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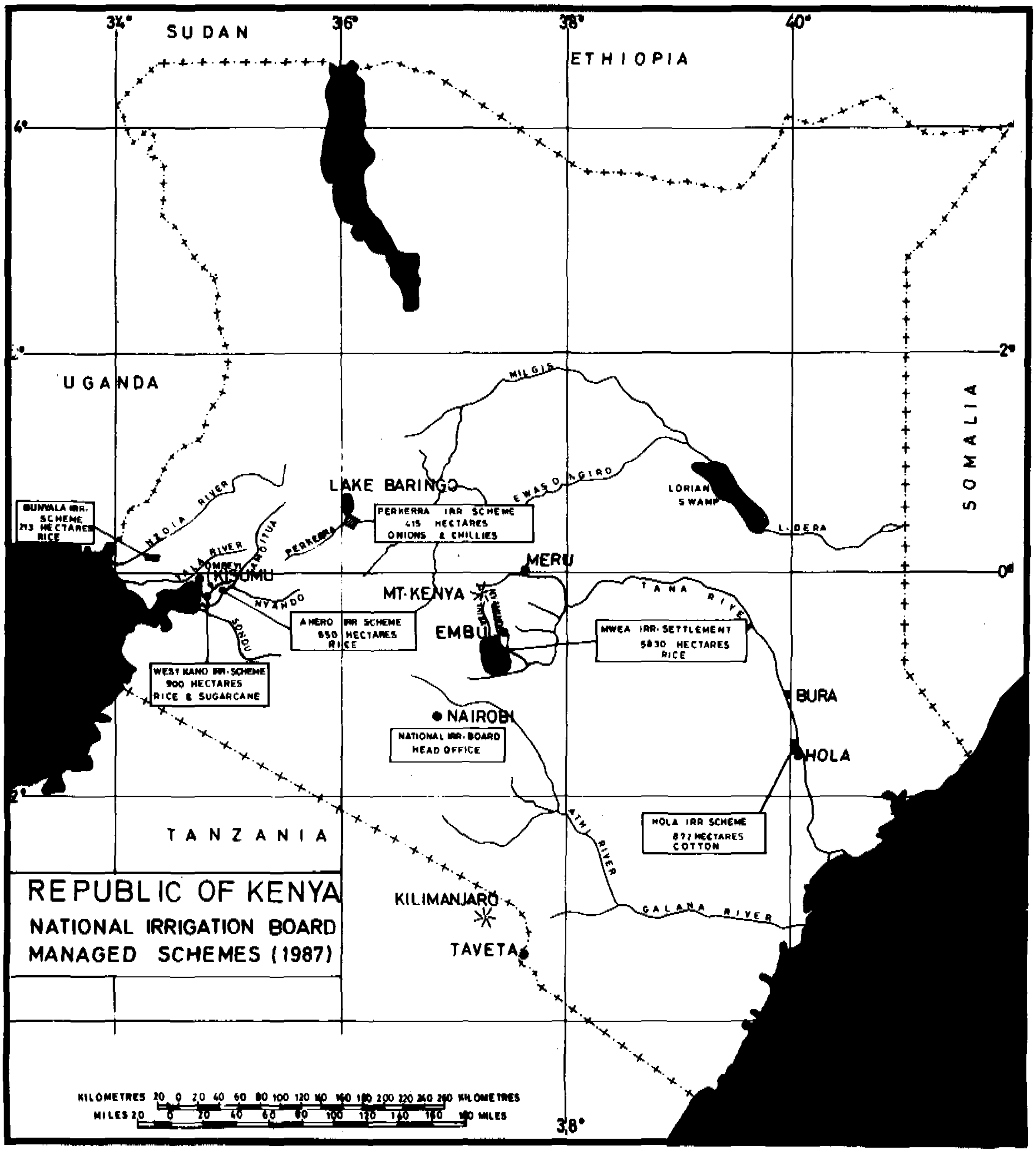
WATER RESOURCES DEVELOPMENT and VECTOR-BORNE DISEASES IN KENYA



Proceedings of a Seminar
Kisumu, 11-13 September 1988

PEEM Secretariat
WORLD HEALTH ORGANIZATION
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ABOUT PEEM

The Panel of Experts on Environmental Management for Vector Control (PEEM) was established in 1981 as a joint activity of the World Health Organization, the Food and Agriculture Organization of the United Nations and the United Nations Environment Programme. The Panel's objective is to create an institutional framework for effective interagency and intersectoral collaboration by bringing together various organizations and institutions involved in health, water and land development and the protection of the environment, with a view to promoting the extended use of environmental management measures for disease vector control in development projects. PEEM's Secretariat is at WHO, Geneva, Switzerland.

Under the Panel's programme of work the promotion of intersectoral linkages at the country level is an important goal. The seminar in Kenya was the second of its kind; the first one was organized in collaboration with the International Irrigation Management Institute (IIMI) in Sri Lanka, and the proceedings of that seminar were published by IIMI in 1986.

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PREFACE

At the end of the 1980s the troubled relationship between the biosphere of planet Earth and the man-driven process of economic development came to the foreground as the key topic in international discussions almost independent of which subject they were addressing. At the beginning of the 1990s sustainability has become the bottomline of deliberations in bilateral and multilateral fora on specific development issues as well as on development at large. It remains to be seen whether sustainable development will not follow the road of previous "buzzwords", whose meaning has been contorted over time through excessive use in often inappropriate contexts or by people with ulterior motives. All the same, it would not seem superfluous to once more repeat in this preface the definition given by the World Commission on Environment and Development: sustainable development should meet the needs of the present generation without compromising the ability of future generations to meet their own needs.

While environmental problems are of a global nature and affect public and private sectors alike, for solutions to be sound and lasting they will have to fit local ecological, social and economic conditions. This idea is perhaps best worded in the slogan adopted by the World Health Organization for World Health Day 1990: Our Planet—Our Health: Think Globally, Act Locally. In the face of a global environmental crisis, proper solutions have, therefore, nothing to do with amplifying technological ways-out to a global scale. They have, on the other hand, everything to do with a change in attitude, with a change in planning, decision-making and implementation procedures for development and with a change in institutional arrangements. To achieve such changes, existing barriers between public sectors need to be torn down, environmental and health aspects of development need to be accounted for in financial appraisals, studies need to be carried out in a multidisciplinary fashion, and project implementation needs to be based on effective intersectoral coordination and sharing of sectoral resources.

Deterioration of the human health status as a result of improperly planned and designed water resources development projects is only one facet of the near- forbidding picture of global environmental problems. Yet its underlying mechanisms are better understood than is the case for many other problems, and it has received relatively much attention for about a decade. Water resources development projects include irrigation schemes, reservoirs for hydropower generation or drinking water supply and flood control structures. Wherever a number of basic climatic and soil conditions are met, such projects may lead to the introduction or intensified transmission of vector-borne diseases, through the ecological and demographic changes inherent to them. In other words, increased environmental receptivity, combined with increased community vulnerability and insufficient vigilance by ill-prepared health services may come to expression in increased morbidity and mortality due to such vector-borne diseases as malaria, schistosomiasis, filariasis and Japanese encephalitis.

Water resources development projects are initiated for the benefit of people, usually to meet growing demands for agricultural produce and energy. Yet vulnerable groups, particularly those in the project area who may not even be the first beneficiaries, require special health-protective measures. It is a regrettable fact that in many cases the severe burden of ill-health put on such vulnerable groups could have been considerably reduced, or even prevented. The aforementioned changes in attitudes, procedures and institutional arrangements provide the key to ensuring that effective health safeguards are incorporated into new projects. For the blame can neither be put on a single public sector, nor on professionals of a single discipline. At all levels professionals must learn to look beyond their sectoral and disciplinary boundaries.

In 1981, WHO, FAO and UNEP decided that the time was ripe to better coordinate their activities for the prevention and control of water resource development associated health problems and jointly established a Panel of Experts on Environmental Management for Vector Control (PEEM). The Panel's main objective is the promotion of the extensive use of environmental management measures to safeguard human health in water resources development. In the Panel's programme three elements have received special emphasis: health impact assessment, the development of environmental management techniques and the promotion of intersectoral collaboration at national level. It was in connection with the latter area of activities that the Panel decided to use the occasion of its eighth annual meeting being held at UNEP headquarters in Nairobi to organize a seminar on Water Resources Development and Vector-borne Diseases in Kenya immediately afterwards (see below). The objectives of the seminar were two-fold:

1. To strengthen the dialogue between planners of the Government sectors involved in health, agriculture, irrigation, water resources development and the environment with a view to increased intersectoral collaboration to prevent or mitigate adverse vector-borne disease implications of water resource development projects in Kenya.

2. To introduce in the intersectoral dialogue experiences from other countries of the region, and from other regions, related to successful institutional arrangements and innovative vector-borne disease prevention and control methods applied in water resources development projects.

Kenya is in many ways an exceptional country. It has taken important initiatives in the field of irrigated agriculture over the past 30 years, although in comparison with Egypt and Sudan (where about half of Africa's irrigated area can be found) its irrigation schemes are still rather minor. An FAO consultation on irrigation in Africa (Lomé, 21–25 April 1986) concluded that while the food production situation in East and Central Africa could be foreseen to become critical and would require high input level farming, only Kenya and Ethiopia had enough irrigation water resources to produce additional food in significant quantities.

Most of the vector-borne diseases transmitted on the African continent which are of importance in the context of water resources development are prevalent in Kenya. Unfortunately Kenya is no exception to the rest of Africa in the patterns of vector-borne disease expansion that have been observed following the commissioning of irrigation schemes and the creation of reservoirs. The expected development of its water resources potential against this epidemiological backdrop makes improved institutional arrangements imperative, if dramatic adverse health effects are to be prevented.

The seminar was attended by national participants representing five public sectors and three development authorities. Their input in the discussion was complemented by that of international participants from Australia, Brazil, Ethiopia, Philippines, Thailand, UK and USSR. The multi-disciplinary group went through two days of inspired debate, which resulted in concrete recommendations. The facilities of the Sunset Hotel in Kisumu could only add to the inspiration. For, as one of the participants remarked "the location for this seminar couldn't be more appropriate: on the shores of one of the world's greatest fresh-water collections, Lake Victoria."

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The seminar was co-ordinated by the Division of Vector-borne Diseases of the Ministry of Health, and hosted by the Kenya Medical Research Institute (KEMRI).

EXECUTIVE SUMMARY

The Republic of Kenya lies in East Africa, between 3°N and 5°S and stretching from 35°E to 41°E. It is bordered in the East by the Indian Ocean, and in the West by Lake Victoria, and the equator runs straight across its territory of 582,647Km^2. It is entirely within the confines of the tropical zone, but its topography, particularly the Rift Valley and the highlands create considerable climatic differences, which are important for the distribution of the country's water resources as well as for certain disease patterns.

In 1988 Kenya's population amounted to an estimated 22 million people and demographic forecasts predict this number to grow to 35 million by the year 2000. Population densities differ within the country, with the Western Province, adjacent to Lake Victoria, being among the most densely populated parts with 9 million inhabitants.

Major sources of water in Kenya are:

- surface water-rivers, springs, lakes and the ice caps on Mt. Kenya;
- groundwater—both fresh and saline;
- harvested rainwater;
- surface and subsurface reservoir water;
- other sources-sea and internationally shared water resources.

The country can be divided into five major drainage basins: Lake Victoria, Rift Valley Basin, Tana River Basin, Athi River Basin and Ewaso Ngiru Basin. The average annual run-off of these basins combined is estimated at 14,800 x 10^6 m^3. There are 928 hydrological measuring stations, but only 506 are presently operational, partly due to shortage of funds for monitoring staff.

With Ethiopia, Kenya distinguishes itself from other East-African countries in that it has sufficient unharnessed water resources to boost its food production substantially were they developed for agricultural purposes. The basic policy of the Government of Kenya is to provide water of reasonable quality and quantity for human and livestock consumption and sustenance of other economic development programmes such as irrigation, fisheries, wildlife conservation, industries and the generation of hydropower. In other words, choices will have to be made for a balanced development of limited water resources.

The Ministry of Water Development, established in 1974, has the responsibility for the development, monitoring and quality control of Kenyan water resources. This Ministry's surveying and monitoring provides the basis for long-term planning of water resources management. In its operational work, the Ministry of Water Development puts a major emphasis on domestic water supply and sanitation activities.

National economic development planning in Kenya is geared towards certain principal goals, among which the full utilization of locally available resources, and the adoption of new methodologies or the improvement of existing ones in support of optimal resource use.

Development projects can be subdivided planning-wise into national and regional, with implications for the level of decision-making. Water resources development projects can be further divided by purpose: irrigation development, water conservation, hydro-electric power generation, development of domestic water supply, flood control, improving a river's navigation potential, aquaculture, recreation and nature conservation, or a combination of two or more of the above.

At the start of any water resources development project, that is during the planning, pre-feasibility and feasibility stages, there are three levels of concern. At the national level foreign exchange, self-sufficiency, employment, taxes and some other considerations play a role. At the project level, the Internal Rate of Return, adjustment of taxes, subsidies and incentives, costs of inputs and shadow-pricing are of importance. And at the farm-level the emphasis is on production costs of machinery, fertilizer and agrochemicals.

A key position in the planning of water resources development in Kenya is occupied by the three Regional Development Authorities. They are: the Tana and Athi River Basin Development Authority (TARDA), the Lake Basin Development Authority and the Kerio Valley Development Authority. These authorities liaise with all public sectors involved in development projects, and at all planning levels. Their outlook on development projects and the implications they may have for environment and health differ according to the resource situation and the socio-economic conditions in the area under their authority.

In the energy sector the Government's basic policy is to ensure that secure and adequate supplies of energy are made available efficiently and at reasonable costs in line with national development needs. The mandate of the Minister of Energy is to match energy needs and resources in a long-term strategy.

The total domestic energy demand in 1987 was covered as follows: woodfuel 70%, petroleum 26%, electricity 3%, coal 1%; for industrial demand the figures were: petroleum 86%, electricity 10% and coal 4%.

The total electricity capacity of Kenya is 686 MW. This is generated by hydropower (69%), conventional thermal plants (21%) and geothermal plants (6%), and is supplemented by import from Uganda (4%). This makes up 70% of the potential system capacity. There are seven main hydropower stations (all on the Tana River) and several small hydro-units. The planned Turkwell Gorge Hydropower Project will add 106 MW to this capacity.

Over the past 15 years the electricity consumption has risen by an average 6.7% annually to 2330×10^6 KWh in 1987. The projected growth until 2000 is estimated at 5.5% annually. In order to meet the demand by 2000 a Power Sector Master Plan Study was carried out in 1987, and 1400 MW of hydropower potential was identified. More than two-thirds of this potential is found in the Tana River Basin, the Lake Basin and the Rift Valley. The main constraint on hydropower development is its capital intensiveness, making external funding a prerequisite for its development.

In the subsector of irrigated agriculture two lines of development run parallel: small scale smallholder irrigation and national irrigation schemes. The total Kenya irrigation potential has been estimated at 540,000 hectares.

The Ministry of Agriculture monitors and promotes, through its irrigation and drainage branch, the development of smallholder irrigation schemes. In principle, these are constructed, controlled, operated and maintained by local farmers. Some 4750 hectares have been brought under smallholder irrigation so far. At the end of the Fifth Plan Period (1984–1988) irrigation development covered a total of 42,000 hectares. Under the Sixth Plan the annual irrigation expansion has to increase from 1300 to 3300 hectares annually, with an end result in 1993 of 12,150 additional hectares. Of this, some 4350 hectares will be smallholder irrigation.

Kenya has seven national irrigation schemes, and six of these are operated by the National Irrigation Board (NIB):

Mwea	5836 ha rice
Hola	875 ha cotton, groundnut, maize
Ahero	840 ha rice
West Kano	900 ha rice, sugarcane
Bunyala	200 ha rice
Perkerra	425 ha chillies, onions, watermelons, pawpaws

The NIB is a parastatal organization under the Ministry of Regional Development. The seventh scheme, the Bura Irrigation Scheme, comes since 1987 directly under the authority of the Ministry of Agriculture.

The NIB takes care of resettlement of landless farmers in its schemes, it gives its tenants technical and material support, and the tenants pay service charges for the maintenance of canals and the overall infrastructure.

All vector-borne diseases present in the African continent which are either directly or in an indirect way associated with water resources development are prevalent in Kenya. In numbers of cases and severity malaria and schistosomiasis are the most important, but filariasis, leishmaniasis, African trypanosomiasis and several diseases of arboviral origin are also present with more limited distribution.

Malaria is holo-endemic in Coast, Western and Nyanza Provinces and other parts transmission patterns are seasonal, with the exception of the highlands where no transmission occurs. The Annual Parasite Index has been recorded as 1.5%, and *Plasmodium falciparum* is in 80-85% of the cases the parasite species responsible.

An estimated 4 million Kenyans are infected with schistosomiasis and the estimated annual incidence amounts to 150,000 clinical cases.

In the context of water resources development projects, both malaria and schistosomiasis have increased: malaria in the intensity of transmission and sometimes with a shift from seasonal to perennial transmission; schistosomiasis by the introduction of the parasite into areas where it was not present before, and by a dramatic rise in its prevalence. With respect to the national irrigation schemes the following observations were made:

Mwea	Schistosomiasis prevalence increased from zero in 1956 to 70% in the 1980s
West Kano/Ahero	Intensification of malaria transmission; outbreaks of O'nyong-nyong virus disease
Hola/Bura	Increased malaria and schistosomiasis transmission. Furthermore, the Tana River hydropower projects have resulted in an increase in malaria and schistosomiasis prevalence, a persistence of leishmaniasis foci and an increase in populations of animal reservoirs of disease.

The economic consequences of ill health are difficult to assess. In an attempt to estimate the economic loss through absenteeism caused by schistosomiasis an annual figure of US$ 8,640,000 was found. Extrapolating from studies elsewhere, the production loss due to ill health was estimated at 10%, which in the case of the schemes under the NIB means an annual loss of US$ 818,700. Such estimates, however, cannot be but highly speculative and should be considered against the backdrop of under-employment, cropping cycles and other local socio-economic conditions.

Among the services offered by the NIB to the farmer communities in the schemes under its management, health measures are also included. Some of these are carried out in collaboration with the health authorities (drug distribution, case detection and treatment, health education, provision of community water supply and sanitation). Molluscisiding is done by the NIB at regular intervals. And certain routine maintenance activities, such as weed clearing, canal maintenance and land-levelling also contribute to a reduction of environmental receptivity for vectors. Annual expenditure by the NIB for health promotional activities amounted to US$ 59,728 in 1988.

Under the umbrella of the Kenya Medical Research Institute, the Vector Biology and Control Research Centre in Kisumu has as part of its remit research on the links between resource development, environment and vector ecology. Past studies have covered the broad area of vector bionomics, genetics and ecology. In the future, a more comprehensive programme of studies is foreseen on vectors of medical importance in Kenya, with emphasis on malaria.

Research needs identified in the area of water development associated vector-borne disease problems include: an assessment of the nature and magnitude of the problems; vector biology and ecology studies to complete the knowledge of vector bionomics; testing of innovative environmental management measures for vector control; the development of better diagnostic tools with emphasis on specificity, rapidity and applicability in the field; studies on the links between health status and productivity; cost-effectiveness studies of vector control programmes; trials to incorporate environmental management in agricultural extension programmes.

To ensure the timely consideration of health in the planning of new water resources development projects, the opportunities for intersectoral cooperation have to be utilized at crucial moments during the project cycle. The first such moment occurs when the Terms of Reference for the feasibility study are formulated. If the health authorities have not yet been contacted by then, they should be asked to contribute a health impact assessment component for the TORs. At the appraisal stage proper resource sharing and allocation will have to ensure that the necessary health safeguards are included in the final design, that health services will be strengthened to meet expected needs, and that recurrent costs for operation and maintenance can be adequately met. For the intersectoral cooperation to be effective, institutional arrangements will have to be put into place.

In Kenya, sectoral ministries are, in principle, responsible for the environmental aspects of their development activities. For national projects two bodies have been established to ensure intersectoral coordination: the National Environment Secretariat (NES), under the Ministry of the Environment and National Resources, and the Interministerial Committee on Environment (IMCE), with representatives of all relevant ministries. The latter body looks at environmental issues at large and also has a National Sub-Committee on Environmental Impact Assessment of Development. This Sub-Committee has as its objectives the *ex-ante* assessments to allow for the design of appropriate measures; the monitoring of projects to identify possible corrective measures that may become necessary; evaluation of projects *ex-post* to provide a basis for decision-making on future projects.

At the district level the District Development Councils, established under the Government of Kenya's District Focus Strategy for Rural Development is the natural meeting point for representatives of all sectors.

Conclusions

From the presentations at the Seminar it was clear that a substantial development of Kenya's relatively abundant water resources potential is to be expected before the end of the century. Projects to this end will be initiated by the Regional Development Authorities and implemented either as national endeavours or through the District Development Councils. All relevant sectors (energy, water supply and sanitation, irrigation) have carried out the necessary surveys and prepared master plans.

From the discussions a number of trends were discernible. In irrigation development a considerable part will be small scale smallholder schemes, and in the bigger schemes there is a tendency for sprinkler irrigation to become more popular. This would be very favourable from the health viewpoint. Concern for the health implications, was on the other hand, expressed with respect to prospects in dam building. Big dam projects had at least included an *ex-ante* Environmental Impact Assessment (EIA). Since 1980, however, some 150 small dams (2000–3000 m^3) had been constructed without any form of EIA, and activities in this area were likely to expand.

The discussions focused on the actual planning process of water resources development and based on the information presented in the various papers a flowchart of decision making processes was prepared (Figure 1). While the flowchart should be considered a simplified representation, it clearly indicates two things: the Regional Development Authorities are the key bodies when it comes to intersectoral planning, and the final decision for the go-ahead of a project lies with Treasury, and will be based primarily on economic indicators. For projects at the district level the District Development Council was an obvious meeting point for representatives of all relevant sectors, but from the discussions a feeling of discontent became apparent with respect to the administrative burden posed by the District Focus Strategy.

The history of water resources development in Kenya has unfortunately shown that insufficient attention for environmental health aspects at the planning and construction stages leads in the majority of cases to a deterioration of the health status of the local population. This is inherent to the eco-epidemiological situation in Kenya. It is imperative that health is considered as an integral part of each project. From the side of the health authorities attending the seminar the responsibility of other sectors to involve the health sector at early project stages was repeatedly stressed. Traditionally there had been no effective linkages between the agriculture, energy and health sectors. If no environmental health impact assessment was carried out then there could be no incorporation of health safeguards in the project, no adequate and timely strengthening of health services, no monitoring of the health status of vulnerable groups and no screening of migrants. There was also criticism of the fact that in cases where health had been considered as part of the EIA, the implementation of recommendations had usually not been possible for lack of funds.

Other issues that came up in the discussions were the need for a smooth transfer of knowledge on environmental and health concerns, in the context of irrigation development, to the farm level; the question whether swamp drainage was favourable or not from a health viewpoint (the general feeling was that development of such areas would lead to an influx of people who would be at increased risk because of the normally persisting small water bodies which made excellent breeding sites); the need to review the compensation of displaced people for loss of land following dam construction; and the need for proper monitoring the effectiveness of health protective measures implemented by agricultural authorities, such as the mollusciciding programme of the NIB.

Quite a range of research priorities were identified, with studies on the economic impact of ill-health resulting from development as a major issue.

It was clear that a mechanism for intersectoral coordination had to be set up, either as a new entity or as part of existing bodies such as the National Environmental Secretariat. If the latter option was selected then it had to be ensured that this body was expanded to include representatives of the relevant disciplines. Engineers and vector control specialists were for instance not represented in the NES. It was also felt that information dissemination by NES and IMCE could be improved.

Finally, it was stated that current legislation in the area of water resources associated health problems and their prevention/mitigation was vastly insufficient. Comprehensive legislation was likely to be part of the new Health and Water Act, but the process of legislation and law-enforcement needed monitoring.

Recommendations

1. In future, all water resources development projects in Kenya should have a public health component, and it should be ensured through proper legislation that the health sector will be involved in such projects from the earliest planning stages onwards.

2. Environmental impact assessments of water resources development projects should have a sound health component, and the budget for the construction as well as the operational phase should include adequate funds for the implementation of the EIA recommendations.

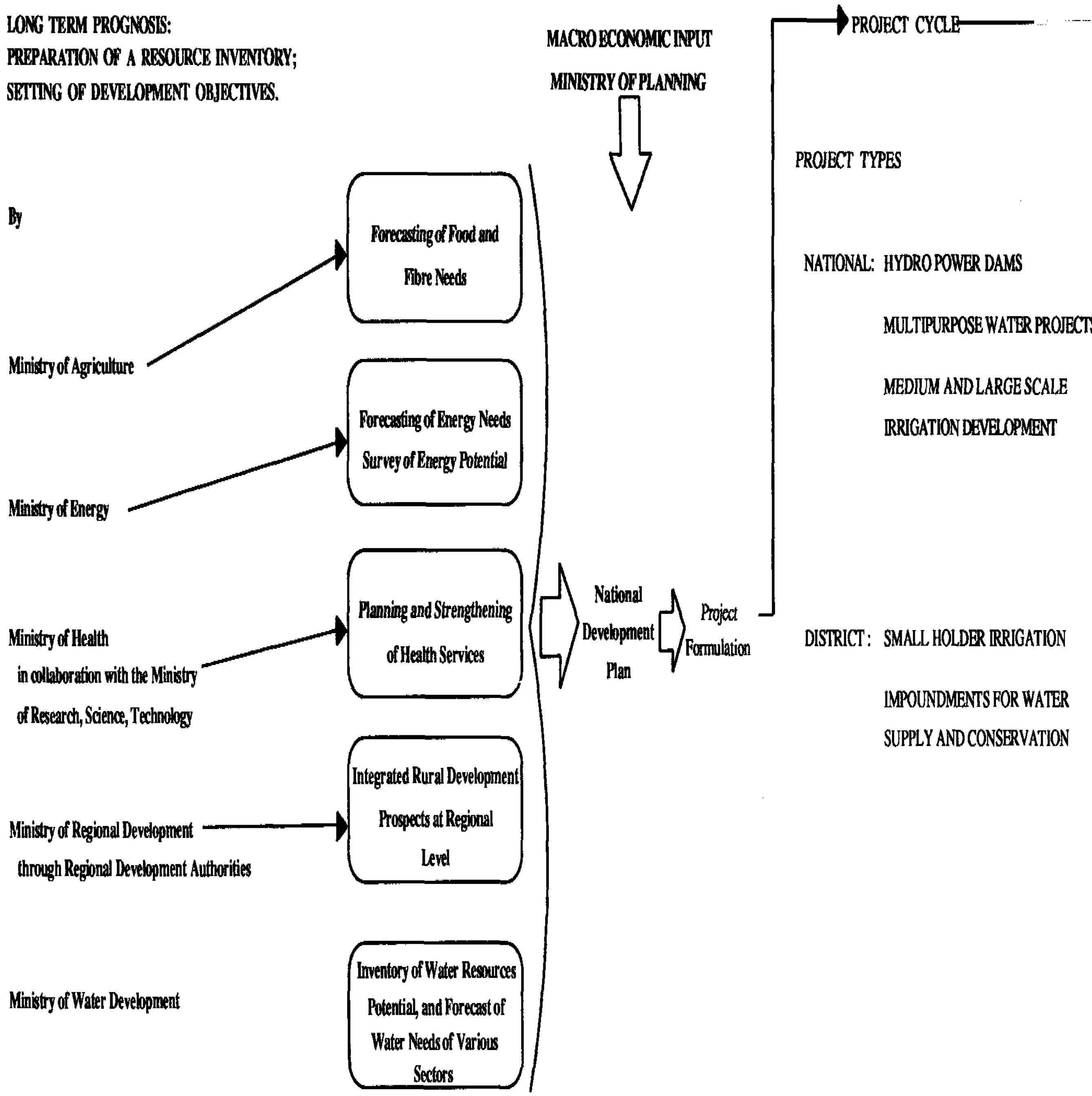
3. A proposal should be prepared for submission to the Kenya Government to establish an Expert Group on Environmental Management in Water Resources development, which could assist in coordinating activities at a national level, screening of new water resources development projects for possible adverse health effects, monitoring of projects under construction and defining specific research and training needs. In such a group the ministries of agriculture, energy, health, industry, planning, regional development and water should be represented. It could be set up under the umbrella of the NES and would have to have strong links with KEMRI, NIB, the Regional Development Authorities, the national Council for Science and Technology and the Universities. At the international level it should liaise, through PEEM, with WHO, FAO and UNEP, as well as with other relevant organizations.

4. Under the auspices of KEMRI a special research programme should be established to study the health aspects of natural resources development, with an emphasis on the priorities presented in the seminar.

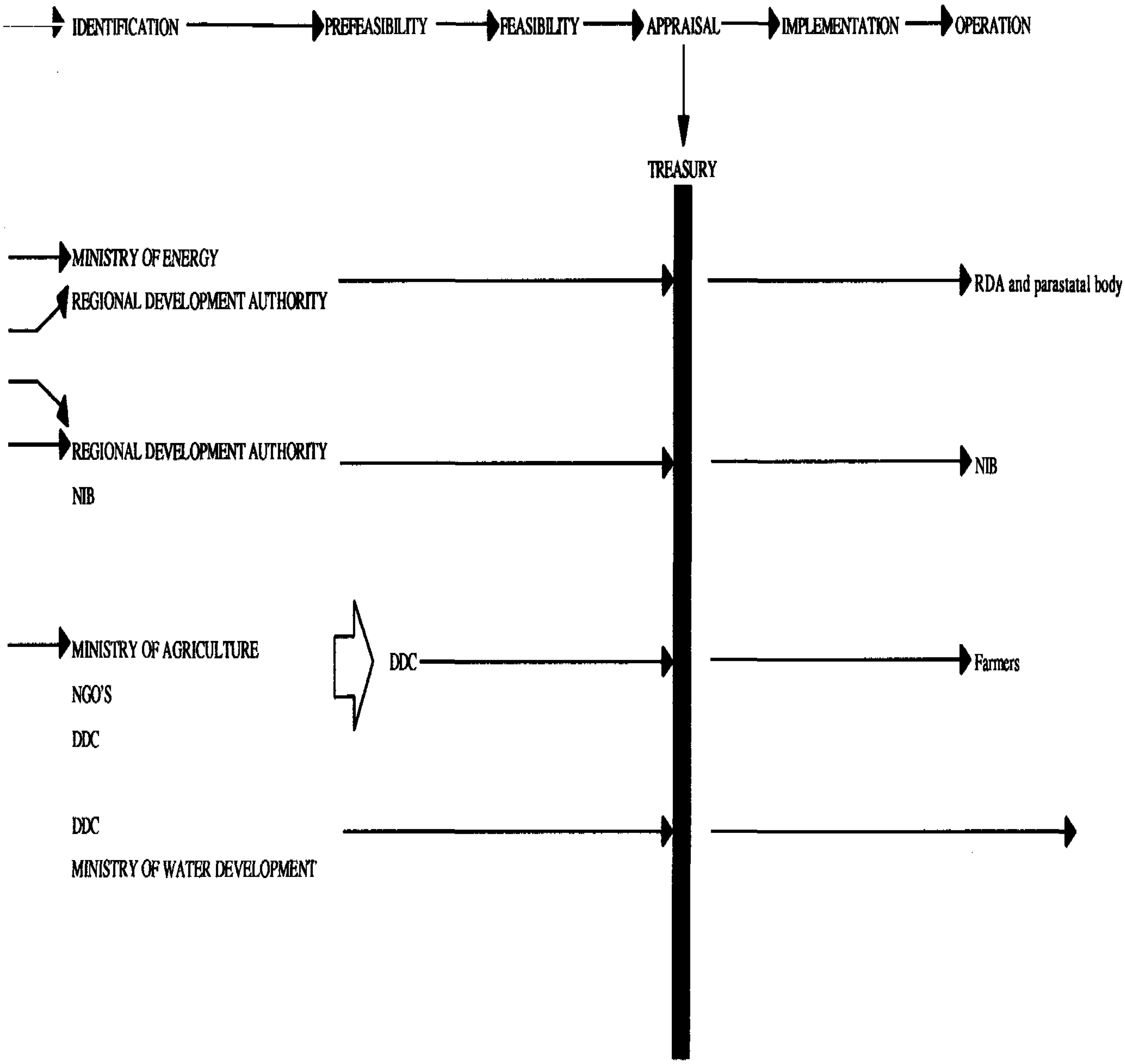
5. Retrospective studies of existing water projects should be carried out to clarify the nature and magnitude of the problem and to identify structural or operational factors contributing to a lowered health status with the objective of correcting these.

6. Special attention should be given to the transfer of expertise and technology in the field of environmental management for vector control to the farmer level and special pilot trials should be organized for the use of the agricultural extension network for the knowledge transfer.

Figure 1. Planning of Water Resources Development



Projects in Kenya: Actions and Processes



SPEECH AT THE OFFICIAL OPENING OF A SEMINAR ON WATER RESOURCES DEVELOPMENT AND VECTOR-BORNE DISEASES IN KENYA

Kisumu, 1–13 September 1988,

DR J. OTETE
Senior Deputy Director Of Medical Services

Distinguished Guests, Ladies and Gentlemen,

First of all I wish to express my gratitude to the organizers of this seminar for having invited me to officiate at its opening ceremony. I am informed that some of you from outside this country have already been here for the last week or so taking part in the eighth meeting of Panel of Experts on Environmental Management for Vector Control (PEEM). I note with satisfaction that most of you made themselves available for this Seminar on Water Resources Development and Vector-Borne Diseases in Kenya—now taking place here in Kisumu.

This meeting aims at strengthening the dialogue between the planners in various sectors involved in health, agriculture, irrigation and the environment with a view to enhancing increased intersectoral collaboration to prevent or mitigate adverse vector-borne disease implications of water resource development projects, a problem not only occurring in Kenya but in other developing countries as well.

As you are probably aware, Kenya's population is growing at a high rate although efforts to stabilize it through promotion of family planning are now slightly beginning to bear fruits. In order to meet food requirements for the growing population, food production must be expanded. But this can only be done through maximum utilization of arable land. Only a small proportion of arable land receives adequate rain. The rest has water shortage much of the year and this has prompted the Kenya Government to undertake major irrigation schemes. Without going into details, several irrigation schemes have been constructed over the last thirty years. They include Mwea, Hola, Ahero, West Kano, Bunyala, Perkerra and more recently Bura, altogether covering approximately 11000 hectares. Only a very small portion of the country's irrigation potential has been developed and with the shortage of high potential land, it is expected that irrigation will develop on a much larger scale in the future. Already plans are on advanced stage to develop irrigation schemes involving a total of 25,200 hectares in Kibwezi/ Munyu and the Tana delta.

Apart from irrigation schemes, a number of man-made dams have already been constructed or are being planned to provide hydro-electric power. Among those already constructed are Kamburu, Kindaruma Gitaru, Masinga and Kiambere. Plans have been finalized for implementation of multi-purpose Turkwell Gorge dam in Kerio Valley which when completed will ensure the generation of sufficient energy to meet the demand of our country.

Water resource development projects referred to above are useful on one hand as already pointed out. On the other hand, they lead to environmental modification which in turn leads to the establishment and spread of various diseases—particularly vector-borne ones. There is sufficient evidence that already established water resource developments in Kenya have so far enhanced mosquito and snail breeding resulting to intensive transmission of malaria and schistosomiasis. There is also a high risk of lymphatic filariasis and a number of diseases of arboviral origin. Although onchocerciasis which causes blindness was successfully eradicated in Kenya in the early fifties, the risk of its re-establishment should not be overlooked. In summary it can be said that water resource development (whether for irrigation or for hydropower generation) will be an important component of Kenya development activities in the coming years and that whenever it occurs, diseases and particularly those transmitted as a result of vectors can be expected to cause unwanted adverse effects on the health of both resident or migrants populations.

While the development of tools for forecasting such adverse effects, and of environmentally sound and cost-effective remedial measures has been going on at an accelerated pace in the past five years we in Kenya believe that a proper institutional framework and effective intersectoral collaboration with all concerned remain the first prerequisite for the optimal consideration of health aspects of water resource development, starting at the planning and design stage, and through feasibility and construction phases until the project becomes operational. Our Government considers the health component to be an essential and integral part of any water resource development project.

Ladies and Gentlemen, I sincerely hope and trust that this Seminar will come out with definite recommendations on water resource development and vector-borne diseases in Kenya and would further wish to emphasis that such recommendations will be carefully considered in our future water resource development projects. I would at this stage like to take this opportunity to thank the PEEM secretariat for having initiated this seminar. I am confident that the next two days will be fully utilized and we are looking forward to the final report with great anticipation. I wish you all success in everything.

With these few remarks, I would now like to declare the Seminar on Water Resources Development and Vector-Borne Diseases in Kenya officially open.

A PROJECTION OF SMALLHOLDER IRRIGATION DEVELOPMENT IN KENYA BY THE YEAR 2000

C.M. OSORO

Assistant Director of Agriculture, Ministry of Agriculture

Irrigation has been recognized worldwide as an important input to agricultural production, as well as a means of creating employment and opportunities for settlement in new areas, particularly marginal and semi-arid lands. The estimated growth in gross irrigated areas by region is as follows:

	(Million Ha)			
	1950	**1960**	**1970**	**1985**
Europe (including USSR)	8	12	20	29
Asia	66	100	132	184
Africa	4	5	9	13
North America	12	17	29	34
South America	3	5	6	9
Australia and Pacific Countries	1	1	2	2
TOTAL	**94**	**140**	**198**	**271**

Source: W. Robert Rangeley, International Commission on Irrigation, London, UK

The contribution of irrigation to food production in the world is enormous: while the total irrigated area only constitutes 18% of the total cultivated area, it contributes one third of the total world food production.

The main factors that have influenced irrigation and drainage development over the past 35 years, when the area under irrigation has more than doubled, include:

- efforts by individual countries and governments to achieve self-sufficiency in food and fibre;
- cost: irrigation is a costly undertaking today and therefore planners have recently tended to favour schemes with low capital costs but (sometimes) with high operation and maintenance costs;
- the green revolution, i.e. the development and introduction of high-yielding varieties (HYV) of certain crops.

Small-scale smallholder irrigation schemes may be defined as those schemes which are under local responsibility, controlled and operated by the local people in response to their felt needs and are characterized by the following:

- schemes are relatively low-cost;
- beneficiaries participate in cost-sharing;
- land is often owned by the small-holders;
- final responsibility for operation and management rests with the local people themselves through their own organization.

There are also formal smallholder irrigation schemes which have been centrally planned and controlled, such as the Kibirigwi and Katilu irrigation projects. It is furthermore possible to implement large schemes on a smallholder approach, whereby only the major irrigation and drainage works are centrally managed and maintained (e.g., Yatta furrow and the proposed 1100 ha South West Kano smallholder project).

Realizing the need to provide a service to smallholders, the Kenyan Ministry of Agriculture in 1977 established the Irrigation and Drainage Branch as the institutional framework for the planning and implementation of small-scale irrigation and drainage projects with the full involvement of the beneficiaries.

Two years later, in 1979, the Branch decentralized its services and provincial irrigation units have now been established in all provinces. Plans for further decentralization of these services to the 20 or so districts that have been identified as having considerable potential for irrigation development are now being finalized in line with the District Focus for Rural Development Strategy.

As pointed out in the country's Sessional paper No. 1 of 1986 on Economic Management for Renewed Growth by the year 2000, irrigated agriculture does hold some promise for the future in Kenya, particularly in the field of small-scale irrigation where the Government is making an attempt to emphasize a low-cost approach to irrigation development.

District	Project Name	Ha
Turkana	Katil	220
	Turkwell	35
West Pokot	Amolem	40
Isiolo	Merti	35
	MalkaDaka	40
	Garfassa	200
Mandera	Border Point One Scheme	100
	Shantole	160
Samburu	Amaya	25
Narok	Narosura	60
Baringo	Eldume	100
	Barwesa	15
	Sandai	90
	Endao	50
Tana River	Mnazini	40
	Hewani	30
	Wema	60
Garissa	Jara Jara	60
	Hodan Farm	27
	First Farm	14
	Sankuri	4
	Umoja	4

District	Project Name	Ha
Machakos	Muka Mukuu	550
Meru	Mitunguu	440
East Marakwet	Chesoi	150
Kajiado	Kimana	100
	Rombo	60
Laikipia	New Mutaro	140
	Kiamarigo	40
Nakuru	Lari Wendani	16
Kirinyaga	Kibirigwi	100
Embu	Ishiara	35
	Rupingazi	80
Nyeri	Mathina	100
Taita/Taveta	Kimorigo	140
	Kimala	180
	Kitobo	160
	Njukini	145
Kisumu	Alungo	70
	Awach	110
	Kore	150
	Wasare	125
	Nyachoda	50
Others		400
TOTAL		**4750**

By the end of the Fifth Plan Period, the total national irrigated area will be of the order of 42000 ha, based on an average expansion rate of 450 ha/year during the 1984–88 plan period. It is proposed to accelerate the rate of irrigation development during the Sixth Development Plan, within the framework set out in Sessional Paper No. 1 of 1986. Accordingly, specific measures will be under taken in order to raise the implementation capacity from 1300 ha/year at the beginning of the Plan to some 3300 ha/year by the end of the Plan period. Thus it is expected that some 12150 ha will be developed during 1989/93, of which approximately 4350 ha will be smallholder developments as follows:

Project Type	1989	1990	1991	1992	1993	Total
South West Kano	50	100	150	200	300	**800**
Other Smallholder Schemes	450	450	500	550	600	**2550**
Private Smallholder Development	100	150	200	250	300	**1000**
TOTAL					**4350 ha**	

REFERENCES

Government of Kenya. *Final Draft Paper on Sixth Development Plan—(1989–1993).*

FAO publication on Small-scale Irrigation in Africa in the Context of Rural Development by H.W. Underhill, Land and Water Development Division, FAO, Rome, 1984.

Proceedings of a Symposium on Water and Water Policy in World Food Supplies (Texas A&M University, May 26–30, 1985), edited by Wayne R. Jordan, Texas A & M University Press, College Station.

ENERGY CONSUMPTION IN KENYA: A PROJECTION OF THE NEEDS FOR HYDROPOWER GENERATION BY THE YEAR 2000

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The Government's overall national development plan emissaries the growth and equitable distribution of national income, the alleviation of poverty through the provision of basic needs, increased agricultural production, accelerated employment creation and improved rural/urban balance.

Energy in its various forms plays an important role in the achievement of these goals. The provision of adequate supplies of energy is thus an important objective for the country.

In recognition of the important role of energy, the policy of the Ministry of Energy has been and continues to be as follows: to ensure that secure and adequate supplies of energy are made available efficiently and at reasonable costs in line with national development needs.

Kenya uses three major forms of energy, namely, petroleum, electricity and fuelwood. Alternative sources of energy used include biogas, wind, solar energy and power alcohol.

The country's total domestic energy demand in 1987 was met from the various energy forms as follows:

Energy Form	Thousand tons of oil equivalent	Percent
Fuelwood	4598	70
Petroleum	1695	26
Electricity	200	3
Coal	82	1
TOTAL	**6575**	**100**

Petroleum is the major source and in 1987, met 86% of the commercial energy demand, followed by electricity (10%) of commercial energy and coal (4%).

At present, alternative sources of energy are only used to a limited extent in Kenya despite the fact that some, such as wind power, have been in use for a long time. As a result, their contribution to total energy supply is negligible. The major constraint affecting their development is high capital costs, thus placing the technologies beyond the reach of many potential users. Energy production costs are also relatively high. For the purpose of the seminar only hydro-electricity will be further discussed.

Electricity, being a versatile form of energy, plays an important role in Kenya's economic and social development both in the urban and rural areas. Even though less than 10% of Kenya's population are direct consumers of electricity, the total number of people benefiting from electricity is much higher since many community-based projects consume electricity, and most finished consumer goods have an element of electricity as an input of production.

The provision of basic infrastructure to small urban and rural market growth centres, as outlined in Government of Kenya's Sessional Paper No. 1 of 1986 on "economic management for renewed growth", will lead to increased economic activity, increased employment and reduced migration to the large urban centres. The basic infrastructure will include water supply, roads, telephone services, social services, electricity, etc.

As a component of an overall rural development strategy, electricity can:

- serve as an important addition to the rural infrastructure;
- contribute to the creation of rural employment through making industry and agriculture more efficient;
- serve in many applications as a substitute for imported fossil fuels;
- reduce rural-urban migration.

The total installed capacity of electrical power is currently 716 MW, composed of various forms of electricity as follows:

Source	Capacity (MW)	Percentage
Hydro	493	69
Geothermal	45	6
Conventional Thermal	148	21
Uganda Import	30	4
	716	**100**

Ten years ago, installed hydro capacity was 57 percent of the total system capacity. The increase to the current figure of about 70 percent is as a result of Government effort of minimizing the country's dependence on external sources of energy through exploitation of indigenous resources.

The above installed capacity of hydro power is located in various stations as follows:

Plant	Installed Capacity (MW)	Year Commissioning
Small Hydro Units	6.2	Between 1925 and 1958
Tana	14.4	1932, 1950, 1955
Wanjii	7.4	1953, 1958
Kindaruma	44.0	1968
Kamburu	94.2	1975, 1976
Gitaru	145.0	1978
Masinga	40.0	1981
Kiambere	144.0	1988
Total	**495.2**	

It is important to note that, except for some of the small hydro units all the above hydro power stations are located on the Tana river. The Tana river is thus a major source of hydro power in Kenya.

In addition to the above hydro power stations, it is anticipated that the Turkwel Gorge hydro power project, on the Turkwel river, with an installed capacity of 106 MW and currently under construction, will be ready for commissioning in early 1991.

Since independence, electricity consumption has grown from 486 million kilowatt hours (KWh) in 1963 to 2330 million KWh in 1987, amounting to an average annual growth rate of 6.7%. The 1987 electricity generation by source was as follows:

Source	Million KWH	Percentage
Hydro Power	1891	69
Geothermal	359	13
Thermal	309	11
Import from Uganda	176	7
Total	**2735**	**100**

From the above data, it is clear that most of the electricity consumed in Kenya is generated from local hydro-power resources. Thus, hydro power has been an important source of energy for the country's socio-economic development.

Between 1988 and the year 2000, demand for electrical energy in Kenya is projected to grow by an average of 5.5 percent per annum as follows:

Year	Power (MW)	Energy (GWh)
1990	560	3276
1995	724	4214
2000	941	5459

Existing and committed generation facilities are expected to meet the projected demand until around 1991/1992. Beyond this date, additional generation facilities will be required.

It is expected that at least 70% of the future electricity demand will be met from hydro-electric power. Existing and committed hydro-electric facilities can only provide about 32% of the total electrical energy demand by the year 2000. Thus, to provide the 70% requires the undertaking of a major hydro-electricity development programme. To facilitate such a programme, a Power Sector Master Plan study was undertaken in 1987. This study has identified potential hydroelectric resources in Kenya totalling over 1400 MW of capacity, which are capable of providing an average of 6,000 GWh per year. These hydro-electric resources are distributed in the five major basins as follows:

Basin	Capacity (MW)	Average Energy (GWh/yr)
Tana Basin	583	2560
Lake Basin	355	1680
Rift Valley	245	739
Ewaso Nyiro North	155	675
Athi Basin	84	463
Total	**1422**	**6117**

This hydro potential is composed of large and small projects. Potential projects with installed capacity of at least 30 MW are listed in the annex (page 19). Currently, the most promising sites in terms of average energy costs, in order of priority, are: Sondu Miriu, Sererwa, Grand Falls, Mutonga, Adamson Falls, Kora and Nandi Forest. However, except for Sondu Miriu, this ranking is based on consideration of power generation only and inclusion of other uses of water may alter the ranking.

In order to provide a minimum of 70% of the country's future electricity requirements from hydro power resources, it is estimated that at least 300 MW of additional firm hydro power* will be required by the year 2000. Of this 300 MW, it is anticipated that the proposed Sondu-Miriu hydro project with a capacity of 49 MW will be commissioned around 1994/95. This project includes the irrigation of some 16,000 hectares of land in the Nyakach and part of the Kano plains.

The major constraint affecting development of hydro projects is that they are very capital intensive. For example, the development of the proposed Sondu Miriu hydro project will require about Kshs 2 billion. Funding of this magnitude cannot easily be generated locally, as domestic resources are limited. The only option is to look for external funds, but these are subject to the international inflation which has affected the world economy over the past decade.

* **Firm Power**

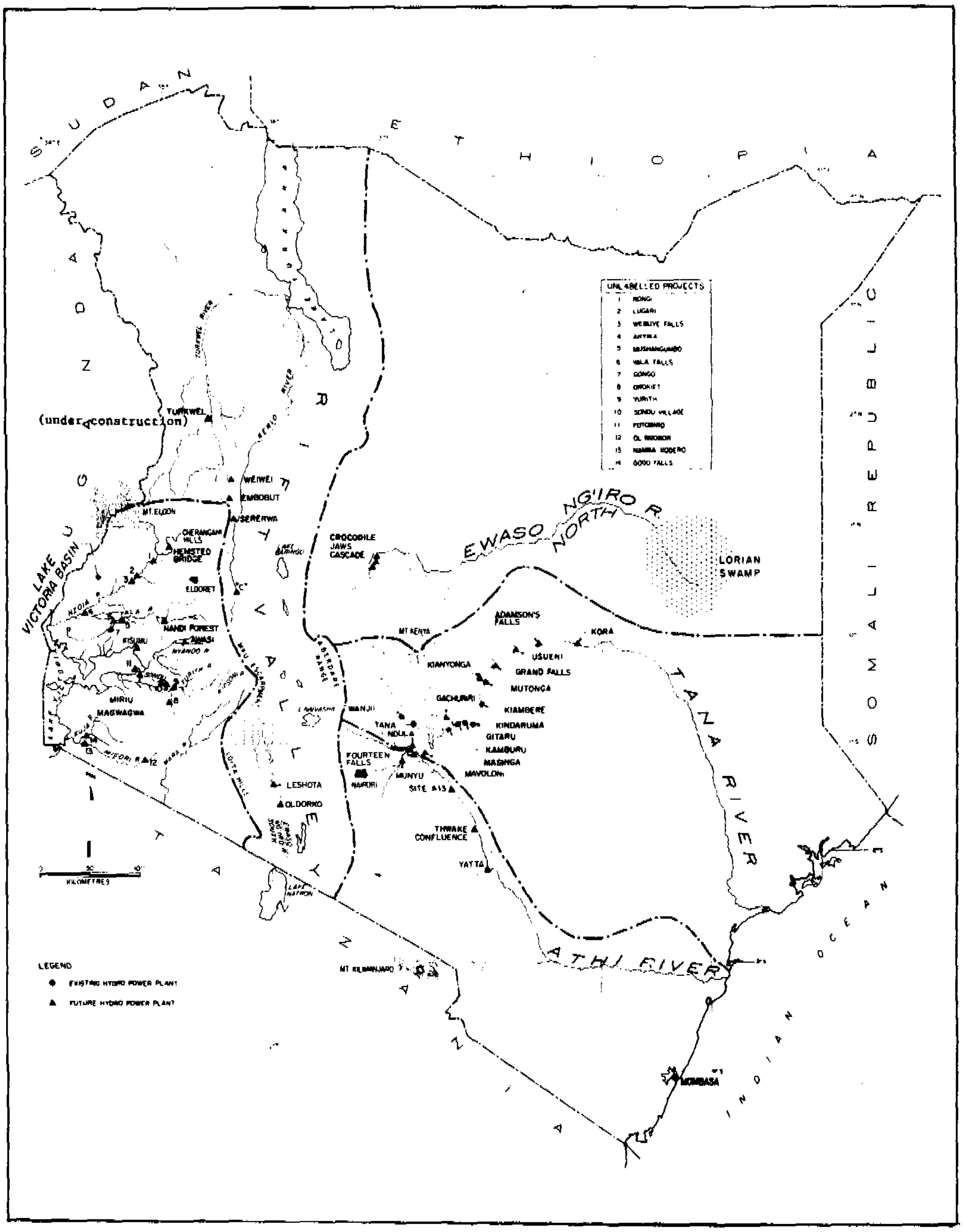
Firm power which only applies to hydro plants is the dependable power. In other words, it is that power a plant can produce during a critical dry period. In Kenya and in the context of power generation, the critical dry period is considered to be the 1947–1949 period.

Annex

Hydro-electric Potential in Kenya

Project	River	Installed Capacity (MW)	Average Energy (GWh/yr)
Lake Victoria Basin			
Hemsted Bridge	Nzoia	60	307
Magwagwa	Sondu	95	438
Sondu-Miriu	Sondu	49	261
Nandi Forest	Yala	50	255
Tana River Basin			
Karura	Tana	50	216
Mutonga	Tana	60	234
Grand Falls	Tana	120	594
Usueni	Tana	70	309
Adamson's Falls	Tana	80	358
Kora	Tana	92	401
Mavoloni	Thika	40	180
Kianyonga	Mutonga	30	120
Athi River Basin			
Munyu/Fourteen Falls	Athi	38	151
Rift Valley Basin			
Sererwa	Arror	60	150
Leshota	Ewaso Nyiro (South)	42	111
Oldorko	Ewaso Nyiro (South)	76	236
Ewaso Nyiro River Basin			
Crocodile Jaws	Ewaso Nyiro (North)	46	175
Kirimun	Ewaso Nyiro (North)	90	400

Figure 1. Existing and Future Hydro-electric Power Plants in Kenya



PLANNING OF WATER RESOURCES DEVELOPMENT PROJECTS

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Planning may be defined as the orderly consideration of a project from the original statement of purpose through the evaluation of alternatives to the final decision on a course of action. It is the basis for the decision to proceed with or to abandon a proposed water resources development project and is clearly an important aspect of the total development process. Because each water resources development project is unique in its physical, social and economic setting, it is impossible to adopt a universal planning procedure. Yet guidelines have been developed to identify elements common to most water resources development projects and to suggest how these might be treated in the course of project planning to ensure that all important aspects are taken into consideration and comparisons can be made between several planned projects.

Most water resources development projects pass through a sequence of events between the conception of a project and the evaluation of the performance of the project, which is conventionally depicted in a cyclic form, called the "project cycle". Figure 1 represents a simplified version of the project cycle. The statement of objectives, outline survey, preliminary project and feasibility report constitute the major steps in the planning of a typical water resources development project. Figure 2 presents a conceptual analysis for development of an irrigation and drainage project.

An essential preliminary to project planning is a clear statement of increasing agricultural production through irrigation and improved farm inputs, or of increasing the standard of living of the rural population in a particular region of a country. Other possible objectives of water resource development projects could be river regulation and water conservation, generation of electricity, developing domestic water supply, recreation, wildlife conservation and aquaculture, and so on. It is not unusual for national planners to have more than one objective when initiating a proposal.

Annex 1 presents a list of some possible objectives of water resources development projects.

Here, only a general idea or a rough outline of the project or projects is given. When several possible projects have to be examined in turn, an order of priority for the studies is laid down. For this, an approximate knowledge of the soil, climate, hydrology, crops and market conditions is needed. If the results of this first stage are favourable, the second stage is begun.

This involves pedological, geological and hydrological studies and the preparation of a preliminary plan of the project with possible variants. At this stage a provisional economic evaluation should be drawn up. It is desirable to calculate the total investment and cost per irrigable hectare and a comparison between this and projects already completed or in progress will show from the outset whether the project is a costly or inexpensive one. Obviously, the project is not taken further if costs are very high and productivity very low. If the technical and economic analyses at this stage produce a positive result, then the next stage is commenced.

This consists of a technical, economic, environmental and social evaluation of the project. It has considerable importance if outside funding is required. Even if no outside funding is envisaged, it is recommended that this formality be followed to ensure that national resources are used optimally and to avoid internal misunderstandings and consequent delays in implementation. The basic purpose of the feasibility study is to define in detail the necessary scope of the project, to assess the practicability of the development and, in so doing, the findings are normally used to:

- compare the development with other possible developments in the same country or region so that priorities can be given to better projects and the best use can be made of the limited resources;

- decide if the development is worth-while;

- initiate arrangements for implementation, particularly finance and design.

Although normally a major portion of irrigation development cost does lie in the engineering works, it should be appreciated that the ultimate success of a scheme depends on an integrated approach which considers all aspects, such as agriculture, human resources, and environment.

At this stage, the project is subjected to rigorous economic and financial analyses. These analyses are conducted at national, project and farm levels.

At the national level, the project should be placed in the wider context of government planning and overall economic resources, and of benefit to the nation in terms of: foreign exchange, self-sufficiency, employment, taxes/savings, raw materials for industry, and contribution to gross domestic product.

At the project level, a full assessment of costs and benefits is carried out and internal rates of return calculated. This would include appropriate adjustments for taxes and subsidies and the cost of inputs, especially labour, at their shadow prices (value in alternative employment).

At the farm level attention is given to farm production costs and prices. This involves detailed estimates of the requirements for machinery, fertilizer and agrochemicals, and their potential availability. Labour-demand patterns are examined and compared with potential availabilities within families and on the wider project basis.

Finally, a feasibility study presents recommendations and conclusions. These may deal with water availability, feasibility and estimated cost of construction of certain engineering works, the productivity of the land, the availability of markets for agricultural products and the estimated benefits of alternative water development projects. A number of recommendations are put forward for consideration, one of which may be that a certain project be adopted for implementation.

Annex 2 presents the layout of a typical feasibility report.

Economists and financial analysts always argue for a strict application of economic criteria in the planning of water resources development projects. A common economic criterion used is the Economic Internal Rate of Return which may be defined as the rate of discount at which the total present value of costs incurred during the life of the project is equal to the total present value of benefits accruing during the life of the project. As a rough rule of thumb, the project analyst might recognize that the project is in the danger zone if the economic internal rate of return arrived at is less than about 10 to 12%.

Controversy often centres on the Economic Internal Rate of Return of the investment, although that percentage figure is only one of the indicators of the project's merits, being only concerned with those effects of the project which can be measured in monetary terms. There are inevitably other effects to be taken into account in making a responsible judgement on whether the project calculation of every irrigation project needs to be supplemented by a systematic review of all other important effects that can be foreseen. The effect on health, risks of disease and costs of disease control should certainly be included in this analysis.

Irrigated agriculture is increasing at a rapid rate throughout the world, yet serious food deficiencies continue to plague many developing countries where the rate of population growth remains over 2.5%. National governments, international lending organizations and donor agencies are devoting massive sums to the expansion or renovation of irrigation. Irrigation is the largest single component in agricultural loans from the World Bank.

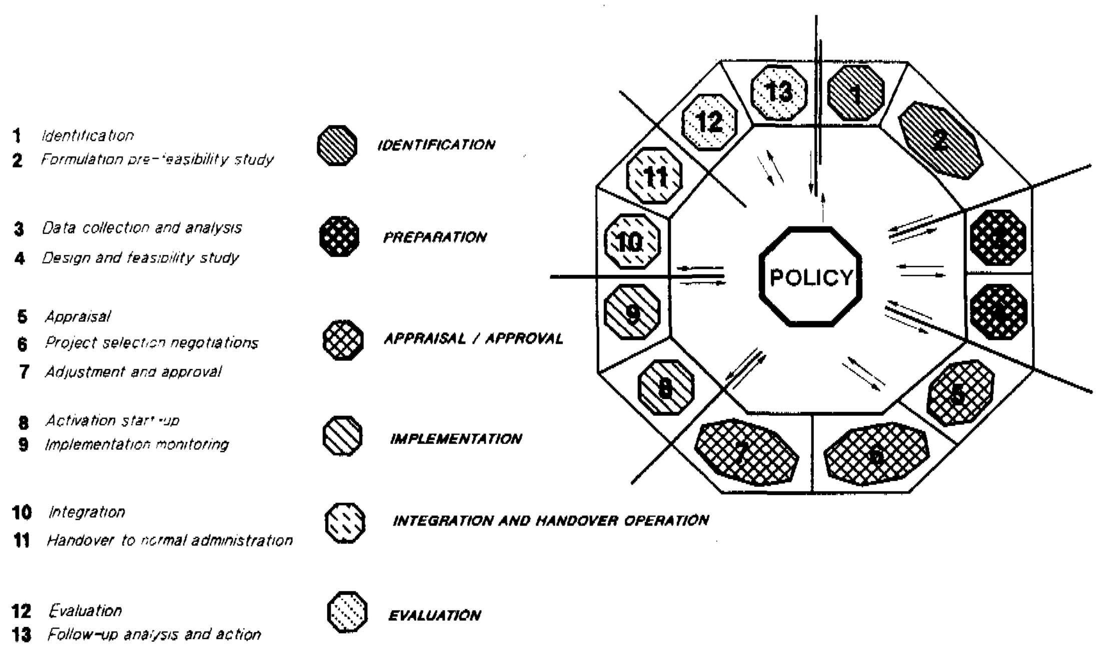
The international pace to expand or improve irrigation is not expected to slow down during the next decade. Certain aspects of development will, however, change or must change if world food crises are to be met and the people are to enjoy a better standard of living.

Since most of the suitable lands have already been utilized, new developments will push into marginal areas which present increased difficulties in soil fertility, water quality, health hazards and social adjustment. Decisions for irrigation development should be based on criteria beyond strict economic projection, if the development is to provide expected long-term benefits.

Over the years the approaches and procedures of planning water resource development projects have improved. At present, a fairly comprehensive consideration, beyond technical and economic considerations, is adopted by most national and international agencies; but there is room for improvement.

Of particular interest are the public health implications of irrigated agriculture. It is recommended that evaluation of public health impacts, particularly vector-borne diseases, should be a major part of every irrigation planning effort. While all adverse side effects cannot be eliminated, proper planning, design and operation of irrigation systems can exert a significant degree of control over major disease hazards.

Figure 1. The Project Cycle



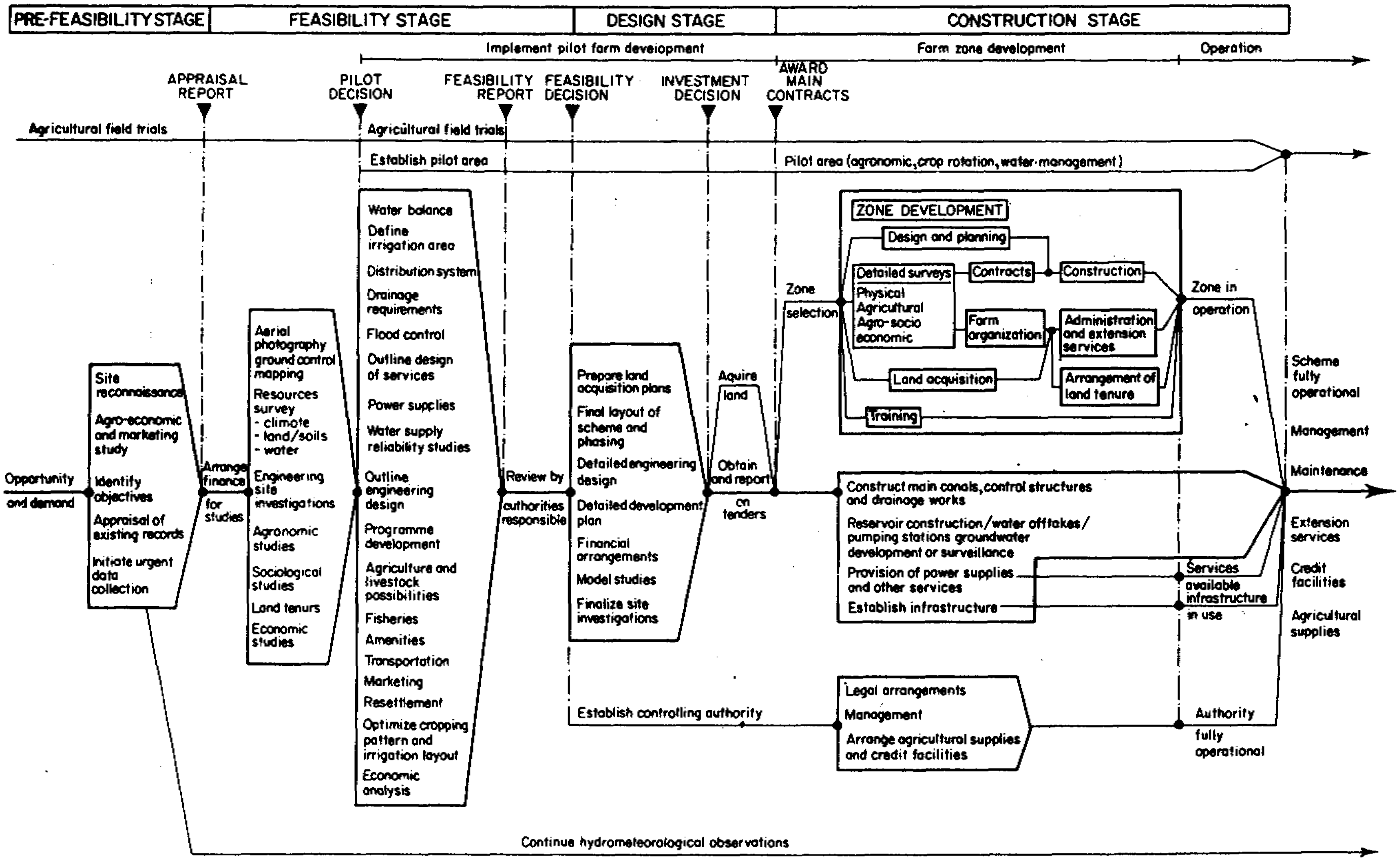


Figure 2. Conceptual Analysis for Development of an Irrigation and Drainage Project

Annex 1

Some possible objectives of water resource development projects:

- Maximizing the return per unit of capital invested
- Maximizing the return per unit of project cultivable commanded area (CCA)
- Maximizing the return per unit of water
- Maximizing the value of the agricultural output
- Maximizing the output of food products (possibly linked with national self-sufficiency)
- Maximizing output of export crops
- Maximizing farm-family net income
- Attaining a minimum level of farm-family net income
- Maximizing the number of families settled on a project (i.e., Minimizing cost per family settled)
- Creating maximum number of jobs (at specified level of skill) for given expenditure
- Minimizing use of foreign currency in project operation
- Maximizing government revenue (from taxation, etc)
- Minimizing public expenditure (i.e., encouraging private-sector investment)
- Achieving redistribution of income in the region
- Generating maximum economic activity in the project area
- Settling previously nomadic communities so as to place them within reach of the instruments of social advancement
- Minimizing environmental and health hazards created by projects
- Establishing social stability
- Satisfying political ideas

Annex 2

Typical contents of a feasibility report:

SUMMARY OF CONCLUSIONS

1. INTRODUCTION

1.1 Brief history of the project
1.2 Purpose and scope of the report

2. THE PROJECT AREA

2.1 Location and topography
2.2 Surface water resources
2.3 Sedimentation
2.4 Groundwater resources
2.5 Soils and land capacity

3. WATER RIGHTS AND LAND TENURE

3.1 Allocation of water
3.2 Land tenure

4. AGRICULTURAL DEVELOPMENT

4.1 Present agriculture in the project area
4.2 Guidelines for development
4.3 Market considerations
4.4 Cropping patterns
4.5 Water application, expected yields and net returns
4.6 Livestock
4.7 Technical inputs
4.8 Organization of agricultural development

5. PROPOSED IRRIGATION DEVELOPMENT

5.1 Storage reservoir or division weirs
5.2 Alternative division schemes
5.3 Distribution network
5.4 Tubewell development
5.5 Project design and implementation
5.6 Cost estimates

6. ORGANIZATION AND MANAGEMENT

6.1 Project organization
6.2 Project management and operation
6.3 Ownership and management of processing plant
6.4 Irrigation Board's senior officials

7. ECONOMIC APPRAISAL

7.1 Basis of appraisal
7.2 Choice of agricultural system
7.3 Market prospects
7.4 Net returns
7.5 Choice of scheme design
7.6 Optimum scheme size
7.7 Economic benefits and costs
7.8 Economic analysis
7.9 Risk and uncertainty analysis
7.10 Financial analysis
7.11 Benefits to the local population
7.12 Secondary benefits

8. OTHER ISSUES

8.1 Need for legislation (water law)
8.2 Need to set up an organization and management board
8.3 Initiation of contracting law to permit international tendering
8.4 Procedures for land acquisition
8.5 Examination of water-borne diseases—malaria, schistosomiasis, etc.—by health authorities

PHOTOGRAPHS

APPENDICES

A Terms of reference
B Hydrology
C Water rights and list of existing diversions
D Tubewell farms
E Unit cost for budget estimates

PLANNING PROCEDURES FOR WATER RESOURCE DEVELOPMENT IN KENYA

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This paper describes the policies and objectives regarding water resources development in Kenya with particular reference to planning issues. It outlines the various water resources development programmes that are being implemented, as well as the planning procedures for the specific projects within the programmes. The institutional framework of the water sector is described. Cases of environmental impact studies are cited.

It is recommended that base-line studies be carried out before implementation of major water development projects such as dams, irrigation, hydro-power projects and establishment of major industries. These should be followed by environmental impact studies after the development has had time to take effect.

The Government of the Republic of Kenya recognizes water as a basic human need and also an important catalyst and agent of development. It is therefore the intention of the Government to provide water of reasonable quality and quantity for human and livestock consumption and for sustenance of other economic development programmes such as irrigation, fisheries, wildlife conservation, industries and the generation of hydroelectric power. It is the Government's long-term objective to bring to the entire population the benefit of safe water supply within reach by the year 2000.

The Government, through the Ministry of Water Development which was created in 1974, has overall responsibility for the development and control of water resources, including water pollution control. Other entities carry primary authority for exploiting of water utility.

To avoid conflict of interest and duplication of effort by institutions dealing with water affairs, the Government has recently adopted a new policy, the District Focus for Rural Development, that makes the district the operational centre for rural development and implementation.

During the Sixth National Development Plan (1989–1993) the Ministry of Water Development will pursue the following objectives:

- to provide water supplies to all rural and urban communities for domestic, livestock and industrial uses;
- the management and development of water resources to achieve national goals such as irrigation, hydropower development, recreation and wildlife conservation;
- the continued operation and maintenance of water supply schemes is attained; proper operation and maintenance of waste-water treatment plants to maintain sanitary conditions and pollution control;
- research and development of appropriate and cost-effective technology for water conservation, water supply and waste-water treatment facilities;
- the provision of incentives for efficient water use and penalties for wasteful and environmentally harmful water use practices;

- the recognition of the principle of cost sharing so that the beneficiaries make contributions towards the provision and maintenance of water services.

The declared targets for the International Water Supply and Sanitation Decade (1980–1990) were:

- for water supply—a coverage of 100% and 75% in urban and rural areas, respectively;
- for sanitation—a coverage of 90% and 50% in urban and rural areas, respectively.

These targets may not be met due to lack of sufficient professional staff and, above all, due to financial constraints. Recent figures from the World Health Organization suggest that by 1990 almost 30 million more people will be without clean water than in 1980, while over 200 million more will lack sanitation.

The available water in Kenya could support an estimated population equivalent of about 200 million including livestock assuming a consumption of $0.2m^3$ per capita per day, if the water were properly harnessed. The major problem is the distribution of the water resources.

At present, a population of close to 9 million in Kenya are served with improved water supply systems. This comprises a rural population of about 5 million and an urban population of about 4 million. The corresponding figures for sanitation services are yet to be computed.

To achieve the objectives for water supply, the Ministry of Water Development is implementing the following programmes: Rural Water Supplies; Self-Help Water Supplies; Sewerage Development Programme; National Water Quality and Pollution Control; Integrated Development Programme; Water Conservation Programme; Private Water Development; Water Survey and Planning (Water Plans for Districts) Programme; Livestock Water Supply Programme (elaborated below); Water Research Programme; Manpower Development Programme.

The Rural Water Supply Programme is one of the major programmes run by the Ministry of Water Development since the majority of Kenyans live in the rural areas. The Programme involves planning, design, construction, operation and maintenance of new rural water supplies, and rehabilitation and augmentation of existing schemes.

The Urban Water Supply Programme involves expansion of existing water supply schemes and planning, design and construction of new urban water schemes.

The Minor-Urban Water Supply Programme involves supply of water to the Minor-Urban Centres where water supply is nonexistent.

The Livestock Water Supply Programme is an integral part of a comprehensive programme for livestock industry development in the range and ranching areas of the country.

The Sewerage Development Programme involves planning, design, construction, operation and maintenance of water-borne sewerage schemes in Municipalities and Urban Centres with populations exceeding 2500 persons. The Ministry of Water Development undertakes this function on behalf of municipalities and urban authorities and also gives technical advice on operation and maintenance of sewerage and other sanitation facilities.

The National Water Quality and Pollution Control Programme involves operation of a National Water Quality Network to ensure maintenance of suitable river water quality and also to ensure that industrial establishments have adequate wastewater treatment plants. World Health Organization Water Quality Guidelines are utilized in the establishment of water quality standards.

The Integrated Development Programme involves soil and water conservation, water development, crop and livestock development, forest development, cooperative development, road and bridge construction, and social services. The on-going projects are in Machakos, Kitui and Baringo Districts.

The Water Conservation Programme involves construction of dams (both surface and subsurface dams) pans (shallow water reservoirs often not more than 2 meters deep), laghas (dry river bed, often containing water during wet season, often used N.E. Kenya) and djabias (rainwater harvesting systems composed of cemented surface draining into a reservoir from which water is drawn, common in coastal area in Kenya). During the period 1980–1988, about 150 dams have been constructed with a total estimated storage capacity of 15 million cubic meters.

Private Sector Water Development is encouraged through provision of technical advice, including borehole siting, to individuals who intend to construct a water supply system. The Government, through the Water Apportionment Board also issues water permits for abstraction of surface or groundwater and for construction of water conservation dams.

The Water Research Programme involves research and development into appropriate and cost-effective technology for water conservation, water supply and sewerage.

The Manpower Development Programme involves recruitment and training of university graduates to implement water development programmes, as well as training of technicians and artisans, at the Kenya Water Institute. The Programme also involves the development of training facilities and the training and retraining of trainers.

The major sources of water in Kenya are:

- surface water, comprised of rivers, springs, lakes and the ice caps on top of Mount Kenya;
- groundwater, including both fresh and saline water;
- harvested rainwater, embracing roof catchment and rock catchment (natural and man-made);
- surface and subsurface dam and lagha water;
- other sources, including sea water and shared water resources.

Quantitative and qualitative assessment of the available water resources is essential prior to development.

Hydrological Network. Kenya is divided into five major drainage basins. These are: Lake Victoria Basin; Rift Valley Basin; Tana River Basin; Athi River Basin; Ewaso Nyiro Basin. The details of the five drainage basins are shown in Figure 1, and Table 1 (see pages 36–39).

A meteorological and hydrological network has been built over the years in Kenya, which allows reasonable estimates of the country's water resources. Tables 2–4 shows the distribution of the hydrological monitoring stations within the major drainage basins.

As can be seen from Table 2, only 54.5% of the total number of stations are operational, the remaining 45.5% having been closed due to shortage of funds for the monitoring staff, shortage of manpower or because the station has been resited.

The average annual runoff has been estimated at 14,830 million cubic meters per year. Table 5 shows the annual runoff/stream flows for the major rivers.

District Focus Strategy. Prior to July 1983, all the planning for water supply development was done by the Ministry of Water Development Headquarters. This meant that all the major decisions, such as the water source, pipeline routes (for piped water supplies), location of storage tanks and, most important, the choice of technology for a water supply were made without consulting the consumer.

In July 1983, the District Focus for Rural Development Strategy was introduced. The aims and objectives of this strategy were to:

- involve the beneficiaries in the identification, planning, implementation, operation and evaluation of water supply projects within their areas;

- coordinate the activities of different organizations with similar goals, (Ministry of Water Development, Ministry of Health, Ministry of Local Government, NGOs and basin development authorities);

- enable local communities to select their priorities in the light of the limited resources available;

- mobilization of locally available resources, mainly labour and materials, to enhance development, in line with the Government's policy of cost-sharing;

- create the needs for artisans within the community and hence create employment for the semi-skilled, instead of importing skills from outside the community;

- create a sense of ownership for the projects so implemented within the community through cost-sharing and consumer participation.

The strategy of District Focus for Rural Development is based on the principle of ministries and districts having complementary responsibilities. Responsibility for the operational aspects of rural development has been delegated to the districts, while the responsibility for broad policy and the planning and implementation of multi-district and national projects has remained with the ministries. The District Development Committees are responsible for the definition of priorities for projects identified locally by the divisional development committee, identification of district-wide needs, preparation of district development plan, and the design of projects which fit within the priorities. The membership of the District Development Committees includes the following: district commissioner (chairman), district development officer (secretary), departmental heads of development-related ministries, members of parliament from the district, chairmen of local authorities, clerks of local authorities, chairmen of divisional development committees, representatives of development-related parastatals, and invited representatives of non-governmental development-related organizations.

The District Development Committee encompasses many perspectives on the development needs of the districts, and its approval of project proposals represents a strong mandate of local support. Being a development-related ministry, the Ministry of Water Development is a member of the district development committees and, to ensure strong representation at the district level, decentralization of technical manpower has been carried out. Now, every district has a district water engineer/officer and a strong support team to ensure execution of water development programmes.

District Specific Projects. Any water supply where the limits of supply are within the district and where the level of technology does not call for special skills may be considered as a district specific water project.

These projects are identified at the local level and are ranked in the order of priority. Each location forwards its water priorities, to the sub-district development committee. The sub-district development committees are chaired by the district officer of the division. Again each division forwards its water project priorities to the District Development Committee, which determines the district's water priorities.

The district water engineer carries out the feasibility studies for the top priorities, according to the district expenditure ceilings for the district specific project. The expenditure ceiling for a period of 3 years is normally communicated to the district by the parent Ministry, in line with the Treasury directives.

National Water Projects. These are normally inter-district water projects or water projects where the technical implications cannot be handled at the district level. These projects may also be in the form of programmes such as the Arid and Semi-Arid Lands Programme which cover districts which although they do not border each other, have similar conditions.

The planning and implementation of such projects are carried out by the Ministry headquarters, with the district development committees of the districts concerned playing a supervisory role. These projects are normally contracted.

Self-help Water Supplies. These are community specific projects. They are either Government Rural Development Fund aided projects or purely community financed projects. The district water engineer assists the community in identifying the most viable water source and most appropriate design criteria, and advises on operation and maintenance techniques.

Nongovernmental Organization Water Supply Projects. The NGO in question may be wholly local or may be a branch of an overseas organization. In the past, some of the NGOs planned and implemented water projects independently. In some cases, some of these projects were implemented without a co-ordinator from other parties with water interests within the area. Today, all the NGOs are required to submit their water projects proposals to the respective District Development Committee for deliberation.

Some of the NGOs have their own technical personnel who carry out all the technical studies. Such NGOs normally do not solicit technical assistance from the Ministry of Water Development. The NGOs without the technical personnel are normally assisted by the Ministry of Water Development in their water project planning and implementation processes.

Presidential Directives. In his wisdom, our beloved President may answer his peoples' request for potable water by directing the Ministry of Water Development to implement a water project within that community. Such projects are normally implemented with direct supervision from the Ministry of Water Development headquarters while ensuring participation of the intended beneficiaries.

Environmental impact studies have not been a common feature in water resources development projects in Kenya. There are, however, a few cases where such studies have been undertaken and these are cited below.

(i) Ecological Survey of the Middle and Lower Nzoia River in Western Kenya—1971

The study was carried out in 1971 prior to the establishment of the Pan African Paper Mills at Webuye on the Nzoia River. The study was undertaken to establish scientific data on the River Nzoia environment to help monitor the impact of the Pulp and Paper Mill. The UNESCO report concluded that Nzoia River was still a healthy stream showing most of the characteristics of a natural watercourse, with the exception of the presence of biocides and high sediment load in the lower course. The study recommended regular survey, at least on a 3-yearly basis, to be carried out along the lines proposed in the original survey. No environment impact study of sufficient scientific rigour has been carried out on the Webuye Pulp and Paper Mills since the Mills were commissioned in 1975.

(ii) Upper Tana Reservoir (Masinga Dam)—Pre-construction Environmental Study—1976

The study examined the existing environment in terms of land forms, soils, water supplies, climate, vegetation, wildlife, soil erosion and existing land use. It presented the anticipated environmental changes with respect to water supplies, effect of the reservoir impoundment on the study area, land use planning and resettlement, wildlife and sedimentation of the reservoir. The Division of Vector-borne Diseases of the Ministry of Health also carried out a medical survey of the dam in 1976.

(iii) Environmental Impact Study of Kiambere Hydro-Electric Power Project—1983

This study focused on the existing environment in the project area considering the following aspects:

Climate, soils, vegetation, wildlife, aquatic biology, population, land use, economic activity, community health, and archaeological and traditional sites.

Possible environmental impact has been projected for:

hydrology and sedimentation, terrestrial ecology, aquatic biology, fisheries, community health, land issues and compensation, construction effects, archaeological and traditional sites, tourism and recreation, economic activity.

Specific recommendations have been made on future environmental monitoring programmes, particularly in reference to:

resettlement and employment of displaced persons, community health, soil erosion and sedimentation, vegetation changes, wildlife and aquatic environment.

(iv) Environment Impact of the Proposed Munyu Dam—Athi River—1984

The study dealt with the immediate environment of the proposed Munyu Dam in reference to the following factors:

physical environment, population and land use, land use implications, impact of the proposed dam on population and land use, resettlement of the displaced persons.

A projection was presented on the impact of the proposed dam on river ecology regarding aquatic flora and fauna, water-borne and water-related diseases, fisheries, population of mammals, scenic and aesthetic features.

(v) Assessment of Environmental Impact of Kirandich Dam for Kabarnet Water Supply—1987

The study has focused on the existing environment of the project area regarding:

climate, morphology, geology, hydrology, soils, vegetation (general flora and productivity), erosion and filtration, tourism and wildlife, aquatic biology, population and settlement, human settlement, census, land owners in the dam site and reservoir area, community involvement in the catchment, economic activity, crop farming, livestock, non-agricultural economy, land use, community health, morbidity, health facilities available, utilization, nutrition, housing and sanitation.

The projected environmental impact of the project dealt with the following aspects:

hydrology and sedimentation, vegetation, tourism and wildlife, fisheries, social dislocation, land issues and compensation, community health and economic activity.

The study recommended environmental monitoring in particular reference to:

human environment, soil, land use, erosion and sedimentation, terrestrial ecology, community health.

(vi) Greater Nakuru (East) Water Supply Project (proposed study)

This is particularly important due to possible ecological impact of transfer of water from Lake Naivasha sub-catchment to the Lake Nakuru sub-catchment.

(vii) Nol Turesh Pipe Line Project (proposed study)

The water supply project involves abstraction of 165 l/sec. from the Nol Turesh Springs which have a yield ranging from 250–330 l/sec. The total expected abstraction in the future will be 205 l/s. The effect of such a large abstraction, in addition to possible land degradation along the pipeline due to changed land use, may have a significant impact. The altered river ecosystem due to reduced river flow is also of interest.

The Government of Kenya has a long-term objective of providing water of reasonable quality and quantity for human and livestock consumption, and sustenance of other economic development programmes such as irrigation, fisheries, wildlife conservation, industries and the generation of hydro-electric power.

The Government has recently adopted the District Focus for Rural Development Policy in order to ensure effective coordination among the institutions in the water sector and to ensure community participation in planning, implementation, operation and maintenance of water development projects.

Baseline studies before implementation, of major water development projects, such as dam, irrigation and hydro power projects and establishment of major industries should be an integral part of project planning.They should be followed by environmental impact studies after the development has taken effect in order to institute any corrective measures.

REFERENCES

African Development and Economic Consultants, 1983. *Environmental Impact Studies—Kiambere Hydro-electric Power Project.* Consultancy Report prepared for the Tana and Athi River Development Authority.

African Development and Economic Consultants, 1987. *Design and Supervision of Kirandich Dam for Kabarnet Water Supply—Assessment of the Environmental Impact.* Consultancy Report prepared for the Ministry of Water Development.

Government of Kenya/UNEP/UNDP, 1981. Report on Project on Development and Environment—Kenya.

Government of Kenya, 1986. *Economic Management for Renewed Growth,* Sessional Paper No. 1 of 1986.

MWASSCO Associated Ltd., 1984. *The Environmental Impact Study of the Proposed Munyu Dam.* Consultancy Report prepared for the Tana and Athi River Development Authority.

Thitai W.N., 1986. *Surveillance and Protection of Drinking-Water Quality in Kenya.* Paper presented at WHO/DANIDA Training Course on Surveillance and Protection of Drinking-Water in Rural Areas, Mongu, Zambia.

UNESCO, 1971. Report of a UNESCO Survey for the Government of Kenya on Ecological Survey of the Middle and Lower Nzoia River in Western Kenya.

Ward Ashcroft and Parkman, (EA), 1976. *Preconstruction Environmental Study of Upper Reservoir (Masinga).* Consultancy Report for the Tana River Development Authority.

Figure 1 Major Drainage Basins in Kenya

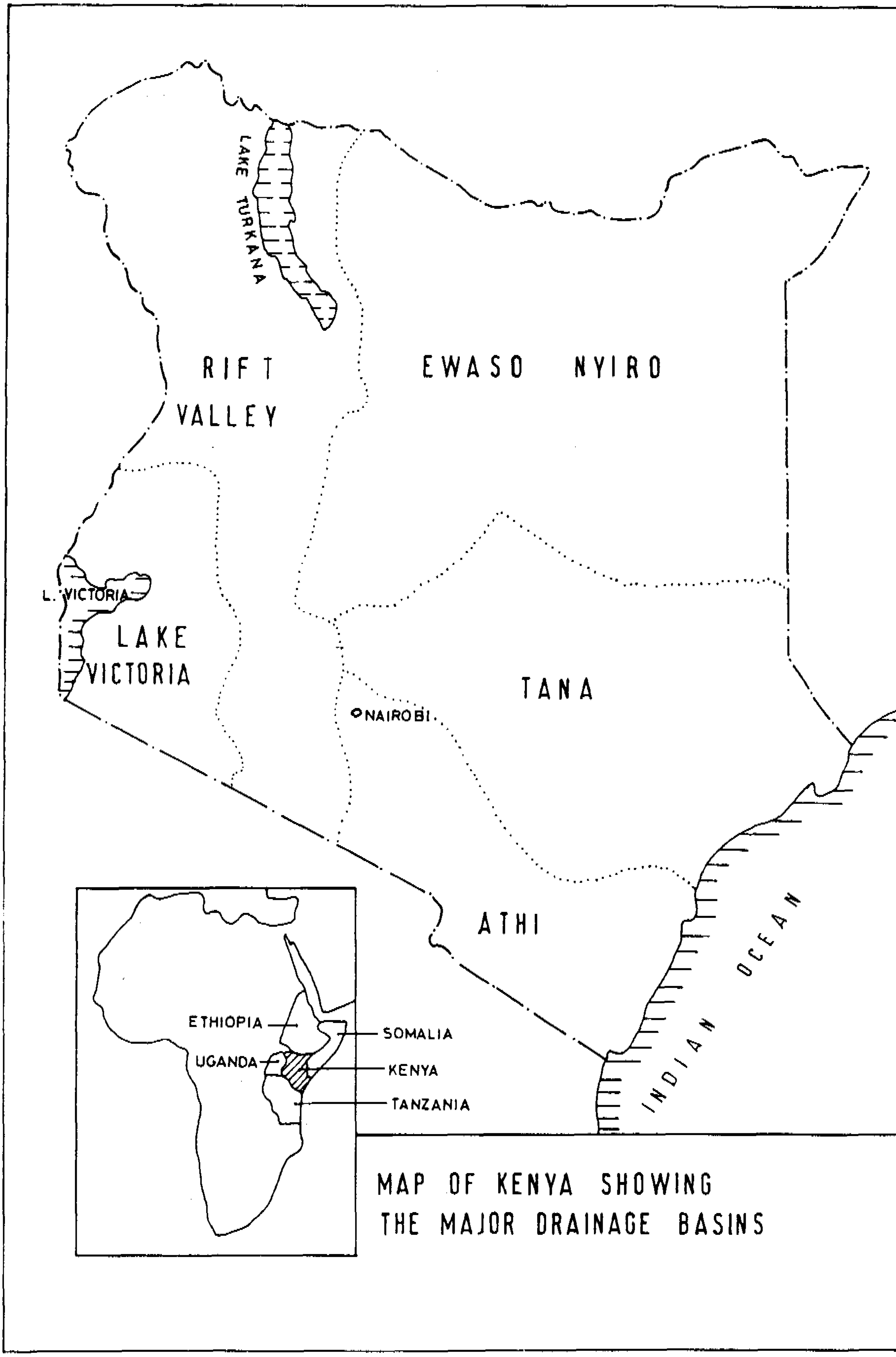

Table 1 Major Drainage Basins in Kenya

Drainage Basin	Catchment Area km²	Mean Annual Rainfall mm	Mean Annual Rainfall 10 x m³	Mean Annual Run off mm	Percent Total Land Area of Kenya
Lake Victoria	49 000	1245	7.30	149	8.4
Rift Valley	127 000	535	0.81	6	21.8
Athi River	70 000	585	1.30	19	12.0
Tana River	132 000	535	4.7	36	23.7
Ewaso Nyiro	205 000	255	0.74	4	35.1
Kenya	583 000	510	14.85	25	100.0

Table 2 Distribution of Hydrological Stations

Drainage Basin	Operating Stations	Closed Stations	Total Number of Stations
Lake Basin	136	94	230
Rift Valley	86	66	152
Athi River	97	124	221
Tana	140	74	214
Ewaso Nyiro	47	64	111
TOTAL	506	422	928

Table 3 Operational Station Types

Drainage Basin	Recorder	Weir	Staff
Lake Basin	20	-	136
Rift Valley	1	-	86
Athi River	12	33	97
Tana	16	12	140
Ewaso Nyiro	6	19	47

Table 4 Hydrological Stations on Kenyan Lakes

Lake	Recorder	Staff
Victoria	2	2
Naivasha		3
Turkana		2
Bogoria		1
Elementaita		1
Baringo		1
Kenyatta		1
Ol Bolossat		2

Table 5 Annual Runoff/Stream Flow of Major Rivers

Drainage Area	River	Mean Annual Runoff $x10^6 m^3/year$	Mean Annual Rainfall mm
	Nzoia	1 920	
	Yala	965	
Lake Victoria	Sondu	1 275	
	Nyando	500	
	Gucha Migori	870	
	Others	1 800	
		7 330	1 245
	Malewa	184	
	Gilgil	28	
	Molo	39	
Rift Valley	Perkera	125	
	Others	430	
		806	535
	Athi	750	
	Tsavo	138	
Athi River	Njoro Luari	293	
	Others	113	
		1 294	585
Tana River	Tana	4 700	535
Ewaso Nyiro	Ewaso Nyiro	740	225
Total Kenya		**14 870**	**510**

Some of the stream flow from the above rivers drains into various Kenyan lakes. The surface area of these lakes is shown in Table 6.

Table 6 Major Lakes in Kenya

Lake	Area km²	Water Quality
Victoria (Nyanza Gulf)	3 785	Fresh
Turkana	6 405	Saline
Baringo	130	Fresh
Magadi	100	Saline
Naivasha	115	Fresh
Jipe	40	Fresh
Hannington	34	Saline
Nakuru	30	Saline
Elementaita	18	Saline

TANA AND ATHI RIVER BASINS WATER RESOURCES DEVELOPMENT

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The Tana and Athi Rivers basins occupy that part of Kenya comprising the southern and eastern parts of both Mount Kenya and the Nyandarua Ranges stretching south-east to the Indian Ocean as shown on the location map.

The water resources of the Tana and Athi Rivers basins are inadequately distributed over the basins, as shown in Table 1. The seasonal distribution is furthermore marked by greatly reduced river flows from January to March and from August to October while there are floods from April to June and from November to December. These characteristics of water distribution call for elaborate planning in the development of water-based projects to even out the seasonal fluctuations and to provide water to deficient areas.

Hitherto, the water development plans in the two river basins have been made to meet the needs of the domestic (household and livestock supply), municipal, industrial, irrigation, hydropower and ecological sectors. Each of these water use sectors is considered under three broad classifications:

- consumption, i.e., uses which involve water transfers that do not return water to sources, examples include irrigation and evapotranspiration, the latter accounting for 94% and 98% of the mean annual rainfall in one out of five years in the Tana and Athi basins, respectively (Table 2 indicates the water availability frequency in the two basins);
- water quality degradation; such uses are largely municipal and industrial uses in which effluents are returned to sources, streams and aquifers; these quality degrading uses compete for the small proportion of fresh water available within each of the two basins;
- uses which do not consume or degrade water; hydropower and ecological uses hardly change the quantity or quality of water and the returned water is readily available for other uses downstream.

By their nature of water use, domestic, municipal and industrial demands are more often than not supplied with water from simple sources such as roof and other minor catchments, groundwater (shallow and deep aquifers) and run-of-river with or without short time regulating storages. A number of irrigation projects also depend on the run-of-river for supply of water.

It is during the conveyance and use of water, as in the case of furrow or flood irrigation, and also after water use, as in the disposal of domestic, municipal and industrial effluents, that the creation of disease vector habitats may occur. The disease vector problem is dealt with at the project operations planning stage by the individuals and agencies promoting or implementing the specific project.

Large-scale irrigation projects like Bura, Tana Delta and Kibwezi and the hydropower generation on the Tana and Athi rivers cannot be developed on a run-of-river basis because of seasonal fluctuations in flows. Furthermore, at any given moment, the quantity of water demanded by a particular project is substantial in comparison with the available natural flow. To avoid severe competition on the natural river flows, large storage reservoirs with storage capacities for a year and more will have to be built.

Among the statutory functions of the Tana and Athi Rivers Development Authority (TARDA) is the integrated resources development planning for the two river basins and the planning of construction works necessary for the protection and utilization of the water and soils of the basins.

Environmental impact studies constitute a vital component in the planning and implementation of the water resources development projects, which are listed in Table 3. These studies also deal with public health aspects, including water-related vector-borne diseases. In each of the studies, the collection of pre-construction public health baseline data is commissioned by TARDA and monitored by the Ministry of Health.

The follow-up of recommendations made for monitoring and evaluating any aspects of environmental impact is coordinated by TARDA with the appropriate agencies or Government Ministries.

Table 1 Tana and Athi Rivers Basins Water Resources Areal Distribution

River Basin	Principal River	Catchment Area km²	Mean Annual Rainfall (mm)	Flow (m³/sec)
ATHI	Mbagathi	3333	701	61
	Nairobi	1920	1120	212
	Ndaragu	361	1253	356
	Yatta Athi	1614	720	55
	Thwake	2935	842	72
	Kiboko Athi	14382	513	14
	Tsavo	6214	414	34
	Galana Sabaki	7150	560	20
	Lumi	2731	457	10
	Ramisi	4140	857	73
	Voi/Rare	8277	689	29
	Mwachi	10378	672	34
	Namanga	3085	426	10
	Sagana	2063	1112	303
TANA	Tana Sagana	2923	1298	484
	Thika	1818	1219	297
	Thiba	2659	1101	317
	Tana Kiluma	5666	953	165
	Tana Kibuka	6163	847	194
	Lower Tana	53835	463	6
	Tiva	20103	477	8
	Jarra Jila	18179	385	4
	Dodori	13518	580	9

Source: *National Master Water Plan State I—MoWd 1980.*
Ministry of Water Development, National Master Water Plan Stage I by Tippetts-Abbett-McCarthy-Stratton Engineers and Architects.

Table 2 Water Availability Frequency in Tana and Athi River Basins

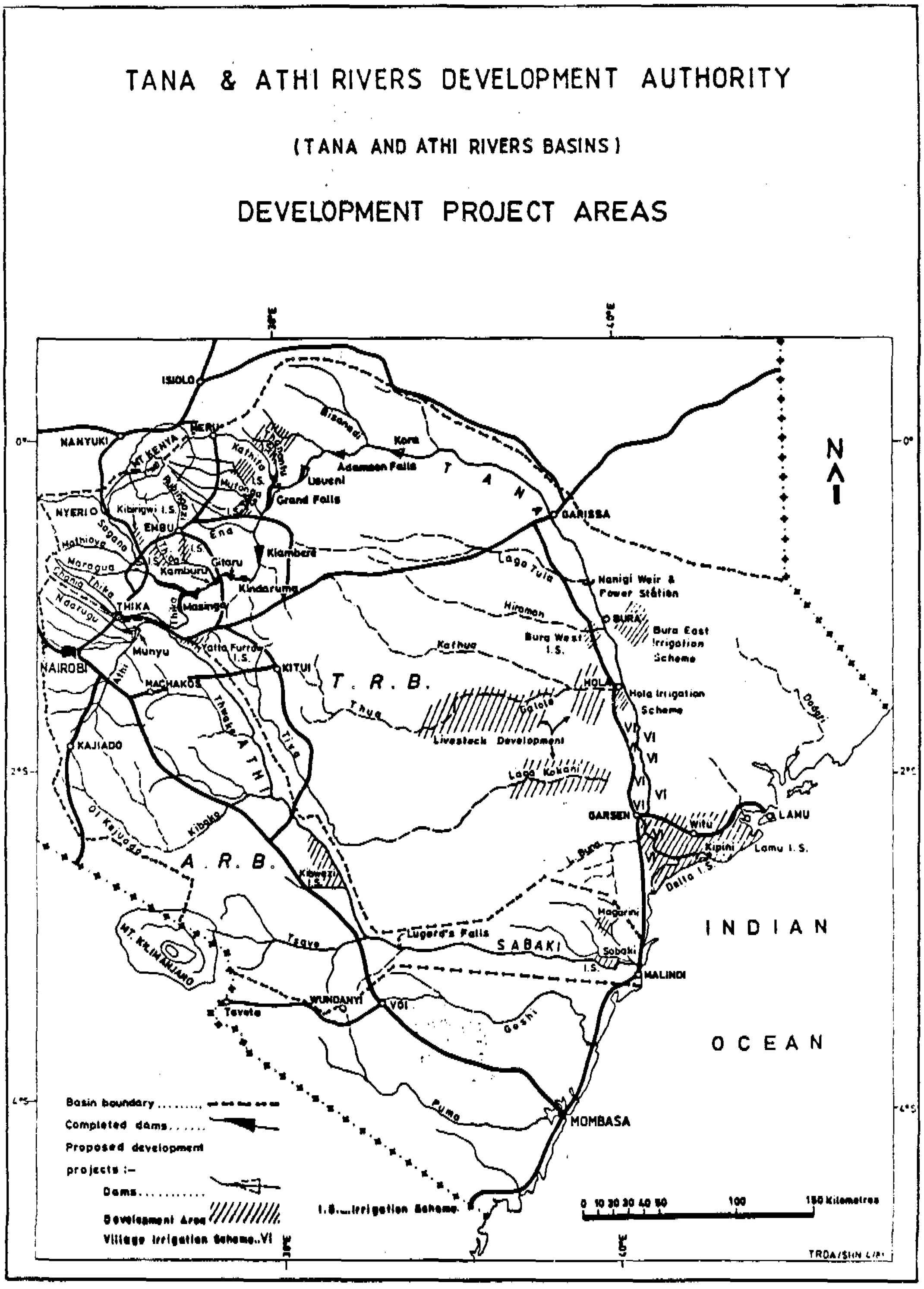
River Basins	Recurrence Frequency	Rainfall	Flow (million m^3 per year)	Evapotranspiration
ATHI	Mean annual	4480	2456	39024
	1 year out of 2 years	39007	1487	37520
	1 year out of 5 years	30704	678	30026
	1 year out of 20 years	24357	378	23984
TANA	Mean annual	71205	6253	64952
	1 year out of 2 years	67882	4986	62896
	1 year out of 5 years	57057	3485	53572
	1 year out of 20 years	44165	2437	41728

Sources: National Master Water Plan Stage I—MoWD 1980. Ministry of Water Development, National Master Water Plan Stage I by Tippetts-Abbett-McCarthy-Stratton Engineers and Architects.

Table 3 Large Scale Water Resources Development Projects in the Tana and Athi Basins

Project	Purpose	Size	Status	Environmental Impact Study	Public Health Health Component	Vector-borne Disease Aspects
Upper Reservoir (Masinga)	Multipurpose	1560 x $10^6 m^3$	Implemented	Yes	Yes	Yes
Kiambere	Hydroelectric with Conservation of Water	850 x $10^6 m^3$	Implemented	Yes	Yes	Yes
Bura	Irrigation	2500 ha.	Under Implementation	Yes	Not Known	Not Known
Kibwezi/ Munyu	Irrigation Hydro-electric with Conservation of Water	13200 ha. about 625 x 106m^3	Being Planned	Yes	Yes	Yes
Tana Delta	Irrigation	1200 ha	Being Planned	Yes	Yes	Not Known
Nairobi Water Supply-Sewerage	Public Water Supply	about 9m3/sec.	Under Implementation	Yes	Yes	Not Known

Figure 1. Tana and Athi River Basins Development Project Areas



WATER RESOURCES DEVELOPMENT AND VECTOR-BORNE DISEASE CONTROL

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The Lake Basin Region has a land area of 51709 km^2 including 4000 km^2 of Lake Victoria. While the area is fertile, it is the most densely populated part of Kenya. Two of its districts, Kisii and Kakamega have in excess of 400 people per km^2. In fact mortality rates are among the highest at about 200 and life expectancy at birth is only 34 years compared to Nyeri in Central Province which has an IMR of less than 52 and life expectancy at birth of 63 years. The Lake Basin region has a population of about 9 million people and an annual growth rate of 4%. It is one of the least developed areas of Kenya. In 1979 the Government of Kenya enacted a parastatal body called the Lake Basin Development Authority with a mandate to plan and implement development projects in the region to improve the socio-economic status of the people and also reduce morbidity and mortality in the region.

In the Lake Basin region, the most common vector-borne diseases are:

- Malaria
- Filariasis
- Sleeping Sickness
- Schistosomiasis

Malaria

All species of *Plasmodium* have been identified in the lower areas of the Lake Basin Region. Health facilities record high prevalent rates of both diagnosed and clinical malaria.

Under the Water and Sanitation Programme project the Lake Basin Development Authority has broadcast a radio health education programme in six languages of major ethnic groups within the region—i.e. Kiswahili, Kuria, Luo, Luhya, Kisii and Kalenjin.

Broadcasts have been geared towards physical control of the vector, isolation and treatment of cases.

Trypanosomiasis (Sleeping Sickness)

Trypanosomiasis has been recorded in Western Kenya in the Lambwe Valley and Kodera Forest in South Nyanza District, Busia District in Western Province and Siaya District in Nyanza Province.

Lake Basin Development Authority has viewed this disease with a lot of concern since it is a threat to its livestock farming. Several mass sprayings of the Lambwe Valley took place about 1983/84 which considerably reduced the vector population, but which also had other environmental effects.

The Ministry of Livestock Development has also established some vector control units at infected areas to monitor vector populations around the river banks and afforestation areas.

Schistosomiasis

Agricultural farming forms the largest development package of the Lake Basin

Development Authority. Wherever this involves irrigated agriculture, schistosomiasis becomes a problem of public health importance. The Authority is therefore organizing the establishment of health facilities at all its agricultural and irrigation schemes. The facilities will incorporate a health surveillance component on water and vector-borne diseases. So far no confirmed cases of schistosomiasis have been notified from our farms.

Water and Sanitation Programme

The inception of sanitation activities in the context of the LBDA—Water and Sanitation Programme took place in February 1986. The sanitation project document with relevant background and justification geared towards improvement of community health and personal hygiene was drawn up after establishing fact potentials. A proposal was made with projected activities and measurable targets.

Priority programme areas were also identified which could go in line with already existing water points under shallow wells and boreholes construction.

Sanitation Activities

- ❑ Sensitization of institution and communities.
- ❑ Group health education.
- ❑ Formation and reactivation of sub-location/village health committees.
- ❑ Siting and sinking of pit latrines preferably VIP latrines.
- ❑ Selection and training of community artisans on VIP latrine construction.
- ❑ Provision of free toilet slabs and vent pipes to community members.
- ❑ Health education workshops for Head teachers, women groups and community leaders.
- ❑ Designing VIP latrine working drawings for institutions and individuals.
- ❑ Construction of institutional toilets for demonstration and public use.
- ❑ Assessment of traditional customs, beliefs and taboos in the use of pit latrines.
- ❑ Water sampling and analysis.
- ❑ Periodic sanitary inspection of water points.

Water Supply—Construction and Community Development Activities

- ❑ Socio-economic survey to determine the needy communities.
- ❑ Geophysical survey to determine underground water potentials.
- ❑ Implementation survey to counter-check socio-economic and geophysical surveys so as to allocate the actual water points.
- ❑ Registration of sites by Ministry of Culture and Social Services.
- ❑ Collection of Ksh. 2000/- maintenance fee by water users.
- ❑ Provision of land for the water point.
- ❑ Signing of agreement forms for construction sites.
- ❑ Provision of accessibility to the site by the community members.
- ❑ Construction of the wells/boreholes.
- ❑ Selection of pump attendants.
- ❑ Training of pump attendants.
- ❑ Maintenance of surrounding of well.

This is carried out in schools, markets, water points and Chief's barazas. Discussions cover of an outline of water and sanitation policies in the programme. They form the initial stages of community mobilization and awareness reaction of our programme. Forums take the process of:

- background of the programme;
- community development role in the programme;
- construction activities;

- public health and sanitation with emphasis on health education on local health problems.

Main water point groups and organized barazas have been covered. The course contents constituted for these groups emphasized major public health problem areas with the communities.

Several water points in South Nyanza, Kisumu and Siaya Districts are inspected once a month to establish their sanitary conditions and defects. The common conditions always registered include:

- grass overgrowth around the sites and blocked open drains for waste water;
- washing of kitchen wastes within water catchment areas of wells particularly water points in schools and public centres;
- sporadic soiling on slabs;
- rampant bathing around the water points at a distance liable to contaminate ground water.

Intensive health education is conducted so that the above insanitary conditions can be improved.

Most water points are periodically sampled and samples analyzed. Physico-chemical parameters measured have been within acceptable standards for drinking water.

Faecal coliform contamination is, however, common in some wells, particularly in water points on low lying sites and open to domestic animals. Wells in Kendu Division of South Nyanza District have shown high level of fluoride. Cases of high turbidity were also recorded in some water points. To combat these problems, health education has been conducted with well groups and water beneficiaries as the target audience. Emphasis was made in proper drainage of the areas, general cleanliness and preliminary treatment of water before use preferably by boiling and filtration at household level.

Construction of institutional and demonstration VIP latrines is being implemented at public places, schools, chiefs' camps and markets. Double door permanent units are being constructed. Community members and well groups qualify for free pre-cast concrete toilet slabs and vent pipes after sinking pits. A good response has been achieved from communities. Various designs for latrines are available for implementation. Sub-structures of individual toilets pose a lot of problems to the communities as they cannot afford permanent construction for foundation before placing the slabs. These problems are rampant in black cotton soils and loose sandy grounds particularly in low-lying areas towards the lake.

Training of community artisans takes place at divisional level with an average output of 20 trained artisans per division. After return to their local communities they avail skilled labour in construction of improved ventilated pit latrines for community members and well groups already provided with free toilet slabs and vent pipes.

Course contents include subject details on:

- overview of environmental health and sanitation;
- faecal-oral route in disease transmission;
- principles and methods of soil waste management;
- construction technology of ventilated improved pit latrine.

Preliminary survey is conducted to determine the needy communities. This is done by use of questionnaire method, e.g.:

- formal discussion questionnaire—interview the key informant (Sub-locational Development Committee members e.g. Assistant Chiefs and opinion leaders/village elders);
- key informant questionnaire—only meant for selected opinion leaders at least three from every village;
- household questionnaire—meant for individual household heads. It ventures into the private life of individual household.

After the field survey has been completed for every division, the collected data in form of completed questionnaires are taken to the office where the data are fed into a computer under a specially designed programme for the socio-economic survey.

When the data entry is finished, this is followed by score calculation done by the computer which enables us to identify the needy communities as per the selected socio-economic indicators e.g. walking distance to hospitals, water points, schools etc. The priority scores per village are given in a descending order by the computer.

The figures on priority scores are based on selected parameters from the key informant and household heads questionnaires while evaluation scores are based on selected parameters from the formal discussion questionnaires. A combination of the two sets of scores provides a relatively good chance of obtaining an accurate information since it is the same individuals interviewed as key informants who report for formal discussion at barazas, but this time with a chance to share the views in response to the questions asked.

Basically priority and evaluation scores criteria for selection of needy communities. However, the purpose of providing a clear picture of the overall socio-economic set up of the communities within our areas of operation the available data could as well be used to calculate other economic and social features e.g. average per capita incomes, household composition, sanitary practice, per capita land-ownership, literacy rate, nutrition, etc. All these can at least help in establishing roughly the present living standards of the communities in the areas of operation.

After the needy communities have been identified, a list of selected villages is given to the geo-physical department which in turn carried out a survey to establish the possibility of locating underground water in the given areas.

The procedure involved in this kind of survey is rather technical. First, to identify areas with high possibilities of getting underground water they consider certain geological factors e.g.:

- resistivity of the underlying rock;
- level of both the permanent and temporary water tables into the aquifer;
- they use geological photographs and maps to guide in locating rock features, fissures or faults all of which are indicators to the existence of underground water;
- nature of the overlying material and the rock harness etc.

All these enable the surveyors to locate the underground water when available, subject to certain technical errors.

Community mobilization is carried out in areas where great need for a water supply has been identified and there is possibility of underground water, following the socio-economic survey and geophysical survey respectively. During mobilization very indicative values of the community have to be considered: e.g. characteristics, lifestyles, traditions, taboos and community leadership.

Efforts have been made to create awareness in the communities within the project areas to prioritize their health as a valued asset for them. This has led to working together with them to make them involved in identifying their won health problems and in decision making in solving those problems.

Community Participation in Water and Sanitation Provision

- ❑ Formation of the water and sanitation committees.
- ❑ Contribution of Ksh. 2000/- for sustaining hand pumps and general maintenance of the water point.
- ❑ Clearing pathways for machinery to reach the water supply construction sites.
- ❑ Expansion of well groups responsibilities to cover income generating activities.

- ❑ Construction of individual toilets after the programme has given out free toilet slabs and vent pipes.
- ❑ Community members play a role in health education at household level.

The LBDA—Rural Domestic Water Supply and sanitation Programme has initiated a study into existing attitudes and practices related to latrine ownership, usage and hygiene in order that health education campaign may be modified to take these factors into consideration.

We investigate appropriate information on various aspects of communities in designing low-cost and sustainable water and sanitation programme. The survey has therefore undertaken:

- to study local beliefs and attitudes with regard water, sanitation and health;
- to analyze of defecation habits and water used and associated practices underlying beliefs and attitudes;
- to examine community organizational structures and the level of participation in sanitation related activities in households, schools and public centres.

In the Lake Basin Region, the quality of rural community life has been adversely affected by development activities. We will therefore endeavour to improve water supply and sanitation which finally will speed up development activities, reduce water collection periods over long distance with subsequent benefits of improved health.

The project will continue to look into appropriate and sustainable sanitation technology for the communities.

WATER RESOURCE DEVELOPMENT AND VECTOR-BORNE DISEASES: THE ROLE OF A REGIONAL DEVELOPMENT AUTHORITY

J.H. VAN DOORNE

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The theme of the present seminar is that the institutional aspect of the integration of the health component in the development process is a prime concern. Because regional authorities can play a role in this respect, perhaps more than the organizers of the seminar are aware of, it may be appropriate to explain briefly the institutional characteristics of a particular regional authority, the Kerio Valley Development Authority.

Regional authorities in Kenya are established by an Act of Parliament and the Act specifies their functions. In the present context, the most important function perhaps is, in the words of the Act, *"to cause the construction of any works necessary for the protection and utilization of the water and soils of the area"*.

Regional authorities are not the only governmental departments or public bodies whose functions concern water or soils but, considering the functions of those institutions already in existence when the authorities were created and the precedents of other regional authorities in Africa and elsewhere in the world, a plain language interpretation of their function is to be responsible for major structural interventions necessary for (more) profitable use by anyone of the resources and for the protection of the resources; that is, generally to maintain and improve the economic potential of these two natural resources, water and soils.

A good and obvious example is a large dam, like the Turkwel Gorge dam. This dam required an investment by far exceeding the capacity of any single industry or group in private enterprise and so it is truly a public responsibility. Furthermore, the potential advantages and disadvantages of the dam mean that it would be inappropriate to associate it with any particular sector or interest. The water storage can provide a reliable supply for hydropower generation and will have a beneficial effect on ground water resources and on agricultural potential in the area around the reservoir. The man-made lake created new opportunities for the fishing and tourism industries; and the building of the dam has resulted in the opening up of the area with access roads and services which would have taken long to be realised otherwise.

In terms of current thinking in development planning, the building of a dam amounts to the creation of an enabling environment which lowers the threshold for economic initiative. In this, dams are comparable to other public infrastructure like roads or services (such as power supply), except that dams are closely associated with a few specific economic sectors, in particular energy and agri-

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culture, including animal husbandry and forestry.

A different aspect of an authority's function relates to the downstream effects of a dam. A dam producing hydropower will discharge water continuously. In Kenya, with its regime of wet and dry seasons, a dam means an end to or a reduction in seasonal floods. In a seasonal river, such as the Turkwel, a dam means a more regular water flow in the river near the dam but less water in the lower reaches of the river where the vegetation dependent on flow and river bed storage will be reduced. Thus, users of the river's water near the dam will gain but others will lose, and the gain may even not be useful, no longer loaded with silt, will actually pick up sediment and gradually cuts into the flood plan, thereby lowering ground water levels and again resulting in vegetation losses near the dam.

Whatever the technical merits of this argument, it points to the problem. Since major water courses often cross administrative boundaries, those who gain, usually those living in the upper reaches of the river, often live outside the territory of those who lose. The latter thus have no administrative means to compel the former to take their interests into consideration.

To enable the regional authorities to deal with the problem of balancing conflicting demands, each authority has jurisdiction over a major drainage basin, their boundaries following the watersheds between the basins of Lake Victoria, Lake Turkana, River Tana, and Uaso Ngiro. It is the authorities' responsibility to consider and evaluate conflicting demands for uses of natural resources and then to coordinate such use to best advantage.

The general purpose of regional authorities, as stated in their respective Acts is to plan and coordinate the implementation of development projects in their regions. The principles for this planning and coordination are to be laid down in a long-range development plan, providing a framework for planned development in the form of a statement of policy and priorities. National policy is, of course, paramount but not all components of national policy are equally relevant to all parts of the country, while a region may pose particular problems not foreseen in the national plan. The regional long-term development plan thus amounts to a region specific approach to development, consistent with national policy; in other words, national policy applied to local conditions.

For the Kerio Valley Development Authority the pre-eminent concern is the aridity of the region and the nomadic lifestyle of its people. In water development, because of water scarcity, efficiency takes precedence over the introduction of new uses. The history of irrigation development in arid areas is a checkered one but, in the present context, food production in irrigation schemes is much less water-efficient than in the pastoral economy. This view runs counter to what has been advocated in the past, but it illustrates a possible area for innovative planning by an authority.

The occasion may well be opportune to say something about the health-related issue of food security. It is now an established Government policy that food security takes precedence over other development. In areas of higher natural, potential better incomes through commercialization of agricultural production usually ensure adequate means for good nutrition. In arid areas, there are seasons and sometimes prolonged periods of insufficiency of food for subsistence; this is often used as an argument to justify the introduction of irrigation. Such a view ignores the fact that, among pastoralists, the livestock provides subsistence and, in so doing, it is more efficient in its water use than cereal production.

Coming to the health aspect, malaria is widespread and severe in the region of the Authority during the wet season, even without irrigation. It apparently does not require much open or stagnant water; a few showers within the period of one month in an area with bush vegetation is enough. Nearer to the rivers the problem is, of course, more serious because of the forest vegetation and the greater humidity. The more sedentary population, especially in the irrigation schemes along the rivers suffers most; the true pastoralists dwell in open country after the rains have started falling, as the herds feed on annual and perennial grasses.

The presence of surface water in irrigation schemes is, of course, unavoidable but problems can be reduced considerably by a substantial dry period in the cultivation cycle which helps to cut back vectors such as snails. A similar effect has been observed in agriculture. If water is not a limiting factor, growing more than one crop per year appears to make good sense. Yet, where this has been tried, the increased losses due to the build up of pests and disease plus the cost of countermeasures have more than offset the extra production. If the "cost" of increased disease incidence among humans is added, it can be seen that there is little sense in double cropping.

An irrigation scheme is normally an artificial, man-made habitat in a rain deficient environment. The extra supply of water interferes with the natural system of checks and balances and causes a problem. Even if the technical knowledge is available to combat the menace, lack of funds and lack of understanding on the domestic scene may prove insuperable obstacles. The threat of disease, whether direct or indirect via vectors, is magnified whenever people live in "untraditional circumstances" in the sense that they cannot adhere to a time-honoured diet and have not adapted their living habits to ensure hygiene around the homestead. The most evident case is the increase of malnutrition in areas where land is turned over wholesale to a cash crop. In the arid lands, there are substantiated cases of children living in settlements or irrigation schemes and suffering from malnutrition though never actually going hungry, while the opposite is true for the children of their pastoral neighbours, hungry at times but nutritionally in much better shape.

The explanation for this has not been established but it stands to reason that, as most people prepare and eat food according to a traditional pattern, when this pattern can no longer be followed they tend to fall back on a stomach filling food lacking the necessary variety. In the new environment some of their habits, or perhaps lack of appropriate manners, may actually be vector enhancing. Because much of this problem lies in the domestic sphere community based health care is an important remedial strategy, not only because it aims at the adoption of precautionary or preventive measures as advised by health professionals but also because it encourages the articulation of common problems and on that basis creates a demand, as it were, for a solution. The studies done under the auspices of the Kenya Medical Research Institute on the epidemiology of schistosomiasis in Machakos should be noted in this context.

The storage lake of the Turkwel dam will create entirely new conditions with their own disease concomitants. The number of people directly affected in this case is at most ten thousand and then only for part of the year, as the people are nomadic in life style. Time will show whether more permanent settlements will develop along the water line.

What at present gives far more cause for concern in the influx of thousands of itinerant workers. The construction industry has by its very nature of organization a highly mobile labour force, and it then takes not long for all kinds of diseases emotionally and unmentionable to be amply represented around the construction camps. Most diseases are of course not vector-borne in the conventional sense but the carriers have in a way acted as "vectors" introducing many diseases on a massive scale into the area. Contact with the local population is limited but common diseases can not be expected to remain within the confines of the labour force community.

These notes should suffice to illustrate the functions of a regional authority, more specifically its role to identify the major problems in a region and through analysis and evaluation of projects explore region specific strategies for greater effectiveness of the planned development effort. By its general responsibility "to monitor and evaluate" in order to "improve future planning...so that resources are utilized to best advantage", an authority is in an eminent position to follow up implications of, or requirements for a particular intervention across sectoral divides. At present the regional authorities are the only governmental bodies with an intersectoral role in the development process.

As for further water development plans, the Turkwel Gorge dam is one of a kind and no other sites have been identified for a project of this magnitude. Along the Elgeyo Escarpment and the Cherangani Hills in the Kerio Valley there are several potential sites for mini and micro-hydropower generation. As indicated the scale is small and it may not be worthwhile to connect these sources of power to the national grid. They can however be of great local importance in the framework of the Government's policy to develop rural centres to back up agricultural development and make them more attractive as places of residence by improving services.

Access is a major problem along the Kerio Valley but with power agro-industry (storage and processing) will get a boost. The establishment of schools, health and other public and administrative facilities will be facilitated.

Probable locations are Kimwarer, Arror and Tot in Elgeyo-Marakwet District and Sigor in West Pokot. The health hazards associated with the storage lakes may be limited because the dams will all be situated at high altitudes. There may be more similar potential along the Eastern wall of the Great Rift in Laikipia and Samburu but that remains to be assessed.

For the rest of the Region water development will focus on retention of rain water, with small dams or in flat areas by diversion structures, to improve or rehabilitate the vegetation cover. In general as said irrigation can not be a priority because of the scarcity of water and its alternative use in the pastoral sector. In existing irrigation schemes sprinkler irrigation (gravity fed) is promoted because of its much better efficiency than is the case with furrow or basin irrigation. The introduction of sprinklers may well have a beneficial effect on the health situation as it does not involve the inundation of land which provides breeding habitats for vectors.

As stated in this conference's brief, water supplies are only to be discussed from the point of view of prevention or remedial measures. It should be noted that in the KVDA region even small water supplies already create problems because of the scarcity of the resource. There seems to be a general but unsaid assumption that domestic water supply systems have absolute priority over any other use of water. While urban settlements can not really do without a water supply and water-borne sanitation, it is known that water consumption per head is many times higher in urban centres than it is in rural areas. That should be considered against the loss borne by the rural residents and the agricultural sector. In this respect water charges do not reflect real costs. Higher charges could reduce consumption and the extra income can be used for purification so that the water can still be of use at least for agricultural purposes.

STRENGTHENING NEEDS IN THE PLANNING AND MANAGEMENT OF INTEGRATED VECTOR-BORNE DISEASE CONTROL

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The National Economic and Health Development plans for Kenya are basically intended to improve the socio-economic status of the people by achieving certain set goals. Some of these goals include utilization of locally available resources, restructuring of institutions, improving literary levels, training of manpower, adopting new methodologies to support or improve existing ones, and involving the community in development.

To achieve these goals, the Government has adopted the National Policy on District Focus for Rural Development. This policy gives the opportunity to both the governmental, and nongovernmental sectors, including the community, to identify the people's needs and priorities when planning for development projects. Water resources development has been identified as one of the potential national economic development processes that would enhance other development processes in achieving the goals. Since the distribution of natural water is uneven, the development of man-made water sources in the form of dams, reservoirs and boreholes for hydro-electric power, domestic water supply and irrigation is encouraged.

Water resources development does improve prosperity but at the same time may cause health problems by creating vector breeding habitats. The ecological changes as a result of the accumulation of still waters may increase the prevalence and incidence of vector-borne diseases in an area. The occurrence of vector-borne diseases is associated with economic effects like loss in man-hours and manpower output, leading to loss in development, for example, failure in land exploitation.

In Kenya, several water resources development projects have created or increased vector-borne disease problems. Some of those projects are listed below.

- The Kano and Ahero irrigation schemes are known to have created ideal breeding habitats for *Anopheles gambiae* leading to increased intensity of malaria in the area (WHO, 1976). Prolonged presence of *Anopheles gambiae* in the area has resulted in epidemics of arboviral diseases like Onyong' Nyong'.
- The Mwea irrigation scheme has caused a tremendous increase in the prevalence of schistosomiasis from no cases out of 1000 examined people in 1956 (Vogel *et al..*, 1974) to over 70% of the people within the scheme being infected in the 1980s (Government of Kenya, 1988a). Malaria transmission has changed from seasonal to perennial. Now the scheme serves as a vector-borne disease transmission site for the local and immigrant populations that come into the area during the harvest season in search of work.
- The hydro-electric power reservoirs of Masinga, Kindarum, Gitaru Kamburu and Kiambere all along the River Tana built within a distance of less than 100 km. have changed the ecology of

the area, modifying the topographic and hydrological features, resulting in an increase in the prevalence of malaria (Government of Kenya, 1988b) the persistence of leishmaniasis foci and perennial transmission of schistosomiasis at some sites. There has been an increase in animals (TARDA, in press), especially baboons and rodents, that serve as reservoirs of schistosomiasis (Nelson, 1960, 1962, 1975, 1983; Else, 1982; Muller, 1960; Kawashima *et al.*, 1978) may be thus increasing intensity of transmission.

- The Hola-Bura irrigation scheme has resulted in an increase in prevalence of schistosomiasis (Government of Kenya, 1987a) and malaria because of the change in breeding sites from seasonal to perennial.

- The Pekerra irrigation scheme has resulted in malaria becoming endemic (Government of Kenya, 1987b) within the area because of the creation of permanent breeding sites for *Anopheles gambiae* as a result of irrigation of pastures with water diverted from the irrigation canals.

Not all water resources development projects increase the density of vectors; some like water drainage, have beneficial effects in reducing vector breeding and disease transmission sites, as well as being of economic value in reclaiming land for agriculture, for example, as in the planned Yala swamp project.

Boreholes as an alternative water source could serve as a means of reducing water contact and possibly reduce schistosomiasis transmission in affected areas. Several such projects have been started in Kenya to provide domestic water supply, without the planners being aware of their potential to reduce some water borne diseases such as schistosomiasis.

The problem of vector-borne diseases created by water resources development projects in Kenya is not the result of the principle of development projects, but of uncoordinated planning in which health implications were not considered. This resulted in inadequate funding of the health component, with only a small percentage of project costs allocated to curative services. Precautions were never taken, in the design and construction of the projects, to minims vector breeding sites and, during operation, environmental changes did not receive timely attention. As a result, vector breeding occurred along the shores and canals, with the concomitant intensification of vector-borne diseases. In some projects, like the Hola-Bura irrigation scheme, the economic objectives were not achieved; health problems might well have been one of the reasons for the lack of success of the project. This is suggested by the impairment of health and productivity within the community, in particular the high mortality from malaria and the chronic debility caused by schistosomiasis. Nutritional problems, especially in immigrant populations, have been associated with the exacerbation of previously suppressed infections. Integrated vector-borne disease control programme should be planned as part of water resource development projects especially in areas where vector-borne diseases are prevalent or there is the potential for change to favour vector survival. Since the epidemiology of a disease depends on geographical and topographic conditions, the development level of the area, and the literary and cultural practices of a given community, each area requires its own methods of approach. It is hoped that, when fully implemented, the District Focus Policy will facilitate and strengthen the planning and establishment of integrated disease control programmes in affected areas.

The Ministry of Health, in its effort to control vector-borne diseases, is strengthening the implementation of the Policy on District Focus for Rural Development and has created district health management teams to look into health problems in the district and to plan ways and means of tackling them depending on the available resources. An integrated disease control programme for vector-borne diseases is being adopted to complement and extend existing methods like vector control, chemotherapy, surveillance, data collection and community participation. The main aims of the integrated vector-borne disease control programme are to prevent occurrence of the diseases, to control existing endemic vector-borne diseases, and to suppress epidemics. To achieve those aims, information is required on disease prevalence, vector dynamics, basic reproduction rates, pesticide evaluation, socio-economic and cultural characteristics of each community and the relative health problem in terms of the socio-economic importance of the disease. Most of this information is available in different institutions but it is not utilized effectively because a mechanism of coordination is not well established. The only way to achieve this coordination is through sectoral and intersectoral collaboration by all relevant bodies in the planning and management of development projects. Such collaboration, in the form of consultation during planning, has started at national level and to a lesser extent at district level. It will take some time before the mechanism is fully established because not all relevant departments have the qualified technical manpower required for the planning and management of such projects. The Ministry of Health has put efforts into developing the required manpower at national and district level by providing and supporting training in the form of short courses, postgraduate and departmental training for epidemiologists, parasitologists, entomologists and technical staff. The retraining of serving district level staff in various disciplines, like primary health care, health education, nutrition, public health, vector control and administration, is also being undertaken. To strengthen the district health management team, the Ministry of Health has changed the operations of the division of vector-borne diseases from vertical to horizontal. This allows for the better provision and coordination of the epidemiological and entomological data required in planning for integrated disease control programmes to choose what is technically feasible and operationally possible. The Ministry has started a health information system to collect and analyse all health data relating to diseases and to make it available when required, for example, in planning or in predicting changes in disease patterns. Extensive collaboration with various institutions in vector-borne disease control and research has been established to provide knowledge and possible solutions to problems in ongoing programmes.

In future, medical specialists will collaborate in the planning and implementation of water resources development projects so that they can propose realistic modifications to allow the project to contribute to the reduction and, possibly the elimination of vector-borne diseases. This kind of collaboration will serve to identify opportunities for joint planning and funding of projects to suit local conditions, people's needs and programme requirements. Current health requirements include the development of a health infrastructure preferably with a primary health care system to undertake disease control measures, and the incorporation of governmental and nongovernmental organizations in disease control programmes.

The incorporation of all relevant bodies is vital if the integrated vector-borne disease control programme is to achieve its goals. This is because some measures, such as vector control, are very expensive and require political will to undertake. Decisions should be supported by accurate information on the economic situations and on the efficacy of the methods, i.e., if they can suppress the vector and its intermediate host, including the infective agent, to tolerable levels for the benefit of the community an its environment. Control programmes should also be consistent with other public needs and priorities to promote health such as education, nutrition, social conditions and housing.

In summary, when planning for water resource development projects, there is a need to identify existing and potential vector-borne disease problems, and to involve the relevant bodies in the planning and management of the disease problems, so as not just to achieve "development" at the cost of creating health problems.

REFERENCES

Else, J.G. and Sturrock, R.F., 1982. Natural Infections of Schistosoma Mansoni and Schistoma Haematobium in Cercopithecus Monkeys in Kenya. *Annual Trop. Med. Parasitology, 76*: 111–112.

Evaluation of Fenitrothion (OMS 43) for Malaria Control in Large-scale Epidemiological Trial, Kisumu, Kenya, WHO/VBC/76.645 pp. 8–17, WHO, Geneva..

Government of Kenya, 1987a, Division of Vector-borne Diseases annual report, Hola, Bura, Garsen.

Government of Kenya, 1984b, Malaria Activities report, Division of Vector-borne Diseases, Ministry of Health.

Government of Kenya 1988a. Division of Vector-borne Diseases annual report, Mwea.

Government of Kenya 1988b. Division of Vector-borne Diseases, annual report, Matuu.

Kawashima K., *et al.* (1978). Investigations on the Role of Wild Rodents as Reservoirs of Human Schistosomiasis in Taveta Area of Kenya, E. Africa. *Japan J. Trop. Med. Hyg. 6*: 195–203.

Muller, J.H., 1960. *Papriodognera,* Dog Face Baboon, a Primate Reservoir of Schistosomiasis Mansoni in E. Africa. *Trans. R. Soc. Trop. Med. Hyg. 54*: 44–46.

Nelson, G.S., 1960, Schistosome Infections as Zoonoses in Africa. *Trans. R. Soc. Trop. Med. Hyg., 54*: 301–316.

Nelson G.S., 1962. *The Role of Animals as Reservoirs of Bilharziasis in Africa.* Ciba Foundation Symposium on Bilharziasis. (Ed. G.E.W. Wolstenholme and M. O'Connor) pp. 127–194 Churchill, London.

Nelson, G.S., 1975. Schistosomiasis. In: *Diseases Transmitted from Animals to Man.* (Eds. Hubbert, W.T. McCulloh, W.P.D. Schnurrenberger), pp. 624–640, Charles C. Thomas, Illinois.

Nelson G.S., 1983. Wild Animals as Reservoir Host of Parasitic Diseases of Man in Kenya. In: *Tropical Parasitoses and Parasitic Zoonoses.* (Ed. J.D. Dansmore). pp. 57–72, World Association for the Advancement of Veterinary Parasitology, Perth.

Tana and Athi Rivers Development Authority, Health Survey Report by Division of Vector-Borne Diseases (Ed. A.M. Ngindu) in press.

Vogel, L.C. *et al* (1974), *Health and Diseases in Kenya* (Ed. R.B. Highton) pp. 347–355.

World Health Organization, 1976.

THE SETTING UP OF THE VECTOR BIOLOGY AND CONTROL RESEARCH CENTRE AND ITS ROLE IN VECTOR-BORNE DISEASE RESEARCH

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The Vector Biology and Control Research Centre is one of the nine departments of the Kenya Medical Research Institute established in 1979 by Act of Parliament to undertake research in the field of biomedical sciences, collaborating with other local, national and international organizations and institutes of higher learning and working closely with its parent Ministry of Research, Science and Technology, as well as with the Ministry of Health, the National Council for Science and Technology, the Medical Sciences Advisory Research Committee (ARC) in matters pertaining to research policies and promotions and to do all such things as appear to be necessary, desirable or expedient to carry out its functions.

In 1984, the Kenya Medical Research Institute Board of Management restructured the Malaria and Other Protozoal Diseases Research Centre, the precursor department, to form the Vector Biology and Control Research Centre. The Centre is expected to be a centre of excellence in research on medical vectors of disease, particularly those of malaria, schistosomiasis, filariasis and leishmaniasis. In the current programme on vectors of medical importance, particular emphasis is placed on applied field research in malaria, priority being accorded to the development and assessment of control strategies. Basic research studies are expected to emanate from these field studies.

Research on the ecological dimension of vector-borne disease transmission, including its relation to water resource development, is one of the Centre's objectives.

Western and Nyanza Provinces, and the Coast province vary in malaria transmission and are holoendemic for schistosomiasis. Malaria is widespread; all four types of malaria parasites have been observed in Kenya, but *Plasmodium falciparum* is by far the most common (80–85%) followed by *P. malariae* (10–15%). Based on the information obtained from out-patient monthly activity reports, the country can be divided into three clearly defined epidemiological zones, namely: endemic areas (Coast, Western, and Nyanza Provinces); those areas that are seasonal; and the highlands where less transmission occurs. During 1982, 27,091,176 new cases were reported giving a case rate of 152,542 per 100,000 population. In 1983, a total of 25,808,578 new cases of malaria were reported thus giving a case rate of 137,460 per 100,000 population, i.e. a decrease of about 5% in out-patient new cases in 1983 over 1982. Coast, Western and Nyanza Provinces had a high malaria risk and the incidence was in excess of 32% of total morbidity. These three Provinces, with 7.2 million (38% of the total population of the country), share virtually the same tropical climatic conditions and had the following: Coast Province 36.5%, Western Province 36.3% and Nyanza Province, 33.2%.

The research results discussed below are drawn from works on vectors of malaria (Kamunvi *et al.*, unpublished), vector seasonal distribution (Seroney *et al.*, 1985), who found that 56.1% *A. gambiae* were feeding on man as opposed to 17.1% *A. arabiensis*, vector adaptation (Seroney *et al.*, 1988), relative abundance and larval distribution at a new institutional site (Marangalla *et al.*, 1988b), basic research on *Toxorhynchites brevipalpis* colonization under normal laboratory conditions (Obudho *et al.*, 1985), egg-desiccation experiments on *Anopheles arabiensis, Aedes aegypti* and *T. brevipalpis* (Marangalla *et al.*, unpublished), approaches to limited malaria vector control by fish (Sabwa *et al.*, unpublished) and by *T. brevipalpis* (Obudho *et al.*, 1985 showed that two categories of *T. brevipalpis* given a restricted and generous offer of *A. arabiensis* larvae took 13.7 days and 12.9 days respectively to pupage and 20.5 days and 18.3 days respectively for adults to emerge; Marangalla and Obala, 1988), methods of bilharzia prevalence determination in the human population in Coast Province (Adungo *et al.*, unpublished), snail infestation in some channels in Kisumu Municipality could be controlled by increasing water velocity in the channels which thus dislodge the snails (Marangalla *et al.*, 1988), and malaria and schistosomiasis control through participatory health motivated the community to help themselves rather than being helped (Ogutu *et al.*, unpublished).

Malaria vector species larvae were found to breed in small pools of water (Kamunvi *et al.*, unpublished) and not in the main Lake Simbi salt water and the hot springs in Nyanza. A well planned study subjecting the *A. gambiae* larvae to the salinity test would confirm the presence or absence of a saline species of *A. gambiae* complex. Unlike White (1972) who found no Anopheline mosquitos at Kiboswa and Odhiambo (1980), Seroney *et al.* (1985) found significant numbers of malaria vector species in Kiboswa at the northern Kisumu Municipality boundary. *A. gambiae* s.l. were found in November 1983 and February, April, May and June 1984 ranging from 0.5–2.3 in relative density. Recently, larval sampling showed a myriad of anopheline and culicine larvae in various breeding sites (Figures 4(i) and (ii)) (Seroney *et al.*, 1988). Some were pools in excavations for murram for roadworks. This could be avoided by filling such potential breeding sites. The relative abundance and larval distribution at a new institutional site (Marangalla *et al.*, 1988) clearly depicts some natural and a majority of manmade breeding sites for anopheline and culicine larvae. Control of mosquito breeding in such sites is recommended since the majority of mosquitoes found were known vectors of malaria, yellow fever and filariasis, apart from the nuisance they caused by biting.

The colonization of a Taveta strain of *Toxorhynchites brevipalpis* (Obudho, 1980) under normal laboratory conditions at the Vector Biology and Control Research Centre was a landmark in the development of an eventual mass production facility although this is currently logistically still impracticable.

Basic experiments in the laboratory on desiccation of *Anopheles arabiensis, Aedes aegypti* and *T. brevipalpis* eggs maintained in dry soil (Marangalla and Obala, unpublished) showed that, with increasing degree of soil dryness with time, *A. aegypti* eggs when exposed to water hatched whereas *T. brevipalpis* eggs did not. This underscores the need for management of water resources to avoid mosquito breeding in order to control vector-borne disease.

Further work on the colonization and conditioning for larval predation by *T. brevipalpis* (Obudho *et al.*, 1985) showed high fecundity and female longevity due to a generous offer of prey larvae. Average number of eggs per female *T. brevipalpis* is offered a restricted and generous number of *A. gambiae* s.l. larvae was 62 and 144.3 respectively. The highest number of eggs laid by a single female emerging from a restricted and a generous larvae offer was 292 and 198 respectively. A functional response of *T. brevipalpis* to larvae of *Anopheles gambiae arabiensis* in the laboratory (Marangalla and Obala, 1988) on attack rates and feeding capacities both within and across larval instars showed that all predator instars were generally hyperbolic particularly at the corresponding prey instars. This area of research is, however, no longer a priority.

Laboratory and field experiments on predation by indigenous larvivorous fish, *Nothobranchius* spp and *Ctenopoma* spp (Sabwa *et al.*, unpublished) in the Municipality of Kisumu and Port Victoria, Nyanza Province, have shown their potential use for mosquito control in temporary and permanent water sources, if properly managed. The target indigenous fish species (*Ctenopoma* spp and *Nothobranchius* spp) were not commonly encountered. However, the larviphagic efficiency in limited samples of fish in declining order over an hour of observations was as follows:*Tilapia niloticus*, *Haplochromis* spp; *Nothobranchius* spp; *Ctenopoma* spp; and *Barbus* spp. The mean number of larvae consumed by the various fish species under field conditions varied considerably possibly due to the new environments the fish were introduced or because the elusive nature of mosquito larvae in the experimental quadrates.

The gut analysis for most of the fish species showed fish scales, *Protozoa, Helminths,* and other invertebrates as *Ostracods, Notonectids, Caradina, Cladocera, Hemiptera* and *Odonata*. The most important finding in respect to *Nothobranchius* and *Ctenopoma* spp were mosquito larvae body parts (heads, trunks, siphons and setae) and the fact that they were found in temporary water where the anopheline and other mosquito larvae were found is notable. More concerted human and financial efforts are needed for this to become a practicable reality.

Snail infestation of some drainage channels in Kisumu Municipality (Marangalla *et al.*, 1988c) showed the presence of vector snails (*Lymnaea natalensis, Biomphalaria pfeifferi, B. sudanica* and *Bulinus africanus*). Snail food components were among the factors that combined to support the large populations and control by frequent servicing of the channels to rid them of vegetation was suggested.

Urine samples examined for urinary bilharziasis (Adungo *et al.*, unpublished) in Kiakungu, Maendeleo and Umoja villages in Hola had 69.4%, 68.4% and 55.4% infection rates respectively. Irrigation is a common practice here, so servicing the irrigation canals and providing ample piped and treated water for domestic use will reduce water contact and, hence, the prevalence of schistosomiasis infection.

Research protocols, written in the format of the Kenya Medical Research Institute, are examined at the Centre by the Scientific Committee and then forwarded to the Scientific Steering Committee Secretary with a recommendation. The Scientific Steering Committee further determines whether the protocol is within a priority area of research, whether it is within the Centre's mandate, its scientific value and whether the budget is reasonable. The protocol is further scrutinized by the Ethical Review Committee which has been in operation since 1982. KEMRI has established Programme Committees for such diseases as malaria, schistosomiasis etc. whose main purpose is to determine research directions and priorities within the programme. There is also Publications Committee which looks after all matters of scientific and other publications of the institute. Courses and seminars are handled by the Technical Services Department of the secretariat in close liaison with the individuals or departments hosting these.

Links have been established between the Vector Biology and Control Research Centre and institutions of higher learning such as the Community Health and Zoology Departments of the University of Nairobi, the International Centre for Insect Physiology and Ecology, the Kenya Trypanosomiasis Research Institute, and the Division of Communicable Disease Control of the Ministry of Health, as well as with other international and national bodies such as the World Health Organization, the United States Centres for Disease Control, the Walter Reed Army Institute of Research, and the Japanese International Cooperation Agency.

Further restructuring is in process within the Vector Biology and Control Research Centre.

Early in 1986, four protocols were developed, entitled:

- determination of the densities, flight behavioural patterns and movement of malaria vector mosquitoes within and between huts, homesteads and villages;

- chromosomal variants in *Anopheles gambiae* species complex as habitat determinants;

- influence of environmental and seasonal factors on sporozoite rates and blood feeding patterns in *Anopheles* mosquitoes in Western Kenya;

- vectorial capacities of anopheline vectors of malaria in different ecosystems.

These protocols were amalgamated in one programme entitled, "Studies on vectors of medical importance in Kenya with particular emphasis on malaria", and a proposal was made to the WHO/TDR Research Strengthening Group for long term funding. The determination of the current degree of chloroquine resistance in *Plasmodium falciparum* infections in the Kisumu area of Western Kenya and the establishment of a malaria sporozoite and blood-meal identification unit for use in Kenya and the surrounding countries are the other main objectives of the programme. The biology and ecology of malaria vectors as they relate to malaria transmission will be studied. It is also envisaged that a schistosomiasis survey in snails and man will be done in 1992.

The current programme incorporates training for all levels of staff, particularly scientific and technical personnel. A Ph.D study is already being undertaken on the sibling species of the *Anopheles gambiae* complex and their malaria transmission dynamics in West Kenya. Another Ph.D study will be devoted to malaria transmission at different altitudes with special reference to blood feeding, sporozoite rates and chromosomal polymorphism in *Anopheles* mosquitoes in Western Kenya. Other training at Ph.D level has been planned.

The Vector Biology and Control Research Centre has matured to undertake specific priority studies within its mandate. Its past, present and future plans emphasize its role in vector-borne disease research. The results of that research should be considered in the management of water resources development.

I am grateful to Professor M. Mugambi, Director, Kenya Medical Research Institute for encouragement and approval of the format of presentation of this paper. My sincere thanks go to Mrs Nancy Ndwiga, Kenya Medical Research Institute headquarters and Miss J.C. Mnaibei, Vector Biology and Control Research Centre, Kisumu for secretarial services. I am also thankful to those whose unpublished and published works formed the basis of reference.

REFERENCES

Government of Kenya (1983). Annual report of the Ministry of Health. Chapter III, pp. 1–10.

Marangalla, G.M. and Obala, A.A. (1988a). Functional Response of *Toxorhynchites brevipalpis* to Larvae of *A. gambiae arabiensis* (Diptera: Culicidae). Ninth Annual Medical Scientific Conference KEMRI/KETRI; Programme and Abstracts, p. 75.

Marangalla, G.M., Ondijo, S.O. and Obala, A.A. (1988b), The Relative Abundance and Larval Distribution of Mosquito Breeding Sites at Vector Biology and Control Research Centre, Kisian Centre. Ninth Annual Medical Scientific Conference, Kenya Medical Research Institute/Kenya Trypanosomiasis Research Institute: Programme and Abstracts, p. 73.

Marangalla,G.M., Obala, A.A. and Adungo, N.I. (1988c) Vector Snail Infestation of some Drainage Channels in Kisumu Municipality. Ninth Annual Medical Scientific Conference, Kenya Medical Research Institute/Kenya Trypanosomiasis Research Institute: Programme and Abstract, p. 32.

Obudho, W.O. (1980). Colonization of *Toxorhynchites brevipalpis* under Normal Room Temperature in Kisumu, Kenya. Proceedings of the First Annual Medical Scientific Conference, Kenya Medical Research Institute/Kenya Trypanosomiasis Research Institute, Nairobi, pp. 235–245.

Obudho, W.O., Seroney, I.K. and Ukumu, F.M. (1985) Further Experience in the Colonization and Conditioning for Larval Predation of *Toxorhynchites brevipalpis* under Normal Laboratory Conditions. Proceedings of the Sixth Annual Medical Scientific Conference, Kenya Medical Research Institute/Kenya Trypanosomiasis Research Institute, Nairobi, pp. 33–43

Odhiambo, F.M. (1980), A Comparative Study of Malaria Transmission Rates by *Anopheles gambiae* Giles Complex and *Anopheles funestus* in Kisumu area, Kenya. Proceedings of the First Annual Medical Scientific Conference, Kenya Medical Research Institute/Kenya Trypanosomiasis Research Institute, Nairobi, pp. 246–259.

Seroney, I.K., Kamunvi, F. and Obudbho, W.O. (1985). A Possible Model for Monitoring Malaria Vectors and its Application to the Surveillance and Control of Malaria in Urban Areas: Kisumu Municipality Case Study. Proceedings of the Sixth Annual Medical Scientific Conference, Kenya Medical Research Institute/Kenya Trypanosomiasis Research Institute, Nairobi, pp. 22–32.

Seroney, I.K., Marangalla, G.M. and Ukumu F.M. (1988). The Adaptation of Malaria Vector and *Culex quinquefasciatus* Say (Diptera: Culicidae) to the Changing Environment: A Kisumu Municipality Case Study. Ninth Annual Medical Scientific Conference, Kenya Medical Research Institute/Kenyan Trypanosomiasis Research Institute: Programme and Abstracts, p. 78.

White, G.B. (1972). The *Anopheles gambiae* Complex and Malaria Transmission Around Kisumu, Kenya, *Trans. Roy. Soc. Trop. Med. Hyg. 66 (4)*: 572–581.

A REVIEW OF THE CURRENT HEALTH-PROMOTIONAL ACTIVITIES IN IRRIGATION SCHEMES UNDER THE NATIONAL IRRIGATION BOARD

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The National Irrigation Board is a parastatal body under the Ministry of Regional Development and was established by an Act of Parliament, the Irrigation Act, chapter 357 of 1966. The Board is responsible for development, control and improvement of national irrigation schemes in Kenya.

There are six irrigation schemes under the National Irrigation Board which provide livelihood to over 6000 farmers and their families. These are:

Mwea (5836 hectares), Hola (875 hectares), Ahero (840 hectares), West Kano (900 hectares), Bunyala (200 hectares) and Perkerra (425 hectares) (see Figure 1 accompanying Dr Choudry's paper, page 80). The Mwea, Perkerra and Hola Irrigation schemes were started by the colonial government by utilizing free labour of prisoners during the emergency war of the early 1950s. The others were started after independence in 1963.

It is important to note that the schemes produce a wide variety of cash crops which include rice at Mwea, Ahero, West Kano and Bunyala; chillies, onions, water melon and papaws at Perkerra; cotton, groundnut and maize in Hola and sugarcane in West Kano.

The National Irrigation Board together with other development authorities responsible for the planning and implementation of water resources development projects, i.e. Tana and Athi River Development Authority (TARDA), Lake Basin Development Authority (LBDA) and Kerio Valley Development Authority (KVDA), all fall under the Ministry of Regional Development.

After the establishment of an irrigation scheme it falls under the authority of National Irrigation Board. The Board resettles landless, unemployed and underemployed people who get a plot of land of between 1.2 and 1.5 hectares for cultivation. These farmers are provided with both technical and material support by the National Irrigation Board. The service charges which include maintenance of irrigation canals and other infrastructure, land preparation etc. are ultimately recovered from the proceeds of the sale of crops and the farmers get the balance. The material support is in the form of inputs such as seeds, fertilizers and agrochemicals. The Board also carries out some preventive health measures in all the schemes.

The major vector-borne diseases found in all irrigation schemes are: schistosomiasis (both intestinal and urinary) and malaria.

Schistosomiasis. Farmers in the irrigation schemes are from all over Kenya, with the majority coming from areas endemic for schistosomiasis (World Bank report No. 29). Other reports also indicate that most of the irrigation schemes have been developed in areas whose surroundings are endemic with schistosomiasis. Kano Plain, where the Ahero and West Kano schemes are located, is known to have a high infection rate of schistosomiasis (Kinoti, 1979). A high infection rate was also reported in the area surrounding Hola (Choudhry, 1975). Besides the tenant population in the schemes, there is a seasonal flow of workers from the surrounding areas into the schemes especially during the harvest time. Such migrations create high potentials for the transmission and maintenance of the infection in the schemes.

Both intestinal and urinary schistosomiasis are found in the irrigation schemes, except in Mwea where only the intestinal form occurs and Perkerra where no cases of schistosomiasis have been reported (see Table 1).

Health promotional activities related to schistosomiasis control in national irrigation schemes. As mentioned earlier, the National Irrigation Board carries out some preventive health measures in the schemes. Those related to schistosomiasis control consist of: mollusciciding, environmental management, health education, sanitation.

Mollusciciding Programme. This programme has been in operation in all the irrigation schemes aimed at reducing the snail vector population.

The molluscicide used currently is Bayluscide 70% w.p. and is applied at a concentration of 1 ppm using drip-feed method and spot or focal treatment by spraying.

Treatment of the entire irrigation system in every scheme is carried out three times a year using the drip-feed method, while focal treatment of drains and seepages is done throughout the year. Though there has been no recent evaluation of the effectiveness of mollusciciding, an earlier report (Choudhry, 1975) of a survey carried out on a seven year control programme indicated a sharp decrease in the population of *B. pfeifferi* by the end of the survey (77,000 to less than 4000).

Environmental Management. This involves clearing of weeds and other aquatic vegetation in the main canals, which is done by the Board while the farmers clear the feeder canals around their plots. Other measures taken involve filling of scattered water collections around the scheme villages and drainage of unwanted water. These activities creates habitats unfavourable for snail population.

Health education and community participation. Health education programmes in the villages aim at making the community aware of the health problems. In doing so, the community is stimulated to participate in health promotional activities and exercise self-protection by utilization of protective facilities against diseases. Screening of people, especially school-children, for infection is also done and those found infected are referred to the nearest health centre for treatment.

Sanitation and community water supply. The Board makes sure that every home a good latrine and that safe drinking water is available to the farmers. The medical technicians and health educators carry out regular inspection tours of all villages to see that latrines are dug and that those which are full are treated with disinfectant and properly filled up with soil.

Malaria. All national irrigation schemes lie in malaria endemic zones. Ahero, West Kano and Bunyala lie in hyperendemic zones where malaria transmission is annual. The predominant infection is *Plasmodium falciparum*, and *Anopheles gambiae* (Type B) is the principal vector. Malaria surveys carried out in the schemes indicate a high prevalence of the disease (see Table 2).

Malaria control programmes. Malaria control programmes exist in all schemes and consist of the following measures:

- a regular distribution of antimalarial drugs to all children under the age of ten years and to pregnant women and to all National Irrigation Board staff and their families in the schemes;
- selective application of larvicides;
- case detection and treatment.

In addition, the regular spraying of both rice and cotton fields with agrochemicals greatly reduces the vector mosquitoes.

National Irrigation Board Annual Expenditure on Disease Control Activities 1984–1989. The Ministry of Health is responsible for providing health services throughout the republic. However, NIB carries out some preventive health measures in all irrigation schemes under its management to supplement the Ministry's effort.

The expenditures incurred by the Board to provide these services are not charged to the farmers. The amount to be used for disease control activities is determined by the NIB management since the Treasury does not allocate a vote specific for these purposes to the Board.

However, the Board's medical team which comprises of 13 trained personnel could work more cost-effectively if provided with a vote specific for these purposes and if more funds are available both for training to raise the team's moral and for carrying out these activities. Following is the estimated annual expenditure of vector control activities for the last five years. The figures below include the salaries of the health personnel.

Though the above health promotional activities are carried out in the schemes, there has been no evaluation of their effectiveness due to lack of facilities and manpower. This is one area which should be looked into by both the National Irrigation Board and the Ministry of Health.

1984/85	US$32,008	equivalent to Kshs.	640,160/-
1985/86	US$36,473	equivalent to Kshs.	729,460/-
1986/87	US$51,687	equivalent to Kshs.	1,033,740/-
1987/88	US$56,197	equivalent to Kshs.	1,123,940/-
1988/89	US$59,728	equivalent to Kshs.	1,194,560/-

REFERENCES

National Irrigation Board Annual Reports 1984–1989.

Table 1 Prevalence Rates of Schistosomiasis in the Irrigation Schemes

Scheme	Type of Schistosomiasis	Prevalence	Intermediate Host
Mwea	*S. mansoni*	25%	*B. pfeifferi*
Hola	*S. haematobium*	50%	*B. globosus*
Ahero	*S. mansoni*	0.8%	*B. pfeifferi*
West Kano	*S. mansoni*	1.7%	*B. pfeifferi* *B. sudanica*
Bunyala	*S. mansoni*	15.9%	*B. pfeifferi* *B. sudanica*
Perkerra	None	0%	*B. pfeifferi*

Table 2 Prevalence Rates of Malaria in the Schemes, caused by *Plasmodium falciparum* and transmitted by *Anopheles gambiae* (type B)

Schemes	Prevalence Rate
Mwea	26.4
Ahero	
W. Kano	19.3
Bunyala	
Perkerra	1.0
Hola	54

SOME PRINCIPLES OF AN INTEGRATED APPROACH TO MALARIA CONTROL

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For the control of the vectors of *Plasmodium* spp., the pathogenic agents of malaria, to be successful it should aim at reducing vector population densities below a threshold level where either:

- transmission of the pathogen stops; or
- the population of the pathogens (i.e. *Plasmodium* spp.) as it is circulating in the natural reservoir host (i.e. man) becomes exhausted; or
- the vector species becomes extinct as a result of drastic ecological changes, and is not replaced by another vector species.

In the application of any control method it is necessary to take into account two possible risks:

- the development of resistance to the applied control means (both in vectors and in pathogens);
- the replacement of one vector species by another, which may be equally or more efficient in the transmission of the disease.

These hazards should be considered and investigated with priority in water resources development projects.

It is necessary to remember as well, that in areas of unstable transmission the level of reduction of vector population densities is correlated directly with the transmission level; in holoendemic situations density reductions have just an auxiliary role in bringing down the number of infective bites and are significant for transmission interruption only when they reach sensitive areas of the transmission/density curve. According to Bradley (1986) a 22-fold reduction of the primary vector density was sufficient to decrease the number of malaria cases in Sri Lanka, but this level produced a negligibly small effect in the African savannah.

A reduction of *Anopheles gambiae* densities by 98.5% using house spraying of residual insecticides in Nigeria did not result in the expected interruption of *P. falciparum* transmission. In this case the observed level of reduction was misleading: main transmission was maintained by the exophilic part of the vector population, and mosquito sampling inside the houses was not representative for the entire vector population.

Therefore, the main parameter for the assessment of control effectiveness should be the sampling of infected species, and the objective of control programme itself should be a selective control of the infected part of vector population and a reduction of the vector competence of the species that survive. Elimination of the oldest segments of the vector population is, from an epidemiological viewpoint, most effective to control malaria, as it is an anthroponosis whose vectors get infected at the imago stage.

Certain conditions adversely affect the chances of the infected part of the population: well-pronounced exophilia and exophagy, broad dispersion, extremely high population numbers and multiresistance to insecticides. If this is the case control by the elimination of early developmental stages of the vector is most effective, for instance, of larvae of exophilic mosquitoes in water reservoirs etc.

The main vector control methods for application in an integrated manner and taking into account the above considerations are the following:

- environmental modifications and manipulations, to eliminate conditions favourable for the propagation of vectors. Such measures should particularly be incorporated in irrigation and other water resource development projects whenever technically and economically feasible. We should bear in mind, however, that these very requirements may be in contradiction with wider use of water reservoirs under development programmes and very often make them more expensive, e.g. canal lining etc.;
- the use of insecticides to control various stages of vectors;
- the use of biological methods (predators and parasites) or biological control compounds.

A combined or consecutive use of various methods should produce a synergistic effect and allow the reduction of doses or frequencies of use of individual agents.

Vector control should be a distinct and important element of overall disease control. Where effective vector control is not possible, more emphasis will have to be given to prophylactic and curative drug treatment, supplemented, in future, by vaccines.

All vector control measures require a sound knowledge of local vectors: their taxonomy, and the biology and ecology of each (sub-) species. Inevitable ecological changes that occur in the course of a control programme may affect the composition of vector populations down to the level of cytogenetic variants, which may have repercussions for the vectorial capacity.

Consideration of all the circumstances described above should assist to design and implement a balanced package of control measures aimed to interrupt the transmission of disease. It is this very goal that the basic scheme of integration of control measures (Figure 1) proposed by the author aims at. In Figure 1, the steps of control are given in a hierarchical way.

A characteristic feature of this hierarchic structure is that if any step reaches 100% effectiveness, the next step will not be necessary. Nevertheless, in the case of vector-borne diseases an integrated application of the components of the chain is usually necessary as each individual method is practically insufficient to achieve the desired goal.

Control of malaria is a matter of great complexity and has met with a varying level of success depending on local conditions. The experience of its control in the USSR is as followed: Step I includes treatment with obligatory hospitalization, Step II is mass distribution of proguanil hydrochloride (gametocide) and meracrine hydrochloride (schizonticide) for prophylaxis; Step III includes resiting of settlements and environmental measures in water reservoirs, Step IV comprises application of DDT prior to formation of resistance to it. This would eliminate a major part of the old Anopheles females that are endophilic in the comparatively cold territory of the USSR, i.e. the ones that had the maximum number of infected species. It should be stressed that in the equation of malaria transmission:

$$Z_0 = \frac{m\, a^2\, b\, p^n}{-r \log_e P}$$

"a" is the number of bites by one mosquito per day. This means that one and the same female is to bite two human beings, one infected the other not, within a certain number of days. Therefore, killing of females that have bitten man at least once, i.e. the "old" ones that have been at rest and several times in contact with insecticide produces effect raised to the square that gives the effect of control of the precisely infected part of the population (Step IV–A). At the same time, reduction of breeding areas, decrease of larvae produce the effect proportional to "m", i.e., the linear one, but not exponential effect (Steps III and V).

The most rapid effect should be achieved by application of stable contact insecticides eliminating in major part the infected part of the population. The same rapid effect but on the limited scale is achieved by the use of individual means of protection (Step II).

All this did not exclude Step V that is reduction of mosquito breeding sites, application of oily larvicides and Paris green.

The principle scheme of malaria control has not changed till now. However, the situation has become more complex due to formation of vector resistance in imago and larvae phase, new agents of biological control have appeared, and the concepts of effectiveness and directions of control of pre-imaginal part of the population of malaria vectors have become more complex. Therefore, the task of governments in selecting the most cost-effective and balanced integrated approach has also been complicated to a large extent.

Figure 1 Basic Scheme of Integration of Control Measures

VI CONTROL OF EGG PHASE OF VECTOR DEVELOPMENT
(ovicides, physical methods of control, predators and parasites)

⇑

V CONTROL OF PRE-IMAGINAL PART OF THE VECTOR POPULATION
(chemical and biological control, environmental management)

⇑

IV ELIMINATION AND STRICT LIMITATION OF NUMBER OF BITING MOSQUITOS
(chemical, physical, genetic and predators)

⇑

IV A ELIMINATION AND REDUCTION OF THE NUMBER TO THE LOWER THAN THRESHOLD LEVELS OF INFECTED BY PATHOGEN BLOOD-SUCKING
(chemical, biological methods of control)

⇑

III ENVIRONMENTAL MODIFICATION AND MANIPULATION LEADING TO ELIMINATION OF ONE VECTOR SPECIES WITHOUT REPLACING BY OTHERS
(ploughing and levelling of lands, elimination water reservoirs, basic sanitary measures, upgrading of dwellings)

⇑

II PRESERVATION OF RECIPIENTS FROM THE INFECTED VECTORS
(vaccination; individual means of protection: repellents, protective clothes nets and collective—protection of dwellings; diverting of vectors—zooprophylaxis)

⇑

I EXHAUSTING OF INFECTION RESERVOIRS
(mass treatment)

ENVIRONMENTAL MANAGEMENT AS A COMPONENT OF INTEGRATED VECTOR-BORNE DISEASE CONTROL

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A title such as that given to this paper carries several implications. It suggests there is room for choice, that environmental management will often be part of the answer to a vector-borne disease problem—not the whole answer, but a part that should not be neglected. It also suggests that the role of environmental management may vary in size: it may play a small or a large part. This paper is concerned with the determinants of that role. There is as yet no adequate general theory of this. I shall therefore take a few specific examples from my own recent experience and attempt to derive some more generally applicable lessons from them which will be of value in answering the question: in this specific situation what is the best role of environmental management as a component of disease control?

There are two broad types of variation that will help determine the answer to that question: epidemiological and economic, vector-borne diseases are characterized by great and visible epidemiological diversity of many sorts in both time and space. The variability of vector-borne disease may be rather different from vector variability. Micro-epidemiological diversity has become much better defined in the last decade for the major parasitic diseases. Where alternative disease control interventions are available, economic and logistic considerations will play a major role in deciding the scale and type of environmental interventions that are attempted. Very closely linked to those are behaviour variables. In the field, what is economically best and what is culturally and behaviourally feasible are inextricably linked. This paper considers first epidemiological diversity and then economic and social variability in relation to environmental management and other control strategies.

Integrated control of vector-borne disease can include, in addition to a variety of interventions that fit under the term "environmental management" broadly defined, other methods of vector control—chiefly insecticides—but also other methods of controlling the disease, by means of vaccines or chemotherapy, together with environmental means of disease control that affect access of vectors to hosts without actually attacking the vectors. These are conveniently grouped with environmental management (Figures 1A and 1B).

The combination of environmental management with insecticiding is more straightforward than combinations with measures against the pathogen since both environmental management and insecticide have their effect through the vectors. However, larviciding, whether by environmental management or toxic materials, affects vector density while residual insecticides have their main effect on adult insect longevity with a more profound effect on vectorial capacity than would be inferred from observations on vector density. The integrated effects can be incorporated with reasonable ease into vector population models and in view of the entomological focus of several other papers will not be pursued here. The simplest overt algebraic handling of the problem was by Macdonald, and while computer models can add realism and particularly heterogeneity of intervention, the simple Macdonald vectorial capacity formula is more fully comprehensible.

Once the focus shifts from vector to disease as the real objective of intervention the assessment of the correct role of EM becomes difficult. There are numerous non-linearities in the relation of transmission of an agent and human infection with it and still more in the relation between transmission and disease.

The recent dramatic improvements in the safety and efficacy of anthelminthic drugs have made chemotherapy the lead intervention for control of several infections, such as schistosomiasis. These parasites are of importance in water resource developments and in irrigated agriculture.

Recently, community-based interventions based in the first instance upon chemotherapy have been implemented on a substantial scale but using the primary health care system as the means of drug delivery. Dr Abdoulie Jack in collaboration with the author has just completed a moderate scale pilot intervention wit very detailed evaluation in a group of twelve Gambian villages in West Africa. The original aim was to compare two antischistosomal drugs: one effective in a single dose, praziquantel, and the other an order of magnitude less costly, metrifonate. The results were unexpected (Figure 2). There was relatively little difference between the two chemotherapeutic agents. However, there were large differences within groups of villages under the same regime. The degree of population coverage affected the outcome to some degree, as expected. But there were two villages where intermittent chemotherapy had very little effect. It was found that whereas transmission was due to seasonal laterite pools with snails in most villages, in these two an arm of the river Gambia provided nearby water all the year round and reinfection after treatment was common and rapid. There is an upper limit to the frequency of repeated chemotherapy, and this was probably already exceeded in the Gambian situation for long-term purposes. In other words, in the high transmission villages intermittent chemotherapy alone would not control urinary schistosomiasis and some form of integrated control is essential. Since the difference between these "treatment failure" villages and the others is a single environmental feature, a bolon or creek of the river Gambia, environmental managementhas great potential. A combination of providing safe convenient water supplied, changing behaviour, and reducing access to the bolon seems advisable. Environmental manipulation of the bolon seems unfeasible at present.

This Gambian situation illustrates the limitations of chemotherapy in community control of schistosomiasis and the epidemiological diversity that, once observed, allows environmental management interventions to focus on a very few restricted sites, giving possibilities of better supervision and lower costs. With the development of irrigation in that part of the Gambia the hazard of perennial water transmission of schistosomiasis is likely to increase, and therefore the combination of environmental management and chemotherapy is going to be increasingly relevant.

The Gambian observations also show that there is no general answer to the question of what frequency and type of community chemotherapy is needed for schistosome control nor to the scale of environmental management needed to complement it.

The micro-epidemiological diversity shown up by attempts at control is reminiscent of the situation in the Sudan, where work on the vast Gezira irrigation scheme showed a variable intensity of *S. mansoni* infection and that the most heavily infected villages were those using a continuously filled adjacent irrigation channel as the community water supply.

The Gezira situation also pointed up the importance of population diversity. It became clear that a substantial part of the population there, in some areas 50%, consisted of migrants from West Africa (originally on the pilgrimage to Mecca) who had settled. Because they were not officially recognized they were outside the scope of water supply and other environmental programmes. They often had heavier infections than other local inhabitants and, as with most migrants, tended to be seen as responsible for the disease in some way while in fact infection was maintained without them and they simply suffered more from heavier infections.

These situations illustrate the high degree of small-scale geographical variation in transmission of infection. Recent work in malaria, leishmaniasis, and other infections had tended to confirm this spatial heterogeneity which has the important general implication that environmental management is locally specific, as is any form of species sanitation, and requires relatively skilled advice if community-based environmental management is to be effective in some situations.

A more subtle form of heterogeneity concerns the vectors themselves. There may be large snail populations all over an irrigation scheme or rice field complex. Yet only a few may be exposed to human excreta and thus be relevant to transmission. This is more a feature of water-based diseases with molluscan intermediate hosts than of those with insect vectors. It is essential to uncover such variation in epidemiological relevance of different snails if it exists, as it can greatly reduce the scale of environmental management needed for mosquito control.

There are as yet no vaccines against human parasitic diseases. They have, however, been in effective use against human arboviruses for many years, first against yellow fever and now against Japanese encephalitis as a disease of particular concern to PEEM. There is no evidence to suggest that environmental management is needed together with a virus vaccine. They appear to be alternative approaches to the same objective, and I admit to a personal view that in the case of a disease so potentially disastrous in outcome as Japanese encephalitis, a good vaccine appears the most satisfactory solution. Where diverse arboviruses are involved, or ones for which no adequate vaccine has been developed, environmental management becomes more appropriate.

The situation may well prove different with vector-borne parasitic diseases. Even the natural infections induce resistance slowly and incompletely, so that it may well be that protection against malaria or schistosomiasis by some future vaccines will be partial and liable to be broken through by a heavy challenge. Under these conditions the concurrent use of environmental management may be highly effective. But this is speculation.

The economic use of integrated control requires an understanding of the relations between interventions and transmission, to exploit the non-linearities in the relationship. The disease where our understanding of the quantitative dynamics of infection is greatest is malaria, and in view of the problems of insecticide resistance and drug resistance environmental measures are returning to prominence, as is well known.

Several new issues are emerging. The current interest in insecticide impregnation of bed nets provides an integrated single intervention: a mixture of environmental and insecticidal approaches with a mode of action that combines separation of host and vector mechanically, with insecticidal mortality. It is likely that other complex interventions will be devised.

Malaria is notable for the great, and well-documented, range of transmission levels in nature above a basic case reproduction rate of one. Values of R_0 range up to 3000 or more, and in steady state endemic transmission the frequency of infective bites per person varies greatly. Both theory and empirical data support the view that at low levels of R_0 bed nets can bring about substantial control. At the other extreme one would expect that, when an individual receives on average an infective bite each night of the year as in Tanzania, the likelihood of preventing transmission by means of bed nets seems remote. The effect of reducing challenge is unclear.

The examples above form a basis for more general hypotheses. It appears that we should consider helminths separately from the other pathogens which can proliferate within the body.

In the case of non-proliferating helminths, pathology is related to intensity of infection which in turn depends upon exposure, which may be cumulative in its effects. The use of intermittent chemotherapy to make the host revert to zero parasites can be effectively combined with environmental management to reduce the rate of worm build-up so that no person is likely to have many worms for a long time. The better the environmental management the more chemotherapy can be spaced out.

In the case of protozoal and viral diseases, where the agent proliferates, the benefits to the individual and community are mainly in terms of reduced incidence, with attacks of disease being as bad as or worse than in untreated people. The case here for integrated use of environmental management is, at least superficially, weaker than with helminth infections. Whether there is a more subtle interaction between environmental and other measures is unclear. In particular terms, is it useful to have environmental management against Japanese encephalitis vectors in places where there is good encephalitis vaccine coverage? So far the answer seems to be "no".

The cost of various possible components of a control programme will determine which are included, in relation to their effectiveness. These costs will be very specific to localities. However, one aspect of the costing of environmental management is likely to be of more general relevance.

Several small scale environmental management approaches to malaria control have been undertaken. One of the most successful has been the malaria control programme developed in Gujerat, India, by the Malaria Research Centre, Delhi, by Dr V.P. Sharma. Such programmes have a large community input, much local enthusiasm, and benefit from enthusiastic leadership. In these respects they resemble the early successful PHC programmes and they need to have the same cautionary comments as were directed by Koch-Weser and Golladay to the early PHC ventures. First, the cost is easy to underestimate as one tends to omit the cost of inspiring visits by senior staff and the time put in by enthusiastic villagers. Later, as the novelty wears off, the community members will count the time cost of their participation more carefully. Second, to scale the project up to run on a large scale for many years directed by more mediocre staff will usually reduce efficacy. Scaling up of mollusciciding projects against schistosomiasis has usually been followed by a marked reduction in efficacy. The PEEM guidelines should lead to more thorough costing of such projects.

The empirical examination of several field situations where environmental management is to some degree part of the integrated control of vector-borne disease has emphasized some aspects of geographical and temporal scale, in particular:

- the micro-epidemiological variation in disease between adjacent villages and its implications for the choice of interventions;
- the consequent need for expert assistance in choosing the optimal interventions at village level, and the flexibility needs;
- the likely clearer role of environmental management as a component in helminth control as compared with control of other infective pathogens;
- the problems of accurate costing of environmental management of some types;
- the role of human behaviour in interventions.

Figure 1A Modes of Control of Vector-borne Diseases

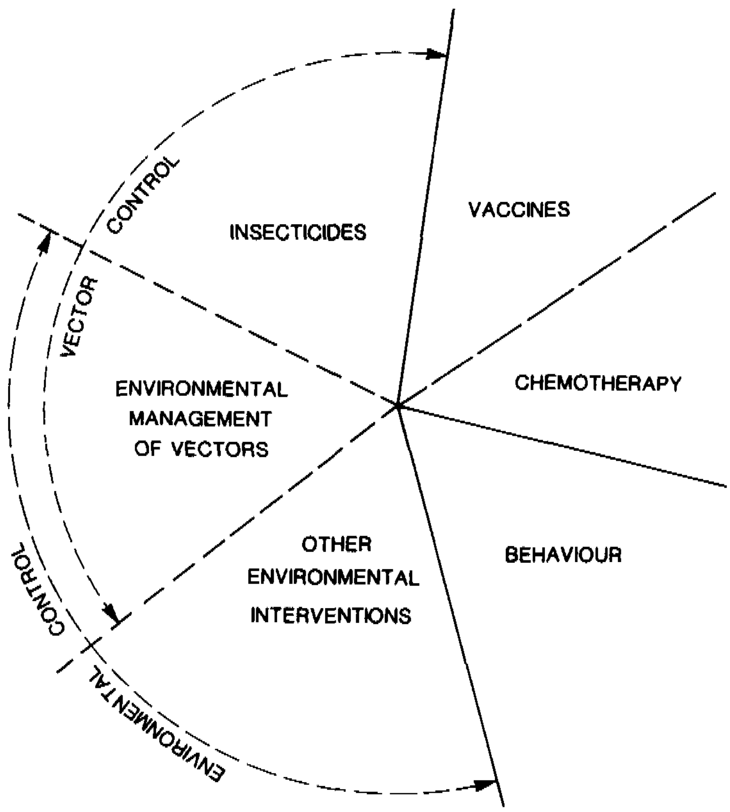
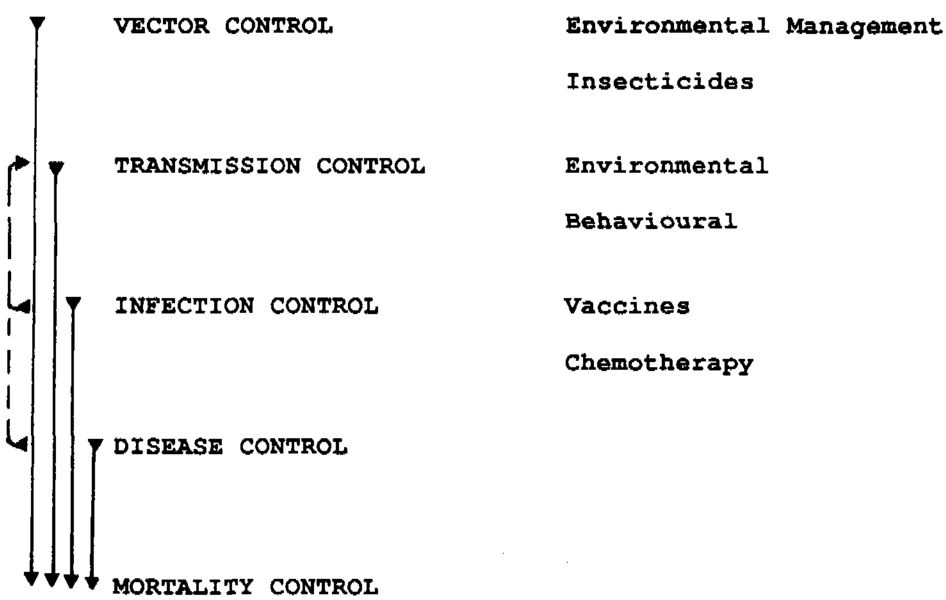


Figure 1B Components of Vector-borne Disease Control



ECONOMIC ASPECTS OF SCHISTOSOMIASIS IN IRRIGATED AREAS IN KENYA

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Water resources development occupies a special place in the history of schistosomiasis. The construction of dams and irrigation schemes in Kenya and other countries in Africa have afforded the disease an unprecedented prosperity and prevalence. The reservoirs and irrigation canals that turn lifeless lands into hospitable human habitats create ideal environments for the proliferation of parasite-infested snails.

Schistosomiasis infects almost four million people in Kenya and its prevalence is continuously increasing. Kenya has a large network of irrigation schemes under the management of the National Irrigation Board, a quasi-governmental body under the Ministry of Regional Development. The total area under cultivation is over 11,000 hectares. Schistosomiasis remains a severe problem in these schemes. For many years, it has been the object of programmes aimed at the control of the disease by means of molluscicides (Choudhry *et al.*, 1974), but evaluation of these in terms of human infection has shown little effect. The vast expansion of irrigation development now being initiated in Kenya and other parts of Africa poses a monumental public health challenge (Choudhry, 1975).

The implications for the health of individuals, and of widely prevalent infections on community life expectancy, linked to economic productivity are not well documented in Kenya or elsewhere, for that matter. There are no adequate measurement records for most of the factors that have to be considered in attempting to estimate the human and economic aspects of schistosomiasis. Among these factors are prevalence, intensity of infection, clinical manifestations, morbidity, transmission pattern, efficacy of snail hosts, human behaviour and agricultural practices (Wright, 1972).

Adequate means do not exist to determine with certainty the nature and magnitude of the economic impact of schistosomiasis. Data available from Kenya and other endemic countries has been utilized in this paper as a guide in formulating reasonable projections. These estimates could be revised as more reliable data become available.

While most infections occur before the age of 20 years, many workers in irrigation schemes and elsewhere in Kenya are initially infected or re-infected with the disease. It is, however, estimated that about 3 million agricultural workers are at risk, and at least 5% get infected each year. Hence an estimated 150,000 persons are infected annually. If each infected person lost, on average, 6 days of work per year, the estimated annual economic loss would be US$ 8,640,000.

The economic impact was estimated by multiplying the morbidity by a daily wage of 40 Kenya Shillings (US$ 2.40), multiplied by the estimated number of working days lost per year, on average, by each person, multiplied by 4, a number frequently used in such analyses to represent the ratio of actual economic impact of work-related morbidity on lost wages (Choudhry & Levy, 1988).

Schistosomiasis profoundly affects growth, physical working capacity and productive output of infected populations (Forsyth & Bradley, 1966). In Egypt, where the prevalence of both *Schistosoma haematobium* and *Schistosoma mansoni* is high, the loss of labour output among infected people is estimated to be more than 35% (Farooq, 1967). In China, where *Schistosoma japonicum* is endemic, an average loss of 40% of adult capacity to work has been reported (Chang, 1971). A study of sugar estate workers in Tanzania showed that those not infected with *Schistosoma mansoni* earned 11% more in bonuses than those infected (Fenwick & Figenschon, 1972). On a sugar plantation in the Sudan, the effect of *Schistosoma mansoni* on the physical working capacity of cane cutters in the field showed a 10% difference of work performance between infected and non-infected groups (Collins *et al.*, 1976).

Schistosomiasis and other helminthic infections have been associated to low productivity of manual labourers on road construction in Kenya. The nutritional status, parasite infections and general health of 801 male road workers living in four different areas in Kenya were investigated by Latham et al (1982). The results of this study showed 41% had evidence of under-nutrition. Examination of faecal samples showed 69% had hookworm, 47% had Trichuris trichiura, 51% had Schistosoma mansoni and about 40% of them had Schistosoma haematobium ova in their urine. These heavy infections were the factors most significantly associated with low worker productivity. Hence these labour intensive road construction methods resulted in more workers being employed than in capital intensive mechanized equipment.

Seven irrigation schemes are currently in operation in Kenya (Ahero, Bunyala, Bura, Hola, Mwea, Perkerra and West Kano) (see Figure 1). Studies on these schemes have already demonstrated ex- tensive snail breeding and intensive transmission of schistosomiasis. Production data for the year 1986/1987, and gross value of crop from each irrigation scheme is shown in Table 1.

Investigations in Tanzania and Sudan, two countries with similarities to Kenya, showed a 10% lower physical working capacity in persons infected with schistosomiasis. Applying this 10% value to US$ 8,187,030, to the value of crop harvested in 1986/1987, then there is an estimated productivity loss of US$818,703 per annum to the National Irrigation Board.

Schistosomiasis infection is an important determinant of the human ability to perform hard work. From this brief review, an assumption can be made that maximum labour productivity is dependent on satisfactory health of those working in the irrigation schemes. Since irrigation is essential to provide food for the growing population, no expenditure of money should be spared to safeguard the health of the people living and working on these schemes. In order to improve productivity through human efforts, recurrent expenditure must be provided for mass chemotherapy for treatment of the infected persons at least twice a year. With the availability of effective drugs that are easy to administer, mass treatment of infected individuals seems a reality, provided funds are made available by management or an annual basis.

REFERENCES

Cheng, T.H., (1971). Schistosomiasis in Mainland China. A review of research and control programmes since 1949. *Am. J. Trop. Med. Hyg. 20:* 26.

Choudhry, A.W. (1975). Potential Effects of Irrigation on the Spread of Bilharziasis in Kenya. *E.Afr. Med. J. 52:* 120.

Choudhry, A.W., Highton, R.B. and Roberts, J.M.D. (1974). Use of Molluscicides on Irrigation Schemes in Kenya. In: *Use and abuse of drugs and chemicals in tropical Africa,* p.187, East African Literature Bureau, Nairobi.

Choudhry, A.W. and Levy, B.S. (1988). Morbidity Estimates of Occupational Illnesses and Injuries in Kenya: Human and Economic Costs. Paper presented at the Ninth Annual Medical Scientific Conference, Kenya Medical Research Institute Kenya Trypanosomiasis Research Institutes, Nairobi.

Collins, K.J. *et al.* (1976). Physiological Performance and Work Capacity of Sudanese Cane Cutters with *Schistosoma mansoni. Am.J. Trop.Med. Hyg. 25:* 410.

Farooq, M. (1967). Progress in Bilharziasis Control. The situation in Egypt. *WHO Chron. 21:* 175, 1967.

Fenwick, A. and Figenschou, B.H. (1972). The Effect of *Schistosoma mansoni* Infection on the Productivity of Cane Cutters on a Sugar Estate in Tanzania. *Bull. Wld.Hlth.Org. 47:* 567.

Forsyth, D.M. & Bradley, D.J. (1966). The consequences of bilharziasis: medical and public health importance in north-west Tanzania. *Bull. Wld.Hlth.Org.* 4: 715.

Latham, M.C. *et al.* (1982). A Comparative Study of the Nutritional Status, Parasitic Infections and Health of Male Road Workers in Four Areas of Kenya. *Trans.Roy.Soc.Trop.Med.Hyg. 76:* 734.

National Irrigation Board, (1985). *Annual report and accounts 1984—985,* Nairobi.

Wright, W.H. (1972). A Consideration of the Economic Impact of Schistosomiasis. *Bull. Wld. Hlth. Org. 47:* 559.

Figure 1. Irrigation Schemes Managed by Kenya's National Irrigation Board (1987)

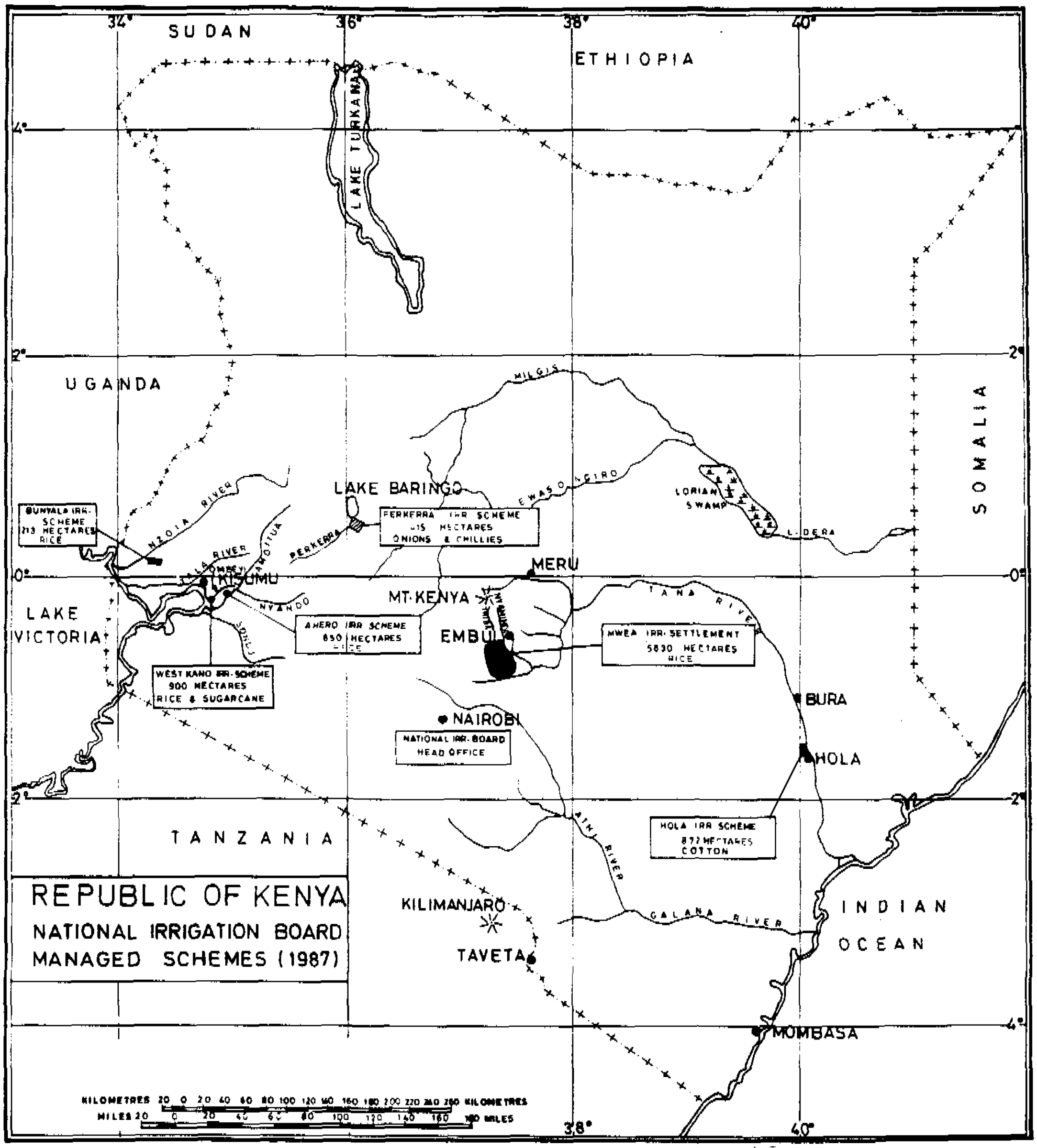

Table 1 Production for 1986/1987 for Irrigation Schemes in Kenya

Irrigation Scheme	Area Cropped (Ha)	Crop Grown	Number of Tenants	Gross Value Crop US$	Productivity Loss 10% US$
Ahero	1 277	Rice	519	483 670	48 367
Bunyala	213	Rice	131	201 420	20 142
Bura*	2 010	Cotton	1 626	1 289 400	128 940
Hola	874	Cotton	678	506 740	50 674
Mwea	5 799	Rice	3 236	4 974 410	497 441
Perkerra	197	Chillies Onions Melons	384	260 390	26 039
West Kano	645	Rice Sugar Cane	553	471 000	47 100
Total	**11 015**	-	**7 127**	**8 187 030**	**818 703**

Source: National Irrigation Board Annual Report and Accounts 1986/1987, Nairobi.
**Management of Bura Irrigation Scheme was switched from the National Irrigation Board to the Ministry of Agriculture in 1987.*

KNOWLEDGE GAPS AND RESEARCH NEEDS TO IMPROVE THE DISEASE VECTOR CONTROL COMPONENT IN IRRIGATION SCHEMES AND AREAS AROUND MAN-MADE LAKES IN KENYA

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The development of new irrigation schemes, the expansion of old ones and the construction of dams is a positive and commendable step towards the overall elevation or improvement of the nutritional, social and economic status of Kenyans. As many a worker in this area has already pointed out, however, health and social problems accompany such development (Heyneman, 1978; Hinkele, 1968; Jordan, 1979; McJunkin, 1983; Ackers, 1988; FAO, 1987). This article will illustrate such problems and an effort will be made to address those specific areas that need strengthening through research.

When people are moved from land which they have inhabited for many years and around which their culture has evolved, in order to make room for dams and irrigation schemes, serious socio-psychological and economic problems befall them.

Even though compensation is offered, the new areas where they are resettled may not be as productive or the climatic conditions may not be as suitable, not to mention the feeling of being "torn" away from belonging—from home. Assuming that all the good fertile agricultural land in Kenya has already been inhabited, it is likely that people would be resettled in areas of low agricultural potential, which means that the movement would make them poorer, physically and materially. Investigations should be carried out to assess whether the benefits of the proposed project outweigh the inconvenience or adverse effects of moving people from their homes.

Health related problems occur, for example, where the people introduce a disease from their old settlements into the new settlements. The problems are aggravated when suitable vectors exist. Another example, as in the case of malaria, is where people become seriously ill as a result of exposure to a disease that their bodies are not used to (Benenson, 1981). Project budgets should include costs for active disease surveillance, drugs and other components of the provision of health services, such as laboratory capacity (Heyneman, 1978; Mouchet, 1982; Gordon, 1979; Stockard, 1978). Social amenities such as schools, water and sanitation should also be seriously considered because, in the long run, they have a bearing on the health status of the people. A check-list system could be used to make sure that basic needs have been considered before the project becomes operational.

While it is known that dams are a potential source of transmission of water-borne diseases, the disease situation around dams in Kenya is not well known. Systematic surveys on both the humans and vectors need to be carried out periodically around all such water bodies and the observations concerning, different control approaches and their treatment and outcome of treatment, properly recorded as a guide to subsequent actions.

Because these surveys are an expensive undertaking they should be budgeted for at the outset, together with the rest of the project, rather than being treated as an afterthought. Where such surveys are not included in the initial budget, efforts should nevertheless be made to carry them out.

Epidemiological studies to establish the nature and magnitude of vector-borne diseases need to be carried out; and practical solutions to the problems of vector-borne disease should be worked out by multi-disciplinary group including the community (Mouchet, 1982). Solutions might include the resiting of village settlements, the provision of health education, the provision of safe water, sanitary faecal disposal facilities and so on. Such efforts would aim to reduce host/parasite contact. Studies on the vectors should be carried out, specifically on their numbers and infection rates, the efficacy and cost of the chemicals used in their control, and biological control through use of natural predators and environmental modification/manipulation methods. Studies should also cover the effect of local plants and herbs on the disease vectors. In the case of smallholder irrigation projects, health aspects should be included in the general agricultural education package that is given to the farmers.

Investigations should be carried out on drug regimens, efficacy and mode of administration, especially in the context of primary health care. Drugs reduce environmental contamination by cleaning up the human reservoirs. De-worming as a control strategy not only improves the health and nutritional status of individual members of the community, it also lessens environmental contamination because less or no eggs are being shed into the environment. Efforts being put into vaccine development deserve encouragement. If there was to be a breakthrough in this area, the community should be protected against infection.

Further research should be carried out to find diagnostic techniques that give better and more rapid results, under field conditions, in order to improve on the quality of diagnosis and hence the quality of intervention, monitoring and evaluation.

Another area where there are knowledge gaps and where controlled studies are needed concerns the relationship between human health and productivity. It is important to test the hypothesis that a disease intervention programme will improve productivity. Cost-effectiveness studies should compare resource utilization under different disease-control programmes in order to select the optimal approach. Cost-benefit analysis would also assist in determining whether it is economically worthwhile to undertake disease-control programmes. These kinds of studies have not yet been carried out in Kenya.

In conclusion, it is important to note that vector-borne disease control is the responsibility of everyone, and therefore calls for a combined effort by all those who are either directly or indirectly responsible for the existence of the diseases. Those concerned should be devoid of personal prejudices and they should pay immediate attention to early signs of disease as, in the long run, this approach will prove to be more economical than trying to deal with a problem that has run out of control. It is also important to note that research needs and priorities change with the times.

REFERENCES

Ackers G.L., Smith D.H., 1988. Design and Management of Development Projects to Avoid Health Hazards, *J Trop Med Hyg. 91*: 115–11129, 1988.

Benenson, A.S., 1981. Control of Communicable Diseases in Man. American Public Health Association, Washington D.C.

FAO, 1987. *Effects of Agricultural Development on Vector-Borne Diseases*, document AGL/MISC/ 82/97, Rome.

Heyneman D., 1978. Manmade Lakes and Schistosomiasis. *Proceedings of the International Conference on Schistosomiasis*, pp 23–311.

Hinkele L.E. Jr., 1968. Relating Biochemical, Physiological, and Psychological Disorders to the Social Environment. *Arch. Environ Health, vol 16*: 77–82.

Jordan P., 1979. Schistosomiasis in Kenya—Report of a Visit, Ministry of Health, Kenya.

McJunkin F.E., 1983. Water and Human Health. National Demonstration Water Project, Chapel Hill, North Carolina.

Mouchet, J., 1982. Vector Control at Community Level, WHO/VBC/82.847, World Health Organization, Geneva.

Stockard J.L., 1978. Economic Justification for Schistosomiasis Control. *Proceedings of the International Conference on Schistosomiasis*, pp.3–11.

INTERSECTORAL COLLABORATION DURING PROJECT DEVELOPMENT AND IMPLEMENTATION

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Representatives of African nations who met at the FAO Consultation on Irrigation in Africa (Lome, 21 April 1986) called urgently for an intensification of explorations and development of the continent's water resources. With only an estimated 5% of the irrigation potential developed, there are real possibilities for expansion of irrigated agriculture to keep pace with growing food demands.

In fact, the outcome of the Consultation showed that countries in Central and East Africa will find it difficult to keep food production proportionate to population growth unless a significant part of the land area is farmed at high input levels. In this region, only Kenya and Ethiopia have sufficient underdeveloped water resources to produce significant amounts of additional food through irrigation development (FAO, 1986).

Resource development projects, often connected to resettlement activities, are multidisciplinary in nature. Their planning therefore involves expert input from a variety of disciplines, and their implementation requires the active participation of all relevant public sectors.

Human health is one of several aspects to be considered. It has been repeatedly shown that the failure to give early attention to this aspect and the lack of effective interactions between project planners and health authorities at the project design stage lies at the root of increased vector-borne disease transmission (PEEM, 1981; FAO, 1987). Unfortunately, very much fewer are the examples of adequate preventive measures implemented in an intersectoral framework. The most often quoted example of the successful intersectoral collaboration is that of Tennessee Valley Authority in the United States of America (PEEM, 1984). Another well-known successful example is the case of institutional arrangements between the National Irrigation Administration and the Ministry of Health in the Philippines (*ibid.*).

When the dynamics of the human health situation are considered in connection with water resource development, the variables involved may be grouped into three distinct areas: epidemiology, ecology and demography. Within the more narrow focus on vector-borne diseases, the ecological variables are especially important because of the role of vectors in disease transmission. All of the entirely or partly irrigation-associate vector-borne diseases found in Africa are present in Kenya: malaria, schistosomiasis, lymphatic filariasis and a number of diseases of arboviral origin.

The project cycle continues to be a valid concept for the planning of large and medium-size irrigation schemes (see Figure 1), although current ideas of flexible planning and management have added the concept of involving the different planning levels (central, provincial, district and even community level) at different stages of the cycle. For each stage of the cycle, the purpose, actors, input and output can be described and the essential intersectoral linkages can be indicated, thus enabling the optimal timing for the incorporation of health safeguards and the planning of health services strengthening to be achieved as the project cycle progresses. Planners involved in this type of exercise will by and large have three planning variables to consider. First, does the project entail a large, formal scheme, with planning mainly at the central level or does it consist of a small-scale irrigation scheme with planning mainly at the provincial level? Secondly, is the project's objective irrigation development or the rehabilitation and modernization of an existing scheme? Thirdly, is there a demographic element involved, i.e., does the project include resettlement or a temporary labour force for the construction phase, and does the project involve recurrent irrigation patterns according to seasonal variation in agricultural activity?

In the African context, the second variable is not yet relevant. The first one, however, governs an entire subset of variables about the planning procedure, some of which may be of importance for vector control. It determines for each phase at which level health and irrigation planners have to communicate, whether administrative and operational structures are compatible (sometimes the boundaries of a river or lake basin development authority do not coincide with those of provincial or district health services) and whether or not specific funding of a health component is feasible (in part, depending on donor agency policies).

Population movement in connection with a project complicates the planner's work, and requires an early strengthening of the involvement of the health sector, to look after the labour force employed during the construction phase, to study epidemiological patterns in the areas from which resettlers will be moved and to set up a screening system for seasonal labourers.

The following table lists activities in support of health during the various phases of the project cycle. Some of the intersectoral linkages necessary for their proper implementation are mentioned.

Phase	Tasks	Sectors Involved
Identification	- Identification - Formulation of pre-feasibility study	Rapid assessment of vector-borne disease hazards followed, if so indicated, by an in-depth survey
Preparation Phase	- Data collection and analysis	Final forecast of possible adverse vector-borne disease implications
	- Design and feasibility study	Programming of monitoring of the health situation
	- Design of environmental engineering measures	Health sector planning for adequate strengthening of health services
Appraisal/Approval	- Appraisal	Cost-effectiveness analysis of different prevention strategies
	- Adjustment and approval	Negotiation for an allocation of funds to a health component

Phase	Tasks	Sectors Involved
Implementation	- Activation, start-up	Screening of labour force for vector-borne diseases
	- Implementation and monitoring	Incorporation of health safeguards into the project
Integration	- Integration	Screening of resettlers for vector-borne diseases
	- Hand-over to normal administration	Extension of health services
		Establishment of permanent inter-sectoral linkages between project management and health services
Evaluation	- Evaluation	Evaluation of the health component of the project
	- Follow-up analysis	Adjustment of policies and action and tools for future projects

Identification Phase. Identification of sites for water resource development projects is usually the responsibility of one sectoral body: the Ministry of Water Resources, River Basin Development Authority, or the Ministry of Agriculture. An initial rapid assessment of vector-borne disease hazards will lead to the first contact with the health authorities. It is in any case crucial that the Ministry of Health is contacted prior to drawing up the terms of reference for detailed studies. If outside consulting firms are contracted to carry out the pre-feasibility and feasibility studies, they will follow the terms of reference to the letter. If the terms of reference do not mention health aspects, those aspects will not be investigated. The health authorities should indicate the most important information gaps for which data collection needs to be ensured in the next phases.

Preparation Phase. The preparation for a large project may include a prefeasibility study to review and outline various options, and a feasibility study of the preferred option. The interval between the two provides an opportunity for further intersectoral collaboration. Once a feasibility study is embarked on, it is generally considered that the political decision to carry out the project is no longer reversible. The vector-borne disease implications should, therefore, be considered among the criteria for selection of the best option. During the preparation phase a number of technical goals have to be achieved (through health risk assessment, design and costing of environmental engineering measures, and recommendations on health sector activities), and adequate institutional arrangements have to be designed for the construction, implementation and operational phases.

Appraisal Phase. The appraisal of the feasibility study should be conducted by all those who are given a role in project implementation. The most important issue is to see whether the specific inputs required are satisfactorily covered by the project's budget. The Ministry of Health will want to ensure that extra resources in terms of staff, equipment, training etc. are included in the grant application. Also, at this stage, institutional arrangements for the next phases will have to be formalized through memoranda of understanding and through legislative changes.

Construction and Implementation Phase. At this stage, intersectoral collaboration should be fully operative, addressing such matters as workers' health, engineering monitoring, modification and finalization of the designs, and monitoring of entomological parameters. Layout of the scheme should be carried out with a view to the operational phase. Managerial structures have to be established to ensure proper maintenance, for better agricultural production and good health.

Evaluation Phase. At the end of the construction phase, a first evaluation of the immediate impact on the project's beneficiaries normally occurs. Usually aimed at measuring economic parameters, involvement of the health authorities at this stage should ensure an assessment of the human health status. An assessment of the effectiveness of the intersectoral collaboration in the project would also be of value for future reference. The evaluation phase is usually the end point of the involvement of the lending or donor agency; it should not be perceived as the end of the need for further monitoring and evaluation during the operational phase. In fact, the institutional arrangements established during the appraisal phase, often implemented under the umbrella of a project authority, should now be carried over to the regular ministries and bodies in charge of operations.

Once the project becomes operational, proper maintenance will be an essential condition for maintaining a good health situation. Intersectoral efforts in the development stages of the projects should have ensured a maximum incorporation of structural health safeguards and a strengthening of health services proportionate to real needs. Intersectoral collaboration will remain needed for ongoing monitoring and evaluation, trouble shooting and further remedial measures that may become necessary under changing circumstances.

REFERENCES

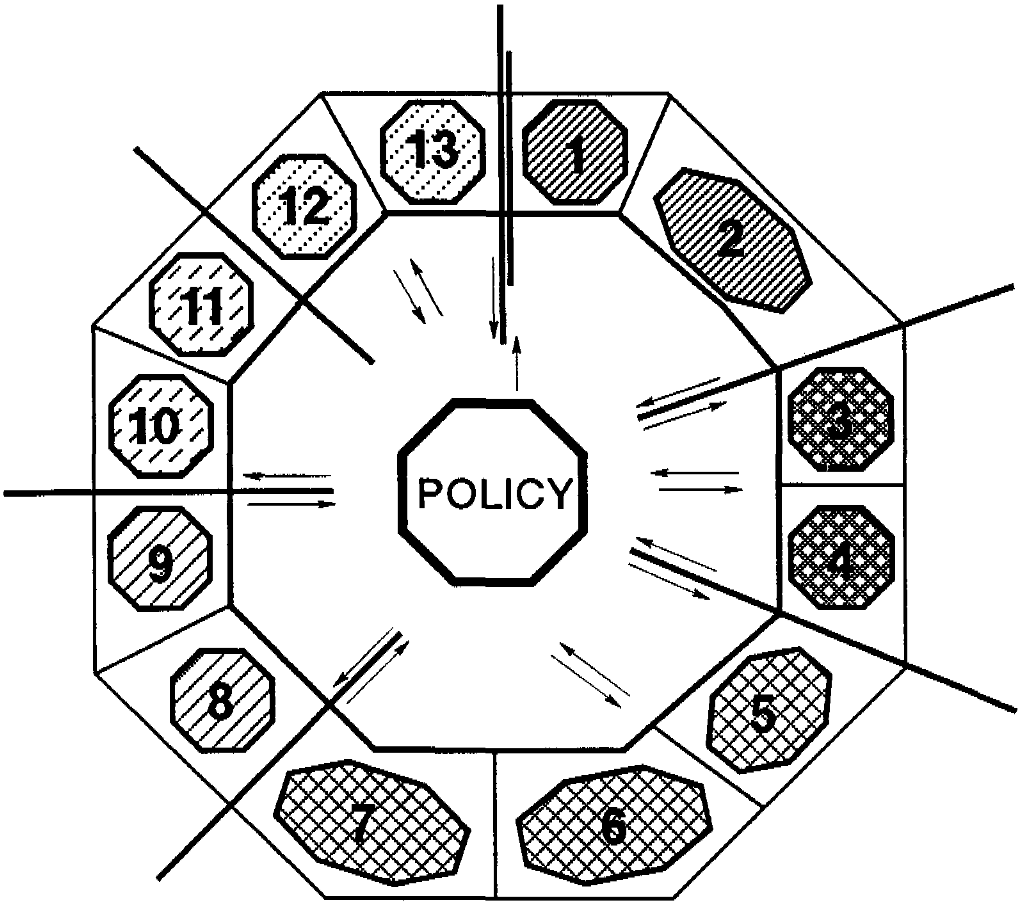
FAO (1986). *Consultation on Irrigation in Africa.* Proceedings of the consultation on irrigation in Africa (Lome, 21–25 April 1986), FAO Irrigation and Drainage Paper 42, FAO, Rome.

FAO (1987). *Effects of Agricultural Development on Vector-borne Diseases.* Document AGL/MISC/12/87, FAO, Rome.

PEEM (1981). *Report of the First Meeting of the WHO/FAO/UNEP Panel of Experts on Environmental Management for Vector Control.* Document VBC/81.2, WHO, Geneva.

PEEM (1984). *Report of the Fourth Meeting of the WHO/FAO/UNEP Panel of Experts on Environmental Management for Vector Control.* Document VBC/84.3, *WHO, Geneva.*

Figure 1. The Conventional Concept of the Project Cycle



1 *Identification*
2 *Formulation pre-feasibility study*

IDENTIFICATION

3 *Data collection and analysis*
4 *Design and feasibility study*

PREPARATION

5 *Appraisal*
6 *Project selection negotiations*
7 *Adjustment and approval*

APPRAISAL / APPROVAL

8 *Activation start-up*
9 *Implementation monitoring*

IMPLEMENTATION

10 *Integration*
11 *Handover to normal administration*

INTEGRATION AND HANDOVER OPERATION

12 *Evaluation*
13 *Follow-up analysis and action*

EVALUATION

COMMITTEE FOR INTER-INSTITUTIONAL COLLABORATION FOR THE PREVENTION AND CONTROL OF VECTOR-BORNE DISEASES IN ETHIOPIA

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Ethiopia, like any other developing nation, is engaged in various types of development activities in both the rural and urban areas in order to meet the demand for an increased production of food and cash crops by a steadily growing population. Such activities centre on developing infrastructures such as construction of roads, harnessing various river and lake systems for use in irrigated agriculture, hydro-electric power and other forms of water resource development (see figure 1) and in establishing various types of industrial and agricultural development schemes. Many of these projects are carried out by different sectors with defined responsibilities and goals and some of their activities either overlap or contradict each other.

It is evident that the activities undertaken by various sectors, such as the further expansion of agriculture by irrigation, the many forms of water resources development programmes as well as public work activities such as construction of roads will inadvertently create suitable breeding sites for vectors and intermediate hosts leading to increased risk to human health. In Ethiopia, most of the malaria outbreaks that occur are directly associated with development programmes, such as irrigated agriculture and public works, and are caused by disrupting the local ecological conditions to create breeding sites. The prevention of such adverse health impacts cannot be addressed by the Ministry of Health alone but requires the effort of intersectoral collaboration among all the ministries and institutions concerned.

The advantage of intersectoral collaboration was initially demonstrated when a group of interested scientists from various disciplines came together in 1981 to coordinate the implementation of a multidisciplinary project for the control of urinary schistosomiasis in the Amibara Irrigation Project in the Middle Awash Valley. The successful effort to control the problem attracted the attention of various ministries and institutions and culminated in establishment of a voluntary arrangement for the Committee for Inter-institutional Collaboration (CIC) in 1985 with the objectives outlined below.

The main objective of the CIC is the control and prevention of actual and to promote potential water-based and water-related vector-borne diseases affecting populations resettling or living in the irrigation schemes or those migrating to and from these areas. This objective is to be achieved through a multidisciplinary approach by soliciting the collaboration of different sectors.

The specific objectives are to:

- provide a technical advisory service on health related questions in connection with irrigation projects, including the development of project protocols, when approached by the authorities concerned;

- provide advisory services to the Ministries of Health, State Farms, and Industries, water resources development agencies, the Relief and Rehabilitation Commission etc. on:

  defining the roles of health institutions in water development project areas;

  the development of appropriate health policies in water development areas;

  the formation and implementation of appropriate environmental health legislations;

- provide assistance, whenever requested, in surveillance and assessment of health problems in specified irrigation development projects;

- develop appropriate guidelines and educational materials to assist health workers in their effort to control and prevent water-based and water-related vector-borne diseases in water development projects, including small and medium irrigation schemes;

- establish *ad-hoc* working groups and pooled resources (expertise, financial and material) from relevant organizations in order to develop and implement irrigation-related health projects of national significance for with consultation and approval of the Ministry of Health;

- create awareness of health problems arising from irrigation development projects and provide advisory services with a view to mitigating those problems;

- provide a forum in the form of seminars, symposia, conferences etc. for the discussion of health problems related to water development schemes in the country, particularly health problems associated with water development projects including small and medium scale irrigation;

- encourage individuals and institutions to conduct research related to the prevention and control of health problems arising from irrigation schemes;

- establish health information systems in irrigation schemes for the collection, collation and dissemination of health data pertaining to irrigation development schemes;

- establish local health committees or strengthen existing ones to ensure effective participation of communities and relevant governmental organizations in the implementation and follow-up of projects executed by *ad-hoc* working groups;

- liaise with national and international organizations on matters related to water-based and water-related vector-borne diseases in irrigation schemes;

- promoting technical cooperation among developing countries with regards to prevention and control of diseases arising from irrigation development.

The organizational structure of CIC includes a General Assembly of all committee members, an Executive Committee, a secretariat, at least three standing committees, and as many *ad-hoc* working groups as found necessary (see Figure 3). The Executive Committee is composed of the founding members namely the National Research Institute of Health (NRIH), the Water Resource Development Agency, the the Institute of Pathobiology of Addis Ababa University, the Occupational Health Unit of the Ministry of Industries and the National Programme for the Control of Malaria and Other Vector-borne Diseases (NPCMVD). The Executive Committee is served by a secretariat, a function which is taken up by NPCMVD.

Participation in the CIC which is voluntary is open to all relevant governmental and nongovernmental institutions. The Ministry of State Farms and the Ministry of Agriculture are encouraged to be members. The newly established Ethiopian Valleys Development and Studies Authority (EVDSA) and the

Department of Environmental Health of the Ministry of Health have applied to join the CIC. Individuals, international organizations and donor agencies who may be interested in the objectives of the CIC are also encouraged to join as associate members.

Since the successful collaborative effort to control urinary schistosomiasis in the Amibara Irrigation Project, various *ad-hoc* working groups of the CIC have rendered significant services. The following are some of the major activities carried out by CIC.

- The CIC has conducted a feasibility study on the health and environmental impact assessment of the Gilgel Gibe Hydro-electric Scheme. The Gilgel Gibe Hydro-electric Project will have a reservoir covering an area of 6200 hectares and a volume of 1000 million cubic metres. The projected dam at the Gilgel Gibe River will have a capacity of 1,900.000 cu. meters with spil-lways and pressure tunnel. A labour force of up to 7000 are engaged in the construction of the dam which is expected to be com-pleted by 1992. According to the CIC survey, the project area is affected by malaria, onchocerciasis and a wide range of intestinal parasites. The CIC findings, along with health safeguard recommendations have been communicated to the Water Resources Development Agency which initiated the request.

- The CIC has carried out an environmental health assessment and monitoring programme for a project involved in a master drainage operation for the Melka Sadi and Amibara area. The project area which is characterized by the presence of stagnant and polluted water is endemic for malaria and for schistosomiasis. The CIC *ad-hoc* group have identified the problem, developed guidelines for the treatment of actual or potential sites, and have helped the project management in the selection and training of a Sanitarian in schistosomiasis control.

- The CIC has prepared a project proposal on integrated malaria and schistosomiasis control in the Wonji Sugar Estate and the document has been submitted to the PEEM secretariat for possible funding. The Wonji Sugar Estate is highly endemic for malaria and schistosomiasis and is faced with the problems of poor sanitation, unacceptable levels of fluoride in water and poor management of the canals and water use.

Figure 1. Major River Valleys in Ethiopia

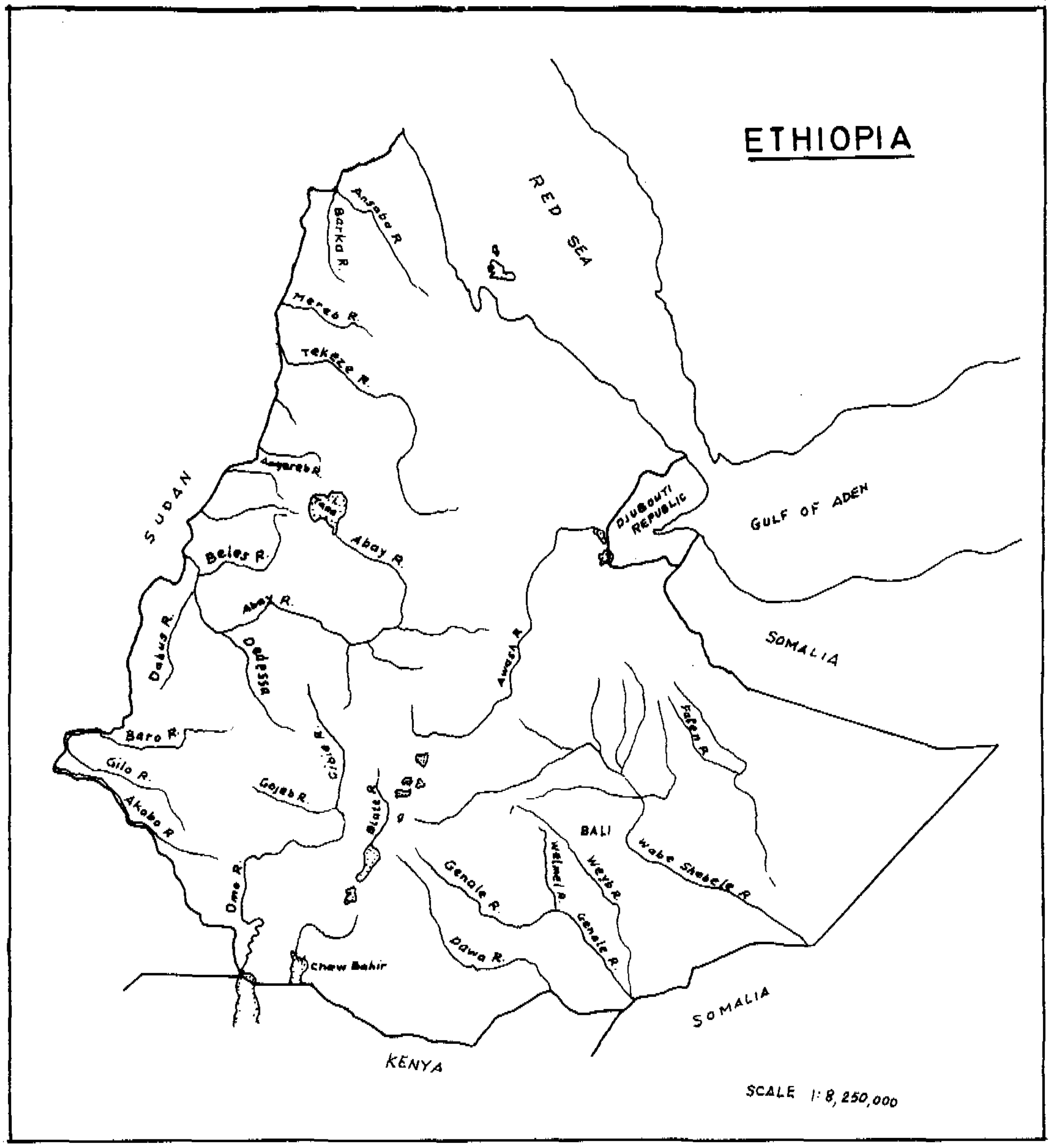


Figure 2. Malaria Endemicity and River Basins in Ethiopia

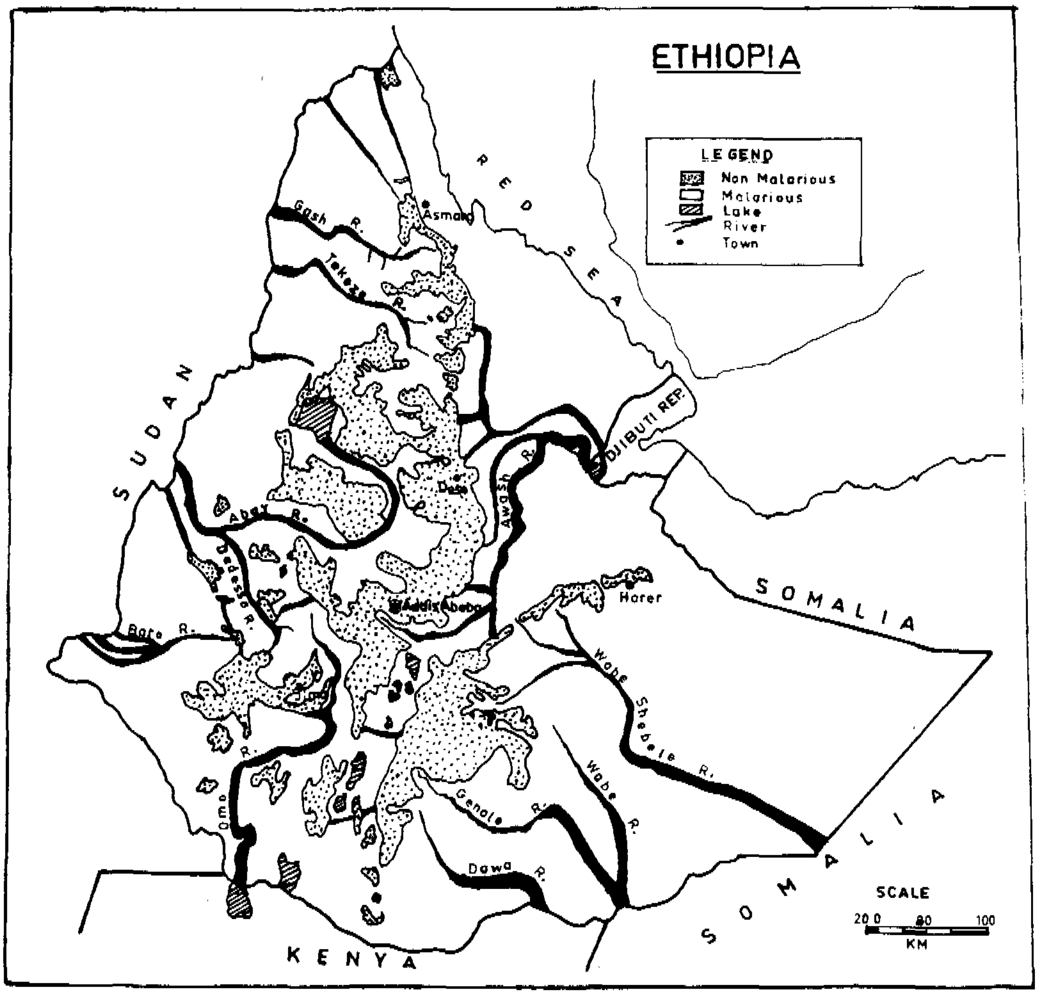
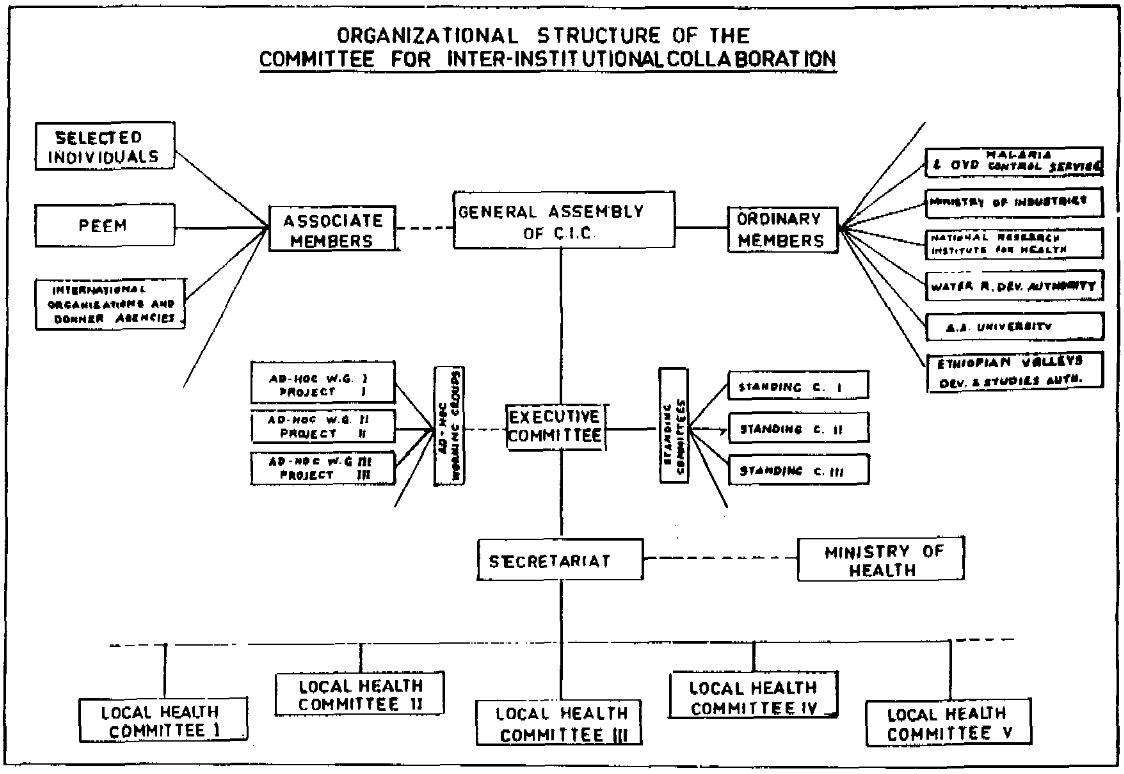


Figure 3. Organogram of CIC



EXISTING INTERSECTORAL LINKAGES IN KENYA FOR THE INCORPORATION OF A HEALTH COMPONENT IN DEVELOPMENT PROJECTS

J. OTETE

Senior Deputy Director of Medical Services

Environmental management, as a concept, gained wide acceptance in Kenya in the early 1970s. It came almost as a revolutionary approach to development and put emphasis on the proper use of resources, both natural and man-made.

The United Nations Environment Programme (UNEP), with its headquarters in Nairobi, was established in 1972 and given the primary responsibility, at the global level, to promote and coordinate environmental management. Environmental policy issues are decided upon by UNEP's Governing Council which is usually held every two years and the Member countries are supposed to implement the resolutions at those meetings. At the regional and national level, matters of environmental importance in the context of development are identified in subject areas under the responsibility of various institutions, national ministries and departments.

Many countries in Africa have identified institutional frameworks for attending to environmental matters or issues. The responsibility has in most cases been given to ministries handling a variety of subjects, including ministries of health, water development, agriculture, and lands, to mention but a few. These ministries are supposed to give priority to environmental matters related directly to them, thus resulting in a tendency for the attention given being sectoral. In Kenya, to ensure coordination of various development efforts and to avoid situations where development projects undertaken by any one ministry create environmental or health problems for another, two national institutions, the National Environment Secretariat (NES) responsible for the environment was created under the Ministry of Environment and National Resources and the Interministerial Committee on Environment (IMCE) were created to be responsible for the environment.

There is also a National Sub-committee on Environment Impact Assessment of Development activities whose membership is drawn from different ministries.

Kenya attaches great importance to environmental management, and different ministries handling a variety of subjects have been given the responsibility of resource conservation. Though each ministry handles environmental matters sectorally, the IMCE whose members are drawn from different government ministries and departments examines environmental issues in totality. Various NGOs in the country are also involved in environmental management to supplement the government efforts in this area.

It is generally agreed that a concerted effort is required to control the quality of Kenya's environment and to assure long-term sustainability, especially in water, air and land. To achieve this, there is a need to put more emphasis on the provision of stronger intersectoral collaboration at the national and grassroots level to ensure that, wherever possible, adequate health safeguards are included, for example, in irrigation and other water resource development projects. Functional institutional arrangements to tackle this and other such multi-disciplinary problems will ensure a process of sustainable development, as underlined in the formation of NES.

Quite a number of irrigation schemes and hydropower projects have been initiated in Kenya in recent years. Nearly all of them are associated with vector-borne diseases such as malaria and schistosomiasis. It can be assumed that water resource development, whether for irrigation or for hydropower generation, will be an important component of Kenya's development activities in the years to come and that, wherever it occurs, vector-borne diseases can be expected to cause unwarranted adverse effects on the health of the residents in those areas.

While the tools to meet such adverse effects have been developed and remedial measures instituted, a proper institutional framework and effective intersectoral collaboration remain top priorities for consideration during planning, designing, construction until the project is operational. These are necessary so that environmental management measures can be incorporated as health safeguards in the project and to allow for coordination to enable the health sector to plan properly for the expected needs of the population in the project area.

Ideally, development projects and programmes should aim at enhancing human welfare. Improvement in the quality of life depends mainly on the careful use of the available resources. In practice, therefore, there is a need for a comprehensive appraisal of resource management which aims at preventing nuisances or hazards. This appraisal should be regarded as the foundation of a new environment or development policy.

In order that this policy may work, the Ministry of Health works very closely with NES, in collaboration with other governmental ministries, departments and authorities, in developing certain environmental development management guidelines which require that environmental impact reports be prepared for all development and industrial projects. In particular, reports should indicate the soundness of such proposed development projects or programmes in relation to national objectives; possible impacts on the environment and human health; and means by which any possible resulting environmental damage could be contained.

With respect to on-going projects or programmes, reports should indicate what is being done or what will be done to curb any environmental degradation or health hazards which may be created by projects. Environmental impact reports are subject to a thorough examination and approval by the NES, in consultation with appropriate bodies or government departments.

The intersectoral linkages at the district level under the umbrella of the District Focus Strategy for Rural Development provide a unique opportunity to discuss and plan the development of enhanced intersectoral coordination to handle effectively any issues or problems which might be brought about by the exploitation of resources. Overall, the D.D.Cs have proved to be very effective coordinating structures for any development programmes, since all governmental departments, including other bodies concerned with development, are represented in the committee under the chairmanship of the District Commissioner.

SEMINAR ON WATER RESOURCE DEVELOPMENT AND VECTOR-BORNE DISEASES IN KENYA

Kisumu, 11–13 September 1988

Programme of the Seminar

Sunday, 11 September 1988

Arrival of Participants in Kisumu

In the afternoon: Optional visit to the Ahero Rice Irrigation Scheme (NIB) in the vicinity of Kisumu

1830–drinks, followed by
1930–official opening of the seminar with opening address on behalf of the Kenyan authorities and on behalf of WHO/FAO/UNEP

Keynote Address: The History and Present Status of Water Resource Development-Associated Vector-Borne Disease Problems in Kenya

Dr J. Otete
Senior Deputy Director of Medical Services
Ministry of Health

Monday, 12 September 1988

0830–1200

Session 1: WATER RESOURCE DEVELOPMENT IN KENYA: PLANS FOR THE FUTURE

Location: Sunset Hotel

Session Chairman: Mrs G.L. Peralta, Philippines
Rapporteur: Dr B.H. Kay, Australia

0830–0850 Agricultural Production in Kenya: A Projection of Irrigation Development Needs by the Year 2000

Dr C.M. Osoro
Ministry of Agriculture

0850–0900 Discussion

0900–0920 Energy Consumption in Kenya: A Projection of the Needs for Hydro-Power Generation by the Year 2000

Mr Ng'ang'a Munyu
Ministry of Energy

0920–0930 Discussion

0930–0950 Planning of Water Resources Development Projects

Mr A. Kandiah
FAO, Rome

0950–1010 Planning Procedures for Water Resources Development Projects in Kenya

Dr W.M. Thitai
Ministry of Water Development

1010–1020 Discussion

1020–1040 Coffee/Refreshments

1040–1140 Presentations of Plans by Three Development Authorities in Kenya:

(a) Tana and Athi River Basin Development Authority
Mr O.K. Bobotti

(b) Lake Basin Development Authority
Dr L.W. Okombo

(c) Kerio Valley Development Authority
Dr J.H. van Doorne

1140–1200 Discussion

1200–1330 Lunch

1330–1615

Session 2: NEEDS AND CONSTRAINTS IN VECTOR-BORNE DISEASE CONTROL IN KENYA

Location: Vector Biology and Control Research Centre (KEMRI), Kisumu

Session Chairman: Dr J. Ouma, DVBD, Ministry of Health
Rapporteur: Dr B.G. Waiyaki, UNEP

1330–1350	Strengthening Needs in the Planning and Management of Integrated Vector-borne Disease Control Dr A. Ngindu Ministry of Health
1350–1400	Discussion
1400–1420	Knowledge Gaps and Research Needs to Improve the Disease Vector Control Component in Irrigation Schemes and Areas Around Man-made Lakes Mrs M.N. Katsivo Kenya Medical Research Institute
1420–1430	Discussion
1430–1450	The Vector Biology and Control Research Centre: Its Role in Vector-borne Disease Research Dr I. Arap Seroney Vector Biology and Control Research Centre (KEMRI)
1500–1515	Coffee/Refreshments
1515–1535	A Review of Current Health Promotion Activities in Water Resource Development Projects under the National Irrigation Board Mr S.K. Kimani National Irrigation Board
1535–1545	Discussion
1545–1605	Environmental Management as a Component of Integrated Vector-Borne Disease Control Professor D.J. Bradley London School of Hygiene and Tropical Medicine, UK
1605–1615	Discussion
1615	Visit to the new facilities of the Vector Biology and Control Research Centre

Tuesday, 13 September 1988

0900–1000

Session 3: SOCIO-ECONOMIC ASPECTS OF IRRIGATION ASSOCIATED VECTOR-BORNE DISEASE PROBLEMS

Location: Sunset Hotel

Session Chairman: Mrs M.N. Katsivo, KEMRI
Rapporteur: Mr A. Kandiah, FAO

0900–0920 Economic Aspects of Schistosomiasis in Irrigated Areas in Kenya

Dr A. Choudhry
Kenya Medical Research Institute

0920–0930 Discussion

0930–0950 PHC Aspects as They Relate to Management and Control of Vector-borne Diseases Associated with Water Development Projects

Dr J. Maneno
Senior Deputy Director of Medical Services

0950–1000 Discussion

1000–1020 Coffee/Refreshments

1020–1200

Session 4: INTERSECTORAL COLLABORATION

Location: Sunset Hotel

Session Chairman: Professor Santasiri Sornmani
Rapporteur: Dr P.L. Tauil, Brazil

1020–1040 Intersectoral Linkages Conducive to the Incorporation of Safeguards Against Vector-borne Disease Problems in the Project Cycle Development

Mr R. Bos
WHO, Geneva

1040–1050 Discussion

1050–1110 Effective Interinstitutional Collaboration to Prevent Irrigation Associated Vector-borne Disease Problems in Ethiopia

Dr Awash Teklehaimanot
Ministry of Health
Ethiopia

1110–1120 Discussion

1120–1140 Existing Intersectoral Linkages and Bodies in Kenya for the Incorporation of a Health Component in Development Projects

Dr J. Otete
Senior Deputy Director Medical Services

1140–1200 Discussions

1200–1330 Lunch

1330–1600 Round table discussion on key issues of improved intersectoral collaboration

Location: Sunset Hotel

Chairman: Professor D.J. Bradley
Rapporteur: Mr R. Bos, WHO/HQ

- Technical Issues
- Managerial Issues
- Financial Issues

1600 Closure of the Seminar

List of Participants

National Participants

Mr J.N. Adhiambo, Sanitation Officer, Lake Basin Development Authority, P.O. Box 4565, Kisumu

Dr N.I. Adungo, Research Officer, Kenya Medical Research Institute, Vector Biology and Control Research Centre, P.O. Box 1578, Kisumu

Dr O.K. Bobotti, Hydrologist, Tana and Athi Rivers Development Authority, P.O. Box 52288, Nairobi

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Dr W.N. Thitai, Head of Research, Ministry of Water Development, P.O. Box 30521, Nairobi

Dr J.M. Waithaka, Senior Public Health Officer, Ministry of Health, P.O. Box 30016, Nairobi

International Participants

Professor A.N. Alekseev, Senior Scientific Worker, Laboratory of Arboviruses Ecology, Institute of Poliomyelitis and Viral Encephalitis, Moscow, USSR

Professor D.J. Bradley, Professor of Tropical Hygiene, London School of Hygiene and Tropical Medicine, London, UK

Dr B.H. Kay, Chairman Parasitology/Entomology, Queensland Institute for Medical Research, Herston, Brisbane, Queensland, Australia

Mrs G.L. Peralta, Lecturer, Environmental Engineering Specialist, University of the Philippines, Diliman, Philippines

Professor Santasiri Sornmani, Dean, Faculty of Tropical Medicine, Mahidol University Bangkok, Thailand

Dr P.L. Tauil, Parliamentary Adviser, Health Area, Federal Senate of Brazil, Brasilia, Brazil

Dr A. Teklehaimanot, Head, Malaria and other Vector-borne Diseases Control Unit, Ministry of Health, Addis Ababa, Ethiopia

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Mr R. Bos, Scientist, Division of Vector Biology and Control, World Health Organization, Geneva, Switzerland

Mr A. Kandiah, Technical Officer, Water Resources Development and Management Service, Food and Agriculture Organization of the United Nations, Rome, Italy

Dr B.G. Waiyaki, Programme Officer, Environmental Management Service, United Nations Environment Programme, Nairobi, Kenya

Dr J.H. Ouma, Senior Parasitologist, Division of Vector-Borne Diseases, Ministry of Health, Nairobi, Kenya