3. ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

3.1 Selected Environmental Items for EIA

In order to formulate an environmental conservation plan for the Lower Moshi Integrated Agriculture and Rural Development Project, various environmental items had been selected for detailed Environmental Impact Assessment (EIA) study, mainly based on the results of the Initial Environmental Examination (IEE) carried out in May 1997.

The selected items are divided into two main groups, namely social and natural environmental items. These items have been clarified in detail in accordance with the "Guideline for Environmental Conversation on Agricultural and Rural Development Projects" (Dec. 1992, JICA). The selected items could be regarded as the most common ones, and are recommended in internationally authorised guidelines as well as the "Environmental Impact Assessment Guidelines for Tanzania (Draft)". The present situation of the selected items as related to the Ecological Regions (refer to Figure I.2.6) are briefly described below.

3.1.1 Social Environment

The selected social environmental items are :

(1-a) Involuntary resettlement
(1-b) Conflict among communities and people
(1-c) Population increase and drastic change in population composition
(1-d) Relocation of bases of economic activities and occupational change
(1-e) Adjustment of water or fishing rights
(1-f) Changes in social and institutional structures
(1-g) Increased use and residual toxicity of agro-chemicals
(1-h) Outbreak of endemic diseases and prevalence of epidemic diseases
(1-i) Increase in domestic and other human wastes

(1-a) Involuntary resettlement

Involuntary resettlement to be caused by land acquisition under this Project can be defined as the forced relocation or replacement of sites or bases on which lives and economic activities of affected people depend. Involuntary resettlement is expected to occur due to problems associated with the project location site i.e. direct agricultural development in Ecological Region 2 and construction of the division channels in Ecological Region 3.

In Ecological Region 1 houses in expanded and new areas should be removed for the construction of irrigation and other agricultural facilities, while in Ecological Region 3 there will be no possible need to remove houses or cultivated areas along the channels and maintenance road routes especially in areas closer to Moshi.

(1-b) Conflicts among communities and people

Conflicts among communities and people refers to friction due to conflicting interests between beneficiaries and non-beneficiaries, people in favour of and those against development, new settlers and host people, people involved in development and out sides, people in the project area and those affected in the surrounding areas.

Conflict among the communities and people are expected to occur in Ecological Regions 2 and 3. In Ecological Region 1, conflicts will occur during the project operation due to social conflicts among the related communities which will most likely happen in terms of water rights and production arrangements. In Ecological Region 3 conflicts are likely to occur during both the construction and operation of the diversion channel, because of illegal water tapping from the channel and feeling of the unfairness in water distribution.

(1-c) Population increase and drastic change in population composition

Population increase is a significant population change (increase) in the project or surrounding area due to development. The population increase in the project area is likely to cause outbreak of conflicts among local communities and people will be affected by the development, especially in terms of settlement or resettlement of affected groups.

The population increase and change in the population composition is likely to occur in Ecological Region 1 and 3 during the construction and operation stages of the project. The population in and around the development sites will increase due to natural growth and artificially due to inflow of construction workers and new settlers. Drastic change in population composition will occur since most of the construction workers will be generally young and most likely males.

(1-d) Relocation of bases of economic activities and occupational change.

Relocation of bases of economic activities and occupational change is a problem which is related to project operation and is anticipated to occur in Ecological Region 6, i.e. areas in and around the Nyumba ya Mungu (NYM) dam reservoir. The major reason for the relocation of bases of economic activities and occupational change is fish depletion in the dam which will result in the loss of income to the people. Fish depletion will be caused by project activities, especially decrease of water flow into the reservoir and pollution due to use of agro-chemicals.

(1-e) Adjustment of water or fishing rights

Adjustment is related to adverse development effects on water or fishing rights and necessary regulations to rectify the same, the assessment of which is essential since the development of the project is likely to cause the disturbance of existing water and fishing rights and hence, cause out breaks of conflicts and disputes among local communities.

Adjustment of water rights will have to be instituted in Ecological Region 1 due to direct agricultural development, while adjustment of fishing right will be instituted in Ecological Region 6, where reservoir water will have to be used for inland fishery, in addition to power generation.

(1-f) Changes in social and institutional structures

Change in social and institutional structures is a problem related to the project operation, which is likely to occur in Ecological Region 1, consisting of the existing Lower Moshi project area, expanded area, new extension area, related villages, village facilities and the Rau river. The major reason for the change in social and institutional structures is the increase in production and irrigated areas, which will improve rural living standards. This may lead to inadequacy in the project area support measures and infrastructure.

(1-g) Increased use and residual toxicity of agro-chemicals

Increased use and residual toxicity of agro-chemicals is a problem related to the project operation which will affect Ecological Regions 1 and 5, especially due to direct agricultural developments in Ecological Region 1. Development of agricultural activities in Ecological Region 1 will result in the increased use of agrochemical since the irrigated area will have to be expanded. Ecological Region 5, which is located down stream of the Rau and Ruvu rivers from the irrigation drains end to its inflow point at NYM dam reservoir (Ecological Region 6) will be affected by pollution because of increased application of agro-chemicals in upstream areas.

(1-h) Outbreak of endemic diseases and prevalence of epidemic diseases

Prevalence of epidemic diseases is the spreading of epidemic diseases attributable to the adverse effects of development. This is expected to occur in Ecological Region 3, particularly during the operation stage of the diversion channel. Prevalence of epidemic diseases will occur as a result of increased water on the surface (channels). There will be a possibility of increased water-borne disease, especially malaria and schistosomiasis.

Such diseases are as well expected to increasingly break-out in Ecological Region 1, before and after the completion of the existing Lower Moshi Project. With the water surface increased, the number of people to be affected by malaria and schistosomiasis in and around the project sites will increase.

(1-i) Increase in domestic and other human wastes

The increase in domestic and other human wastes is expected to occur as a consequence of development in the project area. The increase in the waste will result in the contamination of water, which will cause the deterioration of sanitary conditions in the project area, and hence, added disease cases.

Increase in human wastes is likely to occur in Ecological Region 1, especially due to a huge pile of rice husks. Increase in rice production will degrade the existing waste situation.

Similarly in Ecological Region 3, there will be an increase in domestic wastes, which will be thrown away into the channel, especially around the existing village area. This needs to be studied as it will disturb the channel's function and deteriorate its water quality. People should be educated about relationship of safe disposal of their waste, diseases and channel's operation.

3.1.2 Natural environment

The selected natural environmental items are:

(2-a) Impact on important fauna and flora, and degradation of ecosystem
(2-b) Proliferation of hazardous species
(2-c) Soil erosion
(2-d) Soil salinisation
(2-e) Change in surface water hydrology
(2-f) Change in ground water hydrology
(2-g) Riverbed degradation, water pollution and eutrophication

(2-a) Impact on important fauna and flora, and degradation of ecosystem

The project operations including new developments (i.e. expansion and extension) is anticipated to have impacts on some important flora and fauna as well as on the degradation of ecosystems, especially that of NYM reservoir (Ecological Region 6). Ecological Regions 2 and 4 also seem to be vulnerable to the impact accrued from the project operations. It is also anticipated that the decrease in water level in the dam due to its increased use upstream and the pollution of water with agrochemical and fertilisers will be associated with the reduction in fish production and loss of biodiversity in the dam. The project is as well expected to have negative impact on the Rau Forest Reserve (near Ecological Region 1) due to the construction of another small and short diversion channel running through the forest reserve.

(2-b) Proliferation of hazardous species

Ecological Region 2 (the construction site and direct upstream of the planned headworks on the Kikuletwa river) where inundated areas at the weir might become a good habitat for crocodile living in the Kikuletwa river upper reaches. Ecological Region 4 (downstream area along the Kikuletwa river from the new headworks to its inflow point at the NYM reservoir) where it is anticipated that, as water flow of the Kikuletwa river will become weak, the crocodiles population will increase accordingly. Ecological Region 6 (Areas in and around the NYM reservoir site) where the decrease in water level which will be associated with extensive areas with shallow water will provide favourable habits for crocodile to proliferate rapidly.

Proliferation of dangerous water plants especially at Ecological Region 6 (NYM reservoir) where the reduced water levels together with the excessive enrichment of water with nutrients might favour the proliferation of the so-called dangerous species namely *salvinia* and *Eichhornia* which have devastated many dam projects in Tanzania and East Africa at large.

(2-c) Soil erosion

Soil erosion is the phenomena in which soil is washed or blown away from the earth surface by the action of water or wind. Soil erosion is a smoothing or levelling process, with soil particles being carried, rolled or washed down by the force of gravity. The main agents which loosen and break down the soil particles are wind and water. As for the project, soil erosion is expected to occur in Ecological Region 3, i.e. construction sites for the diversion channel. The construction works will strip vegetation causing additional soil erosion where land slope is steep, and this is likely to damage the new diversion channel.

(2-d) Soil salinisation

An increase of soil salinisation is an expected phenomenon, i.e. salts accumulate in the surface layer of soils. In this case, items for assessment include irrigation water quality, irrigation methods and soil properties (this is in relation to water logging and drainage).

Soil salinisation is an essential item since it affects crop growth in the project area in and around the project area. Water logging will result primarily from inadequate drainage and over-irrigation, and to a lesser extent from seepage from canals and ditches. Water logging will concentrate salts, drawn up from lower layers in the soil profile, in the plant root zone.

Major potential adverse impacts include decrease of land productivity, deterioration and desertification of lands.

The areas of importance under this item are Ecological Regions 1 and 5. In Ecological Region 1 much of the impact is expected here since this zone covers the irrigated land and its neighbourhood. Ecological Region 5 represents an area where drainage will be directed after passing through the irrigated land. These two ecological zones make appropriate areas for monitoring.

(2-e) Change in surface water hydrology

Irrigation projects have the potential of causing changes in surface water hydrology which may consequently affect hydrological and ecological balance of the project area. Major potential negative impacts of the Project include; inadequate maintenance of flow and violation of the integrity of existing water rights downstream the abstraction point; reduction in fish species and stock and interference with hydro-power generation in the Nyumba ya Mungu reservoir. The project impacts on surface water hydrology are expected to be more felt in Ecological Region 6 which covers the Nyumba ya Mungu reservoir and its surrounding areas. The main concerns are decrease in water level in the reservoir and violation of water rights downstream of the dam.

Similarly, diversion of water from the Rau river (near Ecological Region 1) will reduce amount of water downstream along the Rau Forest Reserve.

(2-f) Changes in groundwater hydrology

From the experiences of previous projects in the same Project area, there is a possibility of encountering problems associated with changes in groundwater hydrology during the Project operation stage, notably, water logging and increased levels of water and soil salinity due to excessive recharge of groundwater by irrigation water. The results of the IEE and reconnaissance survey of the Project site have shown that Ecological Region 1 which will be used for paddy cultivation under the proposed Project will be most affected. The area is currently facing problems of salinisation and water logging.

(2-g) Riverbed degradation, water pollution and eutrophication

Environmental issues that are pertinent to riverbed degradation are ;

- Scouring/erosion of the river bed leading to the deepening and increase in river effective cross section area and re-suspension of riverbed sludge,
- Sedimentation/siltation of mainly inorganic materials on the river bed leading to a decrease in the effective size of the river, and
- Accumulation of nutrients on the riverbed leading to build up of sludge and possible resultant eutrophication.

Water pollution may be caused by activities which are directly or indirectly related to the Project. Paddy farming is the direct project activity which may cause water pollution due to leaching of nitrogen and phosphorus into rivers traversing the Project site and the Nyumba ya Mungu reservoir. Excessive enrichment of water bodies may result into eutrophication which can affect ecological balance of the river systems and fishery of the Nyumba ya Mungu reservoir.

3.2 Prediction and Assessment of Environmental Impact

3.2.1 Social Environment

(1-a) Involuntary resettlement

i) Present conditions
Mtakuja and Mvuleni villages have six sub-villages each. These are Mabatini, Upareni, Rizavu, Josho, Mafuriko and Mbyea Juu for Mtakuja village, and Uhuru, Utamaduni, Ujamaa, Muungano, Usalama and Mapinduzi for Mvuleni village. However, a few houses are scattered here and there. The scattered houses are the likely ones to be shifted to the main residential areas to allow for the construction of the paddy fields and the related infrastructure.

ii) Selection of prediction methods/models
The method to be used for the identification of the houses to be removed will be based on comparing the detailed design of the irrigation system in the extended area, the detail map of the new diversion-channel route, and the existing infrastructures including housing.

iii) Prediction of environmental impacts
Involuntary resettlement for this Project is not expected to be a big issue because very few people are expected to be reallocated to new areas. This is because, the diversion channel route does not pass in habitable areas. However there is a possibility of a few people to be involuntarily resettled in the extended area to give room for the farms. These people will be still resettled within the same villages in locations where there is already a high concentration of houses. Reliable prediction can only be done, when a detailed irrigation system and housing distributions are available.

iv) Assessment of environmental impacts
Criteria for assessment is based on the number of people likely to be affected. Since very few people are likely to be affected, involuntary resettlement has a minor impact. But there might be significant negative impact, unless private assets to be lost such as cultivated land, houses and fruit trees are properly compensated especially along the diversion-channel route.

(1-b) Conflict among communities and people

i) Present condition
According to the existing situation conflicts may occur due to land and water shortages.
Land conflict
Construction of the Paddy plots which started in 1984 and completed 1986 was executed by foreign and local experts without involving the local farmers. The following are causes for the land conflicts which occurred :
- Allocation of private lands to project without any consideration being given to individual property rights, e.g. houses, crops, etc.
- Re-allocation of the constructed paddy farms was unfair with some farmers not re-allocated land at all instead it was allocated to some officials and outsiders.
- Others were not satisfied with the amount of land re-allocated to them.

Water conflict
The existing irrigation project faced serious water conflicts only three years after starting of the project primarily due to the following reasons :

- The project abstracted all water flowing into Rau River without any consideration being given to users downstream, thus creating conflicts over water use between the project and cultivators both downstream and upstream.
- Downstream and upstream users were not involved during the planning of the project. Even the local farmers were not involved.
- Formal and traditional water rights were not considered.
- During the water shortages mainly caused by dry season and other factors up stream, unplanned water rationing was introduced resulting into serious conflicts due to corruption.

From field survey conducted by the consultant in November 1997, more than 70 percent of the interviewed farmers singled out "scarcity of water" as the main problem experienced in the existing project area. More than 50 percent of the interviewed farmers complained of unfair water distribution while 95% said that the conflicts in the project are attributed to water use.

ii) Selection of prediction methods/models

The prediction method is based on farm survey and the experience from the existing irrigation project. This method is justifiable because the extended project is similar in many respects to the existing project.

iii) Prediction of environmental impacts

Land conflict

During the construction of the diversion channel and the maintenance road route individual properties such as land and crops will be affected, particularly in the areas closer to Moshi town. Also part of TPC farm will be affected. From the site visit it was observed that the greater part of the channel will be constructed on undeveloped land, hence less conflicts. During the construction of the paddy farms and other agricultural facilities, particularly in the expanded area and new extension area individual properties such as houses, farms and crops will be affected. From the field survey conducted in the area majority (more than 70%) are willing to shift to other places in case of resettlement because of the expected economic benefits. Through meetings organised by various stake holders in the Project the survey shows that more than 90% of the farmers are aware of the plan to change the land use into irrigation scheme. Almost 30 percent of the interviewed farmers believe that the extension programme will reduce community conflicts if is well planned and executed.

Water conflict

If water supply is adequate, conflicts are unlikely to occur. Only proper irrigation schedule and management is needed. But in case of water shortage due to weather or other technical reasons, water rationing will follow. If not well planned and managed it will result into conflicts due to corruption like in the phase one. Also conflicts between formal and traditional rights are likely if upstream users (e.g. Mandaka kwa Mnono area) are not well considered at the planning stage.

vi) Assessment of environmental impacts

The involvement of the farmers from the early stages as indicated in the Report will reduce the level of conflicts. Therefore the Project is expected to cause minimal conflicts.

(1-c) Population increase and drastic change in population composition

i) Present conditions

The existing population in eight villages which are related to the existing Lower Moshi Project area, the expanded area, and the new extension area is as shown in

Table I.3.1. The population for Mandaka Mnono and Kaloleni villages are of 1993, while the data of the other villages are of January 1997. These population figures were determined by DALDO Office in Moshi. Population as per separate study (Baseline Survey) conducted in the villages extending to Lower Moshi Irrigation Project in 1997 are as shown in Table I.2.2. A detail study on the population composition in the study area to show the ratio of male, female and youths has not been conducted. However, a study on the household member according to gender indicated a ratio of 51.4% to 48.6% for males to females (Interim Report). Another detailed study (conducted in February, 1997) on the number of farmers, members and resident condition in Lower Moshi Project indicated population distribution between males and females as shown in Table I.3.2.

ii) Selection of prediction methods/models

The prediction of population increase is based on the short-term basis (during the construction stage) and the long-term basis (during the operation stage). No prediction is made during the construction stage, because the necessary construction details are not available. The prediction during the operation and maintenance stage is based upon the labour requirements on the existing irrigation farms in the project area. This is justified because the extended area has similar ecological and socio-economic conditions as the existing project area. This method is applied on the assumption that the farming conditions and socio-economic status of the extended areas will be similar to the existing Project area.

iii) Prediction of environmental impacts

The process used in predicting is qualitative, because of the difficulties in obtaining reasonable population figures due to many variables involved. The Project area is expected to expand to 7,739 ha from the existing 2,654 ha. This means that the human resources requirements for the whole Project area will be more than double, and that labourers will have to come from outside the Project area as what is currently happening. Some of the labourers hail from Tanga, Lushoto as indicated in the Report. The doubling of the human resources power requirements will only occur, if the quantities of water will be available as planned, and farming practise is maintained as currently done. The population will increase and change in composition in two main areas. Firstly in the villages close to the diversion channel route and the Project area. In addition, the population changes will occur in two phases, the construction and the operation & maintenance phases.

Diversion-channel route : Construction phase

The population will increase along the villages bordering the diversion channel because the construction activities will attract a lot of youth to come and seek employment. This will involve both casual labourers, technical staff, and service providers, especially food vendors. The areas most affected will be the intake itself at the river, the channel and quarry site. The magnitude of population increase in the Project area will occur differently in the area of the existing irrigation system and in the extended area.

Diversion-channel route : Operation & maintenance phase

The intake, diversion channel and the gravel source are not expected to have many people at this stage, because the human resources requirements for maintenance activities will be low.

Existing project area : Construction phase

The population is expected to increase in the existing project area because of the construction of diversion channel which will partly pass in the area, and in the areas where the improvement and rehabilitation of some parts of the drainage systems and the access roads will take place.

Extended area : Construction phase
In the extended area, the population is as well expected to increase a great deal, because of the many engineering works which are expected to be carried out, such as levelling, construction of irrigation system, road network and other related works.
Existing project area : Operation & maintenance phase
The population in the existing project area is expected to increase because of the increased water quantities. This will lead to the farmers to cultivate their fields twice a year, as opposed to the current practice of cultivating rice after an interval of one year. The increased farming activities will lead to an increased number of labourers working in the rice farms. The increased farming activities can also lead to the generation of the other economic and service activities, which in turn will attract more people in the area.
Extended area : Operation & maintenance phase
The extended area is expected to have a drastic increase in population as a result of increased irrigated farming activities. It is expected that more labourers will be attracted, new settlers will come to lease the village fields, absent farm owners will come back to do farming activities and technical staff, and service providers will settle in the village to give the necessary services.

iv) Assessment of environmental impacts
The criteria for assessment is based on relative change of population and the expansion consequences to the Project area. Population change has a major impact, and the necessary mitigation measures must be taken to absorb the new population. The present water and sanitation services are not enough so that these services should be arranged to mitigate the future social negative impacts due to the predicted population increase.

(1-d) Relocation of bases of economic activities and occupational change

i) Present conditions
There are 7 villages engaged in fishing around the Nyumba ya Mungu reservoir. The irrigation project might effect their fishing activities, if there will be a fall in water levels or pollution of water at the reservoir, to the extent of affecting the fishing stock. It is estimated that, a total of 624 people (data for 1997) are engaged in fishing activities. The trend in fish catch (from 1987 to 1996) show that there is significant drop in fish catch at NYM reservoir. The fish catch from 1987 was 4,218 tons while that in 1997 was 408 tons (Table I.3.3). This means that by 1996 the fish catch dropped by 90.4 percent. The drop in fish catch is accompanied by a corresponding drop in number of fishing vessels as well as the number of fishermen. It is obvious that as the fishery becomes poor many fishermen are forced to quit. According to the Regional Fisheries Officer for Kilimanjaro Region, fishing devices/gears include, beach seine, gill nets, hooks and basket traps. Beach seine however have currently been totally prohibited in virtue of their ability to catch breeding and immature fish and to degrade the environment of the reservoir floor on which the fish spawn. Studies by Nhwani (1984) on the trend of the fishery of the Nyumba Ya Mungu reservoir showed that, *Tilapia* were dominant in the commercial and experimental catches with *Areochromis Esculenta* contributing more than 80% of the catches at any time in both gillnets and beach seine. He also reported that the fishing practices, using gillnets of average mesh size 57.1 mm and use of beach seines of average mesh size of 48.9 mm has culminated into decline of *O. jipe* and virtual disappearance of the related and similar size species *O. pangani* from the reservoir. Discussions with local people living in villages near the reservoir revealed that the drop in fish catch is partly due to reduction in water level in the reservoir. They also pointed out that the irrigation activities upstream have no impact on the

water level in the reservoir, and that the extended drought period has significantly affected fish population in the reservoir. At present all villages surrounding Nyumba ya Mungu reservoir depend on fishing as their main economic activity and also fish being their main staple food. However in recent years, there has been a decrease in fish stock and also some fish species have almost disappeared. The main reason cited by the villagers is the over fishing because of increase population of the fishermen, and also the illegal use of small size nets. Through the interviews 47% of the fishermen have monthly income of between Tsh.25,000 to Tsh.40,000, 41% their monthly income is above Tsh.40,000.

ii) Selection of prediction methods/models
The methods used to predict the future fishing stocks is based on water balance, water quality and the past trends of fishing stock and activities. This is justifiable because it shows the quantities and quality of water entering the reservoir when the project is running. The past data on the fish stock shows the trend of fishing activities without the project. The prediction method will work only if the project parameters are adhered to and there are no extreme dry weather conditions.

iii) Prediction of environmental impacts
The process of prediction is qualitative even though the input for prediction, water balance and water quality are quantitative. The Project will not affect the current trend of fishing activities, because the water used for the Project will have minimal effects on the reservoir. (Refer to the following Sections 3.2.2 (2-a) iii) and (2-e)iii) for more details.)

iv) Assessment of environmental impacts
The assessment is based on degree of impact on the fishing activities. There is minimal impact of fishing activities, therefore there will not be relocation of economic activities and occupational change.

(1-e) Adjustment of water and fishing rights

Refer to Items (1-b) and (1-d) above for assessment results of this item.

(1-f) Changes in social and institutional structures

i) Present conditions
In the Project area the key players for O & M are the KADP, CHAWAMPU, to a little extent WUG. In the future, CHAWAMPU and WUG will be the main players.

ii) Selection of prediction methods/models.
The prediction of the social changes are based on the experiences gained from the existing Lower Moshi project and similar projects elsewhere. The institutional changes are based on the proposals as documented in the Report. This method is justified because it is based on the existing experience and on the proposals of the Project. The predictions will only be close to reality if the Project is implemented as planned.

iii) Prediction of environmental impacts
The process of prediction is qualitative. There will be social changes in terms of population and population composition, due to increased services and economic opportunities. These changes will not only increase the well being of the people but can also bring conflicts and new diseases to the area. Changes will also occur in the institutional structures because the KADP will relinquish most of its activities and

give more responsibility to CHAWAMPU and WUA to run the day-to-day activities of the Project. The irrigation project will bring changes in social and institutional structures, because there will be a rapid increase in population both in numbers and composition. There will also be an increase on public services such as water for household use and livestock, electricity from the mini-hydropower stations, and an increase in accessibility because of the construction and improvement of service and canal roads. The institutional change will bring efficient system for running the Project and ensuring its sustainability. However these changes can also lead to conflicts against the traditional institutions operating in the area.

vi) Assessment of environmental impacts

The criteria for assessment is based on the positive and negative aspects which the social and institutional changes can bring. However as long as mitigation measures are adhered to, these are expected to bring more positive aspects, than negative. On overall, changes can be treated as positively significant.

(1-g) Increased use and residual toxicity of agro-chemicals

i) Present conditions

Agro-chemicals used are in three categories, which are pest control, disease control and seed disinfection. The amounts of agro-chemicals applied annually in the existing irrigation area are estimated as below (T. Horibata, 1992).

Pest control

Insect pest	Chemical	Dose/ha	Annual Amount
Rice stem Borer -striped -pink	Diazon or sumithion	450 cc	4,500 l
Stalk-eyed fly	Diazon or sumithion	450 cc	4,500 l
Act worm and worm	Diazon or sumithion	450 cc	4,500 l
Annual total			13,500 l

Disease control

Diseases	Chemicals	Dose/ha	Annual Amount (l)
Blast	Pthalide solution Karugamycin	1,200 ml 1,800 ml	12,000 18,000
Sheath blight	Validamycin diclomezine	1,000 ml	10,000
Bacterial leaf streak	Oxinalic acid	1,800 l	18,000
Annual total			58,000

Herbicides

Herbicides	Dose/ha	Annual Amount
Stam F. 34 (Propamil)	12l	120,000 l
Basagram Bentazon 48%	6-8l	70,000 l
Rilof	6-8l	70,000 l
Orza	9-12 kg	105,000 kg

Seed disinfection

Chemical	Treatment	Dose	Annual amount
Thirambenong (Berilate)	Soak dry seed for 24 - 48 hrs dress dry seed	50g/10l (x 200) 100g for 10kg of dry seed	1,000kg
Trifmine	Soak dry seed for 24 - 48 hours	33/10l (x 300)	
Oxolinia acid	Dress dry seed dry seed	50g/10kg of dry seeds 25g/10l	2226.76kg

ii) Selection of prediction methods/models
The project area under consideration is the Nyumba ya Mungu reservoir and the area surrounding. Samples were taken from water sources feeding the project area and drainage channels draining the project area (both the existing and the expanded area). Nyumba ya Mungu reservoir was also sampled for control and follow-up purposes. Experience already gained from the existing Lower Moshi Project and other projects were used as a basis for impacts prediction.

iii) Prediction of environmental impacts
The impacts are predicted using a quantitative process, receiving water quality analysis results (see Section 3.2.2(2-g)i)) for more detail) and area coverage. Chemicals application rate, frequency and demand are used in predicting their impact on the Nyumba ya Mungu reservoir. No nutrients in excess were found in the receiving water bodies (see water analysis data in Table I.3.4). This is an indication that if chemicals are applied properly the effect on receiving waters including Nyumba ya Mungu reservoir can be minimised. The Project will have no significant impact on receiving water bodies and the environment if proper control of application of chemicals is made and kept at the present levels.

iv) Assessment of environmental impacts
Considering the plan for rational application of agrochemicals proposed in the Report, the overall impact due to increased use and residual toxicity of agro-chemicals will be insignificant.

(1-h) Outbreak of endemic diseases and prevalence of epidemic diseases

i) Present conditions
Tables I.3.5 and I.3.6 show the distribution of reported cases for the whole year and 5 years respectively. In order to ascertain the existence of epidemic and endemic diseases, the data obtained from hospitals for a period of six years, that is, from 1987 to 1993 according to Water and Vector Borne Disease Survey (1994) was used. This revealed that malaria, diarrhoeal, intestinal worms, eye infections and bilharzia (schistosomiasis) arranged in that order of their prevalence, are the commonest debilitating infections in these places. Before and after completion of the Existing Lower Moshi project, water-borne diseases such as malaria and schistosomiasis had prevailed.

Malaria
Mosquitoes of the genus *Anopheles* are known to be responsible for transmission of malaria. Which means, despite the absence of an attempt to identify them on-site, the prevalence of malaria in Lower Moshi area confirms their presence. This implies that irrigation by flooding the fields will provide an excellent environment for their survival and hence increased malaria cases.

Diarrhoea
The case of diarrhoea is however different, in that, in some years like in 1989, the hospital reported cases went down relative to other recorded years. This means that, measures could be taken to minimise such an epidemic.

Intestinal worms
Intestinal worms cases appearing in Table I.3.6 is somehow constant, which means that this disease is as well endemic in the area. The majority of intestinal worms affecting the farmers in irrigation schemes are hookworms and round worms.

Schistosomiosis

Schistosomiasis as well is endemic in the area as shown in Tables I.3.5 and I.3.6. A large number of *Biomphalaria pfeifferi* and *B. sudania* have been found in drainage canals of the project area, while a few *Bulinus tropicus*, non-vector of *haematobium* infection were also collected (Yasuraoka, 1995). In Kilimanjaro Zonal Irrigation Schemes, Schistosomiasis is widespread among peasant farmers and school children who bath in contaminated water especially the irrigation canals. The presence of this disease proves that there exist vector snails which perpetuate it. A lot of work on this disease has been done on the Lower Moshi Scheme involving school children who are susceptible to this disease.

Eye infections

Eye infections recorded in the 1994 study did not mention the vectors which transmit them. However, many of the eye infections are known to be transmitted by flies, notably trachoma and river blindness (onchocerciasis). From the data obtained at the dispensaries it can be concluded that, the reported cases of eye infections have an indirect relationship with wind speed. Whenever the wind speeds are high, eye infections decreased and vice versa. This strongly suggests that, infection of the eyes are not due to dust blown off by high wind speeds. Rainfall appears to have a noticeable relationship with eye diseases. When there is no or little rains, the eye diseases reported cases are on the medium level, that is between April and September whereas, during the beginning of the rainy season, mid-September to mid January, the cases drop considerably and are raised sharply in February. Such a pattern is noticeable for Lower Moshi area according to the data gathered from Mabogini Dispensary.

ii) Selection of prediction methods/models

The prediction of diseases have been based on the existing trends of hospital reported cases, based on the data obtained in dispensaries as presented in Tables I.3.5 and I.3.6. There are no conditions set for the application of chosen method. The selected method can continue to be re-tested by continuous collection of data.

iii) Prediction of environmental impacts

Experience has shown that the considerable increase in the prevalence of schistosomiasis has followed the establishment of irrigation schemes in most endemic areas of Africa according to Yasuraoka (1995, p. 2). It is clear that the canals might harbour or act as a breeding site for mosquitoes and therefore added malaria cases. It is not only that, but also, the snails may not be washed away due to reduced speed of water and therefore prevalence of schistosomiasis in the area. These problems might as well be caused by the swampy conditions during rainy season each year and flood attacks. Given the increased agricultural activities, that is, extension of the irrigation scheme, the prevalence of malaria will be eminent. It will continue to be the endemic disease in Lower Moshi. With the water surface increased, the number of people affected by these diseases in and around the Project sites will increase.

iv) Assessment of environmental impacts

In this case, the criteria used for assessment is mainly on the productivity side. This is because, for people to do any developmental activity, they should be in good health, otherwise diseases incapacitate them from attaining goals in their life. The existing canals are overgrown with grasses which reduces the flow velocity and therefore, siltation problem occurs and increased cases of malaria and schistosomiasis. The new canals will be lined and velocity of flow to be in such a way that, it does not allow silt deposition and ponding, and therefore, no negative impact if they are properly operated. In Lower Moshi, it was observed that, there exist many grasses and sediments in the drains. Grasses and sediments should be removed regularly in order to deny habitat for disease vectors. The proposed water management plan for the new Project site as indicated in the Report will alleviate these problems. This will give rise to clean environment which discourages breeding of disease vectors.

(1-i) Increase in domestic and other human wastes

i) Present condition

Poor disposal of husks in the project area is currently a serious problem. Previously, husks used to be burnt that led to serious air pollution problems from smoke. Currently, the husks are no longer burnt, as such they are piled-up around paddy milling machines. The main rice mill in the study area is owned by the Kilimajaro Paddy Hauling Company (KPHC). It caters for paddy farmers and traders in and around the project area. During the year 1996 the milling centre received 4,928 tons of paddy and processed 4,515 tons. Nearly 50% of the paddy comes from the existing Lower Moshi Project Area. The milling machine has a capacity of 21 to 30 tons of dried paddy per day. The rice mill is operating at about 50% of its capacity. The rice mill is getting popular in an around project area because the rice milled in this facility does not contain foreign matters such as small stones, sand and straw.

ii) Selection of prediction method/models

The method used for predicting the amount of husks production is based on the total amount of paddy currently processed. In the absence of reliable information regarding the amount of waste currently being generated, two assumptions are made. Firstly the amount of waste (husks) generation is 25% of the total amount of paddy processed, and secondly, in future, the milling machine at the project site will operate at 100% capacity.

iii) Prediction of environmental impacts

From the above analysis the total amount of husks to be generated can be taken to be 4,515 ton x 0.25 x 2 =2,258 tons per year.

iv) Assessment of environmental impacts

The generated rice husks will be piled up more, especially around the existing areas of villages. This will disturb the channel's functioning and deteriorate its water quality, thus affecting people and livestock in its surroundings. Rice husks can also pollute the air after being blown away by wind.

3.2.2 Natural environment

(2-a) Impacts on important fauna and flora, and degradation of ecosystem

i) Present conditions

Nyumba ya Mungu reservoir

These are primary producers and providers of fish breeding habitats, shelter against predators and wave action. The excessive growth of the plant which may cause problems related to navigation, fishing and excessive water loss via transpiration does prevail in the reservoir. The Kikuletwa river, unlike Ruvu river, drains Mount Meru (said to be rich in fluorides) and then passes through large coffee and sugar plantations. Insecticides, fertilisers, weed-killers or other chemical by-products could be carried down into the dam. These chemical by-products in excessive concentrations, could lead to excessive growth of aquatic plants and hence, disturbing the dam ecology and the associated fishing activities and fish production. However, the absence of the massive growth of aquatic plants in the reservoir shows that the river does not carry high concentrations of the nutrients into the dam. Fish population at Nyumba ya Mungu (NYM) reservoir is dominated by *Tilapia* sp. They include *Tilapia pangani, T. jipe, T. esculenta and T. rendalii.* However, it is reported that there are about 20 species of fish from seven families. A list of the main species which exist in the river systems, in the reservoir and areas immediately upstream and downstream of the reservoir has been studied and reported by Bailey (1974) and the results are presented in Table I.3.7. This also indicates their distribution in the reservoir and rivers. The information concerning reproduction of major species of fish in the reservoir is less satisfactory and the major spawning grounds have not been discovered. However, Bailey (1974) suggested that the reservoir condition have favoured the spawning of *tilapias, Haplo chromis* and *Rhabdalestes*, while the breeding of *Barbus sp., Labeo sp.* and *Clarias mosambicus*, probably is associated with flow regimes in the affluent rivers and streams. The distribution of *Barbus sp., Labeo sp.* and *clarias* in the reservoir, the location of fish traps in inflow channels, and the statement of fisheries staff (Bailey, 1974), made it possible to suggest that these fishes are anodromic migrating into the inflows and peripheral streams when they become swollen during the rains. These preliminary findings suggest that these fish do not migrate longer distances upstream in the river systems.

Upstreams and downstreams of the Kikuletwa river

The up- and down-streams of the Kikuletwa river is dominated by riverine lowland vegetation. A narrow strip of evergreen vegetation is seen along both banks of the river.

Protected forest reserves (Rau and Kahe II Forest Reserves)

Rau forest reserve is a lowland rain forest which is located South East of Moshi Town and North eastern side of the existing Lower Moshi project and surrounding expanded area. It occupies a total area of 620 ha and it harbours many springs that supply water for the Mabogini intake weir and the surrounding expanded area. Some springs supply water to Rau river to which Rau ya Kati intake weir has been constructed. The Kahe II forest reserve is also a lowland rain forest. It is situated adjacent to the project area south of Rau Forest Reserve. It has an area of 202 ha. Since it is situated below the project area its value in terms of water source is minimal. However, this forest breaks strong winds that blow towards the project area and hence, minimises water loss in the atmosphere. The valuable Rau and Kahe II Forest Reserves are surrounded by farms and residential houses. Due to their location near the expanded area of the irrigated lands, problems related to encroachment to the forest reserves, illegal tree felling and removal of selected tree species for selling are anticipated. The management of both Rau and Kahe II forest

reserves is under the central government where it is entrusted to the Ministry of Tourism, Natural Resources & Environment through its Forestry & Bee Keeping Division. Regional-wise, they are under the Kilimanjaro Catchment Forest Office.

ii) Selection of prediction methods/models

The methods used for prediction of the impacts of the project on flora and fauna at the reservoir and river systems include water balance survey, analysis of water quality and existing data available at the Regional Natural Resources Offices at Kilimanjaro Region. Justification for selection of the water balance survey is due to its ability to predict volumes of water in the reservoir under different cropping alternatives and hence indicate whether the reservoir will be able to sustain fish productivity, fish biodiversity and the aquatic ecosystem in the reservoir at large. The analysis of water quality as a method of impact prediction is justified by its reliability in providing data/information on pollution levels in aquatic environment and therefore the suitability of the water for fisheries development and animal drink will be assessed. The use of existing data is important as it enables one to understand the trends in fish productivity and biodiversity as well as the trend in water quality changes. This will assist in designing the appropriate mitigation measures for the predicted impacts. Gathering informations from local people on issues related to water quantity and quality, in the reservoir, and river systems is another valuable prediction method. This method of prediction is justified by virtue of its ability to assist in getting information which reflect the actual situation pertaining to the impact of the project to the life of the local people.

iii) Predictions of environmental impacts

Data for water quality analysis suggest that, water in the reservoir is not likely to be polluted by chemicals coming from irrigated land. This is because the concentrations of T-N and T-P (nutrients) and fenithrothian (agrochemical) in both river system and reservoir system are below Tanzanian Temporary Standards and World Health Organisation Standards. Therefore the potential impacts of the Project on degradation of dam ecosystem including fish productivity is not expected to occur. The eutrophication of the reservoir due to excessive enrichment of water with nutrients is also not likely to occur in a near feature. However, monitoring of water quality in river system and reservoir will be needed. There is a significant decrease in fish catch, loss of biodiversity and degradation of reservoir ecosystem due to unfriendly fishing technologies used by the commercial fishermen and the local people which live near the reservoir. Natural fish predators especially crocodile are partly responsible for the problems related to drop in fish catch. This shows that the operation of the Project will have no impact on NYM fishery.

iv) Assessment of environmental impact

The impact of the project on important flora and fauna will be assessed by ranking the impact as causing no impact, mild negative/positive impact, moderate negative/positive impact, significant negative/positive impact or highly significant negative/positive impact. Based on this assessment criteria, the irrigation project is predicated to have the following impacts. There will be no impact on fish productivity and biodiversity at NYM reservoir. The loss in fish catch and disappearance of some reservoir fish species is caused by loss of breeding habitats for fish and over fishing using unfriendly fishing gears. The Project operation will have no impact on pollution of water in the reservoir because the concentration of the nutrients (T-N and T-P) and agrochemicals (fenithrothian) in the river systems flowing through irrigated lands into the reservoir is far below international standard. The concentration of these chemicals products in the reservoir is even lower than that in the incoming river water. The Project operation will have no impact on the two

forest reserves (near Ecological Region I). Reduction of water due to the another diversion plan will not severely affect the Rau Forest Reserve, because only 15% of average annual flow will be diverted.

(2-b) Proliferation of hazardous species

i) Present conditions

The up- and down-streams of Kikuletwa river are dominated by riverine lowland vegetation. A narrow strip of evergreen vegetation is seen along both banks of the river. Crocodiles are reported to be present in riverbanks where the speed of water is low specifically at the confluence and at constructed weir where massive growth of littoral macrophytes especially *Typha domininguensis, Cyperus spp., Phragmites mauritious* and *Ludvigia erecto* take place. Also in some springs like Chemka springs crocodiles are reported. Table I.3.8 shows the incidences of crocodile attacks in various places for the year 1996/97. The dangerous water plants, *Eichhomia* have known to devastate many dam projects. The explosive growth of *Eichhomia* have been known to interfere seriously with operations of many dam projects. The explosive growth of *Eichhomia crassipes* have recently been causing problems on Hale dam, Tanzania (Bailey, 1974). The *Eichhomia* is the great threat to fishery at NYM reservoir by virtue of its presence on the Lower Pangani (Bailey, 1974). Monitoring of proliferation of *Eichhomia* at NYM reservoir is however recommended.

ii) Selection of prediction methods/models

The methods which will be used for prediction of the impacts of the proliferation of flora and Fauna are analysis of water quality and existing data available at the Regional Natural Resources Offices at Kilimanjaro Region and gathering information from local people. The justification for the selection of water analysis is based on its ability to provide data on pollution levels (nutrients) in rivers and reservoir, hence one can predict the ability of the reservoir to support massive growth of dangerous water plants. The use of existing data is important as it will lead to the understanding of the trends of proliferation of crocodiles and dangerous water plants so that appropriate mitigation measures could be developed. The gathering of information from local people on issues related to water quality and quantity, incidences of crocodile attacks is justified by its virtue of the ability to assist in getting information which reflect the actual situation pertaining to the impact of the project to the life of the local people.

iii) Prediction of environmental impacts

There is a high incidence of crocodile attacks on people and livestock. The crocodiles are said to be confined to shallow water areas of the dam. The water level in the dam has been reported to have decreased especially during the past two years due to extended drought which affected many other parts of Tanzania. Fluctuations in water level in the reservoir is not associated with the project activities because the results from the water balance survey reveal that the quantity of water flowing in the river downstream to this reservoir is sufficient and hence fluctuation of level of water in the reservoir is not anticipated. It is therefore evident that the Project operations will have no impact on crocodile proliferation in the reservoir. The crocodile population in the rivers (especially Kikuletwa river) has shown to increase at a faster rate. The incidences of crocodile attack on people and their livestock in 1997 has been relatively high. Crocodiles are commonly found near the river banks where the speed of water is low. The speed of water at the river banks is reduced by the massive growth of littoral macrophytes. It is most likely that the nutrients leached from the nearby irrigated lands favour the growth of these aquatic plants. The inundated areas

at the new headworks will become suitable habitat for crocodiles living in the Kikuletwa river. Monitoring of the crocodile intrusion and proliferation at these sites is recommended. Past data on crocodile attacks were not available at the Regional Natural Resources Offices. Due to this reason, it was not easy to compare the present and past incidences of crocodiles attack.

iv) Assessment of environment impacts
The criteria for assessment is based on whether the Project operations will facilitate or reduce the proliferation of the hazardous species in the earmarked ecological regions. The Project will be regarded as having significant negative impact, especially in Ecological Region 3, due to the new diversion channel.

(2-c) Soil erosion

i) Present conditions
Studies done in 1994, at Musa Mwijanga and Kikafu Chini (Mshindo, 1994) show that hilly areas where part of the diversion channel is to pass is subjected to soil erosion. The soil erosion especially gully erosion is increasing with time because of the removal of the vegetation cover. The low areas where farms are located, are subjected to sedimentation from the upper parts. The low areas are classified as moderate erosion areas.

ii) Selection of prediction methods/models
The prediction of soil erosion is based on the experience from similar projects elsewhere, and the knowledge that when vegetation cover is removed and local slopes are created through engineering works, soil erosion is likely to occur unless preventive measures are taken. The universal soil loss equation (USLE) model could not be used because of many missing parameters. This method is justified because not only that the data to apply the USLE model is missing, but the channel will be lined and the embankment will be properly landscaped and regularly maintained to minimise soil erosion. The prediction will only be valid if the channels are constructed, landscaped and maintained as planned.

iii) Prediction of environmental impacts
The prediction process is qualitative. There will be low soil erosion because of the low erodibility of the subsoil, lining of the channel, landscaping and regular maintenance. This prediction is based on the fact that proper mitigation measures will be carried out.

iv) Assessment of environmental impacts
Soil erosion is not a significant issue since mitigation measures incorporated in the water and soil management plan will minimise impacts of the Project on soil erosion.

(2-d) Soil salinization

i) Present conditions
In the southern end part of the irrigated area, substantial distribution of salt-accumulated soils have been identified. The Kikuletwa river, from which water for irrigation will be diverted, has high contents of salts (see Item (2-g) below). However, the salinity level and sodic conditions are not permanent characteristics of the soil and their presence may not be very significant to irrigation development if leaching conditions are satisfactory. Soil analysis studies in the existing Lower Moshi Project show that there is no tendency of salt accumulation in rice fields. On the contrary, the two soils in the upland fields adjacent to paddy fields show high

accumulation of salts compared with the soils in the adjacent rice fields. This might have resulted from the rising of the water table due to irrigation in paddy fields or from leaching of salts occurring during rice cultivation. The lower portion of the existing Lower Moshi Irrigation Project is susceptible to salinization. It is estimated that over 80 ha of the pilot plot has been affected by salinity. Salinity is evidenced by the presence of indicator plants (Crepressus Species, "Minywangwa") that dominate the area. Also white layers of saline soil can be seen along the road. Similarly, darkish colour of the soils which results from the reaction between salt, element (NaOH) and organic matters are seen enormously in the area. In any case it is obvious that there is no tendency of salt accumulation in paddy fields due to irrigated rice cultivation for a period of some ten years. Water analysis results show that saline water will be introduced into the project through the diversion channel from Kikuletwa river. EC for Kikuletwa river is 1082.0 µs/cm and SO_4 concentration is 41 mg/l an indication of salinity causing elements.

ii) Selection of prediction methods/models
The prediction of salinization is based primarily on experiences already gained from the existing Lower Moshi Irrigation Project and other similar projects. Water behaviour and soil properties as far as irrigation agriculture is concerned are also considered. Areas around the project area are considered and sampled for comparison.

iii) Prediction of environmental impacts
The impacts are predicted using a qualitative process, although soil and water quality analysis results are quantitative. The Project will have no significant impact on soil salinization if appropriate mitigation measures are taken as planned.

iv) Assessment of environmental impacts
The assessment is based on the degree of impact on land productivity, soil deterioration and desertification as caused by soil salinity. There will be minimal impact of land productivity, soil deterioration and desertification from the Project.

(2-e) Changes in surface water hydrology

i) Present Conditions
Surface water hydrology of the Project site can be classified into two major categories such as ;

- River systems (Kikuletwa and Ruvu)
- Lake system (Nyumba ya Mungu reservoir)

Kikuletwa river system
Because the base-flow discharge is large, the runoff duration of the Kikuletwa river is very advantageous for a water-use project. Groups of springs (Chanika, Ngulu, Rundugai, etc.) having abundant water, are distributed along the Kikuletwa river main stream and the tributaries including the Kware river. Particularly in the dry season, this spring water contributes greatly to the discharge of the Kikuletwa River. Discharge data for the river system have been established based on measurements made at gauging stations : 1DD1 on Kikuletwa river, about 400m downstream of its confluence with Kikafu river, and 1DD54 on the Kikuletwa river, about 300m downstream of its confluence with Sanya river. A summary of monthly discharge data for 1DD1 and 1DD54 gauging stations are presented in Table I.3.9. Data based on 80% confidence interval are also presented. The flow in the Kikuletwa river is made up of base flow from spring water and flood water during the rainy season between April and June. A base flow of $10m^3/s$ has been observed at 1DD54. The

annual specific discharges are 7.13 l/s/km^2 at 1DD54 and 5.75 l/s/km^2 at 1DD1. In May specific discharge at 1DD1 is 14 l/s/km^2, which is higher than that for 1DD54 which is 12 l/s/km^2. The analysis of flood and low flow occurrence probability is based on annual maximum and minimum discharges. The maximum discharges at 1DD54 and 1DD1 are 29m^3/s and 30m^3/s respectively. Results of the flood occurrence analysis for different return periods are presented in Table I.3.10. The probable discharge for a 100 year return period, which is 234m^3/s as shown in Table I.3.10 is low considering the size of the corresponding catchment area. This is attributed to the existence of a wetland upstream of the Kikuletwa river in Arusha region. The wetland could moderate the peak discharge and, hence, the low peak discharge value predicted. Results of low flow occurrence analysis for different return periods are presented in Table I.3.11. As shown in Table I.3.9, the flows at both 1DD1 and 1DD54 are comparable despite the difference in the size of their catchment areas. This is attributed to the fact that the Kikuletwa river is fed by a steady base-flow which originates from springs located in Rundugai and Hai areas, upstream of the Tanesco Hydropower stations. For a confidence interval of 80%, flow at 1DD54 is estimated at 9m^3/s.

Ruvu river system

The Ruvu river originates from Lake Jipe from where it flows towards the south-east. Its main tributaries are Himo, Mue and Rau rivers, which are fed by base-flow from springs located on the slopes of Mount Kilimanjaro. The Ruvu river finally drains into the Nyumba ya Mungu reservoir. The Rau and Njoro rivers, which are the tributary of the Rau river, are the main water sources of the existing Lower Moshi irrigation project. The Rau river originates from the Mt. Kilimanjaro and traverses the area for the proposed project. Mwanangurue spring which is situated in Mandaka Mnono is a reliable source of water for the Rau River. The slope of the river is between 1 : 5 and 1 : 30 on the mountain slope and between 1 : 200 and 1 : 400 near the project area. The catchment area of the river Rau is estimated to be 122 km^2 where it crosses Moshi to Taveta road. Discharge data for the Rau river at a gauging station located down stream its confluence with Njoro River are presented in Table I.3.12. The Njoro river, a tributary of Rau River, is mainly fed by Njoro ya Dobi and Goa Springs. Supply from these springs is reliable, thus, Njoro river has stable flow throughout the year. Its catchment area is about 15 km^2 at the confluence with the Rau river. Mean monthly discharge data for the Njoro river at Mabogini intake weir is presented in Table I.3.13.

Nyumba ya Mungu Reservoir

At the spill level the water depth at the dam site is 41.15 m and Mikocheni village at the shallow northern end of the lake is at the water's edge. Maximum surface area when the reservoir spills estimated from the map contours is 180 km^2 and the minimum surface area is 110 km^2. According to these estimates, a one meter reduction of water will expose some 20 km^2 of shore. The storage volume of the lake at full capacity has been estimated by three authorities. The Ministry of Natural Resources & Tourism, Tanzania (1992) gave a figure of 9,114,000,000m^3, Bailey (1965) quoted 1,120,000,000 m^3, and it was concluded that the capacity of the lake is not greater than 1,600,000,000m^3. Baileys figure of 1,120,000,00m^3 for the capacity of the lake is considered to be more realistic. The depth of the lake ranges between 5 and 41 m with a mean of 6 m. The reservoir obtains its main water supply from the Rau and the Kikuletwa rivers which receive drainage water from the southern slopes of Mt. Kilimanjaro, Lake Jipe and Mt. Meru. The reservoir losses its water mainly by discharge through the dam into the Pangani river. The reservoir is used for generating power. Two water balance analyses are presented here for

comparison purposes. The first analysis which was done by Bailey in 1974 assumed that no water is lost through subterranean leakage, and therefore it was expressed as follows:

Inflow + direct rainfall = outflow + evaporation + change in volume due to water level fluctuations

Measurable factors that were used in the analysis are water loss by discharge through the dam, water gain by direct precipitation on the lake, and the change in lake level. Evaporation was estimated from radiation and evaporation pan measurements. Results of the water balance analysis are given in Table I.3.14. The water balance analysis shows the water inflow rate is 36 m^3/s, while the discharge from the dam is 27 m^3/s and water loss from the dam is 38 m^3/s. Therefore, an average rate of 27 m^3/s accounted for three quarters of the total water loss, while evaporation accounted for the remaining quarter.

ii) Selection of prediction methods/models

Predictions of volumes of water in the reservoir for two cropping alternatives was done by analysing the water balance of the reservoir using a dynamic computer model. This model was validated by JICA Study Team by comparing simulation results and measured data. Simulation results and measured data differed by ±10%.

iii) Prediction of environmental impacts

According to the results of the Initial Environmental Examination, abstraction of water for irrigation purposes from Kikuletwa river may cause changes in surface hydrology of the Project site. Changes of surface water hydrology may cause negative socio-economic and ecological impacts. During the IEE, it was found that Nyumba ya Mungu reservoir (Ecological Region 6) will probably be affected by changes in the surface water hydrology in the Project site. To predict if there will be any negative impact due to water abstraction from the Kikuletwa river the Nyumba ya Mungu water balance was analysed by using a computer simulation model. The water balance analysis using a dynamic computer simulation model, performed by JICA Study Team, is presented below ;

$$S2 - S1 = Q1 + Q2 + Q2 + Q3 + Q4 - Q5 - E - S$$

Where S1: Storage in the dam at the beginning of the month
S2: Storage in the dam at the end of the month
Q1: Inflow from Kikuletwa river
Q2: Inflow from Ruvu river
Q3: Return flow through groundwater after irrigation
Q4: Inflow from the area downstream of IDD1
Q5: Outflow from the dam
E: Evaporation from the reservoir
S: Seepage from the reservoir

The above water balance analysis model was applied to the two irrigation cropping alternatives. The results of the analysis are presented in Table I.3.15. The water balance analysis has shown that abstraction of water from the Kikuletwa river for the two alternative cropping patterns will not affect the operation of the Nyumba ya Mungu dam.

iv) Assessment of environmental impacts

Major potential negative environmental impacts due to changes in surface water hydrology which may be felt during the post-construction phase (operation phase) include ;

Water shortage in NYM reservoir

Simulation of water volume in the reservoir considering Alternative 1 and Alternative 2 of cropping pattern has shown that abstraction of water from Kikuletwa river will not have any significant negative impact on the hydrologic balance of the lake.

Water rights down stream the reservoir

Violation of existing water rights down stream the headworks and Nyumba ya Mungu reservoir is not anticipated, because the water rights for the proposed Project must be secured as a precondition to the project implementation. Therefore no impact is anticipated related to violation of water rights. Thus, from the computer model prediction results, no significant effects on the hydrology of Nyumba ya Mungu reservoir, hydropower generation, violation of water rights down stream the reservoir and fisheries in the reservoir, are anticipated during the Project operation stage (post-construction phase).

(2-f) Changes in groundwater hydrology

i) Present conditions

The groundwater hydrology refers to changes in groundwater recharge mechanism or groundwater table caused by infiltration of irrigation water and exploitation of groundwater.

Ground water recharge mechanisms

There are two main groundwater recharge mechanisms taking place in the irrigated lands. These are :

- Recharge resulting from irrigation water particularly with reference percolation and overall irrigation efficiency, and
- Natural groundwater flow due to general hydrogeotectonic structure of Lower Moshi alluvial fan in which the Project is located.

Groundwater recharge through hydrogeotectonic structure of Lower Moshi alluvial fan. The hydrogeotectonic structure of Lower Moshi Alluvial fan is estimated to cover 518 km^2 and is 90m deep. It extends over the proposed project area including the intake site and diversion channel route. The alluvial fan facilitates recharge of groundwater in the project site. This phenomenon takes place due to the presence of protruded Usagaran layer group at the southern end that makes the groundwater flows to be possible and eventually coming out flowing into the NYM reservoir.

Existing shallow wells in the Project area

Twenty eight shallow wells investigated in and around the proposed project area had ground water level varying between 0.5 and 7 m below ground surface. About 78.6 % have water levels between 0.5 and 3 m deep indicating that the groundwater table in the Project area is high. In the southern parts of the Project area, groundwater rich in soluble salts at shallow depths from the ground surface has been noted. The distribution of soils with salt accumulation is generally observed to coincide with the distribution of shallow groundwater table. About 1,100 ha have been affected by soil salinity in the southern parts of the project area. Public water supplying the existing Project area is insufficient, there is a poor public water supply system in the expanded area, and there are very limited sources for domestic water in the new extension area and in the headworks/diversion channel areas. Water from wells constitute one of the major sources for domestic use. There are 9 wells in the existing Lower Moshi Project area and over 20 shallow wells in the new Extension area, Kawaya and Mkalama villages allocated along the diversion channel route have two shallow wells each.

ii) Selection of prediction method/models

Prediction of groundwater recharge rate is based on irrigation water demands in the project area. Rationale of using this method is the fact that there will be groundwater recharge arising from irrigation water in addition to natural recharge mechanisms

such as percolation of water from rainfall and melting of snow on Mt. Kilimanjaro. The prediction method has been validated by field investigations on a paddy pilot farm at the Project area. However, the fraction of irrigation water recharging groundwater depends on hydrogeological conditions, climate and farming practices in the Project area.

iii) Prediction of environment impacts
According to water balance study in the irrigated land, actual water consumption by paddy is about 40% of the supplied irrigation water and the remaining 60% constitutes irrigation water that percolates to the groundwater thus acting as a form of recharge that finally reaches NYM reservoir down stream the irrigated area. Table I.3.16 shows the estimates of rate of ground water recharge during the project implementation phase for cropping patterns, Alternatives 1 and 2.

iv) Assessment of environmental impacts
Criteria of assessment are :

- Available field data on groundwater for the existing project area, and
- The expected impacts based on the similar irrigation project elsewhere.

Groundwater table in the Project area is relatively high as described above. The groundwater table is expected to rise even higher during project implementation, which may lead to water logging of the Project area. The upward flow of water which is established in water logged lands leads to a gradual concentration of salts in the surface layer. This phenomenon has been observed in the southern and upland parts of the project area as noted above. Salinisation is manifested by formation of a white crystalline deposit on the soil surface during dry seasons. Furthermore, Inadequate drainage and rising of water table after a few years of irrigation may lead to the entry of saline water into the root zone. Therefore, proper management of irrigation/drainage waters and soil in the Project areas with high water table conditions as proposed in the Report is essential for reclamation of affected areas and prevention of further accumulation of salts in the root zone. In addition to salinisation, water logging may increase chances of ground water pollution which may endanger the public health particularly to those people using shallow well waters for domestic purposes. Therefore, in view of the fact that there will be proper management of irrigation/drainage waters and soil in the project areas, impacts of changes in hydrologic conditions and increase in salinity of the soil in the Project area are anticipated to be negative but small in magnitude.

(2-g) Riverbed degradation, water pollution and eutrophication

i) Present conditions
<u>Water pollution and eutrophication</u>
From Table I.3.17, concentrations of ammonia-nitrogen, nitrate-nitrogen and phosphates are well within the recommended Tanzanian temporary standards, for fisheries, irrigation as well as drinking (see Table I.3.18). Moreover, the parameters do not show an appreciable change from one point to another along the Kikuletwa river at the inlet, middle and outlet of the Nyumba ya Mungu dam. On the other hand DO concentration has been found to be very high at the middle of the dam, with a value of 11.4 mg/l. Generally the results of water analysis do not give cause for concern on water quality. From the results of suspended solids measurement, it appears that drainage water from the fields have higher concentrations of suspended solids than river waters as Table I.3.4 shows. Concentrations of nitrogen in drainage waters are also generally higher than river waters. The highest concentration on value of nitrogen was recorded at Mabogini main canal (see Table I.3.4). This may be attributed to the use of nitrogenous fertilisers in the paddy fields. However,

concentrations of all parameters meet Tanzanian temporary standards for Receiving Waters in Category 3 which covers water suitable for irrigation purposes.

Riverbed degradation

Environmental issues that are pertinent to riverbed degradation are :

- Scouring/erosion of the river bed leading to the deepening and increase in river effective cross section area and re-suspension of riverbed sludge ;
- Sedimentation/siltation of mainly inorganic materials on the river bed leading to a decrease in the effective size of the river ; and
- Accumulation of nutrients on the riverbed leading to a build-up of sludge and possible resultant eutrophication.

The main river system in the project site are Kikuletwa river system, Ruvu river system and Njoro river system. Details on the river systems are given under the section on surface water hydrology, Item (2-e).

ii) Selection of the prediction method/models

Prediction of eutrophication is based on the type and amounts of inorganic fertilisers to be used during the operation phase of the Project. Annual amounts of fertilisers to be used are calculated from the recommended rates of fertiliser application given in the Rice Production Manual (T. Horibata, 1992) and the total land area to be used for rice cultivation. The amount of nutrients that are expected to be released into water bodies can be quantified by knowing the total quantities of fertiliser to be applied and the fraction which may leach from the soil. The Streeter-Phelps model is used for prediction of dissolved oxygen (DO) in rivers traversing the Project area for anticipated BOD loads. This model has been validated and extensively used for prediction of water quality in rivers and found to give results with an acceptable degree of accuracy (H. S. Peavy, 1985). Prediction of the aspects on riverbed degradation draws information from findings based on qualitative and quantitative analysis of the river regime and water quality survey as well as river flow measurement.

iii) Prediction of environmental impacts

Scouring of the riverbed

This may occur if flow in the river increases and/or abrasive suspended material eroded upstream is transported in the river, especially during flash floods. Scouring can result in deepening of the river with lowering of water level, hence, inaccessibility of river water. Also, it can cause disruption and destabilisation of the functioning of hydraulic structures along the river. Another effect is the re-suspension of river bed sludge which may lead to decreased, dissolved oxygen (DO) in the flowing stream and downstream deposition location. From analysis of the available data on water quality and visual evidence of the conditions in the project site, there is no potential for river bed degradation from scouring of the river bed.

Siltation of grit and other inorganic materials

This can occur due to deposition of suspended materials eroded upstream of the river as well as from areas adjacent to the river in the catchment of the river. It can occur as a result of the slowing down of the river flow where the cross-section of the river is comparatively wider than upstream sections. Siltation can reduce the effective capacity of the river and disrupt the functioning of some hydraulic facilities like channels crossing on and converted to the river. It can also lead to river water quality degradation due to growth of needs on the river once it becomes shallow, especially in the presence of plant nutrients. Due to availability of plant nutrients from the project farms, siltation may have an impact. However due to flow velocities of 1.0 m/s and above which are higher than 0.6 m/s (the minimum velocity for no-deposition of sediments), the impact is likely to be insignificant since all transported matter will be kept in suspension.

decomposition in the lower depth of the rivers as a result of deposited sludge. This can lead to benthal oxygen demand upon re-suspension of the sludge nutrients that may contribute to riverbed sludge build-up may come from the farms adjacent to the rivers as a result of fertiliser's washed away by surface run-off. As noted in respect of siltation, flow velocities in rivers are high, which means accumulation of sludge on the river beds is not likely to occur. Therefore, degradation of river leading to accumulation of nutrients is not foreseen to have any environmental impacts on the rivers.

Eutrophication

The inorganic fertilisers that will be used in the project area will pose a potential pollution problem as leaching of nitrogen and phosphorus into the lake from fertilisers applied to agricultural lands can significantly contribute to the eutrophication problem. Since soils have only a limited capacity to take up nutrients, the nutrients which are not taken up by the soil/plant system leach into the surface and groundwater are the sources of water quality problems related to eutrophication. The eutrophication of water courses in the project area may be approached in a very general way by looking at the estimated use of nitrogenous and phosphorus fertilisers during the implementation phase of the project. However, precise estimation of nitrogen and phosphorus pollution loads is complicated since many factors influence the transportation and concentration of these nutrients in the soil. The issue of eutrophication can be examined by looking at potential sources of nutrients mainly inorganic fertilisers, which release nitrogen and phosphorus. The nutrients can gain access to water bodies through surface runoff. Also they can leach into ground water, after which they may be transported by base flow and reach the rivers in the project area and the Nyumba ya Mungu reservoir. Table I.3.19 gives rates of application of fertilisers for different stages of paddy farming and estimated amounts of phosphorus and nitrogen to be applied annually. Extensive and intensive use of inorganic fertilisers as estimated in Table I.3.19 may increase nutrients load to water courses and Nyumba ya Mungu reservoir thus aggravating eutrophication if appropriate measures to prevent the same, will not be instituted. Of the total amount of fertiliser applied to the fields, only a fraction of it is consumed by plants. For TSP fertiliser, active ingredients is only 45%. Hence, only 405 tonnes of TSP will be consumed by plants/year, i.e. 45% x 900 = 405 tonnes. The remaining amount which is 900 - 405 = 495 tonnes will be lost to the environment through different ways. For nitrogen fertilisers, active ingredient = 46%, thus only 345.2 tonnes will be consumed by plants the rest of fertiliser 750.5 - 345.2 = 405.3 tonnes/year will be lost to the environment.

Dissolved oxygen (DO) concentration

The Streeter-Phelps model is a predictive model which is useful in predicting DO concentration under for different BOD values in flowing rivers. Generally, the model gives an indication of potential pollution under the projected environmental conditions. Specifically, it predicts the level of pollution that may be caused by organic loading.

$$D_t = \frac{k_1 L_A}{k_2 - k_1}\left[10^{-k_1 t} - 10^{-k_2 t}\right] + D_A \cdot 10^{-k_2 t}$$

Where D_t = Dissolved oxygen deficit at t

K_1 = BOD reduction rate constant

K_2 = Re-aeration constant

L_A = BOD at t = 0

D_A = Dissolved Oxygen deficit at t = 0

Dissolved oxygen deficit Dc at critical time t_c is given by

$$D_c = \frac{k_1}{k_2} \ln 10^{-k_2 t_c}$$

Critical time, t_c is given by

$$t_c = \frac{1}{k_2 - k_1} \log \frac{k_2}{k_1} \left[1 - D_o \frac{(k_2 - k_1)}{L_o K_1}\right] \quad \text{(after Isaacs)}$$

$$k_2 = \frac{5.14v}{H^{v2}}$$

Where V = mean velocity of flow (m/sec)
H = mean depth of flow (m)

The Streeter-Phelps equation is used to determine stream assimilative capacity

$K_1 = 0.7$/d at 20℃ for sewage

At T ℃

$K_t = K_{20} \times 1.047^{(T-20)}$

General criteria, considerations and input data

- Distance from project farms to NYM reservoir mouth ≅ 21 km
- BOD_5 just downstream of project farms, = 9.3 mg/l
- Dissolved oxygen (DO) equilibrium concentration = 8.7 mg/l
- Initial DO in the river = 6.8 mg/l
- River flow rate (prior to abstraction of water for irrigation) = 35.06 m3/s
- River flow velocity = 0.89 m/s
- DO in the NYM reservoir = 11 mg/l
- BOD reduction kinetic constant, $k_1 = 0.23\ d^{-1}$
- Re-aeration constant, $k_2 = 0.46\ d^{-1}$
- BOD_5 beyond SP. 3 (Confluence of Kikuletwa and Kikafu = 9.3 mg/l)
- Ultimate BOD_u in river, $Lr = 14/(1-e^{-k1t})$
- $k_{20} = 0.23\ d^{-1}$
- Lr = 13.6 mg/l

The observed ultimate BOD (BODu) is wholly from the project activities because water quality analysis show that samples from SP2 upstream of SP3 exhibited no BOD reading at all. It is assumed that the additional BOD load due to expansion and extension of the project will be proportional to the additional agricultural activities and size of cropped area. Thus :

Existing cropped area A_E = 7,739 ha

New area to be cropped, A_n = Existing cropped area + additional cropped area

A_n = 7,739 + 5,000 = 12,739 ha

New BOD_u = (12,739/7,739) x current BOD = (12,739/7,739) x 13.6

New BOD_u = 22.4 mg/l

Total BODu load = 22.4 x 35.06 x 10^3 l/s = 785,344 mg/l

Since the max. amount of water abstracted is 11m/s and of this 70% is recharged back to the river, the net reduction in flow is = 11 - 0.7 x 11 = 3.3 m/s. So, total flow in the river post-abstraction is :

$$Q_D = 35.06 - 4.3 = 31.76 \text{m3/s}$$

Thus, effective BODu concentration is :

$$L_u = 785344 \text{ (mg/s)}/31760 = 24.7 \text{mg/l}$$

Therefore, Initial BODu = 24.7 mg/l, and
Initial DO deficit = 8.7 - 6.3 = 2.5 mg/l

Results from the Streeter - Phelps model for the situation during the operation of the project show that the critical oxygen deficit will occur beyond the Nyumba ya

Mungu Dam. Furthermore, the results show that just before the mouth of the Nyumba ya Mungu reservoir the dissolved oxygen deficit will be about 3.8 mg/l as opposed to around 2.5 mg/l for the point near the confluence of the Kikuletwa and Kikafu rivers (SP3). It can be noted that in the existing situation the DO at the mouth of the Nyumba ya Mungu (NYM) reservoir is at most 4.0 mg/l while in the reservoir itself DO is 11mg/l. In addition, the existing DO deficit at the mouth of the Nyumba ya Mungu reservoir is 4.7 mg/l as opposed to the 3.8 mg/l predicted using the Streeter-Phelps model (for the future situation). It is foreseen that, the existing increase in DO concentration of about 7 mg/l occurs between the mouth and the interior of the Nyumba ya Mungu reservoir will still apply during operation of the Project, since the existing DO concentration and the predicted one are comparable. The increase in DO in the reservoir is attributed to increased re-aeration which results in more DO than the theoretically determined values. This is due to the increase in the size of the exposed surface area of the reservoir and relatively unimpeded mixing as well as contribution from the Ruvu Pangani river.

iv)Assessment of environmental impact
There is a plan to rehabilitate and to expand the existing sewage treatment plant for Moshi town. Therefore, proper management of agrochemicals and pesticides as stipulated in the Report, coupled with rehabilitation and expansion of the Moshi Sewage Treatment Plant, the overall impact of the project to water quality of rivers in the project area and the Nyumba ya Mungu reservoir will be negative but small. As noted in respect of siltation, flow velocities in rivers are high, which means accumulation of sludge on the river beds is not likely to occur. Therefore, degradation of river leading to accumulation of nutrients is not foreseen to have any environmental impacts on the rivers. In addition, the proposed measures to reduce soil erosion under the soil management plan of the Project, will minimise suspended loads into water bodies. Thus, problems of river bed degradation due to siltation will be substantially reduced. From the prediction results of the Streeter-Phelps model, it can thus be concluded that, the BOD load from the project will be offset by dilution and the re-aeration in the NYM reservoir to the extent of having no significant impact in and downstream of the reservoir.

3.3 Results of Impact Assessment and Necessity of Counter-measures and Monitoring

Table I.3.20 summarises the results of impact assessment implemented in Sections 3.2.1 and 3.2.2, for each of the social or natural items selected as Section 3.1. It shows the EIA study results by ecological region and project stage.

In addition, the table mentions necessity of both preventive/mitigative counter-measures and monitoring, according to prediction of significant negative impacts and assessment judgement. Necessary measures and monitoring plan, only for the environmental items marked "necessity", are described in Chapter 4.

4. ENVIRONMENTAL CONSERVATION PLAN

4.1 Preventive/Mitigation Measures against Environmental Impacts

4.1.1 Social Environment

(1-a) Involuntary resettlement (Ecological Region 3 during Construction Stage)

i) Technical aspects
The project is to assist in locating technically suitable places for building houses. Secondly, it should give technical assistance in demolishing, transporting, new and old building materials required for erecting the new structures.

ii) Institutional Aspects
The village governments and the project should jointly assist the families during the transition phase by providing of temporary accommodation and storage of goods of the affected families. The village government may provide security to the properties of the affected people during the demolition and construction of old and new houses respectively.

iii) Financial Aspects
The affected families should be compensated for their properties, house and perennial crops. Secondly, the project should give a priority in employment opportunities to the demolition affected persons during the construction stage so as to enhance the economic standing, soonest. The compensation rates for seasonal, permanent crops and for houses are detailed in Tables I.4.1 to I.4.5 which should be used as a guideline in compensating the affected families

iv) Effects of countermeasures
If the, technical, institutional and financial aspects are implemented, the targets for resettlement will be met. That is the affected families should be resettled in suitable places as much as possible, and they should be compensated for their properties.

(1-c) Population increase and drastic change in population composition
(Ecological Region 1 during construction and operation stages, and ecological region 3 during construction stage only)

i) Technical aspects
During the construction stage the project should provide the necessary facilities and inputs needed to cope with the rapid increase of the population. This include water supply, sanitary facilities, eating places (to be based to food vendors) and basic health. During the operation stage, the mitigation measures as detailed in the rural infrastructure plan are adequate if implemented as specified.

ii) Institution aspects
The key institutional aspects during the construction will be for project implementation team to involve the local project beneficiaries through their local institutions. For example the local village government, CHAWAMPU and WUA. During the operation and maintenance stage, the mitigation measures, as outlined in the strengthening plan of operation and maintenance, the executing agencies and farmers organisations are adequate to cope with the population changes.

iii) Financial aspects

The mitigation measures outlined above have already been specified in the project plan. Therefore most of the financial aspects have already been covered.

iv) Effects of counter measures

The outlined mitigation measures, including those provided in the rural infrastructure plan, water management, operation and maintenance plan, and the strengthening of operation and maintenance for executing agencies and the farmers organisations, will meet the specified targets if implemented as specified. The mitigation measures can be put in two phases, construction and operation. The mitigation measures put during the construction activities, can be regarded as temporary, while those put during operation phase as permanent. The proposed mitigation measures will greatly support and strengthen the existing infrastructure, e.g. health, road and education facilities.

(1-h) Outbreak of endemic diseases and prevalence of epidemic diseases
(Ecological Region 1 during Operation Stage)

i) Technical aspects

Latrines

The construction of latrines should be supervised by technical people in order to have a good workmanship. Furthermore, it is proposed that, the ratio of 50 pupils per squatting hole at any time should be improved to about 10 pupils per squatting hole. Due to the fact that, farmers and field labourers spend most of their time far from their residential premises, communal toilets should be constructed closer to the farms. The sub-structure should be designed by a competent engineer in order to take into account the soil conditions and to avoid contamination of underground water.

Water supply

Provision of alternative/supplementary water supply sources should be an integral part of the scheme's development in order to prevent proliferation of diseases. The environmental design control that is; during the planning stage of this project, adequate consideration should be given to sanitation and water supply. If eggs of schistosomes do not reach water, the transmission of the disease cannot be initiated. This means that, if the faeces or urine of infected individuals do not reach water and so are then the eggs. Provision sanitary facilities should therefore be part and parcel of the scheme. They should however be designed adequately/appropriately in order to cater to the purpose.

Headworks

To alleviate the observed problems, regular cleaning of the headworks should be effected. It should be coupled with de-silting. A plan maintenance prepared for the purpose should be implemented. For the extension area therefore, the above mentioned problems should be avoided. This measure will reduce the flow of disease vectors to downstream part of the headworks. Furthermore, in order to avoid the possibility of snails being carried away to the main canals, the headworks can be provided with barriers like wire-mesh of less than 3 mm diameter and 0.5 m from the maximum water surface.

Irrigation canals

Canal cleaning increases the water velocities and destroy snail's habitation and mosquito breeding sites. It was noted in the feasibility study that, the conveyance efficiency of lined canals is 96 to 97% and that of unlined canals is 80%. This indicates that, possible ponding might occur in the case of unlined canals and therefore a health jeopardy. However, for the extension part of the project, all canals are lined and what is required then is to oversee the maintenance aspect.

Drainage canals

Field drains are responsible for the existence of vectors of diseases particularly bilharzia snails and malaria mosquitoes. They should therefore be designed in such a way that, they convey the water fast enough without causing ponding. The design velocities above 0.65 m/s (Yasuraoka, 1995, p. 5) are recommended.

ii) Institutional aspects

Community level-provision of health education

It was learnt from the 1994 survey that, a lot of health education campaigns have been offered in most irrigation schemes in the country. However, one can safely conclude that, little achievement has been attained especially with regard to excreta disposal methods. This might have been due to lack of enough capital for the provision of good sanitary facilities or, do not, people have not understood the campaigns or were not motivated enough to implement the given or discussed ideas. Another side of the coin might be that, the target group for the campaign did not include the right stake holders. It is therefore worthy to continue with the sanitation campaigns in the new extension Lower Moshi Scheme in order to mitigate the prevailing problems. This is mainly because, labourers change either due to old-age or change of job and new people come in with new views and acceptance possibilities offered by the changing environment. Each family as a mandatory step, should be required to build an acceptable latrine. If they do not have funds, the project planning stage might take this problem into account. The visited schools have inadequate latrines which calls for a need to offer or include health education in the curricula and to construct good quality toilets which suffices the demand. The health education of the population in rice schemes at Lower-Moshi should be given the highest priority. They should be educated about public health as related to schistosomiasis and other vector-borne diseases. Measures like de-worming the patients and frequent checking of the people could be applied. In addition to that, proper hygiene practices should be taught to the people working and surrounding the scheme area. Provision of sound excreta and sullage disposal facilities should be insisted. It was noted in the 1994 study that, intestinal worms in irrigation schemes in Tanzania are due to poor sanitation, particularly with regard to excreta disposal and the low standard of community and personal hygiene among the rural community. The lack of proper latrines around the fields forces farmers to defecate in the nearby bushes or in the fields themselves, where eggs of worms from suffering people are deposited and contaminate the soil. Though the reported cases are low and constant, there is a need of controlling this disease. People should be prevented especially children from playing in the water set aside for irrigation purposes. For the field workers, using protective gears will be an added advantage. A comparison data from Mtakuja Dispensary for Chekereni, Mabogini and Rau river villages, according to Lyatuu (1987) shows that, there has been remarkable increase in the number of individuals suffering from malaria, diarrhoea, intestinal worms and schistosomiasis.

Waste disposal/environmental design

In order to cut down the transmission route of diseases, all wastes need to be disposed of hygienically. All unhygienic practices like those of open-land defecation and haphazard disposal of solid wastes should be discouraged, people should be taught how to build proper waste disposal structures, health campaigns conducted with regard to personal hygiene like washing hands after defecation and before handling food.

Women's groups

Women groups should be established or those available be strengthened and encouraged to participate actively in operation and maintenance of irrigation, water supply and sanitation schemes.

Environmental management

The environmental management through environmental manipulation or medication is most preferable than the chemical control by moluscides and insecticides in order to avoid ground-water contamination and other problems mentioned. Activities for environmental manipulation which could practically be instituted include vegetation removal and intermittent irrigation coupled with mechanical barriers. The channels should be cleaned frequently and be provided with velocity over 0.6 m/s (for snails free channel). Environmental modification is yet another way aimed at preventing, eliminating or reducing the habitats of vectors without causing unduly adverse effects on the quality of the human environment according to Mather and That (1984). Filling in of natural or man-made pools will help to reduce the number of snails habitats where present. This should not be an expensive undertaking, since whoever has caused them should be responsible for levelling off the depressions.

Operation and maintenance works

The increased labour force calls for additional adequate sanitary facilities in order to avoid furthering the incidence of diseases. To cite an example, at present the irrigation section has only one gatekeeper who is responsible for all gates installed, whereas, after the implementation of the project, given the size of the work-load and the number of gates to be operated, 19 gatekeepers will be additionally required for proper operation of the gates. They therefore require enough facilities to prevent contraction of diseases.

iii) Financial aspects

The proposed pit latrines will use the locally available materials and the unit cost might go as high as Tshs. 110,000/=. Other costs of maintenance are similar to those mentioned in water supply section.

iv) Effects of Countermeasures

Diagnosis and treatment

One of the important measures in order to eradicate or reduce the prevalence of diseases in irrigation schemes, is to diagnose and to treat the already sick people. This situation will minimise or curtail the transmission route of diseases. Available medical centres are located far from the easy reach of residents. There is a need to provide health centres closer to irrigation workers' premises. According to WHO (1982) report, it is only recently that, safe, effective and low-cost drugs have become available for treatment of all types of schistosomiasis like oxamniquine, praziquantel and metrifonate. These drugs can be given to endemic communities with medical supervision by paramedical personnel. It is however worthy to note that, indiscriminate mass treatment or prophylaxis of whole populations in endemic areas is not recommended. This is especially apparent limitation to contra-indications for treatment of pregnant women and the possibility of re-infection. Experience has however shown that, these are not serious draw-backs.

Chemical Control of snails (molluscides)

The WHO reports have remarked that, snail control measures undertaken immediately proceeding or concurrently with large-scale use of chemotherapy may cause a dramatic reduction on transmission as well as the expected reduction in prevalence and number of parasites in the population.

Molluscide application

Characteristics of the application are :

- Primarily affects transmission,
- Are undertaken at sites where transmission is most likely,
- Requires specialised trained personnel,
- Should aim at control of snail populations and not eradication of snails, and
- Monitoring is necessary.

If applied, it is worthy to note that, chemical molluscides have the following limitation :

- High cost requiring foreign exchange,
- Should not be used in isolation in agricultural projects, and
- Toxicity to other flora and fauna

Due to these limitations, it is not safe to use chemical molluscide as a control measure in Lower Moshi scheme.

Biological control

The potential of this approach has had a wide appeal to field biologists for quite sometime. As yet, no practical method has been evaluated sufficiently to be recommended or to be in active use today. However, among the suggested methods are the use of :

- Competitors, such as snails *Marisa Cornuarietis* or *Heliosoma, druryi* ; and
- Predators, such as certain species of ducks, fish, turtles, crustaceans, water rats, leeches and aquatic insects.

It was further noted that, *Marisa,* a potential competitor snails has been observed by some investigators to feed on rice seedlings. Its use in rice irrigation is thus neither proven nor recommended. This phenomenon of drug resistance calls for a more attention on vector control strategies. Chemical control however, offers an extremely powerful tool to suppress mosquito populations at times when other strategies have failed. But, previous experience has shown that, mosquito populations are adept at evolving resistant strains. It really becomes apparent that, there is no choice other than relying on non-chemical control strategies to the maximum possible extent and reverse chemical agents for situations where all others have failed. If biological methods of control are opted, that is, basically the utilisation of natural enemies, repetitive applications of microbial insecticides such as serotype H-14, and various genetic methods, according to ecological theory and experience, they will usually give more effective control than indigenous ones. However, the introduction of exotic species calls for caution since unexpected effects can be generated and hence, a need for effective monitoring programme.

v) Relation with local infrastructure

It has been clearly indicated that, the present roads have rough surfaces deep ruts and holes with standing water, which means, breeding sites for mosquitoes and hence, increased reported cases of malaria. In Lower Moshi Project Area, the roads should be adequately maintained in order to eliminate the potential health hazard they have. The largest input of labour in paddy cultivation is for weeding (Twice), harvesting, bird scarring and transplanting such a situation implies a big possibility of many people being infected or contracting diseases. Proper working gears and adequate good quality sanitary facilities should be provided closer to the farms. New sources should be designed appropriately and be operated and maintained adequately in order to prevent the incidence of diseases.

vi) Relations with other existing/planned environmental conservation schemes

Borrowing a leaf of experience from Yarusaoka (pg. 2; 1995), who visited Lower Moshi Irrigation Project (LMIP), Tanganyika Planting Company (TPC) and traditional irrigation scheme cited that, KMIP may be an example of a well-planned and well-managed irrigation project but schistosomiasis is endemic. According to the results of his study, the MIP experiences a large number of *B. pfeifferi* and *B. Sudanica* in drainage canals and a few *Bulinus tropicus*, non-vector of *S. haematobium* infection. However, *Biomphalaria* snails were extremely predominant over other aquatic snail species. He noticed that, out of 61 *Biomphalaria* snails examined, 4 were positive for *S. Mansoni* indicating the presence of bilharzia. TPC has reasonably controlled the snails by using niclosamide (Bayluscide) as a

molluscide and by introducing an ampullarid snail. They apply niclosamide at the intake every three months. It is however worthy to monitor the health impact of this application. Tropical Pesticides Research Institute (TPRI) has got a research project on the control of human disease vectors, that is, control of man biting mosquitoes and schistosomiasis host snails. One of their field stations is Mabogini intake.

(1-i) Increase in domestic and other human wastes
(Ecological Region 1 during Operation Stage)

i) Technical aspects
During the planning stage study on proper waste handling and disposal should be conducted. The best solution for solid waste disposal could be through waste recycling in the form of composting of husks to obtain organic manure which can be used in the farms. Similarly recycling of rice husks can be done by making briquettes which can be used as a source of fuel for domestic use.

ii) Institutional aspects
The village government and the project should jointly assist in the populating the ventilated improved pit latrine for disposal of human excreta.

iii) Financial aspects
In the absence of basis for establishing the costs of husks recycling by making briquettes, only the indicative costs for composting are given. Windrow which is a manual operated system of composting seems to be optimal. Prior to composting the construction of waste chamber for easy collection by handcarts to the composting plants is proposed. The chamber is to be located close to the milling machine, and it should be designed to allow collection frequency of the husks after a maximum of three days. The indicative costs of initiating composting of husks at the project area (based on a study on initiating community-based waste collection system by ILO ,1995) are as follows :

- Construction of the husks storage chamber	US $ 2,500
- Marketing and promotion of compost product	US $ 1,600
- Purchase of handcarts and spades	US $ 500
- Purchase of safety equipment (gloves, boots and overall coats)	US $ 300
- Total	US $ 4,900
- Grand total (Add 30% for operation of the compost plant)	US $ 6,370

vi) Effects of counter measures
If both the technical and institutional measures are implemented, the increased human excreta would have been taken care of.

4.1.2 Natural Environment

(2-b) Proliferation of hazardous species
(Ecological Region 2 during Construction Stage)

i) Technical aspects
During planning stage, technical measures to avoid crocodiles proliferation should be taken into consideration. Construction of the diversion channel should be in such a way that there is a physical barrier to prevent crocodiles from coming into the channel. Dissemination of information on risks from crocodiles, should done.

ii) Institutional aspects
The lead agency which will be associated in one way or another with the implementation of proposed and mitigative measure against environmental impacts is the Ministry of Tourism and Natural Resources in collaboration with the Project Executing Agency. In order for these institutional set-up to work closely with the technical counter measures proposed for mitigation of the negative environmental impacts, establishment of systems ensuring environmental impact monitoring and valuation, and implementation of mitigation measures is necessary.

iii) Financial aspects
The Financial requirement for the mitigation measure for crocodile proliferation will be worked out by both the Project Executing Agency and the Ministry of Tourism, Natural Resources and Environmental (Division of Fisheries - Kilimanjaro region).

iv) Effects of countermeasures
The management of crocodile population at Ecological Regions 2 and 4 will be fully achieved. This is because the technical measures against crocodile proliferation will be incorporated into the project construction designs. There will be no phase-wise approaches employed in implementing the mitigation measures, also the proposed mitigation measures have no direct relationship with the existing local infrastructure.

4.1.3 Summary of Institutional Framework and Financial Necessity to Implement Measures

(1) Institutional Aspect

It is proposed that the Environmental Management and Monitoring Plan (EMMP) be formulated to cope with matters described above in an integrated way for ensuring environmental sustainability of the Project. And an executing body (say the EMMP Group) is suggested to be established to actually formulate and implement the EMMP. The EMMP Group is proposed to be administered and co-ordinated by a steering committee with membership drawn from all significantly affected national agencies. These include :

- Environmental Unit, Irrigation Department of the Ministry of Agriculture & Cooperative,
- Natural Resources Regional Office of Kilimanjaro,
- CHAWAMPU representative,
- Regional Water Engineer of Kilimanjaro Region,
- Regional Water Engineer of Arusha Region,
- Regional Agricultural Officer of Kilimajaro Region,
- NYM Hydropower Station - TANESCO, and
- Water Users Groups representative

The secretary and chairperson of the proposed EMMP Steering Committee are proposed to be the Director of KADP and the Natural Resources Regional Officer of Kilimanjaro respectively. Specifically the Committee is a policy making body and oversees the implementation of EMMP as undertaken by the EMMP Group and its organs.

The EMMP Group will consist of three sub-units, namely the Environmental Management Unit (EMAU), the Environmental Monitoring Unit (EMOU) and the Laboratory Unit (LU). The organisation structures are shown in Figures I.4.1 to I.4.2 for the construction stage period and on a long-term basis (i.e. operation stage) respectively.

EMAU undertakes the supervision of the EMMP, maintains inter and inner institutional co-ordination and makes fundamental decisions concerning the effective implementation of each environmental measures. On the other hand EMOU carries out the planning and executing control of various studies and the monitoring plan and program, in accordance with the policy decided by EMAU. The LU undertakes physical and chemical analyses, testing of water, and other monitoring tasks for the improvement of appropriate EMMP over time for the Project. The principal functions of each unit are described below

i) Environmental Management Unit (EMAU)

- To manage all environmental aspects related to the Project, and to organise the implementation of EMMP;
- To prepare a concrete short-term and long-term preventive and mitigative measures;
- To co-ordinate inter and inner institutional matters related to EMMP ;
- To cope with expected/unexpected environmental issues ;
- To conduct and supervise actual management programs; and
- To establish environmental standards and criteria as a goal and target of EMMP.

ii) Environmental Monitoring Unit (EMOU)

- To prepare a concrete monitoring plan ;
- To conduct and supervise actual monitoring programs ;
- To analyse data obtained from the monitoring plan ; and
- To propose concrete mitigation measures and evaluate effectiveness thereof.

iii) Laboratory (LU)

- To analyse water, soil and other necessary environmental qualities ; and
- To conduct basic studies for the establishment of environmental standards and criteria.

(2) Financial Aspect

Commendable achievements on environmental management and monitoring entail funding provisions conducive to the needed technical EIA findings. The budget for implementing this environmental management and monitoring plan is reflected under each environmental item that requires preventive/mitigation measures against environmental impacts. The basic cost for the plan is estimated below and is mostly consisting of the cost for administration and operation of the proposed EMMP Group (i.e. EMAU, LU and EMOU) and the cost for actual management and monitoring activities.

i) Cost for Administration and Operation of EMMP Group

The annual cost of administration and operation of the EMMP Group is estimated at about US$ 97,000 as shown in Table I.4.6.

ii) Cost for Environmental Management and Monitoring Activities

The total annual cost of environmental management and monitoring activities is estimated at US$ 85,500 as shown in Table I.4.7. Most of the estimated costs are for consulting services for the EMMP Group which will broadly cater for selecting

or developing appropriate managerial measures, to supervising progress of the applied managerial measures, and monitoring any unexpected environmental adverse impacts, during both the construction and post-construction stages of the Project.

4.2 Environmental Monitoring

Environmental monitoring is intended to provide constant feedback on the effectiveness of the mitigation measures instituted, identify and define any problems encountered and provide the opportunity to adjust the approach to mitigation in a timely fashion. Thereafter, it is also recommended that a series of environmental audits, be undertaken to determine the long-term effectiveness of the mitigation measures. This will lead to an enhanced understanding of the impact of the project on the environment and allow more effective planning and implementation of future projects. Details for monitoring of different environmental items are presented below.

4.2.1 Social Environment

(1-a) Involuntary resettlement (Ecological Region 3 during Operation Stage)

During the operation stage, the affected people should be monitored for the early years of the project to see that there are no undue suffering because of the projects, compared with other project beneficiaries.

(1-b) Conflict among communities and people
(Ecological Regions 1, 3 and 4 during Operation Stage)

i) Items to be monitored
- Farm re-allocations, and
- Water allocation and water bills collections

ii) Technical specification
In land conflicts monitoring, the project should make sure that the farmers who will be reallocated the constructed paddy farms are the ones who were the original owners of the farms before construction. CHAWAMPU should prepare the list. The outsiders should be considered last if necessary. In water conflict monitoring, the project should use water allocation schedule approved by CHAWAMPU to ensure fair allocation. The existing water bill collection system to be improved and monitored to ensure that every farmer pays according to the amount of water used.

(1-c) Population increase and drastic change in population composition
(Ecological Regions 1 and 3 during Construction and Operation Stage)

The impact of population change in number and composition should be carefully monitored and the proposed mitigation measures implemented.

(1-e) Adjustment of water and fishing rights
(Ecological Regions 1, 2, 4 and 6 during Operation Stage)

Monitoring should be done to make sure there is an adherence to water rights requirement, and that there is enough water down stream to sustain the ecology and the reservoir. If there are deficiencies adjustment should be made on the water rights, especially by reducing the amount of water in the project area, through the use of rainwater.

(1-g) Increased use and residual toxicity of agro-chemicals
(Ecological Regions 5 and 6 during Operation Stage)

i) Environmental items to be monitored
- Properties of chemicals applied,
- Water resources in and around the project area with stress on Ecological Regions 5 and 6, and
- Fishery at NYM reservoir

ii) Technical specifications
Chemicals applied
The agrochemicals to applied are to be tested of their biological degradation in the environment and the properties imparted in the soil, e.g. acidity/alkalinity properties etc.
Water resources
Rivers, channels (drainage) and NYM reservoir are to be monitored for the levels of agrochemicals elements.
Monitoring stations
Monitoring stations for mitigation measures are to be established in Ecological Regions 5 and 6. In the Ecological Region 5 the stations would be down stream of the project area and the middle the junctions of Rau river and Mue river respectively. In Ecological Region 6 the monitoring stations should be at the influence of Rau river and the middle of NYM dam in the north broad part of the Dam.
Monitoring period and frequency
The frequency of monitoring is to be established by the monitoring agency which in liaison with the chemicals expert will determine the degradation rate of the chemicals and hence the proper time for monitoring. Generally speaking monitoring of agrochemicals should be done esp. during the period of application and during the rainy season (the beginning of rainy seasons) the later is for Ecological Regions 5 and 6. Once in a year fish species can be sampled and checked for bio-accumulation of PCBs and polychlorinated hydrocarbons if present. The monitoring should start at the construction stage throughout the operation stage.

(1-h) Outbreak of endemic diseases and prevalence of epidemic diseases
(Ecological Regions 1 and 3 during Operation Stage)

In the new extension area, which is not provided with any irrigation canals and structures on the western side of the Existing Lower Moshi Project Area, it will be good and safe to monitor the appearance of snails after the implementation of the project. If the canal is provided later in the expanded area then monitoring of the designed parameters should be done continuously in order to avoid any malfunctioning which could result in health jeopardy. Drainage for the control of mosquitoes and other vectors may have less stringent requirements than agricultural drainage. However, it should be noted that complex drainage of low lying areas may be required for effective control even though it may not be necessary for agricultural purposes. Monitoring of this aspect should be done. It is proposed to monitor the impact of diseases continuously at chosen times for school children and farmers.

(1-i) Increase in domestic and other human wastes
(Ecological Regions 1 and 3 during Operation Stage)

The EMOU in collaboration with health authorities should be responsible for following-up the sanitation condition of the Project area. Specific issues to follow-up

are reuse or disposal of rise husks and other crop residuals and waste in a sanitary manner and construction of excreta disposal facilities.

4.2.2 Natural Environment

(2-a) Impact on important fauna and flora, and degradation of ecosystem
(Ecological Region 3 during Construction Stage, and Ecological Region 6 during Operation Stage)

i) Environmental items to be monitored
- Fishery at NYM reservoir and rivers (breeding biology and fish populations), and
- The small diversion channel from the Rau river through the Rau Forest Reserve (construction manner)

ii) Technical specifications
Fishery at NYM reservoir
The migration pattern of three species of Fish, namely, *Barbus spp.*, *Labeo sp.*, and *Clarias mosambicus* which their breeding is known to be probably associated with flow regimes in the affluent rivers and streams. These uncertainties in breeding biology and migration patterns necessitate the need for carrying out monitoring programme of the migration pattern of these fish. The fish population in the reservoir is also to be monitored
Monitoring stations
Monitoring stations for migration patterns and breeding biology of *Barbus spp*, *Labeo sp.*, and *Clarias mosambicus* are to be established downstream reaches of the Kikuletwa and Rau rivers (Ecological Region 4 and 5), and at NYM reservoir (Ecological Regions 6) especially in the Northern region. Monitoring stations for species of fish and fish populations will be carried out all over the reservoir. The areas of the reservoir which are close to the fishing villages will be suitable areas for monitoring.
Monitoring period and frequency
The period and frequency of monitoring of the migration pattern of the three species of fish will be established by a fishery biologist who has a full knowledge about the reservoir fishery and its tributaries. However, it will be proper if the monitoring could be conducted during the construction stage at least twice a year (during rain and dry season), and during post construction stage (operation stage) at least during the first 5 years after completing the construction. Periodic monitoring should be conducted at least twice a year depending on the future conditions of the reservoir fishery and other changes due project operations. Monitoring of fish populations and fish species composition of the reservoir and rivers need to be conducted at least twice during the construction stage and at least once after every five years of the project operation. The frequency of monitoring of fish species and population will depend on the future conditions of the reservoir fishery and other environmental changes due to project operations.

(2-b) Proliferation of hazardous species
(Ecological Regions 3 and 4 during Operation Stage)

i) Items to be monitored
- The trend of change in crocodile population and attack on people and livestock, and
- The intrusion of *Eichhornia* water plant into the reservoir from Pangani basin

ii) Technical specifications

Monitoring stations/area

The areas in which the populations of crocodiles need to be monitored include, Ecological Region 3 particularly along the channel and the Ecological Region 4 especially along the river banks. The monitoring station for the water plant will be confined to the southern end of the reservoir outlet.

Monitoring period and Frequency

During the construction stage, periodic monitoring of crocodile population and attacks is to be conducted at least once per month. During the post - construction stage, monitoring should be done at least for the first 5 years and thereafter followed periodically at a rate of about six times per year. Monitoring of Eichhornia invasion will be carried out regularly at least twice in each year during construction and post construction stages.

(2-c) Soil erosion (Ecological Regions 3 during Operation Stage)

Soil erosion should careful monitored during the operation stage and if there are some problems, appropriate actions should be taken to control soil erosion. Some areas which are more sensitive to erosion can be completely restricted.

(2-d) Soil salinisation (Ecological Regions 1 during Operation Stage)

i) Items to be monitored

- Irrigation methods applied (this is in relation with drainage systems), and
- Soil properties in and around the project area with stress on Ecological Region 1

ii) Technical specifications

Chemicals applied

The agrochemicals to applied are to be tested of their biological degradation in the environment and the properties imparted in the soil e.g. acidity / alkalinity properties and salinity etc. Soil properties: Soils in and around the project area should be monitored for salinity levels

Monitoring stations

Monitoring stations for mitigation measures are to be established in Ecological Regions 1 and 5. In Ecological Regions 1 and 5 the stations should be in and outside the Project area.

Monitoring period and frequency

The frequency of monitoring is to be established by the monitoring agency which in liaison with the soils expert will determine the soil properties and hence the proper time for monitoring. Generally speaking monitoring of salinity should be done esp. during the period of intensive irrigation and during the rainy season (the beginning of rainy and during the dry seasons). Once in a year soils should be sampled and checked for salinization. The monitoring should start at the construction stage throughout the operation stage.

(2-e) Changes in surface water hydrology(Ecological Region 4 during Operation Stage)

i) Items to be monitored

Although no environmental impacts are anticipated from abstraction of water from Kikuletwa river, there is still a need to monitor flows in rivers in the Project site and levels of water in Nyumba ya Mungu reservoir, since there are possibilities of changes in surface hydrology as a result of natural factors especially weather conditions. The monitoring results will provide a feed back in Water Source Development Plan implementation. The results will enable the Project Executing

Agency to review plans and actions pertaining to water use in view of changes in the hydrologic conditions of the Project area as will be manifested by the monitoring results. This will ensure sustainable use of water. Monitoring of discharges in rivers, irrigation and drainage canals, will minimise possibilities of violation of water rights and therefore reduce if not avoid water conflicts in the Project area altogether.

ii) Technical specifications

Discharge monitoring stations

The existing gauging stations should as much as possible be used for the flow monitoring exercise to minimise cost. Only where is necessary new gauging stations could be installed. Discharge monitoring stations are proposed at the following locations :

- Upstream the headworks (preferably within 100m upstream the abstraction point) on the Kikuletwa river,
- Downstream the headworks (preferably within 100m downstream the abstraction point) on the Kikuletwa river,
- At the entrance points to the Nyumba ya Mungu reservoir of the Kikuletwa and Kikafu rivers,
- At the entrances of main drainage canals to the rivers, and
- At the Nyumba ya Mungu reservoir outlet

Monitoring of the water levels of the Nyumba ya Mungu reservoir should be done at the reservoir outlet works using the existing gage near the dam site. Preferably, the gauging stations should be located near sampling stations for water quality monitoring to facilitate determination of pollutants loads.

Monitoring frequency

During the construction stage and the first 5 years, periodic monitoring should be conducted at least once a month for river discharge and water levels in the Nyumba ya Mungu reservoir. Periodic monitoring after the first five years should be conducted at least six times per year. However, if serious problems crop-up the monitoring frequency should be increased accordingly.

(2-g) Water pollution and eutrophication (Ecological Region 6 during Operation Stage)

Water quality monitoring is a "long-term" standardised measurement, observation, evaluation and reporting of the aquatic environment in order to define the status and trends. In the Project area, the monitoring programme envisaged is multi-objective and it is to involve monitoring for various water uses such as fisheries or aquatic life, agriculture and livestock watering. Some important variables are to be monitored. The implementation of the programme shall focus on spatial distribution of quality which requires establishment of monitoring stations and monitoring variable trends, which in turn require frequent monitoring of the pollutants. This programme is expected to provide information that will form basis for sound management of irrigation and drainage waters, pesticides, fertilisers, and soil. Thus, the selection of parameters is based on perceived problems, environmental and water use needs and expected inputs to the Nyumba ya Mungu reservoir.

i) Item to be monitored

Pollution sources (present and expected)

These includes domestic and agricultural sources.

Variables to be monitored

From Section 3.2.2 (2-g), pollution sources have been identified, pollutants of concern inventoried and potential pollution problems predicted. The variables to be included in the monitoring programme include :

- Conventional pollutants (BOD, COD, TSS),

- Pesticides,
- Indicator organisms (faecal coliform and faecal streptococci),
- Nutrients (phosphorus and nitrogen), and
- Dissolved Oxygen (DO)

The media to be monitored will include water and sediments.

ii) Technical specifications

Components of the proposed water quality monitoring programme

The proposed water quality monitoring programme will consist of the following components :

- Programme objectives,
- Selection of variables,
- Field measurements,
- Hydrological measurements,
- Laboratory activities,
- Data quality control, and
- Data treatment, interpretation, storage and reporting

Water quality monitoring objectives

- To provide a basis for reviewing suggested mitigation measures to meet environmental and water use needs ;
- To monitor pollution loads in the rivers traversing the Project area and Nyumba ya Mungu reservoir ;
- To establish amounts of nutrients originating from agricultural activities, domestic wastes and other sources ; and
- To monitor quality of waters in rivers traversing the Project area and Nyumba ya Mungu reservoir so as to establish trends of variables of concern.

Monitoring frequency and period

Frequency of monitoring will depend on the cropping season and should accommodate variations in application of agrochemicals. Therefore the monitoring should be more frequent during the period of application of agrochemicals. During the construction stage and the first 5 years, periodic monitoring should be conducted at least once a month for conventional pollutants and once every two months for agrochemicals. Periodic monitoring after the first five years should be conducted at least six times per year.

Monitoring points

- The entrance of the Kikuletwa river to the Nyumba ya Mungu reservoir,
- At the middle of the Nyumba ya Mungu reservoir,
- At the Nyumba ya Mungu reservoir outlet,
- Upstream the confluence of the Kikuletwa and Kikafu rivers (about 5 m upstream the confluence),
- Upstream the headworks on the Kikuletwa river, and
- At the outlets of main drainage canal(s)

5. CONCLUSION AND RECOMMENDATIONS

5.1 Overall Evaluation of the Project from Environmental Point of View

This Annex-I has presented the results of a series of environmental study (i.e. IEE and EIA) for the proposed Lower Moshi Integrated Agriculture and Rural Development Project in Kilimanjaro region. The results of the EIA study have shown that the Project activities will have no or insignificant negative impacts to most of the social and natural environmental items considered during the study. In view of this, it can therefore be concluded that within the limitations of the prediction and assessment methods employed during the EIA study, the Project is considered to be environmentally viable, provided that the mitigation measures proposed in Chapter 4 are effectively implemented.

It is recommended that the contents of this EIA report be incorporated during the detail design and other pre-project undertakings to ensure environmental sustainability of the Project during its construction and operation stages.

5.2 Recommendations to Counter-Part Agency

5.2.1 Enforcement of Legislative and Institutional Frameworks

The existing environmental laws and regulations pertaining to various environmental items relevant to the Project should be adhered to. To ensure this, the EIA report has been prepared with due considerations of the existing environmental laws and regulations, policies, targets and standards so as to ensure that the Project is sustainable. This will also ensure that conflicts with the country's environmental legislation and institutional frameworks are minimised or avoided altogether. The Project Executive Agency should therefore as much as possible work in close collaboration with government ministries and agencies. The Project Executive Agency should also operate within the present institutional framework of environmental management when it comes to dealing with environmental issues. This is because enforcement of environmental legislation can only be done in collaboration with the government bodies.

Any project activity that may cause significant environmental effects especially beyond the boundaries of the project area should be dealt with in consultation with government authorities responsible for environmental management. The Project Executive Agency should inform government authorities of any significant negative environmental impact taking place as a result of project activities. It is recommended that reports on the state of the environment in the project area be availed on regular basis to the National Environment Management Council (NEMC) and other relevant bodies responsible for environmental management in the government.

5.2.2 Man-power Training

Effectiveness of any environmental conservation plan requires a reasonable degree of education and training for those individuals who will be involved in its implementation. Therefore for the Project it is recommended that those individuals who will constitute the proposed Environmental Management Unit (EMU) be trained in order that potential impacts, mitigation measures and monitoring plans addressed in this report are thoroughly understood and effectively implemented for the sustainability of the project. It is recommended that individuals who have undergone the basic training in environment-related disciplines such as environmental science and engineering be recruited for this

purpose. The recruited persons should be given further training relevant to environmental aspects of agriculture, rural development projects and irrigation projects in particular. Training in the use of facilities and equipment for the Project staff should also be done. The Project Executive Agency should be responsible for the education and training of the personnel. The first step should obviously be identification of training needs followed by preparation of training programmes. For example, in water quality monitoring, training should be based on issues concerning with planning of water quality monitoring programmes including quality assurance, instrumentation, etc. The cost of training should therefore be incorporated in the Project.

The EMU should also be responsible for educating people, especially farmers, living within the project area in order to raise their awareness in environmental management. The success of any environmental management programme depends to a large extent on the participation of the public in general. Therefore, the EMU should organise seminars and workshops for the Project workers and beneficiaries. The workforce to be involved in construction, should be environmentally sensitised to ensure minimum environmental effects during construction.

Counter-part staff should be given opportunities to attend seminars, conferences, workshops and other meetings related to irrigation to keep them abreast with new approaches in running irrigation projects in an environmentally sound manner.

5.2.3 Consolidation of Equipment and Facilities

Successful implementation of mitigation measures contained in this report especially environmental monitoring will depend on availability of equipment and facilities. The Project Executive Agency should therefore identify and procure necessary equipment and facilities to facilitate implementation of the proposals such as transport and laboratory facilities.

To minimise costs, available equipment and facilities should be identified and the possibility of using them explored. For example, laboratory facilities belonging to the Kilimanjaro and/or Arusha Region Water Departments and Arusha-based Tanzania Pesticide Research Institute (TPRI) can be used for water quality analysis in the water quality monitoring exercise. Only those equipment which are not locally available should be procured. In monitoring changes in surface water hydrology, existing gauging stations can be rehabilitated and used for flow monitoring, new ones should only be installed where necessary.

5.2.4 Other Measures

The Environmental Management Unit should be adequately equipped and have staff who are properly trained and well remunerated to enable them effectively implement the proposals recommended in the EIA study report.

Tables

Table I.2.1 Summarized Project Description (PD)

1. Title of Project			
"Lower Moshi Integrated Agriculture and Rural Development Project"			
2. Background and Objectives of Project			
The existing Lower Moshi Project has borne the excellent results more than targeted in crop production, however concurrently it has brought the severe constant water shortage for the project area due to the excessive transfer of project effect to the surrounding area. In order to cope with the problem, it is urgently necessary to execute the comprehensive implementation of an irrigation development project including exploitation of the new water sources and construction of rural area. The major objectives are : (1) to extend irrigation technique developed in the Lower Moshi Project area ; and (2) to elevate living standard of farmers.			
3. Outline of Project			
General conditions of the project site	The Project area extends over the low and flat topography about 3 to 15 km southeast of Moshi city, the capital of Kilimanjaro region located at the foot of the Mt. Kilimanjaro, northeast of Tanzania. Kilimanjaro region is adjacent to the boarder of Kenya to the north, the Tanga region to the southeast, the Arusha region to the east, and administratively consists of five (5) districts such as the Moshi district, Hai district, Lombo district, Mwanga district and Same district, including ten (10) villages and Tanganika Planting Company (TPC).		
Beneficial area	6,000 ha at maximum		
Beneficial population	63,500 persons (10,800 households)		
Executing agency	Ministry of Agriculture and Cooperatives (MOAC)		
Concerned environmental agencies	- National Environment Management Council (NEMC) - Environment Division, Vice-President's Office - Environmental Unit, Irrigation Department, MOAC - Natural Resources Regional Office of Kilimanjaro		
4. Components and Designed Scale of Project			
Major components	Type of activities		Designed scale
	New activity	Rehabilitation	
a. Irrigation	O	O	Max. 6,000 ha
b. Drainage	O	O	Max. 6,000 ha
c. Land clearing & leveling	O		Max. 4,900 ha
d. Land consolidation	O		Max. 4,900 ha
e. Intake weir	O		1 weir
f. Farming system change	O	O	unknown
g. Diversion canal and its OM road	O		23 km

Table I.2.2 Population and Rice Farming Households in the Existing Area

Village	Population	Households	Rice Farming Households	% of Rice Farming H.H.
Chekereni	4,200	930	600	65
Oria	6,500	1,500	1,000	67
Mabogini	11,000	880	650	74
Rau ya Kati	1,941	325	125	38
Total	23,641	3,635	2,375	65

Source : Result of Baseline Survey, Joint Steering Committee for the Campaign against Schistosomiasis in Lower Moshi, KATC, Jan. 1997

Table I.2.3 Summarized Site Description (SD)

1. Social Conditions of Project Site	
Land tenure & land use systems	Tenure regimes are still heavily influenced by "customary tenure systems" where land is communally owned, user rights are administered within the clan, and transfers to outsiders are rare. Governmental control may at one time have been exercised through the village allocation mechanism, but by 1991, this mechanism was firmly in the hands of local authorities.
Economic activities	The agriculture centering crop cultivation such as maize and paddy, and livestock is predominant, and there are no remarkable industries. Inland fishery is popular around the Nymba ya Munga (NYM) dam reservoir.
Traditional systems	In the surrounding expanded area, farmers' organization has been established for water management and operation and maintenance of facility, but is not managed in the systematic manner like the existing Lower Moshi Project area.
Characteristics of local residents	Tribes living in and around the Project area are Chaga, Masai, Pare, Sanpa, and Arusha.
Health & Sanitation	Several kinds of water-borne diseases including Schistosomiasis have been prevailing. Sewer collection systems in the Moshi city leak into groundwater. This has resulted in outbreaks of cholera, typhoid and dysentery.
Population	As in 1995, population and households in the agricultural on-site of the proposed Project, are 63,500 and 10,800 respectively.
Transportation road	Road density is insufficient. Bridges over rivers are inadequate, producing transportation bottlenecks during the flood season.
2. Natural Conditions of Project Site	
Climate	Climate is characterized by three seasons : wet season from March to May, dry season from June to October and small wet season from November to February. The average annual rainfall is about 900 mm.
Geography	The area generally has a gently undulating topography with land slopes ranging from 0.5 % to 0.2 %. The elevation is 800 ~ 700 m.
Hydrology & drainage	The Rau river flows down southwardly across the Project area. The Kikuletwa river flows into the Nyumba Ya Munngu dam after confluence with the Kikafu river.
Soil	They are generally quite fertile with relatively high humus contents, and can be broadly divided into Dystric Cambisols, Mollic Gleysols and Etric Gleysols.
Vegetation	Almost all the area is under cultivation with scattered trees and ample grazing land, except a forest area extended along the Rau river.
Valuable fauna/flora & nature	Very few animals have remained in the area due to human activities. Thus, either they have been poached or have migrated to other places. Flora and fauna species seen there are common types. No species requiring special preservation have been seen.
Water pollution at Moshi city	The priority areas of concentration include Moshi city. Most of the industries discharge untreated wastewater.

3. Remarkable Social and Natural Features			
Special reserve area	On-site	Off-site	Remarks
Under Washington Convention	---	O	Wild animals
Under Ramsar Convention	---	---	
National park	---	O	Kilimanjaro
Forest reserve	O	O	2 (on), 2 (off)
Game controlled area	---	O	Sanya Lelatema
Socially fragile area	The Nyumba ya Munga dam reservoir for fishery		
Naturally fragile area	Ecosystem of the NYM dam reservoir		

4. Experiences of Negative Environmental Impacts around Project Sites	
Social aspect	- mararia and schistosomiasis - unstable water allocation - no or poor irrigation & drainage facility out of Lower Moshi Project area - inadequate water management system - unmatured agricultural product and farmers organization - low unit yield/productivity in outside area of Lower Moshi Project - unmatured supporting system for agricultural productivity - poor rural infrastructure - poor loan and credit services
Natural aspect	- shortage of irrigation water - husk accumulation and its poor treatment at the existing rice mill

Table I.2.4 Occurrence of Water-Borne Diseases in the Project Area

Diseases	Village / Year									
	Mabogini			Kahe			TPC			
	1995	1996	1997	1995	1996	1997	1994	1995	1996	1997*
Mararia	775	678	na	6,888	na	na	4,358	na	na	na
Dysente-ry	112	222	na	1,932	na	na	4,268	108	85	3
Cholera	na	na	na	na	na	na	109	1	na	na
Typhoid	na	na	na	na	na	na	1	120	69	12
Bilharzia	68	71	na	702	na	na	406	na	na	na

Notes : na = Data is not available. * = Data only for January
Source : Health Office of Moshi Rural District

Table 1.2.5 Project Implementation and Environmental Consideration

Source : Guideline for Environmental Consideration on Agricultural & Rural Development Projects (Dec. 1992, JICA)

Stage of Project Implementation			Environmental Consideration Process
Conducted by JICA	Preparatory Study	Preparatory Study	Preliminary Environmental Study
	Master Plan Study	Feasibility Study	Initial Environmental Examination (IEE)
	Feasibility Study		Environmental Impact Assessment (EIA)
Implemented by Executing Agency	Preparation of Implementation Program (including Detailed Design)		Detailed Design for Environmental Protection Measures
	Construction		Implementation of Environmental Protection Measures Preparation of Environmental Management Plan
	Operation		Monitoring of Environmental Impacts

Notes:

1. The correspondence between respective stages and processes indicated above may vary slightly depending on specific requirements of a project or recipient country

2. IEE and/or EIA are not required in some projects.

Table I.2.6 Social Environment Evaluation for Ecological Region 1

Impact Item No. *	Evaluation Const-ruction	Evaluation Post-Con.	Evaluation Base
(a) Socioeconomic Issues			
1)-a)	X	X	The Project is only for the local farmers in the irrigated sites.
1)-b)	?	?	Some houses in the expanded and proposed extension areas will be removed for the Project activities of facility construction.
1)-c)	X	X	Change on life style due to irrigation is quite limited.
1)-d)	X	O	Community conflict most likely happens in terms of water right.
1)-e)	X	X	There is no minorities necessitating special attention.
1)-f)			
2)-a)	O	X	Population will not increase only due to the Project, although some workers will inflow during the construction stage.
2)-b)	O	X	Some workers will inflow during the Project construction stage.
2)-c)			
3)-a)	X	X	In contrary, economic base is strengthened by the Project.
3)-b)	X	X	In contrary, the Project generates stable working situation.
3)-c)	X	X	Income disparities are mitigated with increased production.
3)-d)			
4)-a)	X	O	Regulation and management should be enforced for water use.
4)-b)	X	O	Institutional aspects will be enforced for water and production.
4)-c)	X	X	Basic customs in local communities are hardly affected.
4)-d)			
(b) Health and Sanitary Issues			
1)	X	O	As irrigation is extended, application of agrochemicals increases.
2)	X	X	There is no potential causes for endemic diseases.
3)	X	O	Water surface causing malaria, schistosomiasis, etc. increase.
4)	X	O	It is because of increase of application of agrochemicals.
5)	X	O	Rice husk than the present will accumulate at the rice mill.
6)			
(c) Cultural Issues			
1)	X	X	Any important remains or assets doesn't exist in the sites.
2)	X	X	Beautiful Mt.Kilimanjaro scenery will never be damaged.
3)	X	X	Important mineral resources are not found in the Project sites.
4)			

Notes : * Refer to Section 2.3.2 (1) for each number's impact title.

Table I.2.7 Natural Environment Evaluation for Ecological Region 1

Impact Item No. *	Evaluation: Const-ruction	Evaluation: Post-Con.	Evaluation Base
(d) Biological and Ecological Issues			
1)	X	X	There is no valuable vegetation, but all common, in the sites.
2)	X	X	Important fauna and flora are conserved in the Forest Reserves.
3)	X	X	There is no rich diversity area except for the Forest Reserves.
4)	X	X	The Project is development-oriented and will use locally available rice variety.
5)	X	X	The Project sites are basically the existing cultivated area.
6)	X	X	There is no tropical forest except for the Forest Reserves.
7)	X	X	The Project sites are far away from coasts, so no mangroves.
8)	X	X	The Project sites are far away from coasts, so no coral reef.
9)			
(e) Soil and Land Resources			
1)-a)	X	X	Erosion risk is quite little because of flat irrigated rice fields.
1)-b)	?	?	Occurrence of soil salinization has been found within the sites.
1)-c)	X	X	The Project sites are originally fertile land, and top-soil erosion will be limited as the Project main activity is rehabilitation.
1)-d)	X	X	Chemical contamination is unexpected according to experiences of the existing irrigation area.
1)-e)			
2)-a)	X	X	There is no such a risk because of humid and flat nature of land.
2)-b)	X	X	There is no such a risk because of humid and flat nature of land.
2)-c)	X	X	Utilization of groundwater is not planned under the Project.
2)-d)			
(f) Hydrology and Air & Water Quality Issues			
1)-a)	X	X	Further water is not taken from the Rau River within the sites.
1)-b)	X	?	Groundwater level will rise due to irrigation area's extension.
1)-c)	X	X	There is a limited risk of flood along the Rau River, since it is suffered from lack of water even at present.
1)-d)	X	X	Hydrology and water volume of the Rau River will least change.
1)-e)	X	X	Hydrology and water volume of the Rau River will least change.
1)-f)	X	X	The Rau River has not been used for transportation.
1)-g)			
2)-a)	X	?	Water pollution due to wastewater from the Moshi town and irrigation drainage with increased agrochemicals in the future is questionable.
2)-b)	X	X	Based on the past experience, further water eutrophication due only to the Project can not be thinkable.
2)-c)	X	X	The sites are located far enough from the sea to ignore this risk.
2)-d)	X	X	The canal and river water is flowing in tropical zone.
2)-e)			
3)-a)	X	X	As wind is strong and the sites are less populated, damages due to construction works or agrochemical spreading are very limited.
3)-b) Noise	X	X	As wind is strong and the sites are less populated, damages from noise due to construction works or transportation are limited.

Note : * Refer to Section 2.3.2 (2) for each number's impact title.

Table I.2.8 Social Environment Evaluation for Ecological Region 2

Impact Item No. *	Evaluation: Const-ruction	Evaluation: Post-Con.	Evaluation Base
(a) Socioeconomic Issues			
1)-a)	X	X	Project action here is not related to agricultural settlement.
1)-b)	X	X	Inundated area is limited, and no residences exist around the site.
1)-c)	X	X	Physical construction of the wire doesn't affect local life style.
1)-d)	X	X	There is no major water use such as fishery at the site.
1)-e)	X	X	The weir doesn't affect directly usual activities of local tribes.
1)-f)			
2)-a)	X	X	Inflow of workers for construction is limited in number and time.
2)-b)	X	X	Inflow of workers for construction is limited in number and time.
2)-c)			
3)-a)	X	X	There is no economic activities around the construction site.
3)-b)	X	X	In contrary, labor opportunity for local people will increase.
3)-c)	X	X	Because of increased labor opportunity, local income disparities decrease.
3)-d)			
4)-a)	X	X	There is no significant water use around the construction site, because of the sharpness of the both river banks.
4)-b)	X	X	The weir doesn't affect social and institutional structures.
4)-c)	X	X	The weir doesn't affect social structures or local customs.
4)-d)			
(b) Health and Sanitary Issues			
1)	X	X	The new weir itself is not related to utilization of agrochemicals.
2)	X	X	The new weir has no potential causes for endemic diseases.
3)	X	X	The Kikuletwa River has enough flow even after the establishment of the new wire and inundated area.
4)	X	X	The new weir itself is not related to utilization of agrochemicals.
5)	X	X	Originally and after the construction, gathering local people and livestocks will be limited so that wastes are too small to bring negative impact to around the site and downstream area.
6)			
(c) Cultural Issues			
1)	X	X	Neither historic remains nor assets are found around the site.
2)	X	X	The Kikuletwa River around the site has no significant aesthetic value originally.
3)	X	X	Tanzanite is reported to exist along the Kikuletwa River, but the weir construction itself is not for its exploitation.
4)			

Note : * Refer to Section 2.3.2 (1) for each number's impact title.

Table I.2.9 Natural Environment Evaluation for Ecological Region 2

Impact Item No. *	Evaluation		Evaluation Base
	Const-ruction	Post-Con.	
(d) Biological and Ecological Issues			
1)	X	X	There is the Sanya Letatema Game Controlled Area in the right bank of the Kikuletwa River, but along the site exists no important vegetation.
2)	X	X	Around the site there is no important fauna and flora. Even crocodiles found there are not subject of special attention because of their local commonness.
3)	X	X	Around the site there is no important or rare ecosystem.
4)	X	O	Inundated area can be a good habitat for crocodiles.
5)	X	X	There is neither wetland nor peat swamp around the site.
6)	X	X	There is no tropical forest around the site.
7)	X	X	There is no mangrove forest around the site.
8)	X	X	The site is quite far away from the ocean.
(e) Soil and Land Resources			
1)-a)	X	X	Soil erosion can be technically checked during and after the construction works.
1)-b)	X	X	The new weir is not related to soil salinization.
1)-c)	X	X	The new weir is not related to soil fertility.
1)-d)	X	X	Construction of the new weir does not use harmful materials.
2)-a)	X	X	Construction of the new weir least affects the surrounding land.
2)-b)	X	X	Construction of the new weir least affects the surrounding land.
2)-c)	X	X	The new weir has no potential impact for ground subsidence.
(f) Hydrology and Air & Water Quality Issues			
1)-a)	X	X	Inundated area is established, but no negative hydrological impact will happen.
1)-b)	X	X	There will be no negative impact directly around the site.
1)-c)	X	X	Inundated area is limited, and there is no residences or farms around the site.
1)-d)	X	X	Soil will be sedimented at the new weir from the upstreams. But there is no negative impacts biologically or on the weir function because its objective is not for water reservoir.
1)-e)	X	X	In contrary, the riverbed will rise due to sedimentation.
1)-f)	X	X	Along the Kikuletwa River around the site, there is no river navigation at all.
2)-a)	X	X	Although the river water will be contaminated during construction stage, no severe impacts because there is no major water use and the construction duration is limited.
2)-b)	X	X	Potential eutrophication will be limited as organic inflow to the inundated area is small.
2)-c)	X	X	The site is located quite inland.
2)-d)	X	X	There is no area under irrigation around the site.
3)-a)	X	X	No severe impacts because of no residences around the site.
3)-b) Noise	X	X	No severe impacts because of no residences around the site.

Notes : * Refer to Section 2.3.2 (2) for each number's impact title.

Table 1.2.10 Social Environment Evaluation for Ecological Region 3

Impact Item No. *	Evaluation		Evaluation Base
	Const-ruction	Post-Con.	
(a) Socioeconomic Issues			
1)-a)	X	X	The construction of diversion canal itself is not related to agricultural settlement.
1)-b)	O	O	There is possibility to remove houses or cultivated area along the canal and maintenance road route, especially close to the Moshi city.
1)-c)	X	X	The construction of canal and road will not bring severe impact on the local people's life style.
1)-d)	X	O	Water thief from the canal will happen, causing some community conflicts.
1)-e)	X	X	Any special adverse impacts on grazing tribes are not thinkable.
1)-f)			
2)-a)	X	X	The construction workers will inflow, but only in limited time.
2)-b)	X	X	The construction workers will inflow, but only in limited time.
2)-c)			
3)-a)	X	X	Damaged economic activities due to resettlement will be limited.
3)-b)	X	X	Damaged economic activities due to resettlement will be limited. In contrary, local people have labor opportunity for construction.
3)-c)	X	X	No negative impacts, because the construction period is limited.
3)-d)			
4)-a)	X	X	The new canal construction is not directly related to institutional aspect or local customs.
4)-b)	X	X	The new canal construction is not directly related to institutional aspect or local customs.
4)-c)	X	X	The new canal construction is not directly related to institutional aspect or local customs.
4)-d)			
(b) Health and Sanitary Issues			
1)	X	X	The canal construction is not related to agrochemicals usage.
2)	X	O	Increase of water surface will increase occurrence of malaria, schistomiasis, etc.
3)	X	O	Increase of water surface will increase occurance of malaria, schistomiasis, etc.
4)	X	X	The canal construction is not related to agrochemicals usage.
5)	X	O	Domestic wastes will be thrown away into the canal, especially around the existing vallage area.
6)			
(c) Cultural Issues			
1)	X	X	There is no important historic remains or assets along the route.
2)	X	X	The beautiful Mt.Kilimanjaro senery is not damaged.
3)	X	X	Important mineral resources do not exist along the canal route.
4)			

Note : * Refer to Section 2.3.2 (1) for each number's impact title.

Table I.2.11 Natural Environment Evaluation for Ecological Region 3

Impact Item No. *	Evaluation		Evaluation Base
	Const-ruction	Post-Con.	
(d) Biological and Ecological Issues			
1)	X	X	No important vegetation exists along the canal route.
2)	X	X	No important fauna or flora species exist around the canal route.
3)	X	X	Ecosystem around the route is of low biological diversity.
4)	X	O	Intrusion of crocodiles into the new canal is possible.
5)	X	X	Important wetlands or peat swamps do not exist along the canal.
6)	X	X	No tropical forests exist along the new canal.
7)	X	X	No mangrove forests exist around the region.
8)	X	X	The canal construction site is far away from the ocean.
9)			
(e) Soil and Land Resources			
1)-a)	X	O	The construction works will strip vegetation causing additional soil erosion where land slope is steep.
1)-b)	X	X	The setting of the new canal never brings soil salinization.
1)-c)	X	X	The setting of the new canal never impacts soil fertility.
1)-d)	X	X	The new canal construction does not use harmful materials.
1)-e)			
2)-a)	X	X	Most of the route area is originally semi-arid type land.
2)-b)	X	X	Hinterland of the construction route is humid area.
2)-c)	X	X	The canal construction never causes ground subsidence.
2)-d)			
(f) Hydrology and Air & Water Quality Issues			
1)-a)	X	X	The canal generates additional surface water, but no special negative impact on hydrological situation around the region.
1)-b)	X	X	All the new canal is lined with concrete, so no impact on groundwater.
1)-c)	X	X	Area along the canal will not be flooded as excess water runs towards the Rau River.
1)-d)	X	X	Soil will be checked at the new intake weir.
1)-e)	X	X	The canal is artificial, so any natural riverbed is not affected.
1)-f)	X	X	The new canal is not for navigation.
1)-g)			
2)-a)	X	X	The new canal does not connect any rivers in the sites.
2)-b)	X	X	Water of the new canal is always flowing.
2)-c)	X	X	The new canal does not connect any sea water.
2)-d)	X	X	Water temperature in the canal will rise during going through its long way under tropical weather.
2)-e)			
3)-a)	X	X	Area around the construction route is not populated.
3)-b) Noise	X	X	Area around the construction route is not populated.

Note : * Refer to Section 2.3.2 (2) for each number's impact title.

Table I.2.12 Social Environment Evaluation for Ecological Region 4

Impact Item No. *	Evaluation		Evaluation Base
	Const-ruction	Post-Con.	
(a) Socioeconomic Issues			
1)-a)	X	X	There is no Project activities in the region at all.
1)-b)	X	X	There is no Project activities in the region at all.
1)-c)	X	X	There is no Project activities in the region at all.
1)-d)	X	X	There is no Project activities in the region at all.
1)-e)	X	X	There is no Project activities in the region at all.
2)-a)	X	X	There is no Project activities in the region at all.
2)-b)	X	X	There is no Project activities in the region at all.
2)-c)			
3)-a)	X	X	There is no Project activities in the region at all.
3)-b)	X	X	There is no Project activities in the region at all.
3)-c)	X	X	There is no Project activities in the region at all.
3)-d)			
4)-a)	X	X	There is no major water use such as fishery and irrigation.
4)-b)	X	X	There is no Project activities in the region at all.
4)-c)	X	X	There is no Project activities in the region at all.
4)-d)			
(b) Health and Sanitary Issues			
1)	X	X	There is no Project activities in the region at all.
2)	X	X	There is no Project activities in the region at all.
3)	X	X	There is no Project activities in the region at all.
4)	X	X	There is no Project activities in the region at all.
5)	X	X	There is no Project activities in the region at all.
6)			
(c) Cultural Issues			
1)	X	X	There is no Project activities in the region at all.
2)	X	X	There is no Project activities in the region at all.
3)	X	X	There is no Project activities in the region at all.

Note : * Refer to Section 2.3.2 (1) for each number's impact title.

Table 1.2.13 Natural Environment Evaluation for Ecological Region 4

Impact Item No. *	Evaluation		Evaluation Base
	Const-ruction	Post-Con.	
(d) Biological and Ecological Issues			
1)	X	X	There is no important vegetation affected by water decrease.
2)	X	X	There is no important flora/fauna affected by water decrease.
3)	X	X	Ecological diversity is poor around the region.
4)	X	O	As water flow becomes weak, crocodiles will increase.
5)	X	X	There are no important wetland or peat swamp around the region.
6)	X	X	There is no Project activities in the region at all.
7)	X	X	There is no mangrove forest in the region.
8)	X	X	The region is located quite far away from the ocean.
9)			
(e) Soil and Land Resources			
1)-a)	X	X	There is no Project activities in the region at all.
1)-b)	X	X	There is no Project activities in the region at all.
1)-c)	X	X	There is no Project activities in the region at all.
1)-d)	X	X	There is no Project activities in the region at all.
1)-e)			
2)-a)	X	X	There is no Project activities in the region at all.
2)-b)	X	X	There is no Project activities in the region at all.
2)-c)	X	X	There is no Project activities in the region at all.
2)-d)			
(f) Hydrology and Air & Water Quality Issues			
1)-a)	X	X	Decrease of water flow itself does not change hydrology.
1)-b)	X	X	Groundwater level will be affected, but there is no major use of groundwater around the region.
1)-c)	X	X	There is never such risks, as water flow is less than present.
1)-d)	X	X	Soil sedimentation will decrease due to decreased water flow.
1)-e)	X	X	There is neither major water intake nor important aquatic ecosystem severely affected by riverbed degradation.
1)-f)	X	X	The downstream of Kikuletwa River is not used for navigation.
1)-g)			
2)-a)	X	X	Water quality will be further deteriorated because of continuous domestic waste water through Kikafu River as well as decreased water in the Kikuletwa River, but major water use or ecosystem severely damaged by water contamination is not existing.
2)-b)	X	X	Water will be more eutrophicated, but no water use damaged.
2)-c)	X	X	The region is located enoughly higher than the sea level.
2)-d)	X	X	There is no Project activities in the region at all.
2)-e)			
3)-a)	X	X	There is no Project activities in the region at all.
3)-b) Noise	X	X	There is no Project activities in the region at all.

Note : * Refer to Section 2.3.2 (2) for each number's impact title.

Table 1.2.14 Social Environment Evaluation for Ecological Region 5

Impact Item No. *	Evaluation		Evaluation Base
	Const-ruction	Post-Con.	
(a) Socioeconomic Issues			
1)-a)	X	X	There is no Project activities in the region at all.
1)-b)	X	X	There is no Project activities in the region at all.
1)-c)	X	X	There is no Project activities in the region at all.
1)-d)	X	X	There is no Project activities in the region at all.
1)-e)	X	X	There is no Project activities in the region at all.
1)-f)			
2)-a)	X	X	There is no Project activities in the region at all.
2)-b)	X	X	There is no Project activities in the region at all.
2)-c)			
3)-a)	X	X	There is no Project activities in the region at all.
3)-b)	X	X	There is no Project activities in the region at all.
3)-c)	X	X	There is no Project activities in the region at all.
3)-d)			
4)-a)	X	X	There is no major water use such as fishery and irrigation.
4)-b)	X	X	There is no Project activities in the region at all.
4)-c)	X	X	There is no Project activities in the region at all.
4)-d)			
(b) Health and Sanitary Issues			
1)	X	X	There is no Project activities in the region at all.
2)	X	X	There is no Project activities in the region at all.
3)	X	X	There is no Project activities in the region at all.
4)	X	X	There is no Project activities in the region at all.
5)	X	X	There is no Project activities in the region at all.
(c) Cultural Issues			
1)	X	X	There is no Project activities in the region at all.
2)	X	X	There is no Project activities in the region at all.
3)	X	X	There is no Project activities in the region at all.

Note : * Refer to Section 2.3.2 (1) for each number's impact title.

Table 1.2.15 Natural Environment Evaluation for Ecological Region 5

Impact Item No. *	Evaluation		Evaluation Base
	Const-ruction	Post-Con.	
(d) Biological and Ecological Issues			
1)	X	X	There is no Project activities in the region at all.
2)	X	X	There is no Project activities in the region at all.
3)	X	X	There is no Project activities in the region at all.
4)	X	X	There is no Project activities in the region at all.
5)	X	X	There are no important wetland or peat swamp around the region.
6)	X	X	There is no Project activities in the region at all.
7)	X	X	There is no mangrove forest in the region.
8)	X	X	The region is located quite far away from the ocean.
9)			
(c) Soil and Land Resources			
1)-a)	X	X	There is no Project activities in the region at all.
1)-b)	X	X	There is no Project activities in the region at all.
1)-c)	X	X	There is no Project activities in the region at all.
1)-d)	X	X	There is no Project activities in the region at all.
1)-e)			
2)-a)	X	X	There is no Project activities in the region at all.
2)-b)	X	X	There is no Project activities in the region at all.
2)-c)	X	X	There is no Project activities in the region at all.
2)-d)			
(f) Hydrology and Air & Water Quality Issues			
1)-a)	X	X	Water flow of the Rau River does not change drastically.
1)-b)	X	X	Groundwater level will be not be affected.
1)-c)	X	X	There is never such risks, as water flow is not changed.
1)-d)	X	X	Soil sedimentation will be as present.
1)-e)	X	X	Riverbed will not be changed so much.
1)-f)	X	X	The downstream of the Rau River is not used for navigation.
1)-g)			
2)-a)	X	?	Water quality will be more deteriorated because of increased application of agrochemicals upstreams. But it is questionable whether such water pollution will be purified enoughly through the two Forest Reserves or it will adversely affect these Forest Reserves' ecosystem in contrary.
2)-b)	X	X	Water will be more eutrophicated, but there is no important water use in the downstream area.
2)-c)	X	X	The region is located enoughly higher than the sea level.
2)-d)	X	X	There is no Project activities in the region at all.
2)-e)			
3)-a)	X	X	There is no Project activities in the region at all.
3)-b) Noise	X	X	There is no Project activities in the region at all.

Note : * Refer to Section 2.3.2 (2) for each number's impact title.

Table I.2.16 Social Environment Evaluation for Ecological Region 6

Impact Item No. *	Evaluation		Evaluation Base
	Const-ruction	Post-Con.	
(a) Socioeconomic Issues			
1)-a)	X	X	There is no Project activities in the region at all.
1)-b)	X	X	There is no Project activities in the region at all.
1)-c)	X	X	There is no Project activities in the region at all.
1)-d)	X	X	There is no Project activities in the region at all.
1)-e)	X	X	There is no Project activities in the region at all.
1)-f)			
2)-a)	X	X	There is no Project activities in the region at all.
2)-b)	X	X	There is no Project activities in the region at all.
2)-c)			
3)-a)	X	?	It is questionable to how much extent water decrease and pollution due to the Project activities damage fishery in the Reservoir.
3)-b)	X	?	It is questionable to how much extent water decrease and pollution due to the Project activities damage fishery in the Reservoir.
3)-c)	X	X	There is no Project activities in the region at all.
3)-d)			
4)-a)	X	?	The Reservoir water is used for power generation as well as inland fishery.
4)-b)	X	X	There is no Project activities in the region at all.
4)-c)	X	X	There is no Project activities in the region at all.
4)-d)			
(b) Health and Sanitary Issues			
1)	X	X	There is no Project activities in the region at all.
2)	X	X	There is no Project activities in the region at all.
3)	X	X	There is no Project activities in the region at all.
4)	X	X	There is no Project activities in the region at all.
5)	X	X	There is no Project activities in the region at all.
6)			
(c) Cultural Issues			
1)	X	X	There is no Project activities in the region at all.
2)	X	X	There is no important aesthetic value around the Reservoir.
3)	X	X	There is no Project activities in the region at all.
4)			

Note : * Refer to Section 2.3.2 (1) for each number's impact title.

Table 1.2.17 Natural Environment Evaluation for Ecological Region 6

Impact Item No. *	Evaluation		Evaluation Base
	Const-ruction	Post-Con.	
(d) Biological and Ecological Issues			
1)	X	X	There is no Project activities in the region at all.
2)	X	?	It is questionable to how much extent water decrease and pollution due to the Project activities damage fish species in the Reservoir.
3)	X	?	It is questionable to how much extent water decrease and pollution due to the Project activities damage fish species in the Reservoir.
4)	X	X	There is no Project activities in the region at all.
5)	X	X	There are no important wetland or peat swamp around the region.
6)	X	X	There is no important tropical forest around the Reservoir.
7)	X	X	There is no mangrove forest in the region.
8)	X	X	The region is located quite far away from the ocean.
(e) Soil and Land Resources			
1)-a)	X	X	There is no Project activities in the region at all.
1)-b)	X	X	There is no Project activities in the region at all.
1)-c)	X	X	There is no Project activities in the region at all.
1)-d)	X	X	There is no Project activities in the region at all.
2)-a)	X	X	There is no Project activities in the region at all.
2)-b)	X	X	There is no Project activities in the region at all.
2)-c)	X	X	There is no Project activities in the region at all.
(f) Hydrology and Air & Water Quality Issues			
1)-a)	X	?	It is questionable to how much extent water decrease and pollution due to the Project activities damage fish species in the Reservoir.
1)-b)	X	X	There is no significant groundwater usage around the Reservoir.
1)-c)	X	X	There is never such risks, as water flow will be decreased.
1)-d)	X	X	Soil sedimentation will be decreased due to decreased flow.
1)-e)	X	?	It is questionable to how much extent water decrease and pollution due to the Project activities damage fish species in the Reservoir.
1)-f)	X	X	The Reservoir water is used somewhat for navigation, but not for major transportation purpose.
2)-a)	X	?	It is questionable whether water pollution caused upstreams will be purified enoughly within the Reservoir or it will adversely affect fish species damaging the inland fishery.
2)-b)	X	?	How much water eutrophication will happen due to water decrease, and such eutrophication is bad or good for fish breeding, are questionable.
2)-c)	X	X	The region is located enoughly higher than the sea level.
2)-d)	X	X	There is no Project activities in the region at all.
3)-a)	X	X	There is no Project activities in the region at all.
3)-b) Noise	X	X	There is no Project activities in the region at all.

Note : * Refer to Section 2.3.2 (2) for each number's impact title.

Table I.2.18 Summary and Countermeasures of Significant Negative Impacts on Social Aspects

Environmental Impact	Ecological Region No.[1] / Project Stage[2]				
	1		3		6
	DC	PC	DC	PC	PC
Social Issues					
Involuntary resettlement	O	?	O	O	
Countermeasures : Covering of expenses for resettlement ; support of the livelihood of affected population by providing employment opportunities in the construction ; and monitoring of social impacts during the operation stage, to execute mitigation measures.					
Conflict among communities and peoples		O		O	
Countermeasures : Monitoring of social impacts to execute mitigation measures.					
Demographic Issues					
Population increase	O				
Countermeasures : Careful monitoring of possible deterioration of social fabric or value upheaval as a result of rapid population increase.					
Drastic change in population composition	O				
Countermeasures : Careful monitoring of possible deterioration of social fabric or value upheaval as a result of rapid population increase.					
Economic Activities					
Relocation of bases of economic activities					?
Countermeasures : Monitoring of economic impacts to execute mitigation measures.					
Occupational change					?
Countermeasures : Monitoring of economic impacts to execute mitigation measures.					
Institutional and Custom Related Issues					
Adjustment of water or fishing rights		O			?
Countermeasures : Monitoring of social impacts to execute mitigation measures.					
Changes in social & institutional structures		O			
Countermeasures : Monitoring of social impacts to execute mitigation measures.					
Health and Sanitary Issues					
Increased use of agrochemicals		O			
Countermeasures : Monitoring of sanitary impacts to execute mitigation measures.					
Outbreak of endemic diseases				O	
Countermeasures : Monitoring of sanitary impacts to execute mitigation measures.					
Prevalence of epidemic diseases		O		O	
Countermeasures : Monitoring of sanitary impacts to execute mitigation measures.					
Residual toxicity of agrochemicals		O			
Countermeasures : Strict application of relevant regulations.					
Increase in domestic & other human wastes		O		O	
Countermeasures : Provision of waste disposal measures ; and monitoring of environmental impacts to execute other mitigation measures.					

Notes : 1) See Section 2.3.2 (3) and Figure I.2.6 for more detail of ecological regions.
2) DC = During the construction stage of the Project, and
PC = During the operation and post-construction stage of the Project

Table 1.2.18 Summary and Countermeasures of Significant Negative Impacts on Social Aspects

Environmental Impact	Ecological Region No.[1]		Project Stage		
	1		3		6
	DC	PC	DC	PC	PC
Social Issues					
Involuntary resettlement	?	?	O	O	
Countermeasures : Covering of expenses for resettlement ; support of the livelihood of affected population by providing employment opportunities in the construction ; and monitoring of social impacts during the operation stage, to execute mitigation measures.					
Conflict among communities and peoples		O		O	
Countermeasures : Monitoring of social impacts to execute mitigation measures.					
Demographic Issues					
Population increase	O				
Countermeasures : Careful monitoring of possible deterioration of social fabric or value upheaval as a result of rapid population increase.					
Drastic change in population composition	O				
Countermeasures : Careful monitoring of possible deterioration of social fabric or value upheaval as a result of rapid population increase.					
Economic Activities					
Relocation of bases of economic activities					?
Countermeasures : Monitoring of economic impacts to execute mitigation measures.					
Occupational change					?
Countermeasures : Monitoring of economic impacts to execute mitigation measures.					
Institutional and Custom Related Issues					
Adjustment of water or fishing rights		O			?
Countermeasures : Monitoring of social impacts to execute mitigation measures.					
Changes in social & institutional structures		O			
Countermeasures : Monitoring of social impacts to execute mitigation measures.					
Health and Sanitary Issues					
Increased use of agrochemicals		O			
Countermeasures : Monitoring of sanitary impacts to execute mitigation measures.					
Outbreak of endemic diseases				O	
Countermeasures : Monitoring of sanitary impacts to execute mitigation measures.					
Prevalence of epidemic diseases		O		O	
Countermeasures : Monitoring of sanitary impacts to execute mitigation measures.					
Residual toxicity of agrochemicals		O			
Countermeasures : Strict application of relevant regulations.					
Increase in domestic & other human wastes		O		O	
Countermeasures : Provision of waste disposal measures ; and monitoring of environmental impacts to execute other mitigation measures.					

Notes : 1) See Section 2.3.2 (3) and Figure 1.2.6 for more detail of ecological regions.
2) DC = During the construction stage of the Project, and
PC = During the operation and post-construction stage of the Project