 m^3/second flows eastwards from a dam over a length of 70 km, and feeds water to secondary canals with a total length of 520 kms. The irrigation area comprises a total of 31,200 ha. The malaria vector species are A. culicifacies and A. stephensi. The malaria incidence was high, an API of 81.1% was recorded in 1976. In 1977 after residual spraying with malathion, it dropped the API in the rural areas to 8.3%. API stands for Annual Parasite Index.

The Helmand river includes six irrigation project areas and receives water from the Kajoki reservoir. The existing diversion dams in the Helmand river at Boghra and Derweshan irrigate an area of 95,000 ha. The total length of the canals and drains is 260km and 2248 km respectively.

Over the years, water logging and increasing salinity of the land have become major problems. The initial drainage system has been able to recover the quality of the land.

The malaria incidence has been on the increase ever since the projects were completed. The Annual Parasite Index which was at 0.09% in 1968 was 35.8% in 1976 and this despite control operations.

Unless measures can be implemented which have lasting effect on the malariogenic potential of the area, the malaria situation will gradually deteriorate in the coming years.

In Wadi Gezan Irrigation and Development Project in south-western Saudi Arabia, a 70 million cubic metres' capacity reservoir constructed in 1970, irrigates an area of 22,500 hectares through 120 km long canal system. The system has been constructed to supplement the old practice of flood irrigation. The canals have not yet been lined.

In the project area, malaria and schistosomiasis have been highly endemic wherever permanent water bodies are found. In addition to the establishment of the Malaria Service Station in Gizan in 1972, a schistosomiasis control and research unit was also set up in Gizan in 1975.

There is no legislation empowering the Ministry of Health to prevent and control vectors of public health importance in water resources development projects, and thus there is a risk that malaria and schistosomiasis may intensify and spread.

It was reported that in the South East Asia Region of the World Health Organization, construction of dams in catchment areas of main rivers, for the impoundment of water for irrigation and/or hydro-electric power schemes, have an important impact on increasing water-related diseases' potential, mainly malaria, filariasis and schistosomiasis.

In Puerto Rico in the south coast irrigation system of Guayama a severe outbreak of schistosomiasis occurred about 15 years after construction of the reservoirs and canals. The disease remained at a high level until control operations started in 1954.

The development of water resources is not necessarily linked to the spread of diseases. In fact, the impoundment of water that results from the construction of a dam can contribute towards reducing and even eliminating certain vector-borne diseases. Such is the case of onchocerciasis; in Volta river basin where 200 km of suitable habitats for the breeding of the Simulium fly, vector of this disease, are eliminated by the reservoir. As for other diseases, conscientious planning and a methodical dedication to good management practice has proved to have beneficial effects on health. In Brazil the careful management and efficient flood control in the operation of the dams on the Parana river and its tributaries has considerably reduced the two major vectors of malaria, A. darlingi and A. albitarsus.

In Saudi Arabia malaria has been practically wiped out from the El Hassa oasis by a drainage project. A large irrigation and drainage project was undertaken by the Ministry of Agriculture in 1967-1971. Nearly 162 springs and 336 drilled wells deliver 14.1 m^3/sec to the system. The average velocity of flow of water in drains varies from 0.3 to 0.7 m/sec. Careful planning and implementation of the project has not only saved water but also has reduced the breeding places for An. stephensi, the local malaria vector species. No anti-adult or larval measures have been carried out since the commencement of the project, and yet the number of malaria cases has been negligible, however detailed investigations are being carried out. Health education of the farmers has proved important in avoiding the creation of man-made breeding places for the proved vector species. The Rahad Irrigation Scheme in the Gezira province of the Sudan was given as another example of success. Engineers together with other experts designed a skeleton for the layout of villages and canalization. Primary studies were carried out by the Ministry of Health and epidemiological survey for case detection was performed. Schistosomiasis and its snail vectors was not found.

Preventive measures such as screening of all immigrants were carried out. Treatment and follow-up was also performed. Latrines were constructed in houses and public places. Three deep wells and 18 shallow wells were constructed in various villages. A hospital of 96 beds and three health centres are under construction. Malaria control units and schistosomiasis units were established with adequate technical staff and trained workers. Molluscicides and drugs have been purchased to meet the requirements.

In two systems on the south coast of Puerto Rico a serious outbreak of disease followed their construction in 1914. By 1930 the irrigated southern plain near Guayama had become the major endemic zone in Puerto Rico, with severe disease and many deaths. In contrast to these earlier water resource projects, the more recent Guajataca System and the Lajas Valley Project never experience problems with schistosomiasis.

No transmission occurred in the Gujataca System because of excellent drainage systems. Transmission did not occur in the Lajas Valley System because of a snail control programme initiated when the irrigation system began operation in 1955.

The most outstanding example of success is the work of the Tennessee Valley Authority in USA, a corporate agency of the Federal Government charged with the planning for the proper use, conservation and development of the natural resources of the Tennessee River drainage basin and its adjoining territory. From 1933 to 1943 the Authority built 14 dams on the main river and its tributaries with the purpose of flood control, navigation and generation of electric power. As some earlier reservoirs had created new mosquito-breeding habitats and malaria had increased to become a major problem, TVA decided from the beginning on pre-impoundment activities and post-impoundment measures which collectively have just about eliminated malaria in the Tennessee Valley.

Thus, through the proper and timely study of possible health hazards, wise and comprehensive planning, and careful and methodic application of good management principles, similar success is within reach of every country.

Bearing this in mind, some international agencies of the UN system established a mechanism for early consultation. As the number of water resources development projects increased, it was found necessary to call periodic meetings for review and discussion.

The Sixth Session of the UNEP Environmental Coordination Board in 1976 reviewed the past experience in examining health aspects of water resources development projects. It included a set of provisions, institutional, administrative and technical, to be used as guiding lines for the collaboration of UN agencies in the development of water resources. It also recommended that such a system for reviewing projects should not be limited to projects assisted by UN agencies, but to be extended to include also projects involving bilateral assistance and projects carried out by national government agencies.

WHO and FAO took further action to strengthen interagency collaboration and signed memoranda of understanding on rural water supply; prevention and control of water-borne and associated diseases; use of wastewater in agriculture and forestry; to define and set the institutional and administrative mechanism for mutual collaboration. Other UN agencies, as well as national and international agencies are expected to join in this agreement.

A policy statement, including the health aspects of water resources development, is currently being reviewed and studied by all agencies concerned; intention is to promote and institutionalize cooperative action between national agencies concerned and to bring together at the country level, all national administrations and the international and bilateral agencies involved, through the establishment of a collaborative framework for effective cooperation.

The Seminar noted that a mechanism has been already proposed for comprehensive collaboration at national, regional and headquarters levels. It involves bilateral support and international assistance to national governments through comprehensive cooperation and coordination. The proper functioning of this mechanism depends on the collection of data and assessment of environmental and health implications and problems that the project may produce. For this reason, it was recommended that information on projects at the proposal stage should be supplied to prospective collaborative agencies to intervene from the start and help in the timely formulation of technical and financial assistance.

It was recognized that this collaboration, to be effective and timely, should start at country level by establishing collaborative relations between national officials and UN and other experts and consultants of the various agencies working in the country. This collaborative effort should scale up to regional and headquarters levels as provided for in the UNEP document, the memoranda of understanding and the policy statements. It was agreed that the means for realistic collaboration are already outlined, but their practical application is still to be adequately institutionalized. An important outcome of this Seminar should be the proposal of recommendations on specific guidelines for achieving the required collaboration and coordination at the country, regional and headquarters levels.

The USAID representative indicated that there is a need to provide quantitative information on the effect of water projects on the health of the people. This will convince the planners to give adequate attention to the health matters related to development projects.

It was also pointed out that it was the policy of the loaning agencies not to support development schemes that may add to a health problem or that may not consider prevention of new health problems that may be created by the scheme.

6. Environmental consideration in the development of water resources projects

Dr L.E. Obeng, Senior Programme Officer, Division of Environmental Management, UNEP, Nairobi, introduced this subject of the agenda and brought for the consideration of the participants of the Seminar the most important points of her paper on "Environmental effects of water resources development".

She referred to environmental problems that result from the construction of dams and irrigation schemes in tropical regions. Although the impoundment of water is necessary for the development of agriculture, fisheries, hydroelectric power generation, navigation and other sources of wealth that contribute to social and economic progress, it can also cause major disturbances in the environment with consequent repercussions.

The displacement of populations in the river basin that will be flooded when the reservoir fills causes many social, cultural and economic disturbances. Their resettlement, together with the influx of immigrant populations, produces problems of land tenure, farming disrupture, food shortage, housing, water supply and sanitation, etc. which are difficult and costly to solve. Added to this, relocated people are exposed to diseases for which they have little or no resistance. They feel insecure in their new environment and readaptation is a slow process.

Ecological disturbances in the reservoir can be destructive to existing species of wildlife unless they are capable of migrating to undistrubed areas or of adapting themselves to the new environment; fish, birds, reptiles, mammals and other sorts of fauna are affected. The rapid growth and spread of aquatic vegetation is a recurrent problem that obstructs fish breeding, navigation and recreation.

The introduction of perennial irrigation, unless properly operated and managed, brings with it new diseases or increases the incidence of those already existing. Schistosomiasis, malaria, trypanosomiasis and onchocerciasis are diseases associated with water impoundment and irrigation.

The transportation and introduction of water into an otherwise dry or seasonally wet ecosystem exerts an overall ecological influence. Inadequate management of canals and drains greatly contributes to aquatic weed growth, water-logging, salination and alkalinization of soils with disastrous effects on agricultural production and on the quality of surface and ground water. Excessive use of fertilizers and other agricultural chemicals may encourage also eutrophication in irrigation and drainage canals.

Dr Obeng concluded with a summary of the major undesirable environmental problems associated with dams and irrigation systems of water resources development projects. She stressed the importance of the investigation and identification of possible problems at the early stage of planning and of the inclusion of appropriate and feasible precautionary measures and their conscientious implementation during the construction and operation of the project.

Environmental changes and their impacts

The development of water resources, as any other engineering enterprise, entails the modification of the physical environment. This interfering with natural conditions disturbs the existing ecological balance, either directly and immediately or indirectly and slowly, with far-reaching consequences in time and place. Direct disturbances are usually evident and assessable; indirect disturbances are difficult to detect or foresee, and even harder to evaluate.

These disturbances produce effects that range from highly beneficial to dangerously harmful. When all these effects are analysed and as far as possible quantified, it is possible to make an inventory of favourable and unfavourable effects with their attached values that represent the relative magnitude and importance of each of them. As in business accounting the balance of assets and liabilities shows profits or losses, the balance of favourable and unfavourable effects will represent the overall environmental impact to be expected from the execution of the project.

The overall environmental impact is produced by the combined action of a series of separate but inter-related impacts on each of the elements of the environment and on the different aspects of human life.

Taking for instance the conversion of the section of a river basin into a water reservoir the following direct disturbances, among others, are to be expected; the change in the flow pattern of the river, the loss of cultivable land, the decay and destruction of vegetation, the migration of wildlife, the submergence of roads, factories, villages, drowning of flood plains upstream and a loss of water from wetlands downstream and subsequent effect on fauna and flora, etc., the loss of possible natural resources (mining, forestry, etc) and of sites of historical or cultural value. Among the effects of these disturbances are the reduction of river water supply in the downstream portion, the recharge of ground water sources, the destruction of terrestrial ecosystems, the introduction and increase of aquatic life (vegetal and animal), the interruption of ways of communication, the displacement and resettlement of people, very often accompanied by a disruption of stable communities and interference with local cultural, social and economic systems and other factors which promote security and well-being.

Examples of indirect disturbances produced by impounded water may include the change in climate (increased humidity, for instance), the formation of swamps, the erosion of basin margins, the modification of land-use patterns, the immigration of new settlers, the erection of villages, etc. Among the effects of these disturbances are the intensification of aquatic weeds and terrestrial vegetation, the enhancement of favourable ecological conditions for vectors and intermediate hosts of diseases; introduction of new diseases with displaced people and exposure of people to diseases for which they have no natural resistance; the changes in water quality; the accumulation of sediment in the reservoir basin and reduction of silt downstream; the increased opportunities for employment in more stable economic activities (cattle grazing, tourism, home industries, etc), the impetus to social and cultural development and improved amenities, the enhancement or deterioration of aesthetics, etc.

Most of the problems described for impoundments are also found on irrigation schemes. More specifically, however, environmental problems of irrigation schemes may be identified as those which do not favour satisfactory development. They are usually due to deficient planning and improper management. The major problems are water-logging, salinization, and alkalinization which affects the soil and crop production. Others are inadequate attention to provision of drinking water supply, sanitation, suitable housing and regulated water contact patterns which aggravate health and social problems. The extensive use of chemical pesticides and fertilizers on crops have of course far-reaching health and environmental consequences.

Environmental impact studies

These studies/will determine the overall impact that the project will produce. Ideally the whole environment, in its physical, biological and human systems, has to be comprehensively studied and all possible disturbances and their effects have to be examined, forecasted and evaluated. This task demands the joint action of a group of specialists in the most diversified fields of knowledge and experience. This would cover such subjects as climate (temperature, precipitation, wind, etc.) physiography (topography, geology, surface and subsurface hydrology, etc), vegetation (terrestrial and aquatic plants) animal life (avian, terrestrial and aquatic fauna) human (social and cultural patterns, occupational and economic activities, health, education, recreation, etc). To begin with a clear picture of the existing environment must be defined and baseline data needs to be collected for subsequent evaluation. In a second step the direct changes that the project is expected to introduce into the physical environment should be identified as well as their effects in producing indirect changes. Thereafter it should be possible to investigate and identify the favourable and unfavourable effects that will be created in the total ecology of the region. An appraisal of these effects will lead to determine the impact on the environment that the project will produce during the construction and throughout the successive phases of operation. While an appraisal of the existing environment and an identification of direct physical changes produced by the project may be made with a reasonable degree of reliability, the determination and forecast of indirect effects will be very difficult and needs careful examination and the use of predictive models.

The need for environmental impact studies

Proposals for water resources development are usually supported by engineering and economic considerations. Thus a proposal would be accepted if it could be justified on the basis of needs and economic benefits to be derived from it and all preliminary studies and planning were directed to design and satisfy these criteria.

The experience, however, has shown that this approach to water resources development had a restricted scope. Projects which were sound from the engineering and economic standpoints, could make such havoc of the environment that sometimes they would fail to fulfil their purpose, become uneconomical and cause serious social problems. The damage to health of people was of particular concern.

It was recognized, therefore, that in addition to the customary analysis of costs and benefits in monetary terms, a detailed assessment of the environmental impact of a project including its health aspect was essential. The study and evaluation of probable impacts resulting from various alternative actions cannot produce an overall quantitative rating but can portray many value judgements that can serve as guides to deciding on the choice of the best among the alternatives.

Water resources development is undertaken for a variety of purposes but all projects have an impact on the ecology and environment of the area. This impact can have far-reaching consequences in the improvement or impairment of the environment and the health of the resident or resettled population. Intensive study of the overall environmental impact of any such development is necessary. The study must consider both the benefits so that they can be developed to the maximum, and the adverse effects, so that they may be minimized through preventive measures incorporated in the design. Such measures, when included in the design, are usually less expensive than control or curative measures undertaken afterwards. Environmental precautionary and corrective measures are sometimes difficult and expensive, but they bring benefits far beyond the immediate benefits of the project. The need for standards and guidelines to evaluate environmental impact is clear. A comprehensive approach considering all factors is required.

The practice of environmental impact assessment

The Seminar recognized that the environmental impact studies of water development projects are complex undertakings requiring extensive surveys, studies, and field research and thus considerable financial resources, specialized manpower and legal and administrative support will be necessary.

In the USA for instance, under the National Environmental Policy Act of 1969, a procedure was established for bringing into effect the most comprehensive approach in pre-planning studies for federal projects. The Council on Environmental Quality was entrusted with the issuing of the necessary guidelines to implement this Act. According to these instructions the agency charged with the execution of the project calls upon the services of other agencies concerned for the all-including study of environmental impacts. The results of these cooperative investigations are set forth in a number of reports which are considered by the executing agency in the development of the plan and later on in the preparation of an environmental impact statement. The first draft of this document is submitted to the contributing agencies for their review and proposed amendments. The second draft is widely circulated, with a request for comments, to all governmental agencies concerned, federal, state, county, town, etc., and to selected official and private institutions and associations in the region.

Information copies are sent to libraries for public inspection and through the press, radio and television people are informed of dates and places where public hearings will be held so that any individual interested in the project can voice his opinion. The final draft, issued under the title "Final Environmental Statement", contains a description of the proposal, the existing environment, environmental impacts of the proposed action, mitigating measures, unavoidable adverse effects and other matters related to the project studies. It presents the correspondence received from commenting agencies, institutions and individuals with the answers to their questions and comments; the public hearings are reported and analysed, including the discussion issues and responses.

As an example, TVA, in 1972, undertook a study of the environmental impact of each of the components of the vector control programme : preparation of reservoir before impoundment, water level management, dewatering projects, drainage, control of plant growth, use of larvicides, etc. and presented in a draft statement that was submitted to the Council on Environmental Quality, sent to federal, state, regional and local agencies for comments, and were made available to the public.

The importance and significance of beneficial and adverse effects on the health and welfare of the population and users, the conservation of wildlife and fisheries, the promotion of recreation and the preservation of aesthetic values are concisely stated and the precautions and measures taken to reduce or overcome minor adverse effects are explained. The possibility of alternative measures or modification of present practices is examined and the potential risk of obtaining short-term benefits at the cost of interfering with long-term goals is commented upon.

Six federal agencies and 34 state, regional and local agencies submitted comments, asked questions, requested additional information or proposed amendments. TVA studied carefully all these remarks and answered each one of them. The final environmental statement incorporated changes that resulted from the review process.

Similar procedures are followed in other countries and makes it possible to gather all available knowledge from specialists and public at large; their contributions exert a substantial influence and give practical assistance to the planning of the project. Its application, however, in many countries is problematic in view of lack of resources and facilities and therefore other simpler guidelines may be adequate and helpful in the assessment of environmental impacts in some situations at least during the initial stages of the projects development.

<u>A broad guideline for planning assessment of environmental impact</u>

The Seminar then considered a checklist in the form of a draft matrix (see Annex 8) prepared for the analysis of the ecological impact of a reservoir for a water resources development project. This matrix lists the major project actions that may have an impact on the environment horizontally at the top so that each action forms the heading of a vertical column, and the environmental factors which together make up the existing ecological system of the area at vertically the left margin of the matrix so that each factor forms the heading of a horizontal line. The intersection of a vertical column and a horizontal line forms a block connecting each proposed action with each environmental factor. In this block it can be indicated whether or not it is expected that a particular proposed action has an effect on a particular factor of the existing environment, and whether this effect is beneficial (+), adverse (-) or has no effect (blank). Thus initially, the matrix can serve as a check-list or reminder of the full range of actions and impacts for planning and programming the main studies required for the analysis of the ecological impact.

The second use of the matrix is to present summarily the results of these studies pointing out which of the proposed actions have the strongest impact on which of the environmental factors. It is very difficult to evaluate quantitively the individual effects that added up give an estimate of the impact. In some instances, it is possible to calculate losses in monetary terms, as for the effects of flooding by damages to waterlogged crops, drowning of cattle, destruction of property, etc. But in most cases, and particularly when dealing with long-term effects, it is impractical even to try to evaluate such effects. Taking the same example, flooding, it is not feasible to assign any figure to the loss caused by an epidemic outbreak of typhoid or cholera resulting from the contamination of a water source by flood waters.

Nevertheless, attempts have been made to give factual and unbiased ratings to these effects with satisfactory results. Two terms have been used in the rating of effects, magnitude and importance. Magnitude is applied in the sense of intensity, it will answer the question of how much will the action affect the environmental factor. Importance is referred mainly to extent in place and time, it will answer the question of how far, long or frequently the action will affect the environmental factor. A flood will be of large magnitude if it disrupts community activities and life but it will be of low importance if the area affected is small or the event occurs every 10 years.

Depending on the thoroughness and scope of the inventory study of existing environmental conditions, the analysis of magnitude of the impact, though in some details subjective, can be factual and unbiased. The importance of the impact generally will be based on the value judgement of the evaluator. The review by several independent evaluators may compensate for any unintentional bias of each of them.

The original matrix may have to be changed or extended according to the findings of these studies, so that the second matrix for evaluating the impact is more adapted to reality. Ratings between 1 and 10 are usually set; 10 for the largest, 1 for the least impact. In each relevant block of the matrix two numbers separated by a diagonal line will appear, one for the magnitude, the other for the importance of the impact.

The comparison of the matrices of each of the various alternatives can serve as a basis for the discussion and selection of the proposed action that offers the most beneficial impact with the least adverse impact.

7. Planning for the prevention and control of water associated vector-borne diseases in water resources development projects

Summary of statements made by representatives of international and bilateral agencies

FAO - Mr T.H. Mather, Senior Officer, Water Resources Development and Management Services, in his statement on "The prevention and control of vector-borne diseases in agricultural water development projects" referred to the fact that of more than 250 papers presented by water managers from all over the world at the UN Water Conference, Mar del Plata, Argentina, 1977, none made "more than a passing reference to water-borne and associated diseases in agricultural development". The lack of concern for the health and welfare of millions of people in these development areas is disturbing; present and future generations are at risk of being chronically, and often permanently, sick unless steps are taken to avoid the breakdown of the health through water associated diseases.

In recent years there has been growing concern at the failure of many agricultural development schemes to achieve their planned levels of intensive production. Low yields are connected with progressive waste and degradation of resources of water and soil, and deterioration due to neglect and lack of maintenance. In common with the disease transmission problem, one of the main root causes of agricultural failure is poor water management.

Sound principles of water use and health protection must be built into old and new agricultural developments alike, if they are not to perpetuate the mistakes of the past. The current FAO programme lays emphasis on the restoration and improvement of 45 million hectares of irrigation and 52 million hectares of drainage in existing agricultural development schemes.

With the desire of intensifying their cooperation, FAO and WHO have reached formal agreement of collaboration in the prevention and control of water-borne and associated diseases and the introduction of rural water supply and sanitation in agricultural development activities.

UNDP - Mr G.E. Antippas, Assistant Resident Representative, Cairo, in his statement on "Mechanism for requesting UNDP technical assistance" explained that national projects financed by UNDP are governed by the Indicative Planning Figure (IPF) which gives an indication of the amount of funds available for allocation over a five-year period. The National Government, usually through the Ministry of Planning, is responsible for the coordination and distribution of these funds to its various activities.

UNDP assist governments in identifying the different needs in such sectors as industry, agriculture, health, transport, communication, etc., and in advising on the use of these funds.

The Seminar participants were informed of the mechanism set up by UNDP for applying for technical and financial assistance. The request document should contain information on such essential elements of a project as development objective, functional emphasis, immediate objective, special consideration, background and justification.

The pre-investment assistance provided by UNDP enables countries to carry out feasibility studies that serve as bases for investment decisions. The catalytic character of this assistance is of particular importance as it engenders further financial assistance for major projects.

USAID - Mr J.F. Thomson, Chief Environmental Health, Office of Health, US Agency for International Development, Washington, in his statement on "AID Concern for Environmental Impact" informed the Seminar that the US Agency for International Development recognizes the worldwide and long-range character of environmental problems and supports initiatives designed to anticipate and prevent the decline in the quality of mankind's environment.

AID policy on the environment is directed (a) to assist developing countries in assessing potential environmental effects of proposed development strategies and projects, and to select, implement and manage effective measures of environmental protection, and (b) to ensure that the environmental consequences of proposed AID-financed activities are taken into account and environmental safeguards are adopted before reaching the final decision to proceed.

Through this policy AID puts at the disposal of developing countries the long scientific and management experience gained by the USA in dealing with its own environmental problems. At the same time, it recognizes the sovereignty of assisted countries, their differing priorities, stages of development, cultural and social values, environmental concerns, etc. AID seeks close collaboration with recipient countries in carrying out is environmental responsibilities.

AID gives major importance to the systematic assessment of every proposed new development activity at the earliest possible stage for identifying significantly potential effects on the environment, and to the preparation of a detailed environmental impact assessment in each case where such effects are probable. Based on the results and significance of this assessment, the host country and AID will reach agreement on any necessary modifications prior to the approval of the proposed activities.

It is AID policy to stimulate and assist cooperating countries to develop the knowledge and institutional capabilities necessary to address successfully the environmental aspects of their national development programmes.

Introduction

The planning of activities for the prevention and control of water-associated diseases in water resources development projects can be discussed by following four closely related approaches: (1) activities at the different stages of execution of the project (2) measures applicable to each of the main components of the project (3) measures directed against each kind of vector (4) measures according to their nature or type.

The Seminar agreed to review and discuss the planning of activities in the order presented in the following table, which offered certain definite advantages:-

Phase of Execution	Type of Measure	Transmitting Vector	Project Component
Planning	Environmental	Mosquitos	Reservoir
Design Construction	Chemical	Snails	Irrigation system
Operation and Maintenance	Biological	Flies	Communities

This order gives a chronological sequence and reduces repetition, as many measures are commonly applicable to reservoirs and irrigation systems against different vectors and project components. In addition, the activities involved in each phase of execution are more distinctly differentiated and planners, designers, constructors and operators can refer more easily to that sector with which they are particularly concerned.

During the planning phase, efforts are concentrated on the acquisition of information through the collection and review of data in available documents, records and reports, and in the undertaking of studies, surveys and investigations to complement and bring up to date the available information. During this phase sufficient knowledge should be acquired so that its analysis will lead to the identification of environmental elements, including man, that will be affected, to the prediction of changes in these elements and to the evaluation of the importance and magnitude of the effects that these changes may produce. Most of this information will be valuable as basic data for planning and for the follow-up evaluation of progress and achievements.

During the design phase, attention is directly addressed to vector control plans and designs of features to be incorporated in the proposed works, to consultation and advice so that planners and designers take into account recommended modifications and additions and reflect them.

During the construction phase, the main task centres on supervisory vigilance by competent health specialists so that the approved changes in design are actually carried out during the construction.

During the operation and maintenance phase, the primary concern is with the planning of long-term and routine activities to be carried out as an integral part of the regular operation of the project. The managing staff of the project will be assisted by the health staff to ensure that adverse health conditions are prevented. The planning and execution of emergency on complementary preventive and control operations against disease vectors and intermediate hosts as well as the periodic evaluation of progress and the following adaptation of operation programmes are essential features of this phase.

Before entering into the discussion of planning health safeguards, a summary review was made of measures available for the prevention and control of vectors associated with water resources development projects.

7.1 Prevention and control measures in water resources development projects

A. Environmental Management

Environmental management measures for vector control are directed towards preventing, eliminating or reducing the vectors and they are aimed at:-

(1) Environmental modification or reduction and elimination of sources where the vector lays eggs, breeds and propagates. This term covers any physical transformation of permanent or long lasting character of land, water and vegetation aimed at changing or eliminating habitats of vectors without undue adverse effects on the quality of the environment. It includes filling, drainage, land levelling, etc.

(2) Environmental manupulation is the term applied to any planned activity aimed at producing conditions unfavourable to vector breeding at their habitats. These activities, such as water salinity changes, stream flushing, water level management in reservoirs, shading and exposure to sunlight, etc. are usually of temporary effect and have to be periodically repeated.

(3) Reduction of man-vector contact covers all means, operations and installations that prevent or reduce the access of vectors or disease agents to human beings. This includes site selection of population centres, mosquito proofing of houses, personal protection and

hygiene and provision of such installations as mechanical barriers, water supply, excreta disposal, laundry, bathing and recreational facilities to prevent and discourage population contact with infested waters.

1. MOSQUITOS

Water level management: This measure can be the most effective for controlling mosquito growth in reservoirs. While water level management is most practicable in reservoirs built in series on the same river system, it may not be feasible or require additional structures when it involves very large impoundments or a single reservoir.

It consists of the periodic lowering and raising of the water level so that the shoreline belt is rapidly dewatered or flooded and thus mosquito eggs, larvae and pupae are stranded or drowned and destroyed. Normally this water fluctuation cycle is completed in one week. The effectiveness of this measure depends on the pre-impoundment preparation of the land that is to be submerged; complete clearance of vegetation that may protrude when the reservoir is at its lowest level of operation and proper drainage of the fluctuation zone to avoid the formation of ponds when the water recedes. Maintenance is required to avoid the growth of weeds and vegetation, particularly the floating-mat type of aquatic plants; the objective should be to keep a clean water surface and a clean shoreline around the reservoir. Water level management as practised by the Tennessee Valley Authority, USA, has proved to be the most effective single measure for mosquito control in reservoirs. Here, a series of reservoirs on the same river basin offers the optimum situation to apply water level management. The peak of mosquito production occurs in late Spring when the reservoirs are full; this allows the periodic weekly fluctuation of water level to start when it is most needed for mosquito control and to combine it with the gradual recession of the reservoir level during the dry season drawdown of the year; the fluctuation of water level is interrupted by the end of Summer when mosquito production ceases.

Water that is drawn out of an upper reservoir to lower its level is used in the next down-stream reservoir to raise its level; step by step the water passes from one reservoir to the next until it reaches the last reservoir. As the system comprises 9 main rivers and 21 tributary dams, the operation requires highly developed water control, careful programming and strict adherence to water management schedules.

In the instance of a single dam, to practise water level management may require building one or two minor "equalising" reservoirs; one upstream to store sufficient water for the periodic raising of the level in the main reservoir, and another, below the main reservoir to receive and store the drawn out water from the main reservoir for subsequent distribution to irrigation systems.

Reservoir preparation: whether or not water level management is practised, the land that will be flooded when the reservoir is full should be prepared. The objective of this preparation for mosquito control is to clear, drain and otherwise modify the basin so that a clean water surface and a clean shoreline is created in the reservoir and so that all marginal ponds, sloughs, depressions, marsh areas and swamps will drain directly to the main lake. The preparation of each reservoir is an individual problem and must be approached on the basis of existing conditions and those expected to develop and prevail after impoundage.

For mosquito control, it is not necessary to clear the deeper portions of a reservoir where all timber would be permanently and completely submerged. When the reservoir is not used for navigation, it is possible to reduce the amount of clearing in the deeper part by cutting the exposed tree tops before the reservoir is completely full; this operation is performed from small boats and barges. It is most important to establish the basic clearing line or zone as accurately as possible; local conditions may indicate the need for extending this zone above the maximum water level.

The initial filling of the reservoir should be as rapid as possible after its preparation, as heavy regrowth of woody species of vegetation may take place if the interval between clearing and reservoir filling is prolonged.

Marginal drainage: The flat margins above the water level of reservoirs are liable to be water-logged and can easily create marshes and swamps unless they are properly drained and connected to the main lake. As these drains are frequently clogged by silt carried by surface water they require frequent cleaning to keep them in working order.

Straightening of the shoreline: Many of the indents and protrusions along the shoreline of the reservoir can be rectified through cutting, deepening and filling. This work shortens the length of the shoreline and allows the wave action to reach all parts of the margin, thus disturbing mosquitos egg-laying and the larvae development. Straightening of the shoreline should be a main feature of the reservoir preparation and should continue throughout its operation.

Dyking and dewatering: When the irregularities in the shoreline cannot be corrected through cutting and filling, dykes and levees are built to straighten the shoreline, particularly in swampy areas. Water accumulated behind the dykes is released to flow by gravity to the reservoir at low level, or otherwise must be pumped. Dykes should be designed and built before the reservoir is filled.

Clearance of vegetation: Shoreline and fluctuation zone of reservoirs should be kept clear of all vegetation to ensure effective control of mosquito larvae. Equally important is it to keep all irrigation canals and drains free from weeds and other plants that grow profusely in the beds and banks; this vegetation apart from retarding and even obstructing the flow of water, provides excellent habitats for mosquito and snail breeding. Vegetation clearance may be combined with canal dredging for silt removal, consolidation of banks and filling of bed depressions. Where this is done frequently, it may prevent mosquito breeding. Otherwise additional marginal deweeding should be done regularly.

Effective utilization of irrigation water: The uncontrolled amount of water delivered to the irrigation system is a major cause of agricultural as well as health problems. Overflowing canals that inundate the adjacent lands and excessive seepage that saturates the soil and forms stagnant pools are as harmful to crops as they are favourable to mosquito breeding. Surplus water may also overtax the capacity of the drainage system, with consequent flooding and formation of stagnant pools.

Water velocity: Canals and drains should be designed so as to convey water at the highest possible velocities. This is an important measure from the viewpoint of economy as well as for mosquito and snail control. Gates and other regulating devices should be installed at those points where they are most effective to ensure that the canals work at their design capacity at all times; an overloaded canal causes erosion, overflowing and excessive seepage, an underloaded canal may cause silting and flow at velocities which may encourage ovipositions and larval growth or snail colonization.

Improvement of the conveyance and distribution systems. The lining of canals and their gradual conversion to covered conduits and pipelines and the introduction of sprinkling irrigation in cultivated fields are means of drastically reducing the opportunities for mosquito breeding.

Flushing of canals and drains: Intermittent irrigation and flushing of canals and drains at regular intervals has been reported to be an effective measure for interrupting mosquito breeding. In the Mahaweli Ganga scheme, Sri Lanka, periodic flushing kept canals free of mosquitos as far as 13 km from the water discharge point.

Reduction of man/mosquito contact: Through proper selection of sites for villages and other communities, away from permanently potential mosquito habitats (reservoirs, lakes, lagoons, etc.) and on the leeward of prevailing winds, access of mosquitos to dwellings can be greatly reduced. A blood survey carried out along the Muzaffargarh canal, Pakistan, showed that the malaria infection rate in the population living within one mile on either side of the canal was twice as high as in the population living further away.

Another means for preventing man/mosquito contact is the mesh-screening of windows and other openings of houses and the use of mosquito nets. These measures will be effective only if they are accompanied by intensive health education of the public in their proper use and maintenance.

2. SNAILS

The Seminar noted that most of the environmental management measures already listed for mosquito control are equally applicable to snail control. (See Annex 9).

Control measures applied to reservoirs such as marginal drainage, straightening of the shoreline and dyking and dewatering will obliterate many of the sites favourable to snails. Water level management has not been tried in areas infested by the intermediate host of schistosomiasis, but as snail eggs have a very short life outside the water, this measure may be as effective for snail control as it is for mosquito control.

Clearance of vegetation in the reservoir, canals and drains is even more important to snail control than it is to mosquito control. Snails to survive need vegetation as food, shelter and anchorage in running water; sometimes even the shade provided by trees along the banks favours snail colonization. While for mosquito control vegetation clearance could be limited to removing floating aquatic plants, cutting reeds, bushes and trees shortly below the lowest operation water level of reservoirs and uprooting weeds that emerge to the surface or on the edges in reservoirs, canals and drains; for snail control it is necessary to remove also deeply submerged vegetation, which can only be done by dredging, as snails can survive at depths of two or three meters below the water surface.

As the snail intermediate hosts can migrate from reservoirs and canals to nearby pools and other water collections, including borrow pits, drainage of ground depressions in cultivated fields and neighbouring lands together with effective control of irrigation water is as essential for snail control as it is for mosquito control.

Canal lining is particularly important for snail control; the lining automatically increases the water velocity, reduces silting and thus vegetation growth. Increased water velocity close to the edges and bed, by reducing water friction, produces a more smoothly flowing current and eliminates "water pockets" which are particularly attractive snail habitats.

The conversion of open canals and drains to covered conduits and pipes and the introduction of subsoil or sprinkling irrigation for cultivated fields is a major deterrent to snail colonization.

Intermittent irrigation to allow canals and drains drying has only a partial effect on adult snails as they can survive desiccation for long periods; however, it would be effective against their eggs in the absence of vegetation. Periodic flushing will wash away many smails especially if it is prolonged and energetic.

Reduction of man/water contact: Man plays an active and wilful role in the transmission of schistosomiasis while in the transmission of malaria or other mosquito-borne diseases his role is passive and unintentional. If schistosomiasis carriers and patients could be persuaded to stop polluting water with their discharges or if people could be prevented from contacting this water, disease transmission can stop. Past experience has proved that this is not feasible, but several means are available to reduce man/water contact.

Siting of villages: Villages and other population centres located adequately away from reservoirs, canals, drains, streams, etc. will discourage people from urinating, defecating, washing and bathing in the same water. Barriers to prevent access to infested waters, such as fencing, are a drastic and unwelcome measure which should be used as a last resort when all other ways of persuasion have failed, but overpasses and bridges on canals and streams have been found effective.

Water supply: The provision of safe, convenient and sufficient water for all domestic purposes is an imperative measure. The type of installation should conform to the degree of development of the community, to the local conditions and to the social level of the users. The system should provide for the adequate drainage of wastewater. For schistosomiasis control it is necessary to add convenient public laundry installations and safe bathing ponds or basins or showers, mainly for children.

Excreta disposal: Whatever the degree of community development, every household should be provided with suitable means for the safe disposal of human wastes. These installations may vary from the simplest latrine, to the water privy and septic tank; in any case they should be simple, easy to maintain, properly located, and acceptable to the users. They should be so built and maintained as to guarantee the protection of soil, surface and ground water from any sort of pollution.

Rainwater disposal: Particular attention should be paid to the drainage of surface water in the neighbourhood of villages and other settlements. When rainfall is abundant, diversion ditches along the boundaries should be dug to keep streets and empty plots dry; within the village, all land depressions exposed to flooding should be filled and levelled.

3. FLIES

As the Seminar had previously discussed, the most important fly vectors associated with water resources development projects are the *Simulium* flies and to a lesser extent the tse-tse flies

Environmental management methods for *Simulium* fly are based on the modification of conditions favourable to their breeding. Oviposition takes place in fast flowing waters, with sufficient turbulence such as river rapids to provide for the necessary aeration and food. Irrigation and drainage systems do not normally offer these conditions; the reservoir, when full, floods long stretches of the main and tributary rivers and thus destroys all fly-breeding sites. The dam at Noumbiel on the Black Volta, between Upper Volta and Ghana will permanently eliminate fly multiplication along the 200 km of the river and its tributaries by the inundation of existing habitats. This flooding will represent a saving of US$150 000 a year, currently spent on larvicidal operations. The fly, however, may continue breeding upstream, above the reservoir or in the overflow spillway of the dam and in the downstream current.

Very little has been done to control vector breeding by environmental management methods and the discussion of the subject was purely theoretical without actual support on facts.

The fast velocity and water turbulence in a natural stream can be reduced by enlarging its cross-section or by reducing its hydraulic gradient.

Cross-section and stream training: Whenever possible obstacles that constrict the even flow of water in the course should be removed; these include boulders and rock masses which constitute the natural bed of the river and frequently jut out on the surface. Sometimes this removal demands extensive underwater blasting with explosives. Blasting could be extended to deepening the water channel at the rapids. By increasing and regularizing the cross-sectional area of the stream, apart from reduced water velocity and turbulence, many of the protruding and submerged rock surfaces on which the fly eggs and larvae adhere will disappear. In streams flowing through slightly sloping ground it would be possible to widen its channel by cutting and rectifying its margins, or by removing sand and gravel banks. It must be recognized, however, that the change of water flow conditions at one point of the river, to eliminate one breeding site, may produce new breeding sites downstream.

Hydraulic gradient: The reduction of the hydraulic gradient demands the construction of a series of weirs or low dams across the stream to produce a succession of basins of slow flowing water. To prevent the formation of fly breeding sites at the foot of each weir, water should not be allowed to spill over the wall. Instead, water should pass from basin to basin through submerged sluice gates, piped spillways or inverted syphons; these devices will not provide sufficient aeration for the breeding of larvae. They have to be so designed as to protect them from becoming clogged by vegetation and other debris carried by the current.

Drying and flushing: Drying of streams, tributaries and in certain situations or seasons the river bed down stream of a dam, may be feasible and is effective if done over periods of a few days. Flushing may be effective only if it is powerful and repeated often during breeding seasons.

Diversion works: In certain instances it would be possible to bypass rapids and other river stretches of high water velocities by the construction or blasting of diversion canals looping out to lengthen the course and therefore reducing the slope of its bed.

Vegetation clearance: Because eggs and larvae need a firm support to which to attach themselves while going through their development stages, all material that offers such support should be removed. This includes stranded debris as well as living vegetation in the stream, tree trunks, reeds, weeds, etc. In rivers with a large seasonal variation of water level this is practically impossible; added to this vegetation clearance should be an almost continuous operation because of rapid renewal in equatorial and tropical climates.

The Seminar felt that the application of environmental management measures, excluding vegetation clearance, may demand major engineering works and, therefore, be costly on a short-term basis. As the fly has a flight range that is measured in hundreds of kilometres, to be effective against the disease these works have to be carried out over long stretches of the river system. Besides, the usually inaccessible nature of river basins and their thick vegetation cover makes it very difficult and expensive to reach all the sites where fly breeding takes place.

The environmental management for the control of the Glossina fly, vector of human and animal trypanosomiasis, is directed to the clearance of vegetation in and around human settlements, ponds, lakes, etc. and at watering points and river crossings.

Conversion of forest land to agricultural production, reclamation of swamps, through drainage and filling, and any other work that implies the destruction of thick vegetation in the neighbourhood of communities will drive the vector further away and reduce its contact with man and cattle.

The provision of a water supply will reduce the need for people getting near the river systems, habitats of the tsetse fly.

B. Chemical Control

1. MOSQUITOS

The production of highly effective insecticides with a lasting residual effect in the late 40s brought forth the most reliable, rapid and practical measure for the control of mosquitos and the diseases they transmit. Despite the fact that certain vectors have developed resistance to some insecticides or have changed their behaviour to elude their action, that stringent precautions are needed to protect man and the environment, and that the cost of chemicals is constantly on the increase, the use of insecticides will remain the main method of control of a number of vector-borne diseases for years to come. To overcome the above drawbacks, the Seminar felt strongly that insecticides must be applied at carefully studied timing, dosages and frequencies with the highest standard of operational efficiency and their use must be restricted to areas and situations where they are absolutely essential.

Residual spraying: As most mosquito vectors normally search for the nearest indoor surface after biting to rest and digest their blood meals, they could be killed, if such a surface has been previously sprayed with an insecticide of lasting residual action. As such, this life longevity is shortened and cannot carry and transmit the diseases. This has been the basic principle for massive campaigns of indoor spraying of houses, stables and other buildings in anti-malaria programmes.

Three different groups of pesticides have been used for residual spraying:-

(a) Chlorinated hydro-carbon compounds (DDT,dieldrin, HCH, etc.) They were the first used and proved to be effective, cheap and most convenient. The stability and long lasting effect of some compounds have been the cause of concern among environmentalists (DDT in particular). Vector resistance forced a reduction in their application indoors and the environmental concern in their use outdoors.

(b) Organophosphorous compounds (Malathion, fenitrothion, etc.) are more expensive and have shorter residual action. They require more frequent application than DDT, which increases operational costs.

(c) Carbamate compounds (Propoxur, etc.) like many organophosphorous materials require special safety measures and equipment because of their high toxicity. Its cost is very high and its residual effect shorter than DDT.

The investigation and production of new residual pesticides has lost its impetus during the last ten years. Prohibitive costs, vector resistance and environmental concern have reduced the scale of pesticide consumption in public health. Improved application techniques, correct timing and dosages meeting local conditions (transmission season, vector ecology, climate, habits of populations, etc.) are essential to prolong the efficacy of chemical control of mosquitos.

Space application: It consists of applying minute particles of the insecticide formulations to the air so that they come in contact with flying or resting mosquitos and kill them. The cost is usually high and requires the use of sophisticated equipment, skilled manpower and a high degree of organization and managerial efficiency which is seldom found in field operations. Its use as a routine operation is usually limited to urban areas or to emergency field operations against disease outbreaks; it could also be used in rural areas as a temporary or supplementary measure to more conventional methods.

(a) Aerosols. The insecticide is applied as a fine mist as they come out from the nozzle of a pressurized dispenser. Pyrethrum, either alone or mixed with other insecticides, is commonly used. Dishlorvos and other similar insecticides have become more popular in recent years.

(b) Thermal fog. The insecticide is broken down and dispersed by hot air produced by a small internal combustion engine or electric motor. It can also be discharged from a venturi tube near the exhaust of a motor car or aircraft. The high speed exhaust gases break the insecticide and disperses it as a fog over a large area as the vehicle or aeroplane moves forward. Heat generators can only be used where humidity is high. In dry air, the hot gases rise quickly and are lost. A gentle breeze (3 to 8 km/h) is needed for wide distribution.

(c) Cold fog. As high heat may break the chemical structure of the insecticide and fog causes traffic problems, cold fog and mists have largely replaced thermal fog. It can also be used in humid or dry air conditions. Mistblowers are used for cold fogging. Their effectiveness depends on their ability to produce evenly distributed droplets of a given range size over a determined swath; malathion, fenthion and naled in solution or emulsion are used for cold fogging.

(d) Ultra-low-volume (ULV) technique. By using high-concentrate pesticides at lower application dosages operational logistics and costs can be greatly reduced. This is of particular importance when aircraft or motor cars are used for insecticide application; without increasing the load, wider coverage can be achieved. However, it increases the toxicity risks, especially during handling and application. Malathion is most widely used in ULV application; naled, fenthion and Abate have also been tried with success. These insecticides are biodegradable and at dosages applied for mosquito control they are quite safe to man and the environment.

Larviciding: Together with chemotherapy, larviciding has been the oldest malaria control measure. The application of oils and Paris Green to breeding areas was the major control measure. Operational techniques have now been improved considerably and newer more effective material and methods are available for larviciding.

Most larvicides are short lived and therefore application must be frequent. This calls for a vast number of operators and field supervisory and evaluation staff with increased administrative, logistic and financial complications. Breeding sites differ widely, may be far away and difficult to locate and treat. Their extent and location may vary with the seasons and with rainfall. This demands constant reconnaissance and measurement. The quality of water and the preservation of aquatic life may dictate the choice of larvicide and the application technique. In short, larviciding should be considered as a supplementary measure, applied to well-defined and restricted breeding sites, and with the recognition that it offers only limited control.

Abate is the most common larvicide, and the small dosages needed for mosquito control are safe to mammals and fish.

Other larvicides used are fenthion and dursban. They have higher toxicity and must be used with care and caution. Compounds used in residual spraying must not be used as larvicides as they may accelerate the development of resistance to some of these compounds.

The correct dosage and uniform application of larvicides present a major problem. Wind, water and vegetation affect the efficacy of the chemical; it relies more than in residual spraying, on the skill and conscientiousness of the operator to cover evenly the whole breeding site. This requires proper training, careful supervision and frequent checking of the results. The dosage and frequency of application have to be increased to take into account these variations so that adequate control can be maintained throughout.

2. SNAILS

Because the use of other methods of schistosomiasis control present definite limitations,& drugs are toxic and only partially effective, sanitation is a long-term measure that depends on human collaboration, etc. Control against the snail intermediate host has in the past been the major method of control of the disease.

Several techniques of molluscicide application have been used from dragging and shaking by hand sacks containing the chemical to drip methods and application by plane.

When chemicals with a lasting molluscicidal effect were developed, the technique known as the "chemical Barrier" was applied to flowing waters; it consisted of applying soluble or emulsifiable chemicals at a constant rate at convenient feeding points of the watercourse, the water current carrying and distributing the chemical throughout its length. The chemical barrier technique has been used as a permanent measure with very low concentrations of the chemical constantly fed to the watercourse or at higher concentrations to produce a shock effect of short duration at periodic intervals.

Hand and motor-driven sprayers are used for treating standing waters, such as lakes, reservoirs, etc. or in watercourses where vegetation may impede the proper dispersion of the chemical by feeding method. Emusifiable and spreadable oil formulations are particularly useful for spraying; wettable powders have also been used.

Chemical application from aircraft, as it is practised for mosquito control, has been done in extensive irrigation schemes. In the Gezira irrigated area in Sudan where all the above techniques have been applied, treatment from aircraft was found effective and economical.

New techniques, such as slow-release and bait formulations, have been actively explored in recent years.

Many chemicals have been used as molluscicides. The earliest, copper sulfate in crystal form, proved to be insufficiently active, toxic to fish and other aquatic life and of very short effect. Sodium pentachlorophenate was the first chemical that retained its molluscicidal activity for some time and could be dispersed from feeding points at the head of the watercourse. Its chemical stability was affected by sunlight; it caused irritating and potentially dangerous effects to handlers. These two chemicals have been replaced by more reliable molluscicides.

N-tritylmorpholine, more commonly known as Frescon, is effective at an extremely low concentration (0.1 - 0.5 mg/l for one-hour exposure and 0.01 - 0.05 mg/l for 24-hour exposure) and has limited general biocidal action. It makes it possible to control snails without harming fish populations. Mud, vegetation and light have little effect on its activity. In acidic waters (pH values below 7.0) a loss of activity may occur because of decomposition by hydrolysis. It is not effective against snails' eggs.

Niclosamide, also known as Bayluscide, is effective against snails, snails' eggs and schistosome cercariae without being toxic to man at dosages applied, but it is toxic to fish and other aquatic animals. It is persistent, but two days after application it is degraded by sunlight. Although it is more expensive, it is more efficient and easier to apply, and may therefore prove to be cheaper on a cost/effectiveness basis. In Puerto Rico, where Bayluscide is exclusively used as molluscicide, very successful results have been obtained at dosages of 0.5 mg/l in standing waters and 3.5 mg/l for one hour application to flowing water.

Other chemicals such as Yurimin, copper carbonate and tin and lead compounds are being tested or gradually coming into practical use.

Some plants offer good potential for snail control; Endod, a herb that has been tried in Ethiopia, has given encouraging results.

The application of molluscides requires measurement of the volume of standing or flowing water to be treated, so that the amounts of chemical required are applied in conformity with the specified dosages and times of exposure. After the initial application, it may be necessary to repeat the operation as dictated by the potential of snail repopulation and the normal pattern of disease transmission.

3. FLIES

The chemical control of the black fly vector of onchocerciasis is directed almost exclusively to the larval stage. Adulticide campaigns are practically unfeasible as the fly widely migrates from the sites of breeding; eggs and pupae do not feed and could only be destroyed by strong contact insecticides.

The fact that larvae feed by filtration of suspended matter in the water and that they are, due to their ecological needs (speed of the flow, food in sufficient quantity) usually concentrated in certain spots facilitates chemical control at this stage of life cycle.

Larvicide formulations are released upstream of each breeding site or set of sites to form a wave of chemicals transported by the water current invading and covering breeding sites as it moves downstream. The hydrologic and topographic characteristics of the watercourse need to be considered in the selection of application points, the dosage, and in the timing of the treament. To prevent harming non-target aquatic life, the chemical should be applied in low concentrations and it should be chosen among the least toxic and biodegradable larvicides. Applications should be periodic, every 7 days is the usual practice, and should be carried out throughout the years unless there is evidence of a reproductive season. Larviciding can be interrupted also for a certain period if the absence of flies has been reported for several weeks or months. Surveillance of these areas will indicate when the larviciding has to be done again.

Temephosan organophosphorous compound has proved to be most efficient and safe and therefore is the most common in use. Accessibility to breeding sites is the major obstacle, particularly during the rainy season. The accidental configuration of the terrain, the lack of roads and the thick vegetation cover of jungles and forests make it impracticable to reach, identify and treat all the breeding places in the watercourse. Resort to aircraft has produced good results; aeroplanes are used for large and medium sized rivers, helicopters for the smaller ones. Larviciding needs to continue for many years and is costly.

The chemical control of the tsetse fly, vector of trypanosomiasis is directed to adults at their habitats in the vicinity of population centres.

Residual spraying of vegetation and animals on which the fly feeds has proved to be an effective measure. As the fly is still susceptible to all insecticides, there is no limitation in the selection; however, for large-scale application, chlorinated hydrocarbon compounds should be avoided because of their persistance and adverse effects on the environment.

Application from aircraft over forest canopy or river systems has also been practised with reasonable results.

C. Biological Control

Predator fish, molluscs, arthropods, etc., parasites, fungi, bacteria and viruses have been used for biological control.

1. MOSQUITOS

Of all the biological agents available for the control of anopheline mosquitos, only larvivorous fish has been used on a wide operational scale with good results. It has been reported that over 265 species of fish have been used against 35 species of mosquitos in more than 40 countries. Gambusia affinis was the first fish to be tried and remains the most effective and widely used in large-scale operations. Other fish that are often used include Poecilia, Tilapia and Lebisthes. The annual fish Nothobranchius and Cynolebias species whose eggs resist desiccation, survive winter cold and hatch with first spring rains, are under study; they may be most valuable in areas with temporary mosquito breeding sites.

The usefulness of fish as a biological control agent depends on being highly prolific and amenable to large-scale cultivation, a "top feeder" resistant to climatic and water quality changes, and of small size to penetrate small breeding sites and could be easily transported over long distances.

Male sterilization is another biological method of mosquito control under field experiment. It consists of releasing masses of adult male mosquitos, laboratory bred and sterilized by radiation or chemical treatment.

2. SNAILS

The use of snails, predators or competitors of the intermediate host, immune to schistosome miracidial infection, has proved highly successful in Puerto Rico. The ampullarid snail Marisa cornuarietis and the planoribidae snail Helisoma tenue are extremely voracious and gradually replace the Biomphalaria glabrata when introduced in water reservoirs and ponds. It has been reported that Marisa and Helisoma snails absorb schistosome miracidia and thus prevent them from reaching the intermediate hosts; in addition, Marisa snails feed on egg masses and the young Biomphalaria snail.

Snail-eating fish, Lepomis and Astatoreochromis, may be of value in the control of snails. It has also been reported that the introduction of Gambusia caused a market reduction in the snail intermediate host populations - Sciomyzidae flies that feed on eggs and young snails have been used in Iran on an experimental basis.

It was recognized by the Seminar that the application of biological control measures requires prolonged and careful study and field testing before they are introduced in large-scale operations.

3. FLIES

Both the black fly and the tsetse fly are exposed in nature to many parasites and predators. Research is under way to identify and evaluate the control potential of these biological agents but it is too early to say whether these agents could be used in mass campaigns.

Sterilization of the male tsetse fly is under study. Research carried out in Upper Volta with the aim of eradication has shown that it is possible to reduce Glossina palpalis considerably in a limited area of a forest gallery. The eradication target has not yet been attained, presumably due to continuous reinvasion of the release area by non-sterile male and female flies from adjacent infested areas.

Weed control: The importance of vegetation clearance as an environmental management measure for control of mosquitos, snails and flies was stressed and thoroughly discussed at the Seminar. It was considered that as this measure has to be carefully studied during the planning and design phases of the project and applied frequently during the construction, operation and maintenance phases to all the components of the project, reservoir, irrigation system and communities, the subject of weed control deserved particular attention.

The term "weed" covers any unwanted or out-of-place weed that grows spontaneously, without cultivation or care, and may become a nuisance, hazard or problem. As most of the disease vectors, at certain stages of their development, feed exclusively on organic matter, the prevention of weed growth deprives them of their main source of food or shelter; this is particularly applicable of aquatic weeds which feed mosquitos and fly larvae and young and adult snails.

Annual and biannual weeds are those that seed and die within one or two years. Perennial weeds are long-lasting, their underground short buds protect them from destruction by chemical treatment and are the most difficult to control.

Aquatic weeds can be grouped into (a) immersed (b) floating (c) submerged weeds and (d) algae, which can be unicellular or filamentous.

Weeds, besides representing a permanent potential or active hazard to health by assisting in the propagation of vectors, can be a problem in irrigation and drainage canals as they obstruct the flow of water, increase silting and may damage banks. In reservoirs they can be an obstacle to navigation, recreation and water quality; many weeds absorb oxygen from the water or produce substances that give an unpleasant odour and taste. Weed growth can be indirectly attacked by canal lining, deepening of reservoir shores, flooding and drying, planting of Bermuda grass, occluding sunlight, etc. or directly destroyed by mechanical means, e.g. burning, cutting and raking, chain dragging or hand-cut removal. Even when weed destruction is conscientiously carried out, it only provides a temporary relief and therefore it has to be repeated periodically.

Biological agents such as herbivorous fish (Amur carp, Tilapia zoli), snails (Marisa) and insects (beetles) have been used for aquatic weed control.

Chemical treatment is the most widely used method of control. Herbicides can be selective having effect only on specific plants, or non-selective. The selectivity of herbicides, however, depends much on environmental factors, dosages and thoroughness of application and plant characteristics.

Herbicides for aquatic weed control act either by direct surface contact or by absorption into the plant, thus capable of reaching and destroying the roots of perennial weeds.

Herbicides can be applied in a dry form, water soluble powders, wettable powders, granular or pellet preparations and dusts, or in a liquid form, water soluble and emulsifiable preparations. Application techniques and equipment are practically the same as for larvicides and pesticides in general.

Numerous chemicals, or combination of chemicals, are currently used for aquatic weed control; their selection depends on many factors, environmental and climatic conditions, water quality, effect on crops of economic value, toxicity to man, animals and fish, persistance in water and soil, cost, etc. Of all the herbicides, copper sulfate is the least toxic to man. Organic herbicides in general are less toxic to mammals. The chemicals and method of application have to be carefully selected so that consequent environmental changes do not produce adverse effects. A combined approach to aquatic weed and vector control may be beneficial to both.

Planning in Different Phases of Project Development

The working programme for the sessions of the Seminar in Alexandria assigned two and a half days to this item of the agenda. Added to this, morning and evening sessions in Khartoum and Wadi Medani were arranged to allow full discussion of the subject. They actively collaborated in the preparation of a check list of major steps for the prevention and control of vector-borne diseases at each phase of water resources development projects, which summarizes the items discussed (See Annex 10).

7.1.1 It was recognized that during the planning phase the health contribution to project planning should be directed along three main lines of action:

(a) Compilation and study of all existing information on health and other subjects that may have effects on health.

(b) Undertaking of investigations and surveys to supplement the available information, bring it up to date or extend it to greater detail.

(c) Analysis of the above information for identification and assessment of present health problems and prediction of possible future repercussions, feasibility studies, cost/effective analyses and other means for establishing the foundation for sound decision-making.

7.1.2 During the <u>design phase</u> the health component of the project should receive the following considerations:-

(a) Establishment of criteria to minimize health hazards which should guide the design of reservoirs, irrigation schemes, communities, etc.

(b) Advice to designers in the incorporation of these criteria in the design of structures and other works, and in the planning and design of operations.

(c) Supervision and assessment of the designers' work and if necessary revision of final designs and plans.

7.1.3 During the <u>construction phase</u> the following steps will be followed for the health safeguards in the project:-

(a) Protection against disease and medical care of the construction labour force. Elimination and control of local vectors and endemic disease.

(b) Advice on adequate housing, sanitation facilities and services, etc.

(c) Inspection to ensure that construction is executed in compliance with approved designs and that all recommended features are actually carried out.

(d) Organization of programmes for health education and community participation.

From the beginning of the operation phase, the health organization, either under the framework of the project or directly administered by the government health authority, should be ready to undertake such activities as:-

(a) Executive: Surveillance, screening and treatment of infected persons, operation of disease control programmes; health training of irrigation and agricultural personnel; public health education and development of community participation.

(b) Advisory: Irrigation techniques, including water level management; programming of the investigation and maintenance work so as to be most beneficial to mosquito, snail, fly and aquatic weed control; agricultural techniques and practices that hinder disease transmission, general sanitation, housing, etc.

(c) Supervisory: Prevention and control measures carried out under the responsibility of the project manager and staff inspection of works and activities to identify and correct possible health hazards, execution of recommended measures for disease control.

(d) Assessment: Evaluation of vector and relevant disease changes, progress of disease control programmes according to type: human treatment, vector control, sanitation, etc. efficacy of vector control programmes according to kind: environmental management, chemical, biological cost/effectiveness analysis, etc.

7.2 General Principles

The Seminar reviewed planning principles applicable to programmes for the prevention and control of vector-borne diseases within the context of the health and administration and as an important part of the health component of water resources development projects.

The examination of planning principles led to the more detailed discussion of those that were considered to be fundamental and of general application. These included:-

(a) Comprehensive approach

Within the health context, it was noted that although special programmes are launched against a specific disease or group of diseases and certain control methods are intensified, other diseases relevant in the project area are usually ignored or other methods of control are neglected. Comprehensive approach involves well-balanced programmes planned in an order of priority and careful selection of a combination of methods selected on the basis of their efficacy, feasibility of application, cost, adaptation to local conditions, etc. It was noted that control measures that can be directed against a disease or a vector could be effective against a whole range of vectors and diseases. This approach thus takes into consideration all these factors as well as socio-economic conditions and cultural patterns and plans and operations that best meet the local conditions and needs.

Within the wide scope of water resources development, where many different and possibly conflicting interests are involved, a comprehensive approach is the only means that will prevent errors which the past has shown to be of difficult and costly correction. This approach offers an opportunity to take into account the opinion and recommendations of specialists in greatly diversified fields, such as ecology, environment, agriculture, irrigation, natural resources, industry, health, welfare, communications, economy, etc. and planners, designers, constructors and operators are in a position to carry out their tasks with the minimum risk of producing conditions with adverse effects.

Although the comprehensive approach is essential at all the phases of project development, at the planning and design phases it acquires its maximum importance. It is at this time that the health specialist, after a thorough study of the area, should advise planners and designers on all the necessary measures and features that must be incorporated in the final plans and designs so that health is safeguarded and even enhanced.

(b) Coordination

Although at the preparatory stage an effort must be made to assign as many specialists as possible in various fields for the planning and design of a water resources development project, it is unrealistic to expect to receive aids far beyond those fields directly connected with the project objectives. It is therefore necessary for the project to rely on the assistance of other national and international agencies, which normally have the required knowledge and experience.

The seminar agreed that effective coordination requires establishment of coordinating boards and committees at various administrative levels and within the framework of the project. As proper coordination depends on consultation, discussion and possible decision to modify plans or programmes, meetings of boards and committees should be regular and as frequent as necessary. Special meetings may be called for dealing with urgent or emergency matters.

Coordination is not a matter that can be improvised. It demands careful planning, formal constitution, clear definitions of functions, delineation of duties and commitments. Members of coordination boards and committees should be chosen among highly qualified personnel. They should also be active, responsible and enthusiastic.

Policies, principles and agreements for coordination are normally worked out at ministerial level. They are channelled down through regional and local levels to project and field officials for implementation. From the project and field level the necessary information is channelled upwards so that coordination agreements reflect local conditions and needs.

Through coordination certain definite purposes are fulfilled:-

(a) General understanding of the aims, needs and limitations of each individual field of activity and of their interrelations.

(b) Clear differentiation of functions, duties and responsibilities.

(c) Development of collaboration and mutual support.

(d) Prevention of interference or duplication of efforts.

(e) Agreement between conflicting parties, their opinions, interests, etc.

(f) Decision-making and choice of alternatives which are most convenient to all parties.

Evaluation

The Seminar reviewed certain of the recommended techniques for evaluation and stressed the importance of undertaking all the studies and surveys at the early stages of the project that are necessary to obtain the most complete and defined picture of the situation. This knowledge is not only essential for sound planning but also for establishing base line data on which all further changes can be compared.

The purpose of evaluation should not be limited to assessing the changes and determining whether they represent success or failure in the progress towards the achievement of objectives in accordance with the established plans and programmes. Evaluation should go further to investigating the causes of success or failure in reaching targets so that action can be introduced either to intensify or to correct and improve the control strategy.

As the success or failure of a specific programme may not exclusively be attributed to its components but may happen to be the result of changes produced by other programmes in the project area, evaluation of all these programmes should be made concurrently and correlations between their effects should be established.

The following factors were considered prominent for evaluation of control measures: degree of performance - the actual against the expected or desirable results; degree of efficiency - cost against benefits obtained (including long-term and side effects; degree of applicability - simplicity or difficulty; degree of safety - innocuous or dangerous to use and handling, to man and the environment; degree of suitability - adaptable to local conditions and acceptable to the population).

Legislation

The Seminar considered that legislation should be looked at more as a guide and a tool that helps in performing a task than as an imposition for action. Legislation plays an important role in defining functions, assigning responsibilities and establishing procedures. In this way, legislation can avoid interference or conflict between two or more agencies operating in the same area, towards common goals, but with different interests and points of view; it should be extended to rule the constitution of coordinating bodies so that the individual interests of all agencies concerned are taken into account, streamlines and regulated for making correct decisions.

A review of laws and regulations applicable to vector control in water resources development projects shows how scanty and inadequate these laws are in certain developing countries. This situation was confirmed by the answers received from seven countries of the Eastern Mediterranean Region invited to answer two preliminary questions on legislation.

To the first question: Is there existing legislation which delegates responsibility to the Ministry of Health for preventing and controlling vectors of public health importance in water resources development projects? Only one country answered in the affirmative; four answered in the negative and two did not answer.

To the second question: Has the Ministry of Health authority to develop and establish regulations for preventing and controlling vectors of public health importance in water resources development projects? Two countries replied affirmatively, three negatively and two did not reply. (See Annex 6).

The need for proper legislation to stimulate and support programmes of prevention and control of vector-borne diseases is evident. Unless the health administration is invested with appropriate authority it cannot carry out efficiently its duties and responsibilities.

Training

Comprehensive and coordinated planning requires sufficient knowledge of the aims, means, needs, scope, etc. of the various activities interrelated with water resources development so that every specialist concerned has an understanding of the principles, methods, practices and limitations of the work carried out by the other specialists. Ideally, planners, designers and operators should know enough about the impacts that their work may produce in fields other than their speciality, such as ecology, environment, agriculture, irrigation, health, social behaviour, economy, etc. so that they recognize the need to summon the assistance of the specialist. As the same time each specialist should know about the work of his colleagues within the same field so that he takes into consideration their interests or consults them in matters of common interest.

The participants discussed various ways for imparting such knowledge through short training courses at educational institutions, or practical in-service training in the field. The present Seminar was considered to be a very effective means to gather diverse specialists and learn from the knowledge and experience for the mutual benefit of all.

The Seminar acknowledged also the great need of educating the public so that they become aware of problems and possible solutions and thus stimulate their interest and encourage their participation.

Information systems and reporting

Regardless of the results obtained from a programme information on projects can always be valuable to others. The reporting of a success or a failure could serve as a model and is equally helpful to progress.

The Seminar noted that information should be based on facts, whenever possible accurately measured and objectively analysed.

Every technique used in collecting data has its inherent errors and margins of tolerance; as long as these techniques remain unchanged, the results can be compared. When this change is desirable, the new techniques should be used for a trial period to ensure their preference and precision.

The Seminar agreed that monitoring of data for reporting requires specific planning, determination of subject areas and parameters for each disease and situation. It was nevertheless possible to establish certain bases of general application to vector borne diseases. The main subject areas and their corresponding parameters are:

(a) Human - morbidity and mortality rates - number of people under prophylaxis or treatment, epidemic outbreaks (no. of cases, duration, etc.).

(b) Ecology - number and extension of breeding places, temperature, quality, flow and velocity of water, air temperature and humidity, rainfall (floods and droughts) vegetation density, etc.

(c) Vector-larval and adult mosquito density, snail density in relation to age (size) life expectation, natural enemies, etc.

(d) Control - Environmental management: quantity estimates of work, area of land reclaimed, drainage, filling, etc. length of canals dredged, cleared, lined, etc. water level fluctuation (depth, cycle) etc.

Chemical: number of operators, amount and types of chemicals, etc.
Biological: number of agents introduced, their density, survival, etc.

Records should be kept for the chronological compilation of collected date: they should be complete, concise and clear.

The analysis of data should aim at defining correlations between the four main subject areas (human, ecology, vector, control operations) and determine their significance (if possible by statistical methods). The correlation between the human and ecology areas indicates the need for control operations. Thus the correlation between malaria morbidity rates and mosquito breeding places suggests the need for source reduction, larviciding or other control measures. On the other hand, if malaria incidence has a correlation with seasonal climatic factors (temperature humidity, rainfall, etc) it indicates the time of the year when control measures should be most effective.

THE CLOSING OF THE SEMINAR - PART I

The seminar met for the last time in Alexandria on Monday, 26 March at a closing session under the chairmanship of Dr A.H. Taba, Regional Director.

Mr H.A. Rafatjah, in his closing address reported that the seminar had completed its work as planned. He praised the participants for their interest, enthusiasm and collaboration, making special mention of the general rapporteur and the co-secretary. He thanked Dr Taba for his keen support and unreserved assistance in the organization of the Seminar and the staff of the Regional Office.

Dr G.H. Yakuby, on behalf of the national participants, expressed his appreciation for such a good and interesting Seminar. He thanked the Secretary and Co-secretary for their dedication and all the WHO staff for their efficiency in running the Seminar.

Mr G.E. Antippas, on behalf of the representatives of international and bilateral agencies, congratulated WHO for organizing and conducting so well seminars on such important subjects. He expressed his personal satisfaction of attending this Seminar.

Dr A.H. Taba closed the Seminar thanking the participants and all others concerned. He wished them bon voyage and a fruitful and interesting continuation of their work in the Sudan.

PART II - FIELD OBSERVATIONS AND PRACTICES

The Seminar offered the participants an opportunity for visiting selected areas in Egypt and the Sudan to observe and study existing conditions associated with prevailing water-associated vector borne diseases, mainly malaria and schistosomiasis.

These field trips enabled the participants to become acquainted with typical examples of disease problems and to inspect the related works, operations and maintenance practices. They examined procedures and methods applied to a wide range of control measures, whether of environmental management, chemical or biological nature.

8. Field Trips

(a) 27 March 1978 - The Nile Delta, Egypt. Visits were made to the newly reclaimed land in Nubaria and the main canal which supplies water by a series of pumping stations from the Nile at a rate of 160 m^3/sec. irrigating 300 000 feddans* of formerly desert land. The lining of the main canal was deteriorating; it contained snails and there was indication of human contact with the water as stairs were provided in the canal lining.

A visit was also made to a subsurface tile drainage project in El-Khairy district Damanhour province, where the ground water level is being lowered by a network of concrete pipe drains mechanically installed. The drainage will improve crop yields and reduce breeding of snails and mosquitos.

(b) 29 March 1978 - Khartoum and the Gezira irrigated area, Sudan. The Seminar resumed its sessions at Hasseib Hall of the University of Khartoum. The morning session was opened by His Excellency the Minister of Health Dr Sayed Khalid Hassan Abbas. Engineer Kamal Mohammed Abdou, Deputy Director of Irrigation, reviewed the responsibility of the Ministry of Irrigation and Hydroelectric Power in supplying water to all irrigation schemes in the Sudan, including the Gezira and Managil schemes, the Sennar Sugar Project, the new Rahad System and several others, with a total area of 5 million feddans. He discussed the characteristics of the canals and drains and their relation to vector-borne diseases. The canals are unlined and the tight, clay soil minimizes seepage problems. Weeds are cleaned manually and silt is removed with mechanical drag-lines. Originally only 50% of the land in the Gezira system was under cultivation but now the extension has risen to 75% and soon will approach 100%. This has increased agricultural productivity, created problems of flooded land, and increased seepage around structures. The main crops are dura, peanuts, sugar, rice, wheat and cotton, which is the crop of main economic value.

Dr Mutamed Amin, Director of the Gezira Schistosomiasis project, described the problem of schistosomiasis which has become a major public health concern in the Gezira, being fourth in priority for the present National Health programme. Recent surveys indicate that 60% - 70% of the people in the Gezira scheme are infected with *S. mansoni* and about 13% with *S. haematobium*. Since 1970 the Gezira Schistosomiasis Project has tested frescon and bayluscide and their present choice is bayluscide, assisted with chemotherapy.

Dr Zuheir Ali Nur, Assistant Under-Secretary in the Ministry of Health, gave a general review of bilharziasis problems throughout the country.

Dr A.H. Abu Yosif, Director of Onchocerciasis Control reviewed the onchocerciasis problem in the Sudan. About 1 to 2 million people are infected, primarily in the southern provinces. About 44% of the population of Bahr-El-Ghazal Province are affected, of this group 12% are economically blind. Limited chemotherapy was started in 1961 and new water resources development schemes are being surveyed for the presence of the blackfly.

Dr Khalil Sherif outlined briefly the general epidemiological surveys now being conducted in new agricultural projects. He referred in particular to studies at the new Rahad Scheme for identifying major public health problems which might result and for assessing their quantitative significance. He pointed out that there was insufficient staff to keep up with the large numbers of new projects.

Dr A.A. El Gaddal, the Director General for International Health Affairs and Malaria and the Chairman of the Seminar Preparation Committee reviewed the malaria situation. A large control programme was organized in 1970 following serious malaria epidemics which affected the cotton harvests of 1969 and 1970. Residual house spraying with malathion is now being used as well as larviciding with Abate during the dry season. Gambusia fish are used to control larvae and chemotherapeutic drugs are widely distributed. The situation was under control by 1977 with a parasite rate of 0.1% based on the exmination of 2815 people in 27 monitored villages.

In Khartoum and surrounding urban areas there are considerable mosquito problems due to standing wastewater. These include Culicine and Anopheline mosquitos. Larviciding is being used until a new sewer system can be installed to eliminate the wastewater.

30 March 1978 - A visit was made to the Khartoum Sewage treatment plant which treats 6.5 million gallons per day through conventional secondary treatment processes using trickling filters. The dried sludge is sold to farmers and the treated effluent is discharged into canals which irrigate a forest known as the Green Belt surrounding the city.

The Green Belt receives too much water and is a source of mosquito production, which is sprayed with fenthion and abate as larvicides. Plans are under discussion to provide better water management to eliminate breeding areas.

Larviciding operations were then observed in the Khartoum area where 160 men are engaged in a programme costing S.P. 190,000 per year. Residual spraying with malathion is also conducted once a year in the houses on the fringe of the urban area. A discussion on the observation there took place at the office of the Provincial Health Commissioner for Khartoum.

1 April 1978 - The Seminar moved to Wadi Medani, visiting the Bilharzia Research Station at Abu Ushar and the Provincial Health Headquarters at Wadi Medani. At Abu Ushar the mollusciciding project covers 400,000 feddans,it is fed into the main canal flowing at the velocity of 1m/sec. It delivers 500,000 m^3/day at minimum discharge and 2,000 m^3/day at maximum discharge.

The area is endemic with both types of schistosomiasis although S. mansoni is higher than S. haematobium. Malaria is also present but at low endemicity level.

Frescon was introduced in 1970 and is applied at 0.06 ppm on a sector of 110,000 acres but it must be applied for at least ten days. Other molluscicides have been experimented with, copper sulphate is used for focal control and bayluscide has been accepted as the molluscicide of future choice, but frescon will be used until the stock is exhausted.

The comparative prices of the molluscicides were given as SP400/metric ton for copper sulphate, SP8/Imp. gall for frescon and SP25/Imp. gall for bayluscide.

Aerial spraying has been tried for mollusciciding and has proved to be effective and cheaper. Molluscicides are applied 4 times a year in April, June, September and December.

Evaluation is done by checking the percentage of survival of caged live snails at least 12 hours after application.

Clearing weeds of the main, branch and smaller canals is carried out by the Ministry of Irrigation, while the Abu Ashreen and Abu Sita irrigation canals and drains is the responsibility of the tenants under the supervision of the Ministry of Agriculture. Clearing weeds does not seem to be progressing well.

Briefing at the Provincial Health Headquarters at Wadi Medani by the Assistant Commissioner of Health, Dr Ahmed and his staff.

Organisation of the Health Services

The primary health unit is the Dressing Station at village level; a dispensary serves a group of villages; a Health Centre supervises a group of dispensaries; there is a District Hospital for each district and, at the top, a Provincial Referal Hospital at Wadi Medani. Each hospital has a health inspector who conducts preventive health activities. Malaria and schistosomiasis control activities are coordinated by the Provincial Medical Officer.

Organization for Communicable Diseases Control

A physician assisted by a public health officer is in charge of the malaria control programme, 164 spraymen are employed throughout the year, even during non-spraying periods. Spraying is done in two rounds the first in June-July and the second in October-November. Malathion is used at a dosage of $2g/m^2$. In the summer from April to June larviciding is done with Abate E.C. Parasite rates have decreased from 19.7% in 1975 to 0.1% in August 1977. Plasmodium falciparum accounts for 98% of the positive cases. The rest is made up of P. malariae and P. vivax. Anopheles gambiae is the main vector, and the cost of larviciding is SP 50,000/year for the chemical and SP 200,000/year for labour.

Entomological evaluation of the control measures is done by the entomological teams at the Malaria Headquarters. In order to improve case-finding at night laboratory technicians have been assigned in hospitals with the cooperation of private doctors. Measures have been initiated to prevent introduction of communicable diseases by imported labour.

3 April 1978 - Field trip to Sennar Sugar Estate. The participants were received by Mr Sayed Mufti, Agricultural Manager of the Gezira Board at the headquarters of the Sennar Sugar Estate. He explained that the Government provides the land and looks after its irrigation, while the tenants are responsible for the production of crops, and the Sudan Gezira Board, the overall coordinator and manager, attends to financing and purchase of the crops. The Board supplies the necessary fertilizers and plant preservers and its experts select the proper cultures, the Board maintains the internal light railway, the clearing and processing installations and performs the duties of agricultural planning. The Board consists of eight board members, two of whom are representatives of the Ministry of Health.

Safe use of insecticides and pesticides in farming areas has been greatly improved by careful study and field trials in accordance with the WHO standards and recommendations.

The Agricultural Council informs the public about spraying operations so that they understand its purpose and the need for their cooperation.

New pesticides have been under field trial by the Experimental Unit for comparison of effectiveness, safety and cost.

Experimental cultivation of various kinds of rice seeds imported from China has been undertaken from June to November which coincides with the rain season. Some strains require irrigation once every 10 days and water remains in the field only for one or two days. The rice field requires periodical drying for applying fertilizer, weed control and improved yields. Introduction of dry-paddy cultivation is also under experiment. This would prevent mosquito breeding.

Rodent control. Two campaigns in 1975 in January and June were conducted in order to reduce the rodent population which rose to 300 captured rats/sq km. Zinc phosphate has been used for controlling rats and was found satisfactory without causing danger to the community.

After the visit to the Sugar Estate, the Sennar Reservoir and Dam were inspected, and the Malaria Training Centre was visited. The reservoir is maintained at a constant high level in order to get the maximum production of hydroelectric power and the newer Roseires Dam upstream is used for storage. Films on the Managil irrigation scheme and on reservoir management for malaria control were shown in the evening and this was followed by a discussion session.

4 April 1978 - A tour of the Wadi Medani Provincial Hospital on Tuesday morning began with the observation of four severe cases of S. mansoni infection, one of them was a 17 year old male who was recently in a coma due to hematemesis. More than half of the admissions to the general medical ward are schistosomiasis patients and about 3% die in the hospital because of gastro-intestinal haemorrhage or neurological coma. The physicians use chemotherapy sparingly because of the weakness of the infected persons and fuadin has been the drug of choice. The number of admissions for schistosomiasis was 559 in 1977, twice the number admitted in 1976. Apparently the severity of the cases is also increasing and even 5 and 6 year-old children are being admitted now with severe infections. The 850 bed hospital serves the 2 million people of Gezira Province with about 1/2 million out-patient visits per year.

A brief inspection was made of the research pond containing the White Amur fish which has been found to be extremely effective in controlling weeds in minor canals. Although fish grow well under local conditions, they have not yet been released for possible adverse ecological consequences.

The afternoon was spent at the new Rahad Irrigation scheme which opened in 1977 and brings 300,000 feddans under irrigation. About 100,000 people will be settled in the area and preliminary work has been done to prevent introduction of snail and mosquito populations and transmission of malaria and bilharziasis. For the present, no transmission of these diseases takes place. Participants discussed measures as to how to continue the success of this preventive programme.

5 April 1978 - Recommendations were discussed and approved by the participants. They are attached at the end of the report. The checklist of major steps for prevention and control of vector borne diseases in each phase of water resources development projects, a joint effort of all the participants, was completed, reviewed and approved (See Annex 10).

9. Case Study

While the Seminar held its sessions in Wadi Medani and toured the Gezira irrigated area, the village of El Karaiba and its surrounding area was assigned for carrying out a case study on malaria and schistosomiasis. The Case Study presented the participants with an actual situation and gave them the opportunity for the practical application of the principles, methods, means, practices, etc. reviewed and discussed during the Seminar.

The participants were divided into 4 groups, their members were selected so that the different disciplines were represented in each group. Basic data, maps and other information was provided beforehand as background to assist them in appraising conditions (See Annex 11).

On 2 April the groups spent the day visiting, observing and investigating health problems and physical factors, existing facilities and services, etc in order to assess the situation. During the following evenings each group met to study and formulate a proposal plan and programme for the prevention and control of malaria and schistosomiasis. At the last session of the Seminar, 5 April 1978 the groups presented their proposals; each proposal was reviewed and discussed.

THE CLOSING OF THE SEMINAR - PART II

Mr H.A. Rafatjah in his closing address thanked the Government of the Sudan for their hospitality and the Sudanese officials especially Dr Gaddal, Chairman of the Seminar Preparation Committee who contributed so much to the success of this part of the Seminar. He expressed his appreciation and thanks to all participants for their interest and active collaboration.

Dr O.M. Zimaity, on behalf of the participants replied thanking WHO for organizing and conducting a very educational and interesting Seminar.

RECOMMENDATIONS

As a result of the deliberations and discussions which took place during the seminar, the participants put forth the following recommendations:

1. WHO, as a follow-up of this Seminar, and in collaboration with other agencies, initiate action programmes to assist governments in preventing and controlling vector-borne diseases in water resources development projects. As an initial step it is proposed that a few water development projects should be selected where the methodologies reviewed during the seminar, especially those of environmental management and biological natures, could be locally examined, field tested for cost/effectiveness, and introduced on a comprehensive basis into design, construction operation and maintenance of these projects.

2. A guiding principle in this action programme shall be that man is not created as a servant to water and crops, but rather that water and crops must serve man, and therefore the right of farming families to an adequate, safe and convenient supply of water for domestic and recreational uses must be given first priority in the development of water resources.

3. Studies of socio-economic impact of health projects should be continued, with the objective of showing the links between water resources development, improved health, and socio-economic improvement. Where feasible, models for planning purposes should be developed to quantify these effects.

4. Because large water resources projects usually cause massive changes in traditional, rural societies, all proposed health measures which affect housing or personal and community behaviour should be developed with close participation of the peoples to be involved, including extensive explanation and promotion of the measures finally agreed upon by the communities. Public education and participation should be planned and promoted with the use of various mass media and public hearings.

5. As part of an already organized cooperative system between FAO, WHO and other international agencies, national coordinating committees (focal points) should be established to coordinate health, agricultural and other aspects of water resource developments within the national agencies concerned and with the international agencies as well.

6. Both the short-term and long-term environmental impact of water projects should be fully considered and studied during the planning phase, and necessary actions should be taken for reasonable protection of the environment.

7. Governments, if necessary with the collaboration of international agencies, should review the legislation available for regulating the development and use of water resources and their health and environmental implications, and introduce any additional complementary legal support required.

8. As a sound and orderly development of water resources depends largely on the availability of staff well acquainted with the various health and environmental implications and with the methodology and techniques for designing and implementing the necessary safeguards, governments with collaboration of the international and bilateral agencies shall organize:-

(a) Orientation courses for those involved in planning, design, construction, operation and maintenance of water projects, dealing with the water associated diseases, their impacts, and their prevention and control;

(b) Short seminars and conferences for decision-makers and project managers to assist them with an understanding of the causes of the diseases, their public health and socio-economic importance and their prevention and control;

(c) Training courses for the health personnel, sanitary engineers, biologists and other professionals involved in prevention and control of water associated diseases;

(d) Further vector-borne, water-associated diseases and their prevention and control may be included in the regular curricula of courses in irrigation and construction engineering.

9. Manuals and guidelines suitable for training and reference should be developed for the use of the staff of water resources projects. Also educational material including audio-visual aids should be developed and demonstrated in country projects and educational institutions.

10. Field research should be conducted on methods and techniques for prevention and control of water-associated diseases and that the results be promptly evaluated for application in projects and for publication in scientific journals.

11. Other seminars on prevention and control of vector-borne, water-associated diseases in water resources development projects should be organized, preferably in areas where such diseases are widespread and have caused serious adverse effects on local populations. The collaboration of WHO and other international and bilateral agencies is much desired and should be encouraged.

A G E N D A

1. The purpose and objectives of the Seminar

2. Water-associated vector-borne diseases

   2.1 Major water-associated vector-borne diseases
   - 2.1.1 Malaria
   - 2.1.2 Schistosomiasis
   - 2.1.3 Others : Filariasis, Onchocerciasis, Dengue haemorrhagic fever, Guinea Worm, etc.

3. Socio-economic aspects of water associated diseases

4. Health aspects of water resources development projects

5. General review of experience of the health impact of water resources development projects

   5.1 Worldwide

   5.2 Regional - EMR, EUR, AFR, SEAR

   5.3 Participating countries

6. Environmental considerations in the development of water resources

7. Planning for the prevention and control of water-associated diseases in water resources development projects

   7.1 Prevention and control measures in water resources development projects
   - 7.1.1 During the planning phase
   - 7.1.2 During the design phase
   - 7.1.3 During construction phase
   - 7.1.4 During the maintenance and operation phase

   7.2 General principles

8. Field observations and practices

9. Case study

Annotated Agenda

1. The purpose and objectives of the Seminar

This Seminar is convened with the purpose of examining the present situation, with its problems and possible solutions, that have resulted from:

a) the increasing number of projects planned and executed for water resources development
b) the drastic adverse effects on health that have been observed in some of these projects, and the difficulties faced in the correction of such effects
c) the need for forecasting the health implications of projects being planned or prepared and for giving early attention to their prevention
d) the need for stressing the importance of disease prevention and control measures in existing projects.

The principal objective of the Seminar is to call the attention of planners, designers, engineers, etc. to the health implications of their work and for the incorporation of features and procedures for preventing disease transmission from the initial stages-surveys, planning, design and throughout the periods of construction and operation.

The Seminar will give basic information of the most important vector*-borne diseases associated with water, their influence on socio-economic development and on the achievement of the objectives of water resources development projects.

It will present the available measures (environmental, management, chemical, biological) for the prevention and control of the most common disease vectors (mosquitos, snails, flies), and their application to the various components of water resources development projects (reservoirs, irrigation schemes, communities).

It will offer the opportunity for discussing the way these prevention and control measures could be incorporated into the planning of water resources development projects and the means required for their effective implementation at the various phases of execution of the project (planning, design, construction, operation). It will discuss also the general principles applicable to establishing working relations between agencies involved.

2. Water-associated vector-borne diseases

The importance of water-associated vector-borne diseases in general types of disease; their causative agents; their classification according to the type of vector involved (mosquito-borne, fly-borne, snail as intermediate host); their prevention and control will be discussed under this item. Also the importance given by the national health administration to prevention and control measures as compared to other health activities - the geographic distribution of major water-associated vector-borne diseases will be reviewed.

Major water-associated vector-borne diseases:

2.1	Malaria	: Epidemiology, including geographic distribution and vector ecology
2.2	Schistosomiasis	
2.3	Others - Filariasis, Onchocerciasis Dengue haemorrhagic fever, Guinea worm, etc.	: Prevention and control, including human prophylaxis and treatment, past and present status of the disease

*) for the purpose of this Seminar the snail intermediate host of schistosomiasis is referred to as a disease vector

A review of past experience and the present status of control measures: their relative efficiency (past successes and failures); the restrictions imposed on their application (financial, skilled workers, effective supervision, inadequate knowledge, environmental implications, etc.).

3. Socio-economic aspects of water-associated diseases

The difficulty of evaluating socio-economic impacts - lack of suitable parameters amenable to simple quantification and comparison, the problem of isolating one single factor, (health), from many other factors involved. Poor results obtained from assessment studies carried out until present (examples).

Assessment of socio-economic factors as one of the requirements for determining feasibility for planning and organizing vector-borne disease control programmes.

The impact of socio-economic development on the health improvement and wellbeing of the people.

The health problems of countries socio-economically developed. The change in the types of disease and in the pattern of health services.

4. Health aspects of water resources development projects

The role of water and its influence on the health of the users and beneficiaries of water resources development projects

1. Water as the source and vehicle of disease: pathogenic organisms, parasites, etc.
2. Water as the habitat of disease vectors: mosquitos and other arthropods, molluscs, etc.
3. Water as a man-made health hazard - pollution caused by the discharge of wastes and run-offs into water: chemical and biological.
4. Water as a means for promoting personal and community hygiene.

5. General review of experience of the health impacts of water resources development projects

Review of the experience so far gained with consideration of health aspects of water resources development projects. Coordination among international bilateral and government agencies.

Reference to cases where water resources development had favourable or adverse effects on the health of the population.

5.1 Worldwide - presentation by WHO HQ

5.2 Regional - EMR, EUR, AFR, SEAR - presentation by WHO RAs/CD

5.3 Country - opportunity for a participant of each country represented to speak about actual experience - problems met and solutions devised towards their overcoming; the role of the health administration in water resources development, their participation in the planning process of the project, their collaboration in the operation of the project, coordination of activities among agencies involved.

6. Environmental considerations in the development of water resources

The impact on the environment at large of the changes in the ecology and physical conditions of the area affected by projects of water resources development. Review of procedures and criteria applied to current programmes for assessing the environmental impact. Need for standards and guidelines to evaluate the impact.

7. Planning for the prevention and control of water-associated diseases in water resources development projects

7.1 Review of the existing biological, chemical and environmental management measures for the prevention and control of mosquito vectors, molluscs intermediate host, and fly vectors of diseases, and the application of such measures to reservoirs, irrigation systems and human communities.

Presentation and discussion of the provisions needed for incorporating prevention and control measures into the planning of water resources development projects and for carrying into effect such provision.

7.1.1 During the planning phase

Initial surveys (epidemiological, entomological, etc.) problem identification, establishment of priorities, feasibility studies, selection of methods of control (Environmental Management, Chemical, Biological) against mosquitos, snails, flies, applicable to reservoirs, irrigation schemes, human communities. Selection of sites and provision for sanitary and other health facilities and services for the communities.

7.1.2 During the design phase

Provision for maintenance activities. Design features for incorporation of selected control measures into the design of water resources development projects in reservoirs, irrigation schemes, communities.

Design features for environmental management and manipulation, (mosquito, fly and snail control).

Design features for facilitating or increasing efficacy and effectiveness of application of chemical and biological agents.

7.1.3 During the construction phase

Supervision and guidance needed to ensure that design features for vector control, including selection of sites and provision of sanitary and other health facilities and services are incorporated in the construction of structures.

Protection of incoming labourers and families against malaria, schistosomiasis and other prevalent diseases. Prevention of spread of new vectors and diseases in project areas.

7.1.4 During the operation phase

Operation and maintenance activities - rehabilitation and modernization of structures. Application of chemical and biological measures of control evaluation of results.

7.2 General principles

The incorporation of measures of prevention and control of water-associated vector-borne diseases into water resources development projects to be effective, demands the establishment of close working relations among all agencies involved in or concerned with water resources development - agriculture, irrigation, industry, power production, communications, health, social welfare, etc. Such relations should be governed by general principles involving:

Comprehensive approach : All the individual interests should be taken into account in the planning of works; their design, construction, operation, management and maintenance. Health is the particular interest of this Seminar.

The forecast of health implications should be based on investigation of conditions prior to the final design of the works so as to propose modifications or to select among various alternatives most compatible with project objectives and health requirements. Preliminary studies should cover among other things; compilation and analysis of available data and information, epidemiological and entomological surveys, investigation of topographic conditions to determine the potential risk of producing habitats for vectors of disease, the location of future human communities, etc.

Coordinated effort : All interests involved should be confronted to determine the fields where there is the possibility of collaborating or sharing responsibility to avoid duplication or parallel activities or where there is the risk of conflict and mutual agreement must be reached on the best overall solution for all interests involved. Effective coordination should be achieved whether this involved national, bilateral, international agencies or any combination of these.

Evaluation : Besides the periodic analysis of progress, routine assessment of results should be incorporated into the operation activities so as to have a continuous view of the efficacy or inefficacy of the measures applied and of the need for planning changes to achieve better results.

Cost estimates and accounts should be precisely audited to determine the financial practicability of the measures applied against the results obtained.

Field investigations should be initiated to delineate causes for changes in endemicity of vector-borne diseases and to elucidate construction and operational factors which affect vector-borne disease transmission or its prevention and control.

Legislation : Regulatory procedures and rules for defining the functions and responsibilities of the agencies directly or indirectly involved in water resources development and their inter-relationships.

Training : Opportunities offered by water resource development projects for training staff at different levels of the administration and in the diverse disciplines involved with the purpose of advancing their knowledge and providing them with a better understanding of the aims, scope and means of the work to be carried out by the different agencies interested in water resources development and its implications.

Information systems and reporting : Compilation and analysis of data should be carried out with the view of being used as the basis for preparing reports on the progress of project activities. The material of such reports can be processed to produce publications of more wider distribution to interested readers.

8. Field observations and practices

Field visits to irrigation schemes in Alxandria and Sudan will provide factual information on existing measures for the prevention and control of water-associated vector-borne disease prevalent in these areas. Participants will observe the problems involved and the means applied for their solution.

9. Case studies

Participants will be divided into groups of 5 or 6 to carry out a case study in a selected area. They will be provided with the area situation analysis and will visit the area for verification and on the spot observation and evaluation. Each group will write a report which will include observation, appraisal and recommendations. The group reports will be discussed at the final session of the Seminar.

Programme of Work

Tuesday 21 March

: Opening address by Dr A.H. Taba, Regional Director EMR

: Adoption of the Agenda

: Address by Mr H.A. Rafatjah, Secretary of the Seminar

: Address by Dr L. Kaprio, Regional Director EUR

: Address by Mr G.L. Pennacchio, UNDP Resident Representative, Cairo

: Election of Chairman and Rapporteur

Part I - Deliberations and discussions, Alexandria		Time
Agenda Item No 1	The purpose and objectives of the Seminar	10.00 a.m.
" " " 2	Water-associated vector-borne diseases	10.15
" " " 2.1	Malaria	
" " " 2.2	Schistosomiasis	
" " " 2.3	Others: Filariasis, onchocerciasis, etc.	
	Discussion	12.30
	Closure	14.00

Wednesday 22 March

Agenda Item no 3	Socio-economic aspects of water-associated diseases	9.00
" " " 4	Health aspects of water resources development projects	9.15
" " " 5	General review of experience of the health impact of water resources development projects	10.00
" " " 5.1	Worldwide	
" " " 5.2	Regional - EMR, EUR, AFR, SEAR	10.30
" " " 5.3	Participating countries	12.00
	Closure	14.00

Thursday 23 March

Agenda Item no 5.3	Country Representative - Pakistan	8.30
" " " 6	Environmental considerations in the development of water resources	9.30
" " " 7	Planning for the prevention and control of water-associated vector-borne diseases in water resources projects	11.15
" " " 7.1	Planning prevention and control measures, introduction, environmental management and manipulation - (reservoirs, irrigation schemes, communities - mosquitos, snails, flies).	12.00
	Closure	14.00

			Time
Friday 24 March			
Agenda Item no 7.1		Discussion of Planning for Environmental Control	8.30
		Planning prevention and control measures, Chemical (reservoirs, irrigation schemes, communities - mosquitos, snails, flies).	9.00
		Planning prevention and control measures, Biological (reservoirs, irrigation schemes, communities - mosquitos, snails, flies).	10.00
" " "	7.1.1 7.1.2 7.1.3 7.1.4	Major steps for prevention and control	11.00
		Closure	14.00
Saturday 25 March			
Agenda Item no 7.2		General principles for planning a) comprehensive approach b) coordination efforts c) legislation d) training e) evaluation f) information systems and reporting	8.30
" " "	7.1	Cost analysis of canal lining	10.00
" " "	7.1	Aquatic weed management	10.30
" " "	7.1.1- 7.1.4	Planning- prevention and control measures (conclusion)	11.30
		Closure (Part I)	14.00
Monday 27 March			
		Address by Dr A.H. Taba	9.00
		Address by Mr H.A. Rafatjah (Secretary)	
		Address by Dr G.H. Yacuby on behalf of the participants	
		Address by Mr G.E. Antippas (UNDP) on behalf of the international and bilateral agencies	
		Official closure of the first part of the Seminar by Dr A.H. Taba	9.30
Part II - Observation tours, Egypt and Sudan			
Agenda item no 8		Area in the Nile Delta, Egypt, main irrigation and drainage system in western Nubaria area (newly reclaimed land) and	10.00
		Tile drainage activities in El-Khairy Damanhour province	
		Departure for Khartoum	02.00

		Time
Tuesday 28 March	Arrival Khartoum and rest	04.30
Agenda item no 8	Briefing by Dr A.A. Gaddal, Chairman of the Sudan preparatory committee	17.00
	Continuation of the discussion, agenda item 7.1 (planning)	
Wednesday 29 March		
	Opening address by H.E. Dr S.K. Hassan Abbas, Minister of Health	9.30
Agenda item no 8	Presentations from representatives of the Ministries of Irrigation and Planning	10.10
	Presentation from representative of the Ministry of Health	11.45
	a) Schistosomiasis, Dr A.Z. Nur and Dr M. Amin b) Onchocerciasis, Dr A. Hafiz c) Malaria, Dr A.A. Gaddal d) health surveys at the pre-construction stage, Dr H. Sherif	
	e) discussed, based on presentations	12.30
	Closure	14.00
Agenda item no 7.1.1 -7.1.4	Continuation of discussion, Agenda items 7.1.1-7.1.4 (planning)	17.00
Thursday 30 March		
Agenda item no 8	Field visits - Khartoum Sewage Treatment Plant - Use of effluent in Green Belt. Urban Vector Control Programme in Khartoum and vicinity	8.00
	Briefing and discussion at the Office of the Provincial Health Commissioner, Khartoum	12.00
	Closure	16.00
Friday 31 March		
	Holiday	
Saturday 1 April		
Agenda item no 8	Travel to Wadi Medani. Visit to the Bilharzia Research Station at Abu Ushar	9.00
" " " 7.1.1 -7.1.4	Planning (continuation) joint meeting and briefings with Health, Agriculture, Irrigation and Planning Departments, Gezira Irrigated Area	16.00

		Time
Sunday 2 April		
Agenda item no 9	Case study in El Karcuba - field observations and investigations	8.00
	Preparation of proposals - films on Gezira and weed control	pm
Monday 3 April		
Agenda item no 8	Field observations - Sennar Sugar Estate and Sennar and Roseires dams.	8.00
	Films on the Managil irrigation scheme and on TVA reservoir management practices	19.00
Tuesday 4 April		
Agenda item no 8	Visit to the Provincial Hospital - observation of chronic cases of malaria and schistosomiasis	8.00
	Visit to research station where the White Amur fish is studied as a means for controlling weeds in ponds and canals.	9.00
	Visit to the new Rahad irrigation scheme	9.30
" " " 7.1	Discussion and preparation of guideline (checklist)	17.00
Wednesday 5 April		
	Review, discussion and approval of recommendationa	7.30
Agenda item no 9	Presentation and discussion of proposals resulting from the case study in El Karaiba	
	Closure of the Seminar	13.00

List of Participants

AFGHANISTAN	Dr Ghulam Hasan Yakuby Vice President Malaria Institute Ministry of Public Health Kabul
	Mr Mehrabuddin Formali Director-General Soil Surveys Ministry of Water and Power Kabul
EGYPT	Dr Osman Mahmoud Zimaity Executive Director Upper Egypt Bilharzia Control Programme Ministry of Public Health Cairo
	Dr Abdel Hai El-Refaii Chief, Department of Parasitology Animal Health Research Institute Ministry of Agriculture Cairo
	Eng. Mahmoud Ali El Gindi Lake Nasser Development Authority Asswan
IRAN	Mr Ataollah Naghib Hazrati Chief Field Operation Division Ministry of Health & Welfare Teheran
	Mr Feizollah Golshan Expert of Water Sanitation Ministry of Health & Welfare Teheran
	Mr Parviz Khourshidi Senior Expert for Water Resources Ministry of Energy Teheran
	Dr M. Motabar School of Public Health & Institute of Public Health Research Teheran

IRAQ	Dr Hashim Abdul Jabbar Saleh Assistant Director Bilharzia Section Endemic Diseases Institute Baghdad
	Mr A. Aziz A. Radha Al Bayati Chief Engineer Directorate General of Irrigation Ministry of Irrigation Baghdad
KENYA	Dr A. Siongok Head Division of Vector Borne Diseases Ministry of Health Nairobi
PAKISTAN	Dr Saiyid Mohammad Mujtaba Director Directorate of Malaria Control Ministry of Health Rawalpindi
	Mr Syed Iftikar Ahmed Shah Chief Water Resources Section Planning Division Ministry of Health and Population Planning Islamabad
	Mr A.M. Kango Director Water Management Ministry of Food and Agriculture Islamabad
SAUDI ARABIA	Mr Emran M.A. Kateb Director Environmental Health & Malaria Control Services Preventive Medicine Administration Ministry of Health Riyad
SUDAN	Mr Hussein Abd El Gadir Waziri Senior Public Health Inspector Bilharzia Control Unit National Council for Research Wadi Medani
	Eng. Gaafer Mahgoub Deputy Director Agrarian Production Schemes Ministry of Irrigation Khartoum

Representatives from other United Nations Bodies

Mr Gian L. Pennacchio,	Resident Representative Cairo	United Nations Development Programme
Mr G. Antippas	Assistant Resident Representative, Cairo	United Nations Development Programme
Mr A. Spleit	Junior Professional Officer Cairo	United Nations Development Programme
Dr Letitia Obeng	Senior Programme Officer Division of Environmental Management Nairobi	United Nations Environment Programme
Mr T.H. Mather	Senior Officer Water Resources Development and Management Services Rome	Food and Agriculture Organization

Representatives of other Organizations

Mr James F. Thomson	Chief Environmental Health Office of Health Washington	US Agency for International Development

WHO Secretariat

Alexandria Part

Dr A.H. Taba	Regional Director	Regional Office for the Eastern Mediterranean, Alexandria
Dr M.O. Shoib	Director of Health Services	Regional Office for the Eastern Mediterranean, Alexandria
Dr P. Chasles	Public Health Administrator (Communicable diseases)	Regional Office for the Eastern Mediterranean, Alexandria
Mr H.A. Rafatjah	Chief, Equipment, Planning and Operations and Secretary of the Seminar	WHO Headquarters, Geneva
Dr L.F. Delfini	Regional Malaria Adviser	Regional Office for the Eastern Mediterranean, Alexandria
Mr R. Bahar	Regional Adviser, Vector Biology & Control and Co-Secretary of the Seminar	Regional Office for the Eastern Mediterranean, Alexandria
Mr V. Parisi	Regional Adviser on Epidemiology	Regional Office for the Eastern Mediterranean, Alexandria
Mr Chen Kuo	Regional Adviser, Community Water Supply	Regional Office for the Eastern Mediterranean, Alexandria

WHO Secretariat (Cont'd)

Mr G.R. Shidrawi	Regional Entomologist	Regional Office for the Eastern Mediterranean, Alexandria
Dr S.A. Zafir	Regional Adviser, Health Education	Regional Office for the Eastern Mediterranean, Alexandria
Dr R.O. Darwish	Regional Adviser, Vector Biology and Control	Regional Office for the Eastern Mediterranean, Alexandria

Khartoum Part

Dr R.A. Khan	WHO Representative	Khartoum, Sudan
Mr H.A. Rafatjah	Chief, Equipment Planning and Operations Secretary of the Seminar	WHO Headquarters, Geneva
Mr R. Bahar	Regional Adviser, Vector Biology and Control and Co-secretary of the Seminar	Regional Office for the Eastern Mediterranean, Alexandria
Dr A.A. Gaddal	Chairman, National Preparatory Committee	Director General for International Health and Malaria Services Khartoum
Mr F.J. Guscio	Consultant	Consulting Engineer, Georgia, USA
Dr W.R. Jobin	Temporary Adviser	Head, Human Ecology Division Centre for Energy & Environment Research University of Puerto Rico San Juan
Dr Zuheir Ali Nur	Temporary Adviser	Assistant Under-Secretary Ministry of Health Khartoum
Mr Zein El Din Babiker	Temporary Adviser	Chief of Operation Malaria Control Division Ministry of Health Khartoum
Mr Kamal M. Abdou	Temporary Adviser	Director, Department of Irrigation Wadi Medani

Consultants and Temporary Advisers

Mr F.J. Guscio	Consultant	Consulting Engineer Georgia, USA
Dr W.R. Jobin	Temporary Adviser	Head, Human Ecology Division Centre for Energy & Environment Research University of Puerto Rico San Juan
Dr Ahmed Abdallah	Temporary Adviser	Technical Adviser Ministry of Public Health Cairo

Consultants and Temporary Advisers (Cont'd)

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Conference Services

Mrs C. Cartoudis Démetrio	Conference Officer	Regional Office for the Eastern Mediterranean, Alexandria
Mrs H Ghoneim	Secretary	Regional Office for the Eastern Mediterranean, Alexandria

Resource Staff

Alexandria and Khartoum Parts

Dr H.K. Githaiga	WHO Scientist (Malacologist)	Schistosomiasis Control Project, Syria
Mr A.O. Tuazon	WHO Sanitary Engineer	Malaria Control Programme Islamabad, Pakistan
Mr N.H. Lin	WHO Sanitary Engineer	Malaria Control Programme Riyad, Saudi Arabia

List of Working Documents

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SOCIO-ECONOMIC ASPECTS OF WATER ASSOCIATED DISEASES by Mr H.A. Rafatjah, Chief EPO/VBC/HQ and Mr J. de Araoz	EM/Sem.VBC/9	3
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THE IMPACT OF WATER RESOURCES DEVELOPMENT PROJECTS ON THE VECTORS OF FILARIASIS, ONCHOCERCIASIS AND TRYPANOSOMIASIS by Mr G. Shidrawi, Regional Entomologist, EMRO	EM/Sem.VBC/10.1	2.3
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STATUS OF SOME VECTOR-BORNE DISEASES AND ATTEMPTS AT THEIR CONTROL IN THE WATER RESOURCES DEVELOPMENT PROJECTS IN SOUTH-EAST ASIA REGION by Dr R.O. Darwish, RA/VBC/SEARO	EM/Sem.VBC/11.2	5.2
PROBLEMS OF MALARIA IN CONNEXION WITH IRRIGATION PROJECTS IN AFGHANISTAN by Dr G.H. Yakuby, Vice-President, Malaria Institute, Afghanistan	EM/Sem.VBC/11.3(a)	5.3
SCHISTOSOMIASIS CONTROL IN JAYIF MARSH IN HAMDANYIA by Dr Hashim Abdul Jabbar Saleh, Assistant Director, Bilharzia Section, Endemic Diseases Institute, Iraq	EM/Sem.VBC/11.3(b)	5.3
HEALTH IMPACT OBSERVED ON THE POPULATION OF GEZIRA SCHEME by Dr H.A. Waziri, Senior Public Health Inspector, Sudan	EM/Sem.VBC/11.3(c)	5.3

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PUBLIC HEALTH RECOMMENDATIONS FOR PREVENTION AND CONTROL OF VECTOR-BORNE DISEASES IN EACH PHASE OF WATER RESOURCE DEVELOPMENT by Dr O. El Zimaity, Executive Director, Upper Egypt Bilharzia Control Programme, Egypt	EM/Sem.VBC/11.3/E	5.3
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REVIEW OF EXPERIENCE OF THE HEALTH IMPACTS OF WATER RESOURCES DEVELOPMENT by Mr A. Tuazon, WHO Sanitary Engineer, PAK/MPD/001	EM/Sem.VBC/11.3/W.1	7.1
REPORT ON GENERAL REVIEW OF EXPERIENCE OF THE HEALTH IMPACTS OF WATER RESOURCES DEVELOPMENT PROJECTS IN KINGDOM OF SAUDI ARABIA by Mr N.H. Lin, WHO Sanitary Engineer SAA/MPD/001	EM/Sem.VBC/11.3/W.2	5.3
HEALTH PROBLEMS RELATED TO EUPHRATES DAM PROJECT by Dr M.K. Githaiga, WHO Scientist (Malacologist) SYR/MPD/002	EM/Sem.VBC/11.3/W.3	5.3
ENVIRONMENTAL CONSIDERATIONS IN THE DEVELOPMENT OF WATER RESOURCES by Mr F.J. Guscio, Temporary Adviser	EM/Sem.VBC/12.1	6
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AERIAL SURVEYS FOR RESERVOIR PLANNING by Mr F.J.Guscio Temporary Adviser	EM/Sem.VBC/12.4	7.1
WATER RESOURCES PROBLEMS GENERATED BY OBNOXIOUS PLANTS by Mr F.J. Guscio, Thomas R. Bartley and Arthur N. Beek	EM/Sem.VBC/12.5	7.1
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INTRODUCTION TO PLANNING by Mr H. Rafatjah, Chief, EPO/VBC/HQ	EM/Sem VBC/13.4	7
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PREVENTION AND CONTROL OF MOSQUITO VECTORS ASSOCIATED WITH WATER RESOURCES DEVELOPMENT PROJECTS by Dr F.E. Gartrell Consulting Engineer	EM/Sem.VBC/14.1	7.1
A HISTORICAL STUDY OF AGRICULTURAL DEVELOPMENT AND BILHARZIA IN PUERTO RICO by Dr W.R. Jobin, Temporary Adviser	EM/Sem.VBC/14.2	5
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CRITERIA FOR THE SELECTION OF MALARIA CONTROL METHODS by Mr H.A. Rafatjah, Chief EPO/VBC/HQ	EM/Sem.VBC/14.7	7.1
CHEMICAL METHODS OF MALARIA CONTROL by Mr H.A. Rafatjah Chief EPO/VBC/HQ	EM/Sem.VBC/15.1	7.1
PLANNING FOR THE PREVENTION AND CONTROL OF SCHISTOSOMIASIS IN DEVELOPMENT IRRIGATION SCHEME by Dr H.A. Waziri, Senior Public Health Inspector, Sudan	EM/Sem.VBC/15.2	7.1
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OPERATION AND MAINTENANCE OF IRRIGATION AND DRAINAGE SYSTEMS, THEIR HEALTH IMPLICATIONS AND REQUIREMENTS, AS A CONTRIBUTOR TO BETTER HEALTH THROUGH VECTOR CONTROL by Mr J. de Araoz, Mr H.A. Rafatjah and Mr D.J. Schliessman

REPORT OF THE HEALTH ASPECTS OF THE LAND AND WATER SURVEY IN THE UPPER AND NORTHERN REGIONS OF GHANA by B.Z. Diamant, WHO Public Health Engineer

ENVIRONMENTAL IMPACT AND MOSQUITO CONTROL WATER RESOURCE MANAGEMENT PROJECTS by Dr F.E. Gartrell, W.W. Barnes and G.S. Christopher, Tennessee Valley Authority

SCHISTOSOMIASIS CONTROL IN BRAZIL by Ernest Paulini, School of Engineering, UFMG, Brazil

SIMULIDAE (BLACKFLIES) AND THEIR CONTROL by Hugo Jamnback, Director, State Science Service, University of New York, New York

COST OF HARVESTING AND SPREADING MARISA CORNURIETIS FOR BIOLOGICAL CONTROL OF BIOMPHALARIA GLABRATA IN AIBONITO, PUERTO RICO, by Dr W.R. Jobin, Assistant Chief Tropical Diseases Section and Dr L.A. Berrios-Duran, Tropical Disease Section, San Juan, Puerto Rico

ANTI-SCHISTOSOMIASIS EFFORTS IN RIVER BASIN DEVELOPMENT PROGRAMMES by R.A. Williams, Division of Malaria and Other Parasitic Diseases, OAU

CONTROL OF BIOMPHALARIA GLABRATA IN A SMALL RESERVOIR BY FLUCTUATION OF THE WATER LEVEL by Dr W.R. Jobin, San Juan Laboratories, Puerto Rico

OPERATION OF IRRIGATION RESERVOIRS FOR THE CONTROL OF SNAILS by Dr W.R. Jobin and E.H. Michelson, Department of Tropical Public Health, Boston

VECTOR CONTROL POLICY TO COUNTER RESISTANCE IN SPECIFIC PROGRAMMES OF CONTROL OF VECTOR-BORNE DISEASES by Mr H.A. Rafatjah, Chief EPO/VBC/HQ, WHO

POPULATION DYNAMICS OF AQUATIC SNAILS IN THREE FARM PONDS OF PUERTO RICO by Dr W.R. Jobin, Tropical Disease Section, San Juan, Puerto Rico

REVIEW OF EXPERIENCE IN EXAMINAING HEALTH ASPECTS OF WATER DEVELOPMENT PROJECTS by WHO and FAO for the sixth session of the UNEP ECB

MEMORANDA OF UNDERSTANDING BETWEEN FAO AND WHO GOVERNING (1) WHO/FAO COLLABORATION IN RURAL WATER SUPPLY AND AGRICULTURAL DEVELOPMENT, (2) WHO/FAO COLLABORATION IN THE PREVENTION AND CONTROL OF WATER-BORNE AND ASSOCIATED DISEASES IN AGRICULTURAL WATER DEVELOPMENT ACTIVITIES, and (3) WHO/FAO COLLABORATION IN WASTEWATER USE IN AGRICULTURE FORESTRY AND AQUACULTURE.

DRAFT POLICY STATEMENT ON HEALTH ASPECTS OF WATER RESOURCES DEVELOPMENT PROJECTS by WHO

List of background documents in the Sudan

MULTIPURPOSE EPIDEMIOLOGICAL SURVEYS IN NEW AGRICULTURAL DEVELOPMENT PROJECTS by Dr Khalil Sherif, Chief Epidemiologist, Ministry of Health, Khartoum, Sudan

A BRIEF REVIEW OF MALARIA CONTROL IN THE SUDAN by Dr A.A. El Gaddad, Director-General for International Health and Malaria Services, Ministry of Health, Khartoum, Sudan

SCHISTOSOMIASIS IN IRRIGATION SCHEMES - PROBLEMS AND EFFECTS by Dr M.A. Amin, Faculty of Medicine, University of Khartoum and Director of Gezira Schistosomiasis Project, Wadi Medani, Sudan

ONCHOCERCIASIS IN THE SUDAN by Dr A.H. Abu Yasif, Director of Communicable Eye Diseases and Onchocerciasis Control Division, Ministry of Health, Khartoum, Sudan

THE SITUATION OF IRRIGATION PROGRAMMES IN THE SUDAN by Mr K.M. Abdou, Director, Department of Irrigation, Wadi Medani, Sudan.

QUESTIONNAIRE

With the purpose of obtaining basic data to have a preliminary view on the importance of water resources development inthe participating countries, a questionnaire was sent to the participants in advance of the Seminar.

The questionnaire consisted of two parts - Part A covered general information concerning government agencies involved, allocation of funds and status of legislation with regard to water resources development. Part B requested specific data for each major project; a specimen of the questionnaire is attached.

Although the information supplied does not lend itself to strict analysis, it provides a basis for formulating certain general remarks and trends:

(a) From 3 to 6 governmental bodies are involved in water resources development. Collaboration among them is based on informal relations in all the reporting countries, with the exception of Iraq and Sudan where formal agreements were reported to exist.

(b) The annual budget allocated for water resources development projects shows a significant increase since 1975, ranging from about 60% in Pakistan to about 500% in Afghanistan and Iraq. In Saudi Arabia the budget for 1976 was almost 12 times higher than in 1975.

(c) Concerning the existence of legislation for the prevention and control of vectors of public health importance in water resources development projects, the situation leaves much to be desired. Only Iran reported affirmatively to the two questions, and Saudi Arabia to the second one, in the questionnaire.

(d) Six countries supplied information on 14 water resources development projects, of which 5 are at the construction phase in Iran while the rest are in operation. With the exception of the drainage project reported by Iraq, all are for irrigation, 6 of which are also for hydro-electric power, with a total capacity of about 2200 megawatts. The combined capacity of the reservoirs is about 20 billion m^3, the irrigated area is about 1.9 million ha and the length of major canals and drains is about 19,000 km. These figures indicate the magnitude of investment and development as well as of risk that water associated diseases represent in the reporting countries, particularly when it is noted that all the projects are located in regions where malaria and/or schistosoimiasis were already a major health problem and which was aggravated after the project started operations.

(e) Concerning health personnel, Afghanistan reported that a physician/epidemiologist and a biologist/entomologist were assigned to the Helnand Valley project, Sudan reported that a physician/epidemiologist and five senior health inspectors were assigned to the Gezira irrigated area, Pakistan indicated having physician/epidemiologists and biologist/entomologists at the Mangla Dam project without specifying numbers.

(f) All countries, with the exception of Iran, reported that epidemiological assessment was carried out in 6 water resources development projects, drug prophilaxis in 4, and chemotherapy in 5.

(g) It was reported that vector control by environmental management was carried out in 3 projects, either exclusively (Iraq) or in combination with other measures; by chemicals in 5 projects, either alone (Pakistan and Saudi Arabia) or combined; by biological means, combined with other measures, in Afghanistan and Saudi Arabia.

SEMINAR ON THE PREVENTION AND CONTROL OF VECTOR-BORNE DISEASES IN WATER RESOURCES DEVELOPMENT PROJECTS

21 March - 6 April 1978, to be held in Alexandria and Sudan

Questionnaire "A"

A. General information

From .... (Name of Country)

and submitted by .. . . (Name and title)

1. Names of federal or central government agencies concerned with water resources development and responsible for:

a) Planning

b) Financing

c) Design

d) Construction

e) Operation

f) Control of health problems

(Please give the official title of each agency for each activity listed).

2. Annual budget allocated for water resources development projects

1975	1978
1976	1979
1977	1980

(Please give the equivalent in US Dollars at the current rate of exchange).

3. Legislation

a) Is there existing legislation which delegates responsibility to ministry of health for preventing and controlling vectors of public health importance in water resource development projects? (Yes/no)

b) Has ministry of health authority to develop and establish regulations for the prevention and control of vectors of public health importance on water resources development projects? (Yes/no)

c) If (a) and/or (b) are answered affirmatively, it is suggested that participants bring copies of legislation and regulations to the seminar and be prepared to discuss them and their countries' operational experiences.

SEMINAR ON THE PREVENTION AND CONTROL OF VECTOR-BORNE DISEASES IN WATER RESOURCES DEVELOPMENT PROJECTS

21 March - 6 April 1978, to be held in Alexandria and Sudan

Questionnaire "B"

Title of Project (incl. location) . . ..

Stage of execution ☐ Planning ☐ Design ☐ Construction ☐ Operation

Collaboration of health agency with agencies concerned

by formal agreement ☐ ☐ ☐ ☐

by informal relations ☐ ☐ ☐ ☐

Type of project. For all types Reservoir capacity (m^3) ....

☐ Hydroelectric - Electricity produced (megawatt) ....

☐ Irrigation - Area of land irrigated (ha) ....

- Length of canals (km) ... .

☐ Drainage - Length of drains (km) ....

Major Health Problems	Malaria	Schistosomiasis	Other (specify)
Existing in area before construction	☐	☐	☐
Introduced or intensified by project	☐	☐	☐

Number of professional health personnel employed

Physician/Epidemiologist ☐ Biologist/Entomologist ☐ Engineer/Vector control ☐

Activities undertaken	Planning	Design	Construction	Operation
Epidemiological assessment	☐	☐	☐	☐
Drug prophylaxis	☐	☐	☐	☐
Chemotherapy	☐	☐	☐	☐

Vector control measures ☐ Environmental management ☐ Chemical ☐ Biological

Budget allocated for health component 1977

Amount (indicate currency) ... . As % of total budget of project ....

CANAL LINING

In advance of the seminar the participants were requested to provide information on costs of various types of linings for canals and drains, based on actual experience in their respective countries. A form was provided with the purpose of standardizing the information and costs, a sample of which is attached. The purpose of this exercise was to collect comparative data on costs of various kinds of linings, their service life and the cost of maintenance, rehabilitation and renovation. This information would be valuable to justify the long-term economics of canal lining as a major method of vector control in irrigation and drainage schemes. Based on the data presented, the following estimates and remarks are made:-

In Iran it seems that for canals of 0.2 m^3/sec capacity, it would be more expensive to line them than to convert them into closed conduits by the installation of buried pipelines of concrete or plastic; the initial high cost is compensated for by cheaper maintenance charges, but more importantly by their expected long life. Taking the cost of compacted earth lining as the unit for comparison, the relative cost of other linings is:-

Buried pipes made of concrete or plastic	0.64
Reinforced concrete prefabricated sections	1.07
Concrete lining cast in place	1.29
Asphaltic macadam	1.43

Pakistan provided very ample information on many types of canal linings. Unfortunately this information was presented in a different way from the proposed pattern; it refers to initial costs that exclude the consideration of expected life of the lining and of maintenance costs. It was possible to adjust figures to take into account the serviceable period but not the maintenance charges, which will affect the following comparison. Taken against the cost of compacted earth lining, the following relative costs were calculated:

Concrete lining cast in place	0.40
Asphalt membrane	0.48
Asphalt sheeting	0.71
Plastic film	0.53
Brick masonry	0.52
Brick with prefabricated asphalt base	0.85
Brick with asphalt membrane	0.89

The above values exclude maintenance costs.

Sudan provided information on compacted earth lining and concrete lining of both types, cast in place and prefabricated sections, for canals of 0.9 m^3/sec capacity. Taking again the compacted earth lining as a unit for comparison the relative cost of the concrete linings are:-

Reinforced concrete prefabricated sections	3.30
Concrete lining cast in place	1.52

COMPARISON OF COSTS OF VARIOUS TYPES OF CANAL LININGS WITH EQUIVALENT FLOW CAPACITY

OF 0.9 m^3/SEC. - 1976 PRICES IN US

	TYPE OF LINING	COST/LINEAL M. - US DOLLARS	EXPECTED LIFE	MAINTENANCE COST/LIN. M. PER YEAR - US $	REMARKS
1.	Unreinforced conc. — trapezoidal or parabolic section	$10.80	50 Yrs.	Small amount	Using trimming machine and slip form for installation
2.	Buried concrete or PVC or ZPM pressure pipe	$22.00	100 Yrs.	Very little	Based on US pipe available & installed using modern excavating equipment
3.	Reinforced prefabricated concrete sects. parabolic or trapezoidal	$25.25	50 Yrs.	Small amount of maintenance	Using modern methods for processing prefabricated sections
4.	Asphalt macadam	$8.25	30 Yrs.	Medium amount	Using slip form machinery
5.	Compacted earth - trapezoidal section	$6.00	8 Yrs.	Considerable	Cost will be related to equipment used. Typical for modern excavating and compacting equipment
6.	Unlined uncompacted earth - trapezoidal section	$3.00	Repaired each year	High annual maintenance	Cost will be related equipment used and labout costs. Typical for US equipment and labour.

COMPARISON OF COSTS OF VARIOUS TYPES OF CANAL LININGS WITH EQUIVALENT FLOW CAPACITIES[1]

Type of Lining (1)	Cost per lineal meter: US dollars (2)	Expected Life Years (3)	Cost per Year per Lineal meter: US dollars (4)	Maintenance Cost per year per lineal meter: US dollars (5)	Cost plus maintenance per meter per year: US dollars (6)	General remarks (7)	Main specifications and characteristics (8)
Unreinforced concrete in place		50				Low annual cost	
Buried concrete or PVC or ZPM pressure pipe		100				Low installation cost	
Reinforced pre-fabricated concrete section		50				Low installation cost	
Asphalt macadam		30				Subject to damage by livestock	
Compacted earth		8				Subject to damage by livestock and weeds	
Unlined uncompacted earth						Subject to damage by livestock and weeds	
Other						Subject to damage by livestock and weeds	

1/ State flow capacity of channel in m_3 per second ______________
Column (4) equals column (2) divided by column (3)
Column (6) equals columns 4 plus column (5)

Information provided by ______________________________
(name and title)
Country ____________________ Date ______________

MATRIX FOR THE STUDY AND ANALYSIS OF THE ENVIRONMENTAL IMPACT OF A RESERVOIR IN A WATER RESOURCES DEVELOPMENT PROJECT

Proposed Actions that may cause Environmental Impact

			Construction activities for land transformation								Water and land regime alteration						Operational activities							Human communities			
		Existing Characteristics and Conditions of the Environment	Dam and impoundment	Offshore structures	Dredging and straightening	Dyking and dewatering	Draining and filling	Vegetation clearance	Blasting and drilling	Noise and vibration	Water hydrology	Stream flow and control	Erosion control	Drainage	Ground cover	Vegetation cover	Energy generation	Food production	Cattle grazing	Recreation amenities	Navigation	Weed control	Insect control	Workers' camps	Scattered houses	Villages and towns	Roads and paths
PHYSICAL AND CHEMICAL CHARACTERISTICS	EARTH	Land formation																									
		Soil constitution																									
		Mineral resources																									
		Construction materials																									
	WATER	Surface																									
		Underground																									
		Recharge																									
		Quality																									
	AIR	Climate																									
		Dust, smoke																									
		Quality																									
	PROCESSES	Floods																									
		Erosion																									
		Silting																									
		Landslides																									
		Earthquakes																									
BIOLOGICAL CONDITIONS	FLORA	Crops																									
		Trees and shrubs																									
		Grass and weeds																									
		Aquatic plants																									
		Endangered species																									

BIOLOGICAL CONDITIONS	FAUNA	Insects																								
		Fish																								
		Birds																								
		Land animals																								
		Endangered species																								
CULTURAL FACTORS	LAND & WATER USE	Agriculture																								
		Forestry																								
		Grazing																								
		Fishing																								
		Hunting																								
		Human settlements																								
	RECREATION	Boating and swimming																								
		Camping and hiking																								
		Resorts																								
	AESTHETICS AND INTEREST	Wilderness																								
		Open space																								
		Parks - reserves																								
		Monuments																								
		Historical sites																								
	HUMAN STATUS	cultural patterns																								
		Population density																								
		Employment																								
		Health and safety																								
	MAN-MADE WORKS	Industries																								
		Structures																								
		Transport networks																								
		Utilities networks																								
		Waste disposal																								
ECOLOGICAL RELATIONSHIPS		Food chains																								
		Water degradation																								
		Brush encroachment																								
		Eutrophication																								
		Disease vectors																								
		Others																								

List of Environmental Management Measures Which Have Proved to be Useful in the Prevention and Control of Malaria and Schistosomiasis

The following environmental management measures have been applied for the prevention and control of malaria and schistosomiasis so as to create conditions unfavourable to the breeding and propagation of vectors and intermediate hosts, to reduce opportunities for the man/mosquito contact or the man/cercaria infested water contact and to assist in the application of insecticides and molluscicides.

The letters M or S indicate that the measure is particularly applicable to malaria or schistosomiasis control, respectively. No indication is given where the measure is equally applicable to the control of either disease.

Items 7.1.2 and 7.1.3. <u>During the design and construction phases</u>

A. <u>In the reservoir and surrounding area</u>

1. Removal of all trees, bushes and other plants that would emerge at maximum drawdown water level of the reservoir.

2. Clearance of all vegetation in the zone of water level fluctuation and about 5m beyond the normal full-reservoir contour so as to produce a clear shoreline.

3. Straightening of margins through cutting, deepening and filling of the reservoir edge.

4. Construction of dykes and levees to separate shallow bays from the reservoir and dewatering of the low areas behind the dykes by the operation of gates, so that the water flows by gravity when the reservoir is at low level or by pumping.

5. Removal of earth from higher areas that would protrude as small islands at maximum drawdown water level of the reservoir.

6. Filling of natural or man-made depressions in the vicinity of the reservoir or draining these depressions through ditches leading to the reservoir.

7. Provision in the dam design for the periodic fluctuation of water level. Large-size gates.

8. Paving or lining spillways and diversion channels where they are exposed to wave action and erosion.

9. Use of waterproof membranes, clayish or plastic, at the base and surroundings of the dam to reduce water seepage, and provision of drainage for possible seepage water.

10. Building of boat operating bases, either by the construction of jetties or by the digging of small channels for the docking of boats. Ramps for launching boats.

11. Provision of paths and other means of access to the reservoir edge for vegetation clearance and insecticide and molluscicide application.

12. S Extension into the reservoir of the drawout structure or outlet conduit so that water is not taken from the edge.

13. S Screening of intakes to prevent the passage of snails.

14. S Extension and deepening of the suction pipe of pumps so that snails do not pass through.

15. S Fencing of the reservoir in the vicinity of villages to discourage people from using the reservoir.

B. In irrigation systems

1. Design of main canals, laterals and sub-laterals to follow straight lines with the minimum number of bends; necessary bends to be of ample curvature.

2. Design of canal gradients and cross-sections to ensure water velocities that prevent silting without scouring.

3. Design of canal grids without interconnections so that water enters at the head or upper end and flows in one direction only.

4. Provision of a gate, siphon or other water control device at the tail or lower end of canals so that they can be flushed empty to the nearest drain when this is necessary.

5. Provision of an effective drainage system to collect and dispose of surface and ground surplus water.

6. Elimination of disused canals and drains and natural streams intercepted by the new system.

7. Filling or draining of borrow-pits along canals and roads.

8. Paving or lining of canals as extensively as possible; it is an irrigation improvement as well as an effective health protection measure.

9. Consideration in the design for covered conduits or pipes for water distribution to cultivated plots and for surplus water drainage.

10. Provision of a sufficient number of bridges across canals so that villages are not isolated from main roads; this will also help maintenance work and the application of insecticides and molluscicides.

11. Protection of the canal section at the entrance and exit of culverts, drops, chutes, control structures, etc. against scouring that may form depressions.

C. In communities

1. Selection of land for villages on high ground with a slight and uniform slope, with sandy top soil that allows water infiltration, filling of any ground depressions.

2. Location of villages away from the edge of the reservoir or the banks of rivers and canals. A distance of 1500m has proved to be adequate in reducing the incidence of malaria; this same distance will discourage people from getting in contact with schistosome infected water.

3 S Provision of a safe water supply in every settlement; the type of supply in accordance with local conditions and importance of the community.

4. S Provision of public facilities for laundry, bathing and recreation of suitable capacity. If needed, provision of cattle troughs.

5. S Provision of excreta disposal installations suitable to soil conditions and of a type according with the importance of the community.

6. Provision of open or closed conduits for the rapid collection, transport and disposal of rainwater in accordance with the climate of the locality.

Item 7.1.4 During the maintenance and operation phases

A. In the reservoir and surrounding area

1. Clearance of submerged, emerging and floating vegetation to keep a bare zone of water level fluctuation and a clean shoreline.

2. Dredging of the reservoir margin to deepen it and produce steeper slopes.

3. Repair of dykes and levees to keep them in proper condition.

4. Filling or draining of natural and man-made ground depressions of recent formation or were unnoticed at the time of construction.

5. Straightening of courses and rectification of gradients of natural streams conveying water from the catchment area to the reservoir.

6. Provision of proper management for the punctual operation of water level fluctuation.

7. Repair of spillways, diversion channels and other structures scoured by water and paving of the damaged sections.

8. Repair of drains that collect and convey seepage water from the dam and other structures.

9. S Repair of grids and screens at the intake structures or suction pipes.

10. S Fencing of the reservoir may be more advisable when communities are provided with a proper water supply.

11. Repair of roads and paths of access to the reservoir edge.

B. In irrigation systems

1. Dredging of canals and drains to bring them back to their original dimensions and correct gradients, reshaping of cross-sections and filling of bed depressions that may retain water when empty.

2. Frequent clearance of vegetation to ensure that canals and drains are free of aquatic plants, weeds, etc.

3. Avoidance of the use of canals for night storage.

4. Repair of control structures and gates to ensure their proper functioning.

5. Repair of culverts, siphons, bridges and filling of bed depressions that are formed by scouring at their entrance and exit.

6. Effective control of water quantity at the intake of the reservoir and at equal gates to prevent over-irrigation.

7. Levelling and grading of cultivated land, particularly where it is exposed to flooding, or provision of drainage when levelling and grading is too extensive.

8. Gradual lining of canals, starting in sections most exposed to scouring and where seepage losses are greater.

9. Gradual transformation of open channels to covered conduits and pipes, starting in sub-laterals and feeding canals. Subsurface drainage.

10. Gradual introduction of sprinkling irrigation for cultivated fields.

11. M Restriction of land-use to daytime occupancy to reduce opportunities for mosquito biting.

12. Periodic flushing of canals and drains.

C. In communities

1. S Maintenance, extension and improvement of water supply installations in accordance with the development of the community and the amelioration of living conditions.

2 S Improvement and transformation of waste disposal installations in accordance with the development of the community and amelioration of living conditions.

3. Maintenance, extension and improvement of the rainwater collection and disposal system.

4. M Introduction of a public service for the collection of household and other wastes.

5. M Mosquito-proofing of houses.

Checklist of Major Steps for the Prevention and Control of Vector-borne Diseases at each Phase of Water Resources Development Projects

PLANNING PHASE

(1) Review of existing information on health and related subjects

(a) Epidemiology: morbidity and mortality rates, geographic distribution, vectors ecology
(b) Health and medical services: facilities, staff, special projects and programmes; degree of development, capacity and coverage
(c) Human population and characteristics: agricultural, migrant, nomadic, etc. population growth, importance of migratory movement, displacement within the project area
(d) Cattle: its number and economic importance, cattle diseases
(e) Community and housing patterns: location, design, construction materials
(f) Water supply, excreta and wastes disposal facilities
(g) Climatic patterns: temperature, rainfall, humidity, wind, etc.
(h) Water: surface and ground water, quality, pollution, abundance and seasonal variation, floods and droughts, seasonal variation in temperature
(i) Soil: physical and chemical characteristics, including permeability, stability, salt content, etc.
(j) Natural and cultivated aquatic and land vegetation, domestic and wild animals
(k) Economy: national and local, sources and levels of income
(l) Topographic maps: contour lines, roads, villages, etc. of the region and the watershed, design plans of proposed project, etc.

(2) Surveys : To check or fill in information gaps; assessment and collection of basic data by specialists.

(a) Detailed epidemiology of major existing diseases and biology and ecology of principal vectors
(b) Health and medical services, disease and vector control programmes and activities, evaluation of effectiveness and resources
(c) Human and cattle movement: migratory currents, their origin and paths
(d) Sanitation: sources of water supply in use and potential, investigation of ground water sources, active and potential sources and ways of pollution, practices of water contact, excreta disposal, cattle watering and manure disposal.
(e) Existing and proposed agricultural crops and practices: irrigation methods, suitable crops, rotation in cultures and irrigation, use of pesticides and fertilizers, their kind and amount
(f) Local economy: at present and prospects of future development
(g) Socio-cultural patterns: present level and possible disturbance produced by the project
(h) Engineering and operational reconnaissance and mapping for ecological, hydrological and geological or soil studies
(i) Contact with agencies operating in the project area, type of their activities and possibility for assistance and coordination.

(3) Decision making for the prevention and control of diseases

(a) Review of project proposals and preliminary designs and options
(b) Identification of existing health problems
(c) Prediction of possible future problems and of their health effects
(d) Determination of the importance and extent of actual and potential health problems to establish an order of priorities in prevention and control operations
(e) Feasibility studies of control measures, including cost/effectiveness and cost/benefit analysis
(f) Selection of village sites and types of water supply and excreta disposal installations
(g) Selection of methods of vector and disease control and estimates of manpower and organizational requirements
(h) Organization of field trials and pilot projects
(i) Settlement of displaced and immigrant population and estimates for the provision of water supply, sanitation and other health facilities.

DESIGN PHASE

(1) Establishment of design criteria to minimize health hazards and to achieve objectives of the health programme.

(2) Evaluation of preliminary project designs and alternatives.

(3) Establishment of proposed practices of water system management and their effects on vector habitats.

(4) Preliminary design and options for canal lining overpasses and other health structures

(5) Final detailed design of works in the reservoir
(a) shoreline modification and improvement
(b) clearance and disposal of trees and brush, of man-made structures and fences
(c) relocation of roads, villages, cemeteries, shrines, etc.
(d) discharge structures sized for water level management and downstream flushing.

(6) Final detailed design of works in irrigation schemes
(a) Equalizing reservoirs and night storage ponds, when necessary
(b) Canals and drains
(c) Regulating structures, gates, sluices, etc. and distributing chambers.
(d) On-farm water use
(e) Ground water use and control
(f) Potential for incorporating domestic water supply

(7) Final detailed design of measures and works in communities
(a) Selection of sites for new communities distant from water
(b) Provision of safe, adequate and convenient water supply and sewage disposal systems
(c) Recreation, safe ponds as alternative to infected water contact, sports grounds, etc.
(d) Other protective measures, such as house screening, surface water drainage, general sanitation, public laundry installation, etc.

(8) Provisions for maintenance activities and their financing.

(9) Environmental management.
   (a) Regulating structures for measurement and control of water discharge and velocity
   (b) Gates required for rapid drying and flushing of irrigation syb-systems
   (c) Adjustment of water salinity in coastal breeding sites through the installation and operation of gates
   (d) Water level management in small reservoirs by means of automatic siphon spillways
   (e) Safe crossings and bridges over canals and drains
   (f) Lining of canals and drains, closed or subsurface conduits.

(10) Enhancement and simplification of chemical and biological control
   (a) Design dispensers for chemical application attached or incorporated to regulating structures, metal rakes and screens against snails,
   (b) Provide access roads and paths for surveillance and spraying, clear water lanes and landings for boats

(11) Public health education and development of community participation.

(12) Health facilities - dispensaries and hospitals.

CONSTRUCTION PHASE

(1) Health protection of the construction labour force

(2) Special facilities for disease control and treatment at the construction site

(3) Adequate housing and sanitary facilities for construction workers and their families.

(4) Surveillance of infections in imported manpower and local population.

(5) Monitoring, vaccination, treatment of local population and elimination and control of endemic diseases especially those with potential for intensification with project operation.

(6) Environmental protection, erosion, spillage, air and water pollution, disposal of wastes, aesthetic alterations, etc.

(7) Inspection to ensure that construction is carried out according to health designs.

(8) Public health education and development of community participation.

OPERATION PHASE

(1) Allocation of funds, assignment of staff and implementation of disease control programmes.

(2) Surveillance, screening and treatment of infected persons.

(3) Establishment of rule curves and schedules for the control of mosquitos, snails, flies, weeds, etc.

(4) Establishment of water level management practice and schedules

(5) Maintenance and modernization of structures and other works.

(6) Application of chemical and biological methods for vector and weed control.

(7) Drainage of all water collections around the reservoir.

(8) Prevention and correction of excessive seepage.

(9) On-farm water management.

(10) Operation, maintenance, improvement and development of water supply and sewage disposal systems, general sanitation.

(11) Public health education and development of community participation.

(12) Evaluation of vector and disease pattern changes, efficacy of control programmes, study and implementation of amendments or alterations to improve results.

(13) Preparation of periodic and special reports for information.

CASE STUDY

BILHARZIA CONTROL

ADMINISTRATION

1. General:-

a)	Name of Village	Al Karaiba
b)	Location	3 miles West of Madany town (Within Madina Arab Rural Council)
c)	Population	2150
d)	Area	About one square mile
e)	Communities	60% involved in Agriculture Works, the rest in different Professions
f)	Roads	One 3 miles - paved road connected to Madany Khartoum
g)	Living Habits	Days are spent in field work i.e. agriculture activities where they are in contact with canal infested water in sense of washing and drinking

2. Crops:-

a)	June - April	Cotton
b)	October - March	Wheat
c)	July - February	Dura, rice and ground nut
d)	All the year round	Vegetables and fruits

TEMPERATURE, HUMIDITY & RAINFALL

Month	Temp Max	Temp Min	Relative Humidity 8 a.m.	2 p.m.	14 p.m.	20 p.m.	R. F. in c.m.m.
June	31.9	13.1	34	17	30	35	27
July	35	15.8	40	17	29	37	55
Aug.	37.7	18.3	20	14	18	25	47
Sept.	39.7	19.3	17	10	15	22	20
Oct.	41	23.8	28	16	22	32	11
Nov.	39.5	24	50	24	42	57	-
Dec.	36.6	23.3	67	30	51	72	-
Jan.	34.4	21.9	76	46	70	82	-
Feb.	37.4	21.8	55	34	56	73	-
March	36.1	19.2	49	28	47	59	-
April	36	16.4	33	20	37	43	-
May	32.7	14.8	34	21	37	40	-

4. Health Services

a) Sanitation:-

1) One Assistant Sanitary Overseer responsible for inspection of houses and other institutions plus infection diseases detection and supervision, health education and health surveys

2) Cleaning facilities - 3 sweepers

3) Human remains are disposed of either in pit latrines or nearby the boundaries of the village

b) Medical:-

One dressing station run by a certified nurse.

5. Water Supplies

Taps are distributed to houses in a pipe line system supplied from a deep bore well.

6. Bilharzia

a) Transmission Season: All the year round

b) Vector: Blinus and Biolphlaria Snails species

c) Breeding places Shores of Canals agmonst Plantation

d) Behaviour of Vector:

e) Resistance to molluscicides: Copper Sulphate does not kill eggs of snails

f) Prevalence: Endemic

g) Density. High 8/c.m.

7 Control Measures

a) Environmental Severity of Heat and Cold Affects the life of Snails.

b) Biological: Not yet introduced.

c) Chemical: Due to shortage copper sulphate is applied in focal treatment activities

PLAN FOR 1978.-

To run the same activities

Organization and Administration

Only 48 trained Labours are distributed in an area of 300,000 acres covered with a great net of canalization,nearly 10,000 miles in length. Also 9 each of 2 - persons mobile teams of examination are scattered on the area in which our village is included.

A Public Health Inspector without technical subordinate staff or communication facilities is supposed to administrate this body.

Remarks

The disease attacks 30% of children between 5 - 15 and 50% of the adults according to entertainment and agricultural activities consecutively. This village was examined thrice. The infection rate was always over 23%. No treatment was offered, but the infected persons were told to manage it themselves.

Chief of Bilharzia Control Division
GEZIRA PROVINCE

CASE STUDY

MALARIA

1) General

a)	Name of village:-	El Karaiba
b)	Location -	3 miles west of Wadi Medani Town (Within Madeena Arab R. Council)
c)	Population:-	(G.R.) Population 2105 House holders 407 Rooms 1741 (Date of G.R. 13/6/75
d)	Area.-	About one square mile
e)	Communities:-	Majority tenants, others employees in Wad Medani Town
f)	Roads:-	One main paved road connecting the village with Wad Medani Town
g)	Living habits:-	Work from 6 a.m. to 6 p.m in the fields where they drink and wash from the canals. They sleep indoors in winter and out doors in summer keeping their animals nearby

2) Crops

a)	Cotton:-	From 15th June to 15th April
b)	Wheat:-	" 30th Oct. " 30th April
c)	Dura:-	" 15th July " 15th "
d)	Ground nut:-	" " " " " "
e)	Rice:-	" " " " " "
f)	Vegetable gardens:-	All the year
g)	Fruit gardens:- 3.	Each about 5 acres

3) Health Services

a) Medical:- One dressing station run by a certified nurse

b) Sanitation:- One A/sanitary overseer, 3 sweepers. They dispose their excreta in pit latrines, and all refuse is collected and burned in the vicinity of the village.

4) Water supply

One deep-bore well

Water is distributed to the houses by a pipe line system

5) Temperature, Humidity and Rainfall

1977/1978

Month	Temp.		Humidity				Rainfall
	max.	min.	8 am	2 pm	14 pm	20 pm	
June	31.9	13.1	34	17	30	35	27
July	35	15.8	40	17	29	37	55
August	37.7	18.3	20	14	18	25	47
Sept.	39.7	19.3	17	10	15	22	20
Oct.	41	23.8	28	16	22	32	11
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April	36	16.4	33	20	37	43	-
May	32.7	14.8	34	21	37	40	-

6) Malaria Control

a) Transmission season:-

1) From August to November - due to rainy season

2) January and Feb. - due to winter cultivation

b) Vector:-

Main vector is Anophline Gambia

c) Breeding places:-

Small collections of water especially in the cultivated area where favourable conditions.

d) Behaviour of the vector:-

Endophilic and Endophagic

e) Resistance to insecticide:-

Resistant to D.D.T., B.H.C. and Dil. Susceptible to organo-phosphorous compounds (Malathion and Abate)

f) Control measures

1) Residual spraying with Malathion 50% W.D.P. two rounds a year 1st round 21st June to 20th July, second round 21st October to 20th November with a technical dose of 2 grams/sq M.

2) Larva control in the summer season from 1st January to 1st June with Abate 50EE with a dose of 1/1000.

3) Treatment of positive cases:-
With 4-Aminoquinolines 1500 mg base for the adult.

g) Type of plasmodium: %98 Falspurm

h) Biological control:-

Medina Arab R. Council area is under trial of introducing Gambusia fish.

j) Organization and management:-

One Public Health Officer for the whole Medina Arab R. Council assisted by two sanitary overseers. Means of transport, two landrovers and one motorcycle. The Council is composed of 12 agricultural block offices: El Karaiba village lies within Dirweesh block Office.

In the council there are 38 mosquito men and 76 spraymen. Every mosquito man (squad leader) have two spray-men. The whole area is divided into small areas to be covered by one squad by a weekly program.

Every squad is checked by the P H.O. or the S.O. at least four times a month, then a monthly report is submitted by the P.H.O. to the Province Malaria H.Q. showing the following.-

1) Number of visit made to every squad.
2) Larva survey made by the P.H.O. and S.O.
3) Amount of Abate consumed.
4) Area covered during the month.
5) Anything else to be mentioned.

During spraying time all mosquito-men and spray-men in the council in a campaign

7) Data of spraying

1975

		1st round - 1st July		
Sprayed:-	Houses	518	Rooms	1805
Unsprayed:-	"	70	"	121

2nd round - 21 October

Sprayed:-	Houses	326	Rooms	1220
Unsprayed:-	"	64	"	128

1st round only - 21st June

Sprayed -	Houses	331	Rooms	1334
Unsprayed:-	"	31	"	226

1st round only - 21 June

Sprayed.-	Houses	424	Rooms	1687
Unsprayed -	"	28	"	150

8) Surveys

1) Special survey

June 1977 - 250 slides all negative - 2 - 9 ages

Oct. 1977 - 125 " " " " "

2) Routine survey Nil

3) Fever cases reported in Wadi Medani Hospital and Central Malaria lab.

1974	346	slides	40	positive	P.F.	all	ages
1975	256	"	67	"	"	"	"
1976	338	"	38	"	"	"	"
1977	182	"	27	"	"	"	"

H Q. Malaria Section, Gazeera Province
Wadi Medani

1/4/1978

Summary of Malaria activities since 1971

	1971	1972	1973	1974	1975	1976	1977	1978
Larva Control	Dies. Oil	Dies. Oil	Dies. Oil	Dies. Oil	Abate	Abate	Abate	Abate
Residual spraying with Malathion 50% W.D.P.	Nil	Nil	Nil	Nil	1st round June Coverage 88.4% 2nd round November Coverage 82.1%	One round June Coverage 81.1%	One round June Coverage 84.1%	
Slides collected from P.C.D.								
No slides	50260	88941	90344	128489	124761	118320	126358	
Positive	14409	19330	20715	27501	19292	11853	3188	
P.R.	%28.6	%21.7	%22 9	%21 4	%15.4	%10	%2 5	
Blood surveys (Children 0 - 9 years) :-								
January No slides					2017	2197	4040	2855
Positive					411	115	80	5
P.R.					%20.4	%5.2	%1.98	%0.17
October No slides						2259	2815	
Positive						59	3	
P.R.						%2.6	%0.1	