Chapter 22

FLOOD & SEDIMENT RELEASE REQUIREMENTS

22. FLOOD AND SEDIMENT RELEASE REQUIREMENTS

22.1 INTRODUCTION

The downstream environment of the Tana River Basin is composed of ecological and production systems which depend on both flooding and precipitation. Because of the inadequate precipitation in the region, these systems rely heavily on biannual flooding. Theoretically, the communities in the downstream environment are at risk from the proposed large dam on the Tana River, but in practice proper integrated management of the entire river basin may alleviate the undesirable impacts. The different ethnic communities population in the downstream region practise a complex set of production strategies sustaining an overall low density through intense but seasonal use of the floodplain resources. If the dam is built without appropriate management to release water during the demand periods, it will adversely affect downstream production systems.

Recent studies show that large dams designed for hydropower generation adversely affect downstream production systems, income and employment (Roggeri 1985, Dixon et al 1990, Scudder 1991, Horowitz and Salem - Murdock 1991). These studies demonstrate that such dams would restrict the natural flood, causing:

- Drastic reduction of flood recession agriculture;
- Heavy reliance on costly irrigated production;
- Decline in the quality of riverine pasture and in the number of stock that can graze during the long dry season;
- Reduction in fish capture;
- Transformation of the natural floodplain, reducing its capacity to support migratory birds and other wildlife, thus resulting in reduced biological diversity;
- Fluctuations in river fishery due to changes in flow regime, effect of dam blocking fish migration, changes in water quality resulting from loss of nutrients trapped by dam; and
- Decline in estuarine and marine fisheries and marine biota, including endangered species, through changes to flow regime and water quality and through loss of nutrients.

The above lessons indicate that there is an urgent need for new approach to the Tana River Basin development whereby dams combine hydropower generation with the release of controlled floods, synchronised with reservoir drawdown, for the benefit of riverine populations and ecosystems.

Annual flood regimes have sustained the economies of downstream communities and production systems without environmental degradation (Scudder 1991). Furthermore, Scudder noted that not only are those producers dependent on annual flood regimes, but their productivity, with associated multiplier effects could be significantly increased by low resource development strategies, embracing the improved water management that controlled flooding would provide.

This has now been recognised in the study terms of reference which refer to the multi-purpose objectives of hydropower production and flood management, acknowledging that in the case of the Tana river this implies flood release which could improve the downstream flooding regime and to some extent compensating for previous phases of dam construction that have affected stream flow.

22.1.1 Implications for Flood Release

The normal flood at Garissa estimated from the analysis of flood events with discharge greater than 500 m^3s^{-1} (section 4.4) has a total volume of 394 MCM. The corresponding flood volume at Grand Falls was estimated to be 490 MCM during a type A event (floods driven exclusively by rainfall in the upper catchment), 406 MCM during a type C event (floods supplemented by rainfall in the catchment between Grand Falls and Garissa) and 364 MCM during a type D event (floods including significant rainfall in the catchment below Grand Falls). These values may be assumed to represent the release, and hence the reservoir storage, required at Grand Falls to support the normal flood at Garissa.

The required storage at Grand Falls was estimated by a previous study (Nippon Koei, 1995a) as 423 MCM. The results presented here are at variance with this figure and suggest that either more or less storage is required depending on the volume of additional runoff to the Tana downstream of Grand Falls. The earlier study did not identify the different patterns of rainfall and inflow from Grand Falls which we now believe to be very important in flood production at Garissa and the Lower Tana.

In the case of a type A flood, with relatively low tributary inflow, the estimated release required from Grand Falls is 16% greater than that previously estimated. A release of this size should be able to guarantee normal flooding at Garissa regardless of inflows below Grand Falls. With relatively more runoff from tributaries of the lower Tana the release from Grand Falls could be reduced with the additional runoff supplementing flow in the main river to produce the normal flood at Garissa. In these circumstances, an estimated release of between 74-83% of that required in the type A situation should be sufficient to support the normal flood depending on the extent and intensity of rainfall.

These findings suggest two alternative strategies for the release of flood flows from Grand Falls.

Predefined Fixed Flood Release

The first, and more straightforward, strategy is to release the flood flow which will guarantee the normal flood at Garissa regardless of other inflows (type A release). A possible concern with this strategy is that it could result in more extreme, and potentially hazardous, flooding than required at Garissa if coinciding with large inflows from the catchment downstream of Grand Falls.

Variable Supplementary Flood Release

The alternative strategy is to deliberately release floods flows to coincide with tributary inflows. This strategy would require a smaller release from Grand Falls, but is reliant on an ability to forecast runoff generation from the top end of the lower Tana catchment, particularly from the Nyambene Hills. Although not analysed here in detail, the lag time between rainfall in these areas and flow at Garissa appears to be around 3-4 days. The lag time between flows at Grand Falls and Garissa was estimated as 1-2 days. This difference in lag times suggests that a strategy of flood flow release which takes into account rainfall on the Nyambene Hills and lower slopes and in the area downstream of Grand Falls over the previous 1-2 days would indeed be feasible. This strategy would require a system of instrumentation to monitor rainfall in the critical areas of the catchment and a set of release control rules governing the volume of flows released in relation to threshold rainfall values. The release of flows in accordance with these control rules could ensure that extreme flooding would not occur at Garissa because inflows downstream of Grand Falls were always taken into account.

A critical benefit of this supplementary release strategy is that the minimum volume of water is released to provide a downstream flood event, and hence maximising the storage volume for power generation. Initial estimates indicate a saving of at least 12 % of the flood volume that would then be available for power generation. Clearly if the entire upstream system of 7 reservoirs were managed according to upstream rainfall events to maximise use of seasonal flows, the potential to increase power output from the whole system would also be increased.

One further comment relates to the frequency of the normal flood at Garissa. Floods of greater than 500 m^3s^{-1} currently occur in at least one of the two wet seasons in 8 out of every 10 years (see section 4.2). However, the chance that a flood of greater than 500 m^3s^{-1} will occur in only one wet season of any year is estimated to be 0.5. The release of flood flows, by whatever strategy, to allow out of bank flooding at Garissa in every wet season would therefore represent a marked improvement on the current pattern of seasonal flooding.

22.2 FLOOD RELEASE

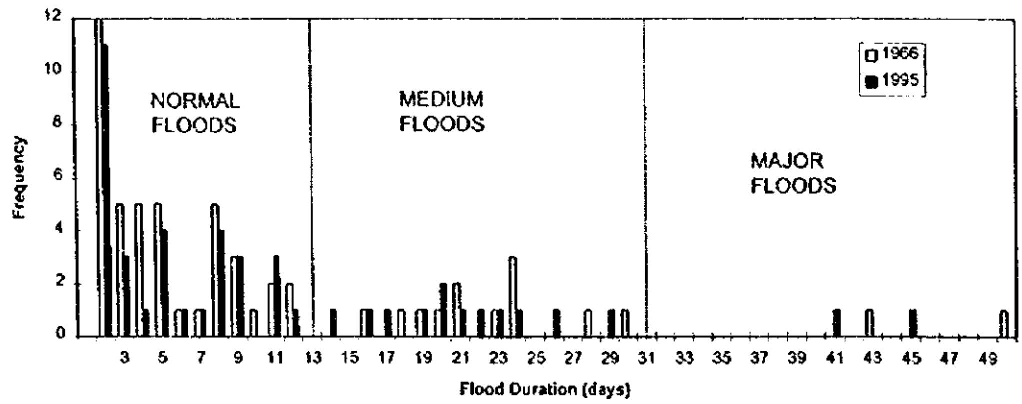
Given the strong dependence of downstream ecological, social and production systems on the regular flooding regime of the river, the impact of existing reservoirs on this, and the potentially severe impact of the proposed reservoirs, the study adopted a concept of "artificial" or managed flood release as a mitigation measure.

Given the general lack of detailed data on downstream systems and the long time period over which such information will need to be collected, the study adopted a concept for resolving this issue along the following outline:

- Floods which normally occur bi-annually on the Tana will play, as generally admitted, a key role in the maintenance of downriver environments, through inundation on the floodplain.

- Floods which have a magnitude of over 500 m^3/sec flow volume at Garissa will contribute towards the inundation of the floodplain downstream of this point.
- Analysis of the 1995 flow series (Delft simulations) indicate that 70% of the recorded floods with magnitude of over 500 m^3/sec at Garissa have had a duration of inundation of 5 days[1]. A 5-day flood can therefore be regarded as a "normal" flood. (See Figure Figure 22-1)
- It is proposed that the dam will be equipped with a facility to allow artificial release of water with the same magnitude as the "normal" 5-day flood at Garissa. As a result, the dam should be able to provide mitigation against a majority of the adverse impacts that would occur downstream in the absence of a controlled flood release.

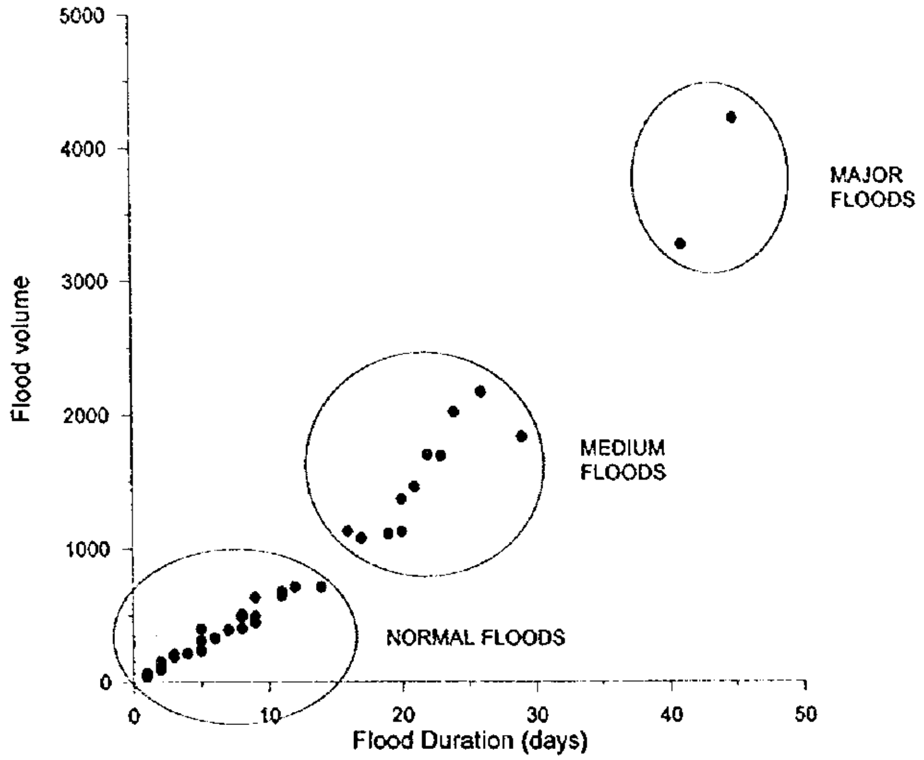
Figure 22-1 Estimated Frequency of Flood Duration at Garissa, under Natural Conditions (1966 situation) and with Existing Upstream Reservoirs (1995 situation).



Floods of less than 24 hours are not included. Source: Estimated 25 year discharge series at Garissa: 1966-90

[1] Floods with a duration of only one day or less were not included in this figure.

Figure 22-2 Flood Duration at Garissa (days with flows over 500 m^3/sec) and Total Flood Volume (million m^3), estimated from the 1995 situation (25 year daily flow series).



22.3 SEDIMENT RELEASE

The present river system has already been affected by the upstream dam construction, which will have reduced the sediment; the proposed dam construction will remove the majority of sediments that are carried by the last two permanent tributaries, leaving only inputs from the seasonal laghas. The sediment load can be considered as having two roles in the downstream system, the first is structural and the second nutritional.

Sediment erosion and deposition changes the topographic nature of the environment, while the nutrient load enhances the biotic productivity. The most obvious structural features associated with this sediment load are the levees rising above the floodplain and main river channel, and the delta and mangroves extending into the sea.

The management of sediment release is more complex than the management of flood release; the discharge pattern is far more variable, depending heavily on the vegetation status of the catchment, which in turn can be strongly affected by the rainfall patterns for the previous season. Within any season, much of the initial sediment transport occurs at the start of the rains and as a result need not coincide with the periods of highest flow.

Under an un-regulated stable river flow system, these sediments are transported through the basin in a stages. High sediment load from fast flowing tributaries may be temporarily stored in the main river channel until the flow and hence transport capacity of the main channel increases. As a result over the whole year, the sediment transport may be taken as being in balance with sediment input.

In terms of sediment composition, there will again be selective transport throughout the year as the coarse sediments can only be carried by the higher flows. The effect of this is that during high flow periods the proportion of coarse sediment particles will be higher than the source material as coarse materials are picked up from sites where they had been temporarily deposited by previous lower flows. During the dry season the proportion of fine particles will be high as flows are too low to transport coarse materials. However, the balance of particles transported and deposited throughout the system over a long period must equate to the composition of the original eroded sediments.

It has been clearly established that under all scenarios, there will be a reduction of sediment load that will lead to major changes in the downstream environment. The most obvious change will be in channel erosion, which has been predicted to extend for 40 km below the rapids at Kora to a depth of 11 metres. The impact of the decrease in fine sediments has not been adequately evaluated as no complete seasonal data sets are available and as a result the overall transport pattern can not be clearly established. However the loss of fine sediments will have implications that extend further down the basin than the loss of course sediments. The effects of decreased clay concentrations could be most significant at the delta, where the presence of brackish water provides the salts that cause the clays to flocculate and deposit building up the surface of the delta and providing the substrata for the mangroves systems. The models have predicted that the combined reservoir systems will trap around 60% of the fine clay particles and associated phosphate and organic matter during the wet season and 85% during the dry season.

Release Of Density Current

The reservoir model has indicated that at high flow discharges in the Mutonga and Kathita rivers, the cool sediment laden waters are likely to pass directly through the reservoir bodies as a density current. The dead storage in the Mutonga reservoir would be filled fairly rapidly with this flow, and the density current would then be discharged through the turbines, mixed to the discharge capacity of 200m^3/sec with supplementary water from Kiambere. This current would then flow towards the dam wall of Low Grand Falls. At very high discharge rates this flow would be expected to reach the reservoir and settle in the dead storage zone. A similar process would occur with the Kathita water, although the gross discharges are considerably lower than Mutonga.

It may be possible to release some or all of this density current through an undershot structure, both delivering some sediment to the downstream system and reducing trapping within the reservoir body. The information available is not adequate to indicate with any certainty the frequency or scale of this effect, and it is not possible to predict the scale to which this undershot discharge could mitigate for downstream sediment loss.

It should again be emphasised that the maximum sediment load generally occurs at the start of the rains which may well not coincide with the peak flood period.

22.4 OPTIMUM RESERVOIR OPERATION

Clearly optimum reservoir operation will be aimed at maximising power output while maintaining enough excess storage capacity to allow for flood release. The design objective of a storage reservoir is to provide enough storage capacity to hold the excess wet season flow for release during the dry season, aimed at providing a consistent power output throughout the year. This aim has to be balanced against the cost of providing storage for both seasonal and longer term variations.

The total volume of water that needs to be released at Grand Falls to generate a single flood event is typically between 6 and 8% of the total annual flow, depending on the downstream rainfall contribution. Bi-annual floods therefore would be equivalent to between 12 and 16% of the total annual discharge past Grand Falls.

However this does not equate to the same loss of power potential, as the flood discharge will be split between the discharge through the turbines, the discharge through an undershot or other offtake and the discharge over the spillway which would occur at peak flood flows however the reservoir system was managed. The actual power cost is likely to be around 5% of the total power generation capacity, and could be compensated for even further through the integrated management of the combined power generating capacity of the seven dam system.

The optimum management of the reservoir will therefore require the ability to predict and monitor rainfall patterns in the upper catchment as well as in the lower basin to guide flood release for downstream benefits. The use of longterm forecasts would improve the dry season management in the drawdown period prior to the rains to equate to the expected rainfall patterns. The use of rainfall prediction, combined with realtime measurements of actual streamflow, could significantly improve the management of the combined upstream dams. This combined management therefore has further implications on future institutional arrangements for the management of the power generation industry.

22.5 MANAGEMENT OPERATION REQUIREMENTS

Clearly the optimum management of the system will rely heavily on the capacity to monitor and predict the rainfall events within the basin, to provide the information that will allow flow rates to be adjusted for future events and to maximise the benefits of power output and the release of downstream floods.

There are two aspects to the improved management of the Mutonga-Grand Falls system that have not been reflected in any previous phases of hydropower development in Kenya;

- Reservoir operating decisions will need to be made by the power engineers with the support of **additional expertise in establishing and managing a basin wide real-time monitoring system** covering actual flow and sediment rates in the tributaries and main channel, and monitoring and predicting rainfall both in the source of the upper catchment and in the downstream flood area; and
- The management decision making process, supporting the release of floods to the downstream systems, must include **representation from the downstream communities**, extending beyond consultation to active participation planning and management.[1]

The necessary expertise to manage an effective monitoring system could be established as part of the institution responsible for the day to day management of outflow release and hence power generation[2]. As an alternative the management of the monitoring system could be taken on by an independent institutional arrangement building on expertise found in other government and parastatal institutions, the universities and private companies. Whichever arrangement is preferred, there will still be the need for a major capacity building exercise as neither the necessary equipment nor the expertise is presently available.

The second requirement is possibly even more critical, in that it reflects the willingness of management authorities that consider themselves to be specialists, to delegate part of their present executive decision making role to other (non-specialist) organisations. However, given the critical demands for management that are defined by the release of floods rather than the traditional maximisation of power output, the structure of the management institution must reflect the multi-purpose objectives of the project and include representatives from the traditional pastoralist and arable farming and fishing communities, as well as the more established formal structures of the irrigation schemes. The concerns of the "conservation" bodies will also only be

---

1 These consultitative and management processes are not covered by Chapter 25 (Institutional Requirements) but need to be examined in detail, as a prerequisite to the design of systems for management of controlled artificial flood releases to maximise benefits to the Kenyan economy.

2 The final operational management of the reservoir could come under a number of institutional arrangements, ranging from direct management by TARDA, to management by TARDA on behalf of Kenya Power and Lighting, or some other institutional arrangement which does not include direct participation of TARDA. A further discussion of institutional issues is contained in Chapter 25.

met by their direct inclusion in the decision making process, there will therefore be a need to incorporate representation from KWS, NMK and national and possibly international NGOs.

Again it needs to be stressed that this broadening of the institutional scope is more than a consultation process and provide the capacity to negotiate acceptable management decisions between users with potentially conflicting demands for timing and extent of flood release. Only if the communities can be assured that their views are incorporated will there be a possibility of avoiding conflict, this assurance must be given by their own representatives involved in the decision and negotiation process.

Given that the maximised benefits of the project will only be met by extending that management to include the upstream reservoirs, a new institutional arrangement would appear necessary that has executive authority over the previous phases of hydropower development. In addition, as upstream demands for water abstraction increase, the upstream users should also be included as part of the institutional arrangements, to provide an overall basin management capacity that will represent the views of all users within the basin, as well as the wider national demands for power and water.

Section 6

POWER TRANSMISSION SYSTEM

Chapter 23

POWER TRANSMISSION SYSTEM

23. POWER TRANSMISSION SYSTEM

Electric power transmission systems include the transmission line, its right-of-way (ROW), switch yards, substations and access or maintenance roads. The main structures of transmission line include the line itself, conductors, towers and supports. The ROW in which the transmission line is constructed can range in width from 20 to 500 m or greater depending upon the size of the line and the number of transmission lines located within the ROW.

23.1 POWER LINE ROUTE

Hydropower development along the Tana River began in 1968 with the completion of Kindaruma dam with an installed capacity of 44 MW. Since then, four further dams with power plants have now been built at Kamburu (94.2 MW in 1975), Gitaru (145 MW in 1978), Masinga (40 MW in 1981) and Kiambere GORGE (144 mw IN 1988). The proposed dam sites (Mutonga and Grand Falls) for hydropower development are located downstream of Kiambere hydropower station. The Mutonga dam site is proposed to be located immediately downstream of the confluence of the Tana and the Mutonga rivers. The Grand Falls dam site is proposed to be located about 4 km downstream of the rapids referred to as Grand Falls.

The proposed power line route covered by this study is shown in Figure 23-1. This study does not cover the route taken by the power line from Kiambere Power Station on to Nairobi and/or other centres[1].

As seen in Figure 23-1, the main power line extends from Grand Falls dam site to Kiambere Power Station covering a distance of about 50 km. A short (approx. 5 km) line from the Mutonga dam site joins the Grand Falls/Kiambere power line near Kamunyoni Primary School of Katse location.

The power stations associated with the proposed dams would be built on the right bank of the Tana in Mwingi District. The transmission line will be confined to Tharaka and Mumoni Divisions. The proposed Grand Falls Kiambere power line will pass through Tharaka Chief's Camp and close to Kamunyoni Primary and Katama Primary Schools of Tharaka Division.

The transmission line mainly follows a north-south direction from the proposed Grand Falls dam site to the Kiambere power station. For much of its distance the power line is confined to the corridor between the Tana River to the west and the Mumoni Hills to the east. The power line crosses several seasonal rivers including the Kalange,

---

1 It is, however, considered that an additional power transmission line, or additions to the planned planned lines, will be required in order to carry the full power output from Grand Falls and Mutonga as well as Kiambere. This additional line is the subject of a separate environmental assessment and any additional lines on the same route are expected to be subject to the same environmental assessment criteria as this other study.

Kamura and Konyu. Near Kiambere power station the power line crosses the Tana River and connects with the Kiambere/Nairobi power transmission system.

23.2 BASELINE CONDITIONS

23.2.1 Topography

Generally, the area associated with the proposed dams and the proposed transmission line is characterised by the presence of two major landforms, the Kijege Mountains to the west and Mumoni Range to the east. The Tana River runs in the area between the two mountain system in a south to north direction until Grand Falls where the river changes its course towards east.

The landscape over which the proposed power transmission line passes varies from the high relief of the Mumoni mountains and other small hills to the low relief in close proximity of the Tana River. The physiographic features of the transmission line stretch consists of mountain slopes, hills, plains and river valleys.

The area to be crossed by the transmission line is a lowland and mainly lies between 500 and 700 metres a.s.l. However, to the east along the Mumoni mountains, the landscape is rugged and hilly with several inselbergs rising to or above 1,200 metres a.s.l. Rugged and hilly landscape is also found in the area towards Kiambere where slopes of 5 - 15% are found in the lower lands and 15 - 30% on the hills and mountain slopes.

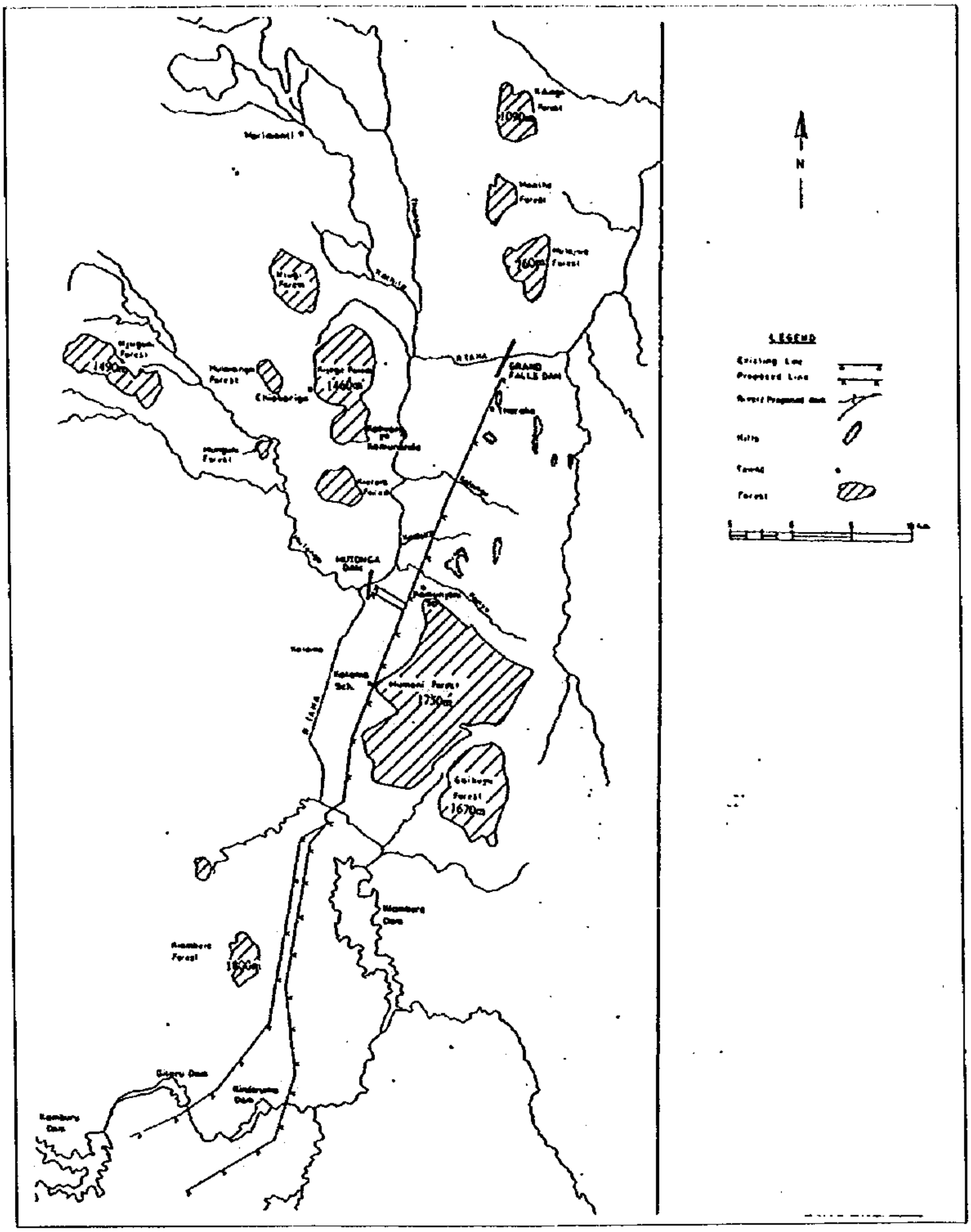
The area is drained by the Tana and several seasonal tributaries including Kalange, Kamura and Konyu rivers. The banks of the Tana river have variable slope gradient. At the proposed dam site, the Tana has steep slope with 30 - 40 degrees which change from about 20 m above the river bed to relatively flat plains.

23.2.2 Geology

The most comprehensive information on the geology of the reservoir area is contained in geological survey reports by Schoemen (1951) and Dodson (1955). The study area is underlaid by rocks of the Basement system generally considered to be Lower Precambrian (Archean Age). The basement complex is part of the original crust of the earth that has a risen through metamorphic processes (extreme heat and pressure). The basement system forms an extensive and highly dissected plain. However, in the study area, it has been altered by the emergence of intrusive rocks which have given rise to mountains and hills of Mumoni, Kijege, Ntugi, Kierera and Mutejwa among other inselbergs.

The most common rocks in the basement complex of the study are gneisses which include biotite gneiss, granitoid gneiss and hornblende gneiss. Other common rocks of the study area are granites, granodiorite and migmatite. In addition, there are small areas of schist and quartzite.

Figure 23-1 Power Line Route



To the west and north of the study area the basement rocks are overlaid by Tertiary and Quaternary laved from Mt. Kenya and Nyambeni Range. The basalt lava flow forms a narrow ridge which reaches close to the Tana River in the vicinity of the confluence of Mutonga and Tana about 1.5 km north of Mutonga dam site.

The mountains and hills of study area are formed by mainly granitoid gneisses which have rather high resistivity to weathering. In contrast the area along the Tana River, between the Kijege/Kiera Mountains to the west and Mumoni to the east is formed mainly by semi-pelitic banded gneisses which are relatively poorly resistant to weathering.

A more recent geological survey of the proposed dam sites (JICA Report, 1995), has revealed similar rock composition as discussed above. The bedrock at the dam site belong to the Archean Kenyan Basement System consisting of gneisses or migmatites which have been intruded by small contemporary bodies of granite and pegmatite. The migmatite gneisses comprising closely spaced bands of quartz-feldspathic materials are mainly the dominant rock types at the Mutonga and Grand Falls dam sites.

23.2.3 Soils

Soils of the study area are developed from the Basement complex rocks, predominantly gneisses. They consist largely of ferric, orthic, rhodic or chromic Cambisols, Arenosols, Ferralsols, Luvisols, Regosols chromic Acrisols and Lithosols. These soils are generally well drained, shallow to moderately deep and are low in organic matter and plant nutrients. They are often excessively sandy or gravely and are characterised by quartz stonelines and a high degree of erodability. Three major types of soils are found in the area that will be traversed by the proposed power line.

Chromic Cambisols	These are soils developed on undifferentiated Basement System rocks, predominantly gneisses and are associated with dissected erosional plains. They are well drained, shallow dark red to yellowish red, friable to firm, stony loamy sand to clay. The chromic Cambisols are mainly confined to the corridor along the Tana and occupies the area to be covered by the proposed reservoirs of Mutonga and Grand Falls.
Chromic Luvisols (Lixisols)	Like the chromic Cambisols, the chromic Luvisols are also developed from undifferentiated Basement System rocks which are predominantly gneisses. These soils are associated with the undulating landscapes. The soils are well drained, moderately deep to deep, dark red to yellowish red, friable to firm, sandy clay to clay, often with a top soil of loamy sand. These are the type of soils found between the plains of the Tana and the lower reaches of Mumoni and Kiambere.

Eutric Regosols — These are the soils developed on mountains and hills where the slopes are predominantly over 16%. They are like the above soils developed on un-differentiated basement rocks which are predominately gneisses. The soils are excessively drained, shallow, reddish brown, friable, rocky or stony, sandy clay loam. These are the soils characteristic of Mumoni Range Kiambere hill and other areas of high relief.

The mode of cultivation the semi arid nature of the area livestock overstocking have all contributed to the development of both sheet and gully erosion observed in the study area.

Soil erosion is common in the area to be traversed by the proposed power transmission line. This is mainly attributed to overgrazing and the shifting cultivation which are widely prevalent in the study area. A combination of the above factors leads to depletion of vegetation cover and complexity, thus exposing the soil to erosion from sheet wash and rain plash. Since the soils in this area have generally low infiltration capacity, the rainfall is rapidly converted into surface runoff which washes away large quantities of loose detached soils and sediments leading to gully and sheet erosion.

23.2.4 Flora

The general vegetation attributes of the area that will be traversed by the transmission line has been covered in Chapter 12 on the Natural Resources of the study area. Three major vegetation types including the riverine vegetation, bushland and forests are present in the area that will be impacted by the transmission line.

Riverine Vegetation — The riverine vegetation is a narrow and that runs between the Grand Falls dam site and Kiambere Gorge. The most dominant emergent tree species of the riverine zone are the *Ficus sycomoras, Spirostachys venenifera, Phoenix reclinata, Lawsonia inermis, Newtonia hildebrandtii, Diospyros abyssinica, Sepium ellipticum, Ficus sur and Acacia elatior.*

The understorey of the emergent tree canopy is dominated by a mixture of shrubs, lianas and climbers of which the most dominant are *Hippocratea africana, Thespesia danis, Acalypha fruticosa, Lawsonia inermis, Harrisonia abyssinica, Acacia ataxacantha, Entada leptostachya* and *Calotropis procera.*

The common aquatic macrophytes along the river banks are *Polygonum senegalense, Kanahia laniflora, Sphaeranthus ukambensis, Phragmites karka* and *Cyperus immensus.*

Bushland — This is the most important vegetation community in regard to the construction of the power transmission line. The proposed power line will exclusively pass through the bushland in its entire stretch from Grand Falls dam site to Kiambere area. The vegetation of the stretch is dominated by the species of *Acacia* and *Commiphora*.

Trees of the bushland vegetation are dominated by *Acacia tortilis*. Other important trees include *Balanites pedicillaris, Hyphaene compressa, Sterculia stenocarpa, Adansonia digitata* and *Terminalia brownii*. Towards Kiambere area, *Acacia mellifera* is quite common.

The middle layer of the bushland canopy is dominated by the shrubs of *Commiphora africana*. The shrubs of *Lannea africana* are also extensive in the bushland vegetation. Other common shrubs *include Boscia coriacea, Combretum aculeatum, Acacia senegal, Acacia brevispica* and *Grewia villosa*.

The floor of the bushland is dominated by the grass species of *Aristida keniensis, Brachiria deflexa, Cencrus ciliaris, Chloris roxburghiana, Dichanthium insculptum* and *Heteropogon contortus*.

Forests

The forest vegetation found nearest to the area that will be traversed by the power transmission line lies to the east on the slopes of the Mumoni Range. These are mainly dry forests that are dominated by the decidous trees that shed their leaves during the dry season.

The prominent trees and shrubs of the forest vegetation are *Acokanthera schimperi, Bridelia taitensis, Euphorbia candelabrum, Terminalia brownii, Antidesma venosum* and *Commiphora boiviniana*. Common climbers and lianas found in the forest include *Cissampelos pereira, Dragea abyssinica, Keinia kleiniodes, Chasmanthera dependeus, Tiliocora funifera, Adenia gummifera, Zehneria scabra* and *Meyna tetraphylla*. The common herbs found in the forests are *Gloriosa simplex, Commelina bengalensis, Panicum denstum, Justicia flara* and *Dichoriste thunbergiiflora*.

23.2.5 Fauna

Reports from the local community indicate the area once supported high densities of wildlife including the elephants (*Loxodontia africana*), buffalo (*Syncerus caffer*), rhinoceros (*Diceros bicornis*), impalas (*Aepyceros melampus*) and other large mammals. However, the great majority of large mammals have long since disappeared from the area, as a result of increased human settlement, poaching and habitat change. Rhino are now virtually extinct throughout much of their range. The more common wildlife of the study area including the area of the proposed transmission line is presented in Chapter 12.

Riverine Fauna

Among the riverine vegetation along the Tana, the sykes monkeys (Cercopithecus mitis) and the velvet monkeys (C. aethiops) are common in the tree conopies. The Tana river supports large populations of hippo (Hippopotamus amphibious). These are large numbers of crocodiles (Crocodylus niloticus) and other reptiles including the African turtle

(Trionyx triungis) and the monitor lizard (Veranus niloticus). Several bird species are associated with riverine aquatic habitats including the Grey heron (Ardea cinerea), Pied kingfisher (Ceryle rudis), African fish eagle (Cuncuma vocifer) and the Egyptian goose (Alopochen aegyptiacus).

The fish fauna of Tana river is varied and comprises the species of *Anguilla, Tilapia, Synodontis, Clarias, Labeo, Alestes, Mormyrus and Barbus*. The aquatic invertebrate fauna is dominated by adults and larva stages of aquatic insects including Hemiptera, Diptera, Odonata and Ephemeroptera.

Bushland Fauna

Due to extensive human encroachment in the bushland community, the wildlife population is low to non-existent, especially amongst the mammals. The exisitng mammals of the bushland community are the Dik-dik (*Rynchotragus kirkii*), the Ground squirrel (*Euxerus erythropus*) and the Porcupine (*Hystrix cristata*).

Reptiles found in the bushland community include the African python (Python sebae), leopard tortoise (*Geochelone pardalis*) agama lizard (*Agama agama*) and a wide variety of snakes. Most of the avifauna listed in Chapter 12 are found in the bushland community. Exceptions are fish eagles, grey herons, kingfishers, geese, and waders (plivers, sandpipers etc.) that are associated with the Tana's riverine environment.

Forest Fauna

The mammals that are mainly found in the forest are the sykes monkeys, the vervet monkey and the baboon. The bush pig (*Potomochoerus porcus*) and the warthog (*Phacochoerus aethiops*) are also found in forest habitats. Many of the terrestrial birds listed in Chapter 12 will also be associated with the dry forests bordering the bushland community.

23.3 POTENTIAL IMPACTS

Electric power transmission systems are linear facilities that will affect both the natural and socio-economic resources of the study area. In general the environmental impacts pertaining to either natural or socio-cultural resources increase with increasing line length. As linear facilities, the impacts of transmission lines occur primarily within or in the vicinity of the right-of-way. Negative impacts of the transmission line will mainly occur during the construction and operation phases of the power transmission lines.

23.3.1 Construction Phase

Construction activities pertaining to the installation of power transmission system involve excavations, concreting, transportation, bush clearing and building of substations, campsites, access roads and erection of tower pads and support systems.

These activities will have negative impacts on the biophysical environment including the soils, flora and fauna as discussed below:-

Soils

The severity of impacts of the transmission line on the soils will depend mainly on the types of soils where construction activities are taking place the nature of terrain in the project area and the vegetation cover.

The soils of the transmission line project area are chromic Cambisols, chromic Luvisols (Lexisols) and eutric Regosols. These soils are developed from basement complex rocks predominant by gneisses. They are friable, excessively sandy or gravely and have a high degree of erodibility. Construction activities will enhance the erosion of soils in the area traversed by the transmission line. Where there is little vegetation cover the risk of soil erosion will be higher than areas with sufficient vegetation cover. A combination of shifting cultivation and overgrazing has led to depletion of vegetation cover and complexity in many sections of the project area. The worst hit section is between Grand Falls dam site and Katama.

Areas which are hilly, rugged and with steep gradients will be much more vulnerable to soil erosion than flat and gently undulating landscapes, hence have a greater impact of the construction activities. Construction activities are expected to stimulate soil erosion in areas with steep slopes such as the Grand Falls dam site, Mutonga dam site, the area close to Kiambere gorge and where the transmission line passes close to the hills of the study area. The impact of construction activities will be more pronounced in these areas more than any other section of the transmission line.

The combined effect of the transmission line construction, camp site preparation and the building of access roads will lead to acute and chronic soil erosion problems in some sections of the transmission line as explained above. Some of the excavated soils will be washed away as runoff to the Tana River and the seasonal tributaries. This will contribute to the siltation of the water bodies albeit on a small scale.

Flora

The transmission line mainly passes through the Acacia/Commiphora bushland community. The project activities that will affect the structure and composition of the vegetation are excavation of soils and other geological formations, clearing and cutting of tree, trampling of vegetation, levelling of landscapes and general construction work.

The above activities will destroy the habitat for both faunal and floral communities along the transmission line. There will be a loss of biomass from the cut trees and shrubs. To a small extent there may be a loss of biodiversity of plants of economic and medicinal value. Plants of economic value that will be affected by the construction activities *include Acacia tortilis, Hyphaene compressa* and *Tamarindus indica*. Plants of medicinal value that will be affected include *Erythrina burtii, Solanum renschii, Zanthorylum usambarense* and *Entada leptostachya*. The impacts, however, will be minor since the transmission line is narrow and go for a short stretch. The plant density is low and the trees are widely scattered in this area.

Fauna

The above project activities that affect the floral communities will also have an impact on faunal community. Virtually there is no wildlife in terms of large mammals along the transmission line. However, there are small mammals such as dik-dik, squirrels, porcupines and rodents in the bushland community of the transmission line. In addition, there are reptiles including snakes, tortoises and lizards.

The project activities will destroy the habitat for the above faunal communities. In addition, the movements of people and machinery will disturb and harass the animals along the transmission line and the surroundings. The above impacts are unlikely to be significant because few animals occur along the proposed trace.

23.3.2 Operational Phase

Operation and maintenance of the transmission line involves the control of vegetation in the ROWs and occasional line repair and maintenance. The above activities plus the physical presence of the line itself can be a source of environmental impacts.

Soils

The maintenance of the transmission line will mainly involve clearing of shrubs and other plants that have grown along the transmission line since the installation of the facility or following a previous maintenance exercise. During the operations phase, the soils will only experience minor direct impacts. There will be minor cases of soil erosion especially where the plant cover has been completely destroyed and in areas where the soils are highly susceptible to soil erosion. Such areas include where the transmission line passes across or in close proximity of river banks at Mutonga and Grand Falls dam sites and across the Tana in the Kiambere area.

Flora

Project activities during the operations Phase will mainly consist of trampling and clearing of vegetation along the trace. This will eventually have some limited impacts on the structure and composition of the plant community. The shrubs and trees growing in the ROW will be periodically cut during the operations phase. There will be negligible impact on the grassland community since vegetation whose height is less than one metre will not be cleared. Consequently, there will be a change of vegetation structure and composition where the grass community will be the dominant vegetation along the transmission corridor.

Fauna

The operations phase will virtually have no negative impacts on the wildlife along the transmission line. This is due to the fact that animal population density along the transmission line is quite low.

On a positive note, power line ROW when properly managed can be beneficial to wildlife. Some small mammals such as dik-diks will prefer to graze along the cleared trace to avoid the predators. The power lines and other transmission structures can serve as nesting sites and perches for many birds especially the raptors.

23.4 MITIGATION MEASURES

Development of transmission line facility and the associated activities will have some impacts on the area of operation. Excavation activities and removal of vegetation will stimulate soil erosion and to a small extent siltation of nearby water bodies. The project will cause habitat loss for plant and animal species, a decrease in species composition, biomass and in some areas lead to a fragmentation of habitats. In order to minimise the negative impacts, the following mitigation measures are proposed:

23.4.1 Soils

Following the completion of the construction activities, a programme should be initiated to rehabilitate the degraded environment. Immediate action should be taken to address the problem of soil erosion and the potential for the siltation of the nearby bodies. Towards this end the following short-term measures are proposed:

- relevant planning to minimise unnecessary excavations and vegetation clearing.
- excavation and other earth works to be carried out during the dry season.
- excess loose earth to be disposed of before the onset of the rains.
- cover all pits, borrows and other excavated areas.

The recommended long term measures to mitigate negative impacts on soils are:

- Landscaping of the degraded areas and substrates including the building of gabions, drainage channels and terraces.
- Planting of suitable sediment binding grasses such as *Cenchrus ciliaris*, *Chloris roxburghania* and *Eragrostis superba* in the degraded substrates
- take measures to discourage public use of the trace in order to avoid soil erosion and formation of gullies.

23.4.2 Flora

The proposed measures to mitigate against negative impacts on the plant community along the transmission line are as follows:

- Use of heavy machinery in the clearance of the trace should be discouraged in order to avoid large scale trampling of the vegetation. Only the woody vegetation such as shrubs and trees in the trace should be cleared.

- Caution should be exercised in selecting the technique for clearing vegetation from the ROW and control of new growth. From an environmental point of view, selective clearing using mechanical means is more favourable than use of herbicides. Spraying of herbicides along the area of the transmission line should be avoided. This application affords no selectivity and releases unnecessarily large amounts of chemicals into the environment. The technique is imprecise and may result in the contamination of both aquatic and terrestrial food chains and elimination of desirable species.
- During the construction and operation phases work force camps should be located away from areas of natural vegetation to avoid unnecessary cutting and trampling of vegetation. The campsites should be located preferably within or near the market centres.
- The work crews should be prohibited from engaging in vegetation clearing and cutting of trees outside the transmission trace. This will deter the workforce from cutting the trees for charcoal burning, building, fuelwood and other purposes. This measure will help to curb the spread of environmental degradation outside the area of operation.

23.4.3 Fauna

Impacts of the power transmission line on the wildlife will be minimal. This is mainly due to the fact that animal population density of the area of operation is very low. However, use of heavy machinery in the clearance of trace should be discouraged in order to minimise the loss of animal habitats and also reduce animal disturbances.

Camp sites should be located away from the trace and areas of natural vegetation in order to avoid encroachment on the animal habitats. Use of herbicides should be discouraged in order to avoid direct poisoning to wildlife.

Section 7

MANAGEMENT

Chapter 24

MONITORING PLAN

24. MONITORING PLAN

24.1 INTRODUCTION

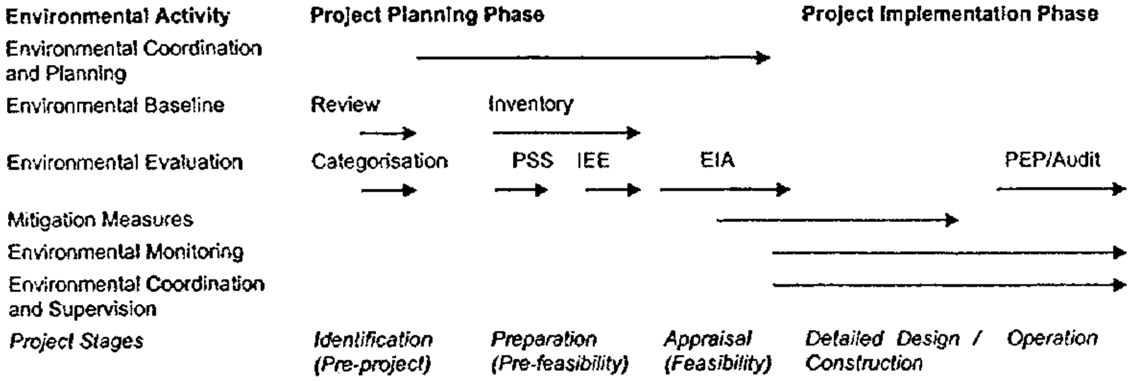
The major justification for recommending environmental monitoring activities is that they can provide valuable feedback information into a management plan.

The establishment of an **Environmental Monitoring and Evaluation System** (EMES) will provide ongoing monitoring for the agency administering reservoir and operations and hydropower generation and for other agencies. These data will provide information relevant of the project's environmental and socio-economic impacts and assist in supporting improved environmental management of the Project itself (i.e. dam operations). This will also provide a basis for appropriate and timely mitigatory measures during the project's life.

Environmental Monitoring may be defined as the "collection of specific information on the characteristics, quantities, and functioning of environmental variables over space and time". **Environmental Evaluation** can be defined as the "analysis and interpretation of this monitoring information to allocate environmental values to the variables at particular points in space and time and so to determine trends".

Environmental Monitoring is an integral part of the environmental management process; it rationally completes the process which starts with establishing the environmental baseline, carrying out the environmental impact assessment, recommending and implementing mitigating measures, and finally monitoring the success of those measures.

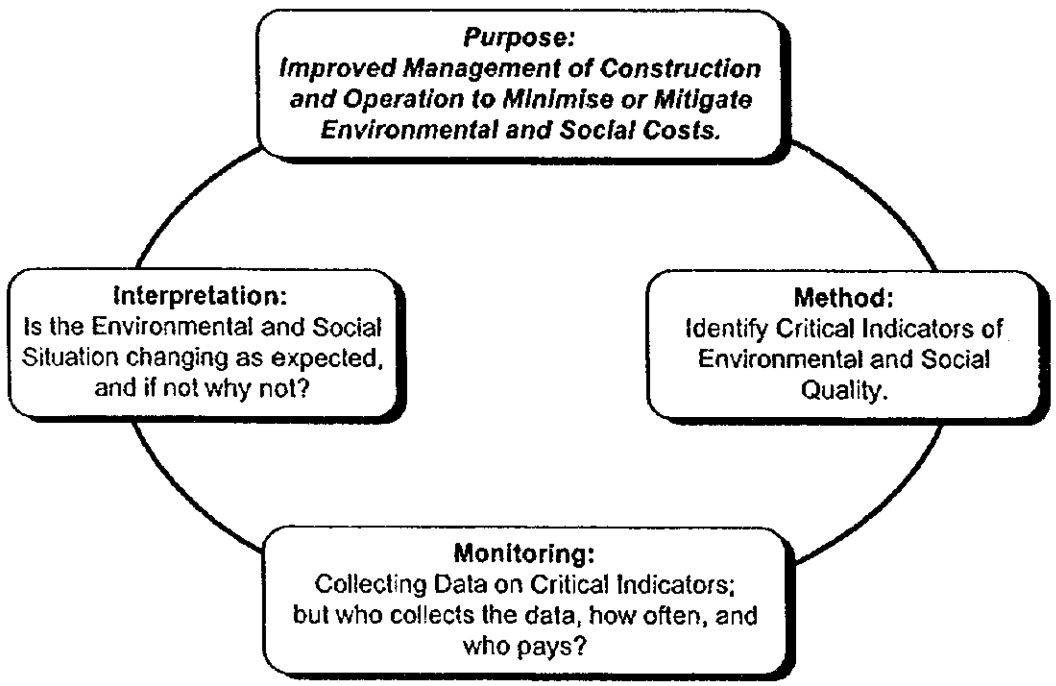
Environmental Management Plan Framework



PSS - Preliminary Screening and Scoping; IEE - Initial Environmental Examination; EIA - Environmental Impact Assessment; PEP - Preliminary Environmental Post-Evaluation.

Amongst the advantages of incorporating environmental monitoring into management, the funding can be built into the overall project costs for both planning and implementation, while appropriate institutions can be contracted to undertake monitoring of various sectors in an optimum fashion. In this way, management can concentrate on ensuring that the data is received in convenient formats and timescales for use with other aspects of the project. Much of the data is likely to be capable of being displayed in map form and managed spatially though an appropriate Geographical Information System.

The Role of Monitoring within the project Structure



24.2 MONITORING SYSTEM

The key function of setting up an EMES is to act as an **early warning system** for management, in which monitoring identifies any sudden environmental deterioration that needs to be countered.

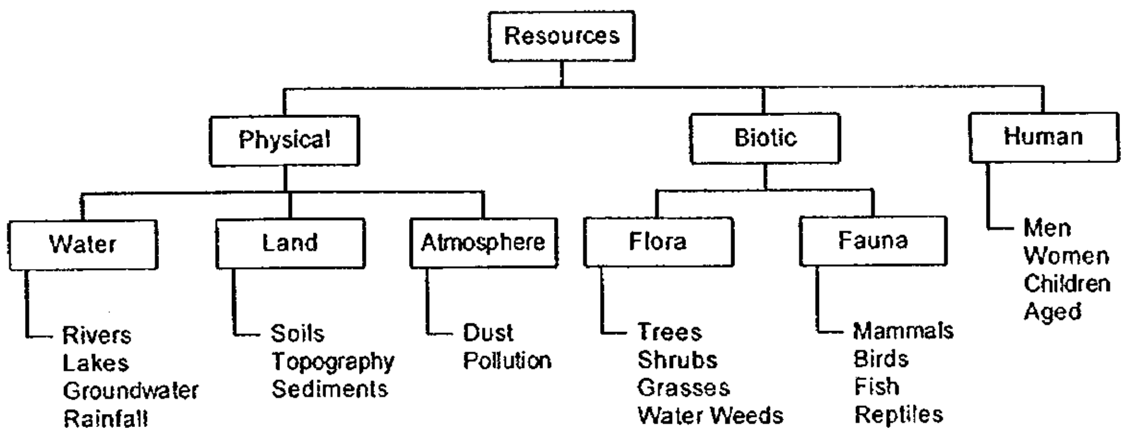
Monitoring should be stipulated in an EIS whenever there is uncertainty about either the level, extent or duration of impacts and/or the effectiveness of proposed mitigation measures, or the proficiency with which they will be carried out. It is also important for assessing residual impacts and for contributing to a cumulative database for use in future assessments to improve the planning process.

Before the question of addressing which impact indicators are to be used to characterise changes in flood release patterns, a programme of monitoring needs to address a number of basic questions:

1. **Purpose** : what is the aim of the monitoring?
2. **Method** : how can this aim be achieved? How are the data, which are to be collected periodically, to be handled? How often is the data required?
3. **Interpretation** : what might the data mean, who will make use of it and when?
4. **Fulfilment** : when will the aim have been achieved?

Monitoring should be conducted throughout the construction, operation and decommissioning phases of the project and funding needs to be guaranteed as part of the development. Parameters used in establishing the baseline conditions can be monitored and their inclusion in a programme of supporting management can help to justify the collection of field survey data in the baseline studies.

Resources Framework



The key resources to be monitored can be categorised as being physical, biotic and human. The following resources framework indicates the potential scope within which indicators may be identified.

Following on from this, it must be accepted that despite the project having one official set of objectives, there are various ways of viewing the success of the project and these should be considered before preparing a monitoring programme. The different interests of affected institutions and communities need to be ascertained so that they can be incorporated as necessary as part of the plan. These different interest groups will attach different values to the outcome of the project.

On order to accommodate these different values the monitoring process should not be seen as static, but regarded as a continuous and participatory process of information sharing to improve decision making. The project must, however, remain flexible enough to respond to the findings of the monitoring programme through

24.3 PROJECT RISKS

A number of "risks" have been identified as potentially limiting the benefits of the project, some of these risks can be assessed and avoidance strategies planned for in advance at this stage of project planning. Other risks will only be identified as the project proceeds, and as, over time, the social, economic and environmental situation evolves, within which the project operates.

It is clear that certain "risks" can be attached to certain aspects of the project function and in certain cases to specific mechanisms promoted to mitigate against negative social and environmental impacts. The following pages indicate ***some*** of the identified risks and possible risk avoidance strategies.

24.3.1 Upstream Risks

The major mitigation measures proposed for the upstream areas include the resettlement of the displaced populations within under-utilised land in adjacent areas. The resettlement planning process has included some measure of consultation with the directly affected and indirectly affected host populations within and around the reservoir area, and this process will have to continue if the major risks to the success of the resettlement component of the project are to be avoided.

However, the implementation of past involuntary resettlement programmes has been well documented and there are international guidelines which can be consulted to avoid major risks.

Insufficient Land

The definition of sufficient land is complex, involving the assessment of quality as well as area. The common definitions of land quality used in surveys are generally not appropriate for individual fields or farms, and each resettled family both owns and will be allocated land that is effectively unique in it's production potential. The allocation of land according to family "requirements" is highly controversial, and it is likely that land allocations will be standardised. However certain families will suffer as a result of this process, and there must be mechanisms to support those families with particular requirements that are not met by the proposed structures for compensation and mitigation.

Unsustainable Pressure on Natural Resources

Additional pressure will be placed on (common) forest and grazing resources, and the proposed mitigation will be the promotion of improved community management, including on-farm planting and controlled grazing. The problem here is again complex; the present land management systems practised by the host populations will become non-sustainable as the population expands, this process will be accelerated as a result of resettlement. The proposed mechanism for management of this risk is the promotion of "improved" farming practices through an extension programme. The immediate risk is that no appropriate (or acceptable) improved farming practices can be identified, or that it can be funded for an adequate period of farming system development.

In addition, no extension package can cope with all possible family requirements, and limitations which vary between households include lack of capital and lack of labour.

Unsustainable Pressure on Infrastructure

The increased pressure on infrastructure can be reduced through direct interventions within the settlement area. However, the increased support of this infrastructure requires long term commitments both in terms of staff and maintenance costs.

Social Unrest Increased

It is possible that resettled families will fail to establish themselves and integrate with host communities, leading to dissatisfaction, marginalisation and increases in unemployment, crime, and social breakdown. This risk is major, increased land pressure and pressure on water resources is already reported to have increased social tensions. Increased social tension may, under certain circumstances, result in severe political pressures. The risks can be minimised through real involvement of both the host and displaced populations in the planning and decision making process.

Reservoir Water Quality Decreases

The predicted water quality is based on an extrapolation of the present agro-industrial patterns within the upper catchment, if these patterns change there is a risk of increased pollution and eutrophication of the reservoirs, preventing or impeding their development as a source of alternative livelihoods in resettlement areas, notably through artisanal fisheries. Additional side effects would include health risks.

24.3.2 Downstream Risks

The maintenance of downstream systems is reliant on the continued release of seasonal floods, and on the release of sediments. It is assumed that the reservoir and dam structures will be constructed to allow for the release of floods and sediment.

Impounding Period Extended

The impounding period has been estimated on the basis of set operating ruels and releasing given water flows. These calculations were carried out using the existing flow series and therefore represent "average" conditions. The management of the impounding period will have to be guided by the actual rainfall patterns within the basin at the time of impounding. The occurrence of drought will, for example, significantly extend the impounding period, and minimum seasonal flow rates will have to be agreed in order to maintain downstream production and avoid serious social tension, famine/starvation and costly relief efforts. The risk here is of an extended impounding period delaying commissioning, or of over-ruling minimum acceptable flow rates to ensure that project completion is on schedule.

Reduced River Flow

River flow and periodic flooding will be further reduced, as additional upstream extraction occurs. The present predicted basin extraction for domestic, agricultural and industrial needs is already of some concern. If the predicted growth rate occurs or is exceeded, total water flow will be reduced. The major risk is then of reduced gross power output and hence of increased commercial pressure to maximise power production at a cost to flood release.

Changed Management Objectives

The stated multi-purpose management objectives are now to use the reservoir to generate power, while at the same time releasing flood and sediments for the benefit of downstream systems. Future changes in management objectives could result in the prioritisation of additional demands on water resources. This will be particularly the case if gross extraction increases in the up-stream areas. The risk here is that the management of the reservoir can be changed to preclude the release of floods and hence reduce the viability of downstream economies.

Sediment Release

All downstream systems rely on the fertility loads of downstream sediment deposits, which are predicted to decrease following dam construction, due to reductions in overall quantities and to changes in physical and chemical composition. This could lead to a fertility decline of riverine land. One risk is that the possible improved regularity of flooding may lead to greater demands and an expansion of arable and pastoral systems. The reduced sediment loads are unlikely to support intensified production, which would therefore require changed farming systems. If this is not practical then there could be a collapse of productivity to lower stable levels.

24.4 PROPOSED MITIGATION

The monitoring plan should provide for feedback of information to project management as a basis for management and timely implementation of the project's proposed mitigatory measures, so as to minimise negative impacts.

The principal mitigation measures proposed are:

Upstream :

- monetary compensation for resettlers, to cover the value of lost land, housing, capital assets and crops;
- compensation in kind through land allocation, on a plot for plot basis;
- improved social and economic infrastructure, including health education, water supply and marketing for the resettlement areas, to cater for the needs of both resettler and host populations;
- management of the newly created reservoirs as commercial and artisanal fisheries;
- plantation of a reservoir buffer zone, and further woodlots, to meet the fuelwood and wood product needs of the resettlement areas ;
- funds to support development and management of a drylands farming extension programme.

Downstream :

- a mechanism to allow controlled, periodic (annual/bi-annual) flood and sediment release, to simulate the natural flood regime;
- institutions to ensure representation of downstream users in decision making, especially those relating to flood/water release, and to control upstream abstraction;
- a fund to support food/drought relief, during the impoundment period;

24.5 MONITORING INDICATORS

Monitoring will need to assess the *biophysical* and *socio-economic changes* which occur in representative and important portions of the lower Tana valley, and upstream, in the reservoir and resettlement areas. It is assumed that separate biophysical and socio-economic monitoring teams will be appointed, from appropriate local or regional institutions.

A full baseline survey, to complete available information on the river basin is an essential basis for subsequent monitoring. This will draw upon existing secondary sources, covered and referenced in the EIA, phases 1 -3, and where necessary, field survey to determine the baseline status of the key monitoring parameters recommended below.

Baseline assessment should take place well before construction commences so that several years of records for the upstream and downstream locations can be obtained.

24.5.1 Socio-Economic Monitoring

Periodic (generally annual, in some cases, biannual) monitoring exercises will need to take place which combine farm household surveys in representative areas with discussions with local government departments, NGOs, Chiefs, location development committees, and councils of elders. A core group of informant households and institutions should be monitored on a regular basis, to ensure consistency and follow up, although wider samples should also be taken.

In addition to questionnaire based surveys, participatory methods and qualitative analysis should be employed to determine the responses and views of local people, and to shed light on the implications of statistical data. If formal arrangements are made for consultation and involvement of local groups and institutions in river basin management then participatory monitoring exercises should be used to stimulate the involvement of local people, and to feed their views into the management process. In any case, there should be a dynamic link between monitoring reports and active mitigation planning. The effectiveness of mitigation measures themselves must also be a focus for monitoring.

24.5.2 Biophysical Monitoring

The monitoring will consist of recording observed effects upon the flora and fauna, and measurement of the physical and chemical parameters of the terrestrial and aquatic environments, to understand the causal factors. The sectoral institutions may well have to conduct preliminary on site surveys to identify appropriate indicator species to follow up. For example it may be necessary to conduct surveys of pasture grasses and herbs to find species which are sensitive to changes of downstream flows and nutrient status. The same may be true of the fishing sector and the forestry sector.

Due to cumulative effects of the existing dams further upstream, changes to the downstream natural resources have already been observed. It is expected that the proposed baseline survey will record the progression of those changes until construction and impoundment commences.

24.5.3 Integrated Natural Resources Monitoring

Some attempt must be made to integrate the results of socio-economic and biophysical monitoring, and assess the implications for management. Collaboration of the two teams should be encouraged, especially where interdisciplinary assessment of certain parameters is useful: e.g. assessment of the availability and diversity of seasonal pasture; assessment of vegetation cover and forest product availability in wetland areas. Ideally, natural and social scientists would collaborate in the field, to undertake joint, participatory investigations with resource users.

Key areas for integrated monitoring include :

- fuelwood and forest product availability in the resettlement zone
- pasture quality and availability downstream and in the delta; regeneration of the useful floodplain species
- fish populations, catches and fishing opportunities
- livestock: numbers, health and condition

24.5.4 Upstream Monitoring: Resettlement Areas.

Upstream monitoring is necessary to ensure that the resettlement process itself proceeds smoothly, during the construction phase, and, subsequently, to minimise social, economic and environmental problems that may occur in the reservoir and resettlement areas.

People removed from the reservoir area need adequate compensation for all land, assets and crops lost, sufficient to establish equivalent, or better, livelihoods elsewhere, and to recompense the loss of ancestral resource rights. They will require transitional assistance in food, cash or kind until productive livelihoods can be re-established elsewhere.

The rapid influx of more people to already settled areas creates new demands upon the existing socio-economic infrastructure and natural resources. These include fuelwood for cooking and warmth, construction materials, land for growing crops and grazing animals, domestic water supplies and disposal of increased quantities of dirty water and sewage. Social services and infrastructure such as schools and clinics will also be put under strain.

Available common land will be cropped and grazed more intensively and needs to be monitored closely to identify requirements for interventions. In addition it will be necessary to ensure that the adjacent lands are protected and well managed., to avoid serious land degradation and possible vegetation loss and soil erosion due to overgrazing, which may result in the sedimentation and pollution of the reservoirs.

The critical factor in ensuring that the resettlement programme proceeds with the minimum of disruption will be to integrate representatives of the local communities within the land allocation and compensation decision making process and in the monitoring of the implementation of the programme. Independent NGOs can be included to allow for an impartial valuation and to act as intermediaries in conflict resolution which is bound to occur with the allocation of land.

Table 24.1 Key Resettlement Monitoring Programme - Physical Attributes

Factor to be Measured	Indicator	Frequency	Suggested Sources
Changes in land availability; relative land availability, settlers vs hosts	Land holdings; pre- and post-resettlement (land area and land value); settlers and host populations	Ongoing during resettlement process; thereafter annually	Farmer surveys
Security of tenure	Progress with land registration	Annually	Lands department, DDC
Changes and differences in farming systems, productivity and capital assets;	Farm productivity, farming methods and assets (including livestock): pre and post-resettlement; settlers and host populations	Annually	Farm household surveys: men and women
Access to wood products; effectiveness of buffer zone reforestation	Distance and abundance of fuelwood and construction timber, pre and post-resettlement	During resettlement and woodlot establishment; then annually	Household surveys, ground survey of buffer zones
Relative availability of gathered produce	Access to wild resources: forage, household materials, medicines etc pre- and post-resettlement		Household surveys
Relative accessibility and adequacy of water supplies;	Distance to water supplies; water quality	Directly following resettlement; annually	DDCs; household surveys
Impact of dam construction and resettlement on forest and bush resources	Changes in vegetation cover and composition pre and post resettlement	During construction and during resettlement; then annually	Biomass and species composition and land use assessment; aerial photography

Table 24.1 Key Resettlement Monitoring Programme - Social Attributes

Factor to be Measured	Indicator	Frequency	Suggested Sources
Changes in livelihoods; relative income levels and sources, settlers vs hosts	Income levels, income sources and employment opportunities: pre and post resettlement; settlers and host populations	Annually	Farm household surveys: men and women
Utility of monetary compensation paid	Disposal of monetary compensation	During resettlement process	Household expenditure surveys
Adequacy of farm production and income sources	Food aid requirements, following resettlement, settler and host populations;	Following construction; following resettlement; annually	DDCs, NGOs
Relative accessibility and adequacy of social services infrastructure, before and after resettlement, for host and settler populations	Distance to health and education facilities; numbers of facilities and utilisation rates, before and after resettlement	Directly following resettlement; annually	Health and education data; DDCs; household surveys
Perceptions of relative welfare conditions; adequacy of compensation and mitigatory measures	Views of settlers and host populations	Following resettlement; annually	Independent, participatory surveys
Effectiveness of consultation process	Involvement of settler and host populations in resettlement process	Before, during and after resettlement	Independent, participatory surveys; Elders and community leaders of host and settler populations
Impact of resettlement on social cohesion and levels of stress	Assessment of social wellbeing and problems (violence, alcoholism, crime etc)	Following resettlement; periodic	District social services department; elders and community leaders

Resettlement Health Concerns

The construction of the reservoir will create conditions which will promote the development of a number of water related disease vectors. In addition, during the construction period the presence of a large workforce is expected to result in increased incidence of other non water related diseases, including STDs.

Detailed studies have not been carried out into the health impacts of the project and the control mechanisms that will be necessary, however it is likely that the interventions will include both vector control and public health and awareness programmes. The capacity of the medical infrastructure in the settlement area will have to be expanded to compensate for the increased population demands.

Table 24.2 Public Health Monitoring Programme

Factor to be Measured	Indicator	Frequency	Suggested Sources
Data on the spread and succession of aquatic weed populations and water borne disease vectors of bilharzia, malaria, tsetse, Cyclops and hookworm.	Extent of aquatic weed cover, presence of increased populations of larvae, snails and other vectors	Baseline data and Quarterly sampling of sites around the reservoir in conjunction with seasonal air photography if available	NMK / University of Nairobi
Disease Incidence	Type and number of cases treated	Baseline data followed by seasonal analysis of records	Medical Centre Records

24.5.4.1 Natural Resources Monitoring Requirements

Fuelwood Assessments

In order to quantify the fuelwood requirements of the settlers, surveys need to be conducted on existing collection sources and consumption patterns both amongst prospective resettlers and host communities.

The useful amounts of wood within the area under impoundment and the distance of haulage can also be estimated as well as that of future supplies for the resettled locations such as small construction timber requirements. The objective of such a survey should be to determine whether there is likely to be a deficit of fuelwood for the whole community and how this might be addressed on a sustainable basis and to enable calculation of requirements for planting up the reservoir buffer zone and local woodlots in the resettlement area.

A well designed questionnaire for interviewing a random sample of households should enable extension officers to determine collection and consumption. The interviewing should be repeated amongst the resettled persons and the original occupants every three months until a stable pattern of usage emerges.

Sample biomass measures of potential fuelwood should be correlated with up-to-date aerial photography to enable calculation of potential stocks from the area of impoundment and from the areas to be resettled[1].

If long terms shortages have been predicted, consideration should be given to planting fuel wood lots and introducing low cost alternatives to wood, this will also need monitoring to assess the effectiveness of these interventions.

Where Ministry of Agriculture and Department of Forestry is unable to undertake this type of survey, it may be appropriate for members of Forestry NGOs and research staff from Departments of Environmental Science and Remote Sensing at Nairobi University to do so.

Land Use Suitability Mapping.

The opening up of land to cropping and grazing should take into account the suitability of the soil type for a particular usage. Detailed maps of the lands to be allocated to the settlers should be prepared and guidance given where usage is deemed to be inappropriate. Land Use Officer from the Ministries of Agriculture or Local Government should be well placed to make use such maps and where they do not exist, they can be compiled from soils data and air photographs. It should be born in mind that land use changes by the season, so that during the resettlement period and for at least a further five years, the land use changes should be mapped seasonally. Videography may be an acceptable, cheaper alternative to air photographs for noting rapid land use changes. Timely advice provided through the extension service can minimise costly remedial actions. Once again, collaboration between the University, NGOs and various ministries might spread the work load.

24.5.5 Water Quality of the Reservoir

The impoundment of a major river in Africa has profound effects on the ecology of the entire river basin and research is necessary, both before and after the closure of the dam into the reasons for changes in the interrelationship between physico-chemical factors and such aspects as invertebrate production and fish population biology.

---

[1] The clearing of vegetation from within the area due to be inundated will reduce the effects of eutrophication of the reservoir being created. This could produce a stockpile of useful wood products for use or sale by the population of the resettlement area.

The likely effects of creating reservoirs at Low Grand Falls and Mutonga on the ecology of system and the consequent need for monitoring are summarised in the table 2. below.

The reservoirs behind the proposed dams will be typically high nutrient load, warm water with all the attendant management problems of eutrophication, deoxygenation and waterweed control. These aspects will obviously require a programme of careful management to ensure that the reservoirs created remain conducive to good fish growth.

Clearance of the vegetation below the zone of inundation possibly with the aid of local labour will considerably reduce the sources of organic matter contributing to the process of eutrophication of the reservoirs.

Table 24.3 Reservoir Water Quality Monitoring Programme

Factor to be Measured	Indicator	Frequency	Suggested Sources
Sampling of spatial distribution of toxic substances before and after impoundment. Distinguish toxins brought into the system from those generated in situ such as those from blue green algae	Concentrations of pollutants in the inflow from Kiambere, Mutonga and Kathita, within the reservoir water profile and in the discharge	Baseline survey and quarterly sampling through impoundment and for several years thereafter.	Depart of Water in collaboration with University of Nairobi
Nutrients likely to cause undesirable changes on water chemistry and biological growth	Concentrations of nutrients within the reservoir water profile and in the discharge	Baseline survey and quarterly sampling through impoundment and for several years thereafter.	Independent consultant / University of Nairobi
Sampling of sediment transport and dispersion through the reservoir	Water sampling and turbidity measurements	Baseline survey and quarterly sampling through impoundment and for several years thereafter	Independent consultant / Ministry staff

Preventative Actions

Phosphates, nitrates, pesticides/herbicides together with the soluble components of decomposing organic matter entering the reservoir from upstream will aggravate the eutrophication process. Once in the river it is much more difficult to treat through remedial action than through preventive action at their sources of generation. Producers of domestic, agricultural and industrial waste and effluent should be encouraged to impound and treat on site thus removing the elements of pollution before they enter the water supply.

Non soluble elements of pollution such fine sediments, clays, silts and organic matter can be trapped again preferably at source before being discharged into the river. The use of biological buffer zones and filters which can take pollutants out of the system before they reach the rivers have been used with success.

Any agricultural or building activity which exposes bare soil to heavy rainfall and unchecked water flow is inevitably going to increase the risk of finer elements finding their way into the adjacent watercourses and hence into the rivers.

Seasonal upstream land use activity surveys to detect bare soil exposure should be considered by local authorities. There also needs to be a feedback mechanism put in place so that those responsible can be advised on how they can maintain effective vegetatal cover over the soil. Solutions to the problem include modification of the site layout and project components to where they will have least impact.

For example, coffee pulp water which introduces a particularly high COD to water should be re -aerated where possible before being allowed to enter the river. Again toxic heavy metals should be precipitated out of solution before reaching the river.

Curative Actions.

While prevention of entry of pollutants into the river is still better than remedial action one can still install a series of filters and traps upstream of the reservoir which will need to be regularly emptied and serviced. Such devices should also take account of and provide for the upstream migration of fish. Biological filters such as beds of appropriate vegetation may also be able to play their part in purifying the river water.

Table 24.4 Reservoir Fisheries Monitoring Programme

Factor to be Measured	Indicator	Frequency	Suggested Sources
Sampling of changes in species composition ,	Changes of fish populations, reports of fish catches.	Baseline survey and quarterly sampling through impoundment and for several years thereafter	Research programme by Dept. Zoology at Uni. of Nairobi ; Extension staff of Fisheries Dept.
Water level fluctuation, shoreline erosion and littoral vegetation establishment.	Reservoir levels, buffer zone vegetation establishment and management	Baseline survey and seasonal assessments thereafter.	Reservoir management reports, vegetation surveys carried out by NMK and Forestry Department

Fisheries

One of the major predicted benefits of the construction of the reservoir is the creation of a new lacustrine fisheries resource. This will, however be at a cost to the existing riverine fisheries, and in particular will effect the pattern of migratory species throughout the river system. There will therefore be a change in species composition of the existing fish population as well as an increase in fish production. From a sociological point of view, there will be a direct economic benefit, although this may not accrue to the local population unless there is a specific programme directed at promoting the industry to the resettled and host communities. It is assumed that economic indicators will be collected as part of the monitoring of the impacts of the resettlement programme on income sources.

24.5.6 Downstream Monitoring

24.5.6.1 Natural Resource Information Needs

Assuming that a flood and sediment release dam will be built, there is an opportunity to start a monitoring programme immediately to collect base data in the years leading up to construction. The critical data includes daily variations in flow and sediment load, and the composition and in particular the nutrient load dissolved in the water and carried in suspension.

There is a clear relationship between the velocity of the current in a river and the amount of matter carried suspended in its waters; this data is critical to both downstream production systems, and for assessing morphological impacts. The channel profile and structure should be monitored using both remote sensed imagery and, possibly at five year intervals, ground survey to establish the extent of channel erosion.

24.5.6.2 Downstream Ecosystems

One of the potential impacts of the reservoir would be a reduction of species diversity and the extent of floodplain species coverage. The downstream ecosystems include the riverine forest, floodplain and deltaic grasslands and the mangroves. Total areas may be susceptible to remote sensing, but for management purposes detailed ground assessment of key species is likely to give a better indication of changes in time to allow improved timing and period of regulated flooding. Indeed as Symoens (1985) points out, fortunately many African flood plain species are quite sensitive to water level and periodicity of floods, and therefore can be used as fairly precise indicators of changes in the system.

Infra-red air and false colour photography and remotely sensed images have been used successfully to track forest changes over time. These would have to be correlated with annual sampling of species and biomass estimates along transacts across the forest.

Increases in charcoal production would suggest that the forest is under increasing pressure.

Table 24.5 River Discharge Monitoring Programme

Factor to be Measured	Indicator	Frequency	Suggested Sources
River level and river course	Variability of flow section at selected downstream sites	Several times in a day during the flood periods and twice a day at other periods.	Automatic gauge systems, as part of overall reservoir management system
Flood Extent	Area and period of flooding	Daily during flood period	Satellite data and ground correlation, as part of overall reservoir management system
Sediment Load and Turbidity	Upstream measurements to improve timing of sediment release, downstream measurement to evaluate success of release	Minimum of daily measurements	Automatic sampling systems, as part of overall reservoir management system
Carbon and Organic Matter	Alluvial sediment content	Seasonally from baseline survey onwards.	Ministry of Water in collaboration with University of Nairobi
Nutrients and trace elements available to downstream systems in solution and suspension.	Levels of Fe, +Ca, +Mg, +Na, +K, NNO3, NNO2, PPO4, N organic, Cl, Si, and SO4	Daily levels, seasonally analysed and correlated with flow	Ministry of Water in collaboration with University of Nairobi

Attribution of changes in Flora and Fauna to Controlled Flood Release Interventions.

What perhaps is more problematic, is being able to attribute a change in productivity of the downstream fauna and flora to changes in flow due to controlled low level floods, as opposed to those resulting from human activities. A limited annual flood will result in some seasonal inundation of deltaic and some riverine grasslands allowing greater regular grassland regeneration than is presently the case. Consequently it is necessary to monitor the impact of dam operations on flooding and the regeneration of downstream vegetation.

Though the flood release mechanism may maintain downstream flows and quantities of water, it is assumed that fertility of the hitherto natural floods will gradually decline to a lower stable level, as sediment is trapped upstream behind the dam wall. Eventually a point may be reached at which the fertility of the downstream flood plains, critical to cropping, fish production and cattle grazing, drops below the renewable annual thresholds as the residual fertility is then drawn upon.

Fauna and flora which are not tolerant of these lowering of fertility levels would act as good bioindicators. One would expect to find lowering of productivity in species which have been traditionally most useful to the stakeholder communities perhaps to be replaced with less useful (i.e. productive or palatable) but those which are more tolerant of a system of declining fertility. It may be sufficient to sample biomass and productivity of the vegetation annually through ground survey complemented high resolution digital aerial photography with false colour and infra red ability once every five years.

Table 24.6 Flood Plain Ecosystem Monitoring

Factor to be Measured	Indicator	Frequency	Suggested Sources
Persistence of flood dependent deltaic wetlands	Herbage availability in delta	Seasonal grassland surveys	NMK surveys, participatory monitoring by pastoralists
Floodplain species composition	Identify key indicator species within the grassland, linked to known flooding requirements	Seasonal surveys	NMK surveys, participatory monitoring by pastoralists
Riverine Forest species composition and extent	Species composition, extent of forest cover, age structure	Annual or less frequent surveys, aerial photography	NMK and KWS surveys
Mangrove species composition	Presence and extent of less salt tolerant species	Annual or less frequent surveys, aerial photography	NMK, Forestry Department and KWS surveys

Floodplain and Delta Grasslands

A longer duration of water on the floodplain, and especially in the delta, could be expected to result in a partial restoration of the vegetation conditions which existed prior to the construction of dams upstream. Moreover a regular annual flood should allow for some stabilisation of seasonally inundated grassland ecosystems, reversing the drying trends of recent years. This may involve an improvements in species composition, and in the quality and availability of seasonal pasture, leading to improved grazing conditions, and animal quality, subject to the overall grazing pressure on these resources.

The duration of flooding, and the timing of their recession will affect the seasonal availability of inundated pasture, and therefore the volumes, timing, and duration of controlled flood release will have considerable bearing on the management conditions of downstream riverine and deltaic pasture. There should therefore be scope, within the project, to vary dam floodgate operations according to downstream requirements. Assessment of these, in turn will depend on effective biological and socio-economic monitoring of grassland dynamics, and pastoral grassland use.

The ability to regularly survey the species composition at the beginning and end of every season is essential, in the first five years of operation, and the services of a rangeland ecologist will be required.

There are a number of other projects in Africa (albeit in different ecosystems e.g. Range Inventory and Monitoring Project, Botswana, 1995) currently considering approaches to rangeland monitoring. Institutions such as ILRI and KARI should be able provide experience of rangeland monitoring in Kenya.

In addition to tracking of the vegetation and water levels, measures of the stocking rate of cattle (number of animals per unit areas at any given point in time) and of the carrying capacity or grazing potential (animals/per unit area/annum) will indicate whether tendencies towards overstocking are taking place. A baseline survey might also be able to establish a relationship between levels of water on the flood plain and the amount of grazing expected to be available to cattle. In addition to the regulation of flood release, this information might also be used to manage and control the numbers of animals accessing the pasture, in order that species composition and overall pasture availability are not adversely affected. However, deltaic and remaining riverine grasslands are currently open-access resources, subject to regular use by local Orma and Wardei pastoralists, and to periodic fallback use by pastoralists from outside the Tana basin.

If insufficient or ill-timed inundation has adverse effects on the quality and quantity of available perennial grasses, then one could expect to see symptoms of reduction in liveweight gains of animals, lowered calving rates and therefore reduction in herd size, assuming alternative dry season feeding arrangements are not in place.

On the other hand, where stocking is controlled and the grazing period is lengthened due to greater availability of water, then one might also expect liveweight gains to be made by the cattle, although there increased incidence of worm and snail borne parasitic diseases resulting from increased grazing in waterlogged pasture could offset the potential gains.

Mangroves.

Both the mangrove and animal marine life associated with the trees are likely to be quite sensitive to seasonal changes to the nature of the natural floods. There needs to be control over the impact of increased salinity due to salt works if mangroves were not longer regularly flushed. Changes in salinity could have profound effects upon important economic activities such as prawn farming and timber harvesting.

The levels of salt and inundation tolerance of many mangrove species is very narrow, key species can therefore easily be identified and their presence linked to very precisely defined flow regimes. In particular the loss of the less salt tolerant species is likely to be linked to reduced flooding and hence flushing of the soil profiles.

The extent of the mangroves system could also be reduced as the erosive effects of the sea exceed the deposition of sediments as sediment load is reduced through trapping within the reservoir.

Fisheries

Statements from The Environmental Assessment Report at para. 6.2.2 p. 6-5 make it clear that there is a need for new and complete sampling and study of fish communities in the lower Tana River. The main freshwater species mentioned are either predators such as tilapia or bottom feeders such as catfish and lungfish.

Increasing changes of flow in traditionally low flow periods would be expected to favour top feeding fish species. In any case, adequate flows are also essential for the breeding of and migration of many fishes. Adequate flows are essential for the breeding and migration of many fishes. Physiologically, fish respond to flood conditions becoming sexually ripe and by movement to breeding grounds. Certain critical levels of flow are also needed to maintain certain types of breeding substrate in a suitable condition for spawning.

The breeding conditions for the main species mentioned should be thoroughly researched in order to ascertain whether minimum flows during the period of filling would damage the local fishing opportunities. Tennant 1976, describes the effect of various flow regimes at different times of the year for fish and related environmental resources in a range of North American Rivers. However, Welcomme 1985 cautions that there in insufficient data in the tropics upon which to base such indices.

Even if average flows within the system remain unaltered by controlled flood release, changes in the timing or form of the flood may have grave consequences. In many fish, breeding success depends upon a coincidence of characters of which flow is but one. Consequently races or strains of species have adapted to a particular timing in their breeding and displacement of the floods to a different time of the year may not permit the fish to reproduce. However there are signs that in some systems fish may adapt to altered flow regimes following dam construction. Table 4 (below) lists an approach to an integrated downstream fisheries monitoring programme. This should be undertaken by a specialist fisheries institution, drawing on socio-economic monitoring work for the assessment of catch, diet and local knowledge of changing fisheries conditions.

Table 24.7 Downstream Fisheries Monitoring Programme

Factor to be Measured	Indicator	Frequency	Suggested Sources
Species Composition and Populations	Updated survey of Lower Tana fish communities	Baseline survey; during construction and then every five years	NMK and University of Nairobi; Fisheries department data, and surveys of fishing communities
Fish landing statistics. catch totals by type and location	Reported catches by local and commercial fishermen, including species and size	Seasonally	Fisheries department catch data; sample surveys
Consumption of fish in the diet	changes in availability of fish to local populations	during filling period; biannually for first few years	Socio economic monitoring institution: Household surveys; social and health services; NGOs

Note that numbers engaged in fishing as a supplementary activity is no indication of the state of fish populations or the sustainability of the fishery, since adoption of fishing may also reflects the decline of other traditional livelihood activities, notably farming and livestock. Rather fish *catch* should be the critical indicator, not only in terms of overall volumes landed, but also species composition, which may be affected by changes in flood conditions. Catch composition, and fish size, may also change as a result of fishing pressure however, and so the take up of fishing as a supplementary livelihood activity, by arable and pastoral people, should also be monitored.

24.5.6.3 Downstream socio-economic monitoring

The purpose of downstream socio-economic monitoring is primarily to identify the impacts with further damming, and floodgate operation have on downstream production systems and livelihoods. The project, as proposed, has the potential to have both negative and positive impacts on the population of the lower Tana, according to how flood release is managed. In principle, an annual artificial flood whose timing, duration and volume corresponds approximately to those of one of the two biannual floods which previously occurred, has the potential partially to restore the flood recession cropping, seasonal grazing and fisheries resources which characterised the lower Tana valley prior to the interference of the natural flood regime by upstream dams. However, ill timed, or high volume/ short duration floods have the potential to further damage arable, pastoral and fisheries production systems. Effective monitoring of impacts, arrangements for consultation with downstream populations, and the willingness of management to modify floodgate operations according to downstream socio-environmental requirements, are thus of paramount importance for a successful project.

The principle methods for socio-economic monitoring will be:

1. standing arrangements for consultation and feedback with downstream stakeholders and representatives of downstream communities, as proposed in the EIA Phase 2

2. farm/household surveys, commissioned from an appropriate specialist socio-economic institution, to establish an adequate baseline and to monitor impacts during the filling period and the first five years of dam operations.

A large scale questionnaire survey will only be appropriate if enumerators are given adequate training on the background and purpose of the exercise and in the use of participatory interviewing and group discussion methods. Surveys conducted should have the following characteristics:

- representative segments of the lower Tana valley should be sampled
- current production practices should be established for the baseline, including both flood recession cropping and participation in small scale irrigation schemes
- livestock, annual and perennial crops should be covered
- fisheries and other livelihood / income sources should be covered
- incidence of dependency on food aid, or destitution should be included

In addition, baseline and monitoring surveys should access data from other sources, including:

- District government departments: production and marketing data

The DDC system

- Councils of elders of indigenous tribal groups
- Chiefs and administrative authorities
- NGOs working in the valley

To be effective and fair to all the stakeholders, yet not of overburdening cost to the developers and sponsors, the monitoring programme should make full use of the local knowledge and skills which are available. The flood recession farmers, pastoralists, and fishermen are the groups of people who should be regularly consulted through structured interviewing, to obtain both qualitative and quantitative field signs of significant changes to the flora and fauna which may directly or indirectly affect their livelihood and way of life. To compensate for the time spent and the costs of coming to meetings in the course of the participatory enquiry, the project should establish a fund to support participatory enquiry, to compensate people for time lost in in-depth interviewing, and the cost of attending meetings. The institution appointed for the socio-economic monitoring should determine the precise needs, and exactly how this fund should be spent.

All Downstream Populations

The monitoring of income and livelihood sources, food availability, food aid requirements and nutritional status will be important for all downstream populations, although, once again, for pastoralists, and for farmers with access to irrigation particularly, it will be difficult to attribute changes to the project alone. Nevertheless arable, non-irrigating farmers in lower rainfall areas (i.e. all those outside the delta) are wholly dependent on the maintenance of some sort of flood regime, and pastoralists are seasonally dependent on this. Overall, nutritional status, and supplementary food needs, if these can be determined, probably provide the best indicator of the well being of production systems downstream.

During the filling period monitoring of food requirements should be directly linked to a scheme for supplementary food distribution to needy populations. Subsequently, data should be assessed alongside agricultural and river-flow data, to assess the adequacy of the flood management regime. Although adjustments can be made in the first few years of dam operations, a thorough review of the situation downstream should be undertaken after the first five years.

Table 24.8 Downstream Populations Status Monitoring Programme

Factor to be Measured	Indicator	Frequency	Suggested Sources
Food availability in local diets; viability of floodplain livelihoods	Child nutritional status	Regularly during filling period; thereafter biannual	Health department / NGOs; nutritional surveys
Food deficit; failure of production systems	Food aid requirements	Throughout filling period; thereafter biannual	NGOs, Location development committees
Natural resource dependency of flood plain livelihoods; diversification as a result of dam development	Income sources and income levels	Annual	River basin census data; household surveys

Downstream populations: arable farming

During filling it is to be expected that flood recession farming will not take place, unless filling is extended to allow for periodic floods. Once floodgate operation is established, some downstream farmers should be able to return to their traditional practice, and the growing dependency on small scale irrigation should start to reverse. Which farmers are able to plant following the flood, and on what land, will depend on the unpredictable character of the floods themselves, and on customary land holdings in the flood plain. The timing and volume of flooding will need to be carefully monitored, and production data subsequently collected. This will then need to be set against available hydrological and sediment data in order to gain a full picture of downstream impacts.

Since sediments deposited downstream will be restricted by the dam, whatever flood management regime is introduced, it can be expected that fertility renewal will not occur as it would with a natural flood cycle, and that floodplain fertility will gradually run down, over the years, according to the demands of arable cropping.

Downstream Populations: pastoralism

Since the availability of grazing resources, and pastoralist production in the lower Tana valley are subject to pressure from multiple factors, changes which take place cannot be directly attributed to dam development and operation. A number of independent variables affecting resource availability in the lower Tana valley need to be monitored, including: drought incidence; rainfall and pasture availability in the river's immediate hinterland; wider regional availability of pasture according to drought and land use factors elsewhere, affecting the scale and frequency of seasonal migration by non-local pastoralists; impact of Somali and *shifta* bandit activity on herd sizes and pastoralist migration routes.

However some changes are directly related to previous damming of the river, and these remain within the project's influence, if a floodgate is to be operated to help restore downstream conditions. These include:

- changes in the capacity of riverine and deltaic grasslands to regenerate following flooding;
- resource conflict between farmers and pastoralists resulting from changes in the availability of dry season grazing, as remaining inundatable land is occupied for arable farming.

If the wider factors affecting pastoralist production and livelihoods can be established, then it should be possible to assess the scope for managing improvements to resource availability by modifying the flood regimes, or by other mitigatory action designed to assist pastorlists resident in the lower Tana valley.

As discussed above, a specialist livestock institution will need to access socio-economic expertise in assessing changes in pastoralist production and livelihoods, and participatory methods will be important in both this process and then planning of mitigatory improvements in the management of grazing land.

Table 24.9 Downstream Agricultural Community Monitoring Programme

Factor to be Measured	Indicator	Frequency	Suggested Sources
Effectiveness of flood management in restoring floodplain agriculture	Areas under flood recession farming	Biannually / annually once annual pattern of flood release is clearly established	Aerial photography; district agriculture departments; chiefs; location development committees
Extent of flood / productivity of riverine land	Productivity of cropping season	According to frequency of flooding	District agriculture departments; development committees; farmer surveys
Declines in fertility due to changes in sediment deposition	Use of (or demand for) organic / inorganic fertiliser on flood recession fields	At least annually; according to frequency of cropping season; increasingly important as dam operation continues	District Agriculture departments; development committees; farmer surveys
Effectiveness of consultation and liaison between dam management and downstream communities	Timing, scale and duration of released floods in relation to land preparation, planting and farm operations	According to frequency of floods; Especially important in high and low rainfall years	District Agriculture departments; development committees; farmer surveys; Chiefs and Councils of Elders
Demands for alternative livelihoods (arising from failure of arable farming)	Incidence of charcoal burning and fuelwood sales; urban settlement and outward migration	Annual	Market surveys; Development Committees; village elders and participatory surveys; census data

Table 24.10 Downstream Pastoralist Community Monitoring Programme

Factor to be Measured	Indicator	Frequency	Suggested Sources
Grazing patterns on delta	Livestock numbers and origins utilising deltaic pasture	During filling period; biannual	Field observations; local chiefs and development committees; pastoralist elders; pastoralist forum
Competition for deltaic pasture / trends towards establishment of permanent grazing rights	Pastoralist settlement in delta	Annual	Delta area Development Committees; chiefs; elders of pastoralist groups; dry season observation and field surveys
Persistence of flood dependent floodplain pasture	Access and utilisation of riverine pasture by pastoralists	During filling period; Biannual	Aerial photography + ground truthing; Orma and Wardei elders; participatory surveys
Resource pressure and conflict over floodplain land	Cases of conflict between farmers and pastoralists	Ongoing	Arable and Pastoralist group elders; local Chiefs
Availability of pasture and feed for livestock	Livestock nutrition / milk yields	Annual	Participatory surveys; pastoralist elders; veterinary data
Livelihood security of pastoralists	Incidence of pastoralist destitution, dependency on food aid, and demands for alternatives e.g. irrigation	Annual	NGOs; pastoralist elders; Drought relief data; Development Committees
Success in incorporating pastoralists in river basin management arrangements	Pastoralist participation in floodplain management forum	Annual	River Basin management reports; Pastoralist forum; pastoralist elders

24.6 OPERATIONAL MONITORING

It is clear that the dual objectives of the project can only be achieved if the reservoir is managed to release floods and to a lesser degree sediments. The maintenance of both human and natural downstream production systems will depend on the successful management of floods through deliberate releases from the reservoir.

As has been demonstrated the present pattern of flooding can be roughly divided into three types of events: floods generated entirely in the upper catchment above Grand Falls; floods in which there is significant rainfall in both the upper and lower catchments; and floods generated by rainfall predominantly in the middle and lower catchment. To replicate the first two cases water would be released from the reservoir body, either to create a flood or to supplement local rainfall in the middle and lower catchment. However, in the third case where there has been adequate rainfall in the downstream catchment to create a floods, largely delivered through flow from the laghas, a release of water from the reservoir would create an excessive flood and could cause damage to the downstream systems.

It is therefore necessary to develop a mechanism which would monitor and predict rainfall events throughout the Tana river basin, and allow for the release of floods based on downstream requirements. This also would have the distinct advantage of minimising the release of floods to supplement downstream rainfall inputs, and hence maximising the potential power production, fulfilling both project objectives.

The monitoring system would then be linked with an information distribution process, so that downstream users are advised of likely flood timing in advance and of actual flood releases when they occur. The management of the monitoring system should include representatives from the downstream user communities, who should be linked directly into the decision making process of size and timing of floods, which would be optimised following experience of the results of artificial flood release.

The basic tools for real time rainfall monitoring are available. Low cost satellite receiving stations can access meteorological data that provide updated images every thirty minutes, providing an image that requires only calibration for the specific Tana basin conditions. To ensure that the system is operative at the time of commissioning, the system should be installed as soon as possible.

The monitoring system will therefore include the following:

- Long-range, regional weather forecasting
- Short-term national weather forecasting
- Near real-time rainfall and river flow measurements, and telemetry systems for delivering these data.

- The use of geostationary and orbital satellite information (Meteosat, NOAA), and models relating cloud cover, cloud temperature and other environmental / physical variables to rainfall and/or discharge.
- Rainfall-runoff models used to produce warnings and forecasts.
- A mechanism for communication of flood forecasts.

NOAA-AVHRR imagery

This imagery, from the AVHRR sensor on board the NOAA series of polar orbiting satellites, produces imagery at a spatial resolution of 1 km. These images are available on a daily basis (several times every 24 hours, both night and day) from each of the current orbiting satellites. Very detailed temporal resolution is therefore possible.

A low-cost local receiving station[1] would need to be installed. This will enable a complete set of AVHRR imagery to be obtained for verification of the models, and will enable a higher frequency of observation than through the use of existing image capture facilities. Flooding is detected both by the spectral signatures on a individual image, as well as by the change in spectral signature with time (e.g. one day to the next). Flooding will be detected by this system within areas down to about 1 km^2, and it will therefore be feasible to verify the models on areas throughout the Tana Delta, and over significant parts of the lower Tana. Higer resolution images (SPOT, Landsat, IRS) can then be used to examine smaller areas in greater detail, as well as parts of the floodplain not suited to assessment by AVHRR imagery.

Meteosat Imagery

Data from the geostationary Meteosat weather satellites can be received every 30 minutes (or every 15 minutes with the planned new Meteosat system due to be launched early next century and expected to be operational before planned reservoir impoundment). The spatial resolution of the current data is approximately 5 x 5 km, equivalent to a weather station for every 25 km^2. These data provide information for use in weather forecasting and monitoring, measuring cloud temperatures and ground temperatures as well as providing regular images of cloud patterns. Recent advances in analytical techniques mean that this imagery can be used to provide daily estimates of rainfall within entire river basin catchments. The case of the Kenya highlands is complicated by orographic effects and a certain amount of basic research will be required in order to calibrate the satellite imagery and derive a model for estimating either rainfall or catchment runoff. Accordingly, it is proposed to carry out the necessary research, in collaboration with the

---

[1] Systems are available at a total cost in the region of US$50,000 for a complete receiving station plus software. In addition, systems are now becomming available that can capture high resolution satellite imagery, which could then be used for closer monitoring of flood extent and land use throughout the basin. Alternatively, regular high resoluton satellite images can be obtained from outside commercial providers and processed on a regular basis for particular applications.

Kenya Met. Dept., and to install the receiving equipment and computer software in the relevant institutions together with the NOAA receiving equipment referred to above. Once calibrated, these data will be capable of providing an important component of the flow forecasting system necessary for optimum management of the reservoirs.

Calibration of the System

The use of satellite imagery will need careful calibration both through measuring rainfall at large numbers of stations throughout the basin, and through direct measurement of stream and river flow on all components of the river system and specifically including the laghas. This data will have to be collected at daily or higher frequency intervals. It would therefore seem most appropriate to install automatic flow measurement devices that are linked to the management office via remote telemetry.

The system should again be installed well in advance of operational management, and would provide further data on which to base the planned release of floods. It should also be linked to the required sediment monitoring programme.

Information Dissemination

The national radio service already transmits "farmer" programmes in support of the extension service. These broadcasts are in both Swahili and other local languages. The service is managed by the Agricultural Information Centre and was established with the support of the UK Overseas Development Agency (Department for International Development). This could be used as the mechanism for providing information to downstream farming communities on the timing of flood releases, and to advise them on the best timing of specific farm activities in response to flood release.

Chapter 25

INSTITUTIONAL REQUIREMENTS

25. INSTITUTIONAL REQUIREMENTS

25.1 INTRODUCTION

The success of the proposed Mutonga and Grand Falls Hydropower Project, in terms of its economic and social benefits, will greatly depend on constant assessment and efficient management. A vital element of management is environmental monitoring. Such monitoring will entail the following courses of action:

- Measuring the effects of the hydropower operations on the environment.
- Reporting to the competent authority, regularly and upon request, on such effects on the environment.
- Effecting such reporting in accordance with established procedure, so as to facilitate appropriate responses.
- Regular inspection by the competent authority, of the hydropower installations, with the object of ensuring that the conditions on which the project was authorized, are complied with.
- Ensuring that the conditions referred to in above are complied with.

This monitoring function cannot be performed without suitable institutional arrangements. Schemes of this kind will range from organisational systems through to governing laws and other regulatory norms, and to operative management practices and policy orientations.

In this consideration of institutional arrangements, we should be clear about the agencies which perform the various roles; the law or administrative arrangements regulating such agencies; the functions and powers of such agencies; the environmental monitoring and reporting procedures; and the role of sanctions in the operation of arrangements for environmental protection.

This institutional requirements discussed in this section, apart from addressing the foregoing points, reviews existing arrangements, considers present institutional requirements, and makes simple, practical recommendations in respect of the environmental monitoring process for the hydropower project.

25.2 EXISTING INSTITUTIONAL STRUCTURE

The current state of the law should be considered in relation, firstly, to environmental protection in general, and environmental assessment and monitoring in particular; and secondly to the production and consumption of hydropower. Both aspects must be clarified, so as to shed light on the legal context in which the Mutonga and Grand Falls hydropower project will have to operate.

Such issues of legal character should be viewed in relation to the national (Kenyan) legal system, as well as in relation to international legal developments.

25.2.1 The National Legal Prospective

25.2.1.1 The Law in relation to environmental protection in general, and environmental assessment and monitoring in particular

Kenya's place of priority for environmental protection is closely linked to the interplay between environmental goals, and the conception of public policy in many areas of life. Such policy areas include the following:

- Types, varieties and levels of natural resources found in the country;
- Operative modes of resource use and development;
- National productive capacity, e.g. in relation to irrigated agriculture, soil fertility, forest and genetic resources, wildlife resources, fisheries, water resources, and hydro-electric power capacity.

All these items are determinants of the level of national development, and for this reason the policy areas which form the primary concern of environmental protection measures are also the subject of present approaches to law-making and to institutional arrangements.

Such law-making and such institutional arrangements form an integral part of the scheme of environmental management. This refers to the initiatives which the public institutions of the State must take, to ensure a balance in the natural resources. Management measures should ensure the balanced utilisation of these resources, so as to prevent over-exploitation, and to restore and replenish those resources which have been over-exploited. Another aspect of environmental management is that which seeks to control and limit pollution of air and water.

Against this background, should be seen the current laws and institutional arrangements designed to realise environmental protection.

25.2.1.2 Environmental Protection In General

Kenya's scheme of environmental protection has been greatly influenced by the colonial policy and legislation of the first half of this century. This early period was marked, as regards the conception of public policy, by the object of resource exploitation. The resources in question were the minerals, forest products and agricultural resources. The State's primary interest in these resources was from the standpoint of economics, rather than from that of conservation as such. Such measures as were taken to conserve those environmental resources, were mainly incidental to the object of economic productivity. The effect of such a policy orientation was that the existing environmental law was built around economic resource sectors, such as agriculture, mining, forestry, etc. There was no overall national structure responsible for co-ordinating environmental activity, in the measure in which this was dictated by the operative economic goals. Such a sectoral scheme of environmental management was not regulated by any fundamental policy commitment on the part of the State.

In such a policy context, the basic law that could serve in environmental protection was the ordinary private civil law relating to contracts or legal wrongs. This body of law was a central aspect of the English common law, which had been imported into Kenya at the advent of colonialism, for the purpose of regulating private relationships.

Since contracts, under the common law, operate only on the axis of mutual agreement, they could only provide a framework for environmental protection in those situations in which an occupant of a particular property had taken upon himself a contractual duty to a neighbour, or another person, in relation to the manner in which this occupant would be using the property in question. Any obligations for environmental protection which arose out of such an agreement bound only the persons who were party to the agreement, and thus could not be relied upon by the members of the public in general.

Another aspect of the English common law which has been used in a limited aspect of environmental protection is the general law of wrongs (also known as the law of torts). The wrongs in question include: negligent acts which may cause injury to others; trespasses; nuisance; etc.

Where a person commits environmental wrongs which qualify as nuisances, trespasses, or acts of negligence, the persons injured may bring legal action for appropriate redress. However, this is a rather limited opening to environmental protection, as only those who are injured may, in general, seek redress.

These common law openings for a certain limited measure of environmental protection are still possible in Kenya today, since the common law has been adopted as part of Kenyan law, by virtue of the Judicature Act (cap. 8). Indeed one aspect of the common law of nuisance has been reinforced by the Penal Code (cap. 63), which institutionalises the concept of public nuisance, and provides an appropriate State sanction.

Section 175 (1) of the Penal Code states:

> "Any person who does an act not authorized by law or omits to discharge a legal duty and thereby causes any common injury, or danger or annoyance, or obstructs or causes inconvenience to the public in the exercise of common rights, the misdemeanor is termed a common nuisance, and is liable to imprisonment for one year".

Thus, where an environmental injury may be described as a common nuisance, the culprit can be subjected to penal sanctions.

Apart from such general laws, which in certain cases might (and may) be applied in the interests of environmental protection, the environment as a subject of general interest was regulated spectrally by statutes such as:

- the Agriculture Act (cap. 318);
- the Food, Drugs and Chemical Substances Act (cap. 254);

- the Fertilizers and Animal Foodstuffs Act (cap. 345);
- the Forests Act (cap. 385);
- the Plant Protection Act (cap. 324);
- the Grass Fires Act (cap. 327);
- the Public Health Act (cap. 242);
- the Water Act (cap. 372);
- the Merchant Shipping Act (cap. 389);
- the Factories Act (cap. 514).

The foregoing statutes do, each in its own limited way, provide for some measure of environmental protection. In their totality, these various statutes, taken together with the general private law, today constitute the basic legal framework for environmental management. The framework is a highly unsatisfactory one, as it is not founded on any general policy, nor does it give scope for the conception and enforcement of general standards in relation to discharges, deposits, emissions of wastes, in relation to land, water, soil, air or built-up environments.

This inadequacy of the basic legal framework is especially remarkable as regards environmental monitoring. Such monitoring can only be done against approved standards, and in the context of clear structured management arrangements. The basic legal framework, at present, fails to provide such a mandatory framework; and hence we must now consider the sphere of general practice, as a source of direction on the matter of environmental assessment and monitoring.

25.2.1.3 Environmental Assessment and Monitoring

Under the existing legal framework, there are no firm provisions for environmental assessment and monitoring. These modern tools of environmental management had been accorded hardly any place in the colonial legal system, which was substantially adopted at independence in 1963, apparently because their imperatives would have been in conflict with goals of economic productivity. While Kenya has, since independence, committed itself to environmental goals in its public policy, the country has not yet come round to enacting a comprehensive law of environmental protection. Towards the end of 1995, a team of experts working under the Attorney General's Chambers formulated a draft Bill, bearing the title Environmental Management and Co-ordination Bill. If this is approved by the Cabinet in 1996 and passed by Parliament, then for the first time the country will have a central environmental statute providing comprehensively for the management of environmental resources, and employing as its critical tools environmental impact assessment and environmental monitoring. These instruments would, in that case, for the first time be accorded binding statutory status in Kenyan law.

Until the proposed environmental protection law is passed, the role of environmental assessment and monitoring in Kenya will remain, as they have been for more than a decade, only a moral and/or administrative requirement.

Today, the central institution responsible for the application of environmental impact assessment is the National Environment Secretariat (NES), which operates within the Ministry of Environment and Natural Resources. NES's role is not set out in any statute, and NES itself has no legislated basis in its existence. It follows that NES itself has no final authority in the conduct of environmental impact assessment (EIA), and EIA itself has no imperative role today under Kenyan's legal system. In view of the gap which exists in the legal system as regards EIA, NES has been able to play a highly valuable role, in those cases where developers voluntarily undertake to comply with NES's advice, and in those cases where relevant Government Ministries consider compliance with NES's recommendations to be important. Under the present conditions it is quite possible for organizations established under statute law, where they are involved in projects with environmental implications, to overlook the role of NES, in relation to the conduct of environmental impact assessment.

Since NES has no sacrosanct authority in relation to the conduct of EIA, it follows that it has hardly any authority in respect of environmental monitoring. Just as NES must depend on the goodwill of the developers and of relevant statutory bodies, in order to retain control on matters pertaining to EIA, so must it depend on the consent of such statutory bodies to secure the conduct of any environmental monitoring. Moreover, in the case of environmental monitoring, the controlling authority will be the statutory body to which the regulating of the project in question is entrusted; and all reports, of the nature of monitoring, must be submitted to this statutory authority.

25.2.1.4 The law on environmental assessment and monitoring: the case of the Mutonga and Grand Falls Hydropower Project

If the Mutonga and Grand Falls Hydropower Project is executed under the present law, then the imperatives of environmental impact assessment will be dictated mainly by the following range of factors:

- Government policy goals;
- Priorities of donor agencies;
- Informal pressures emanating from individuals and non-governmental organizations;
- Policy commitments of the relevant statutory body - in this case assumed to be the Tana and Athi Rivers Development Authority (TARDA).

It is in the context of such possible commitments, on the part of concerned bodies and persons, that NES could come to play a role in the conduct of environmental assessment for the project. Assuming EIA is conducted on that basis, further problems would in any case arise later, in connection with the monitoring process. Monitoring cannot take place effectively unless the following matters are agreed upon:

- The specific authorities to be primarily responsible;
- The specific roles of the responsible authorities;
- The reporting order, and the procedures for reporting, as part of the process of environmental monitoring;
- The lines of remedial action to be taken, in the event that there is a breach of the conditions on which the project has been approved.

If, however, the Mutonga and Grand Falls Hydropower project is executed under the regime of the proposed environmental law, then the position would be as follows:

- A national environment agency will be in place, mandated to oversee the establishment of quality standards in relation to the environment, and entrusted with the task of co-ordinating all public bodies dealing with matters of environmental character.
- Environmental impact assessment will be a legal requirement, before the undertaking of all major projects, such as the Mutonga and Grand Falls Hydropower Project. [1]

Environmental monitoring, in connection with the Mutonga and Grand Falls Hydropower Project will therefore be a mandatory requirement, the performance of which will be subject to the ultimate oversight of the national environment authority. The task of monitoring will involve co-ordinated initiatives between the national environment authority and the various lead agencies such as the statutory bodies in place, as well as such ministerial authorities as may be entrusted with the environment portfolio.

Since no predictions can be made about either the timing or the enactment of the new environmental statute, we must give particular attention to the position under the present state of the law.

As already noted, at present there is no organized legal framework, nor institutional arrangement for the carrying out of environmental impact assessment, nor indeed environmental monitoring, in respect of large projects such as the Mutonga and Grand Falls Hydropower project. There is no doubt that this is a major gap in the law, and must be filled in the very near future. Concrete steps have already been taken towards filling this omission, by the preparation of a draft Central Environment Bill.

Yet the existing institutional setting, as well as the general orientation of public policy, and the principles followed by donor agencies when they contribute to major projects, do dictate that there be, as well as provide a framework for, both environmental impact assessment and thereafter, environmental monitoring.

[1] Therefore, environmental assessment would be required as an integral part of the design phase of the project.

On the foregoing principle, it must be assumed that environmental monitoring cannot be avoided once the Mutonga and Grand Falls Hydropower Project is put in place.

Environmental monitoring is the continuous determination of actual and potential effects of any activity on the environment, in the short term and in the long term. How can such an exercise be conducted, in the context of the skeletal legal framework such as exists today? It is necessary to know, firstly, the particular institutions that will carry responsibility for such monitoring; the chain of authority in the monitoring process; the reporting procedure to be followed; the existence of any sanctions to back up the obligations attached to the operation of the hydropower project.

The basic law that touches squarely on the above questions, as regards the Mutonga and Grand Falls Hydropower Project, is the Tana and Athi Rivers Development Authority Act (cap. 443). This statute is described in the preamble as:

> "An Act of Parliament to provide for the establishment of an authority to advise on the institution and co-ordination of development projects in the area of the Tana River and Athi River Basins; and for matters connected therewith and incidental thereto."

By this enactment, Parliament places upon the Tana and Athi Rivers Development Authority (TARDA), in clear terms, the responsibility for (i) advising the Government on development projects in the basins of the Tana and Athi Rivers; (ii) co-ordinating such development projects as there may be (whether conducted by public or private agencies) in the basins of the two rivers.

The Act sets out the specific functions of TARDA as follows:-

- To advise the Government generally, and the Ministries responsible for agriculture, economic planning, finance, natural resources, power, wildlife and water development in particular, on *all matters affecting the development of the two river basins, including the apportionment of water resources.*
- To draw up, and keep up-to-date, a long-range development plan for the two river basins.
- To initiate such studies, and conduct such surveys, of the two river basins as TARDA may consider necessary; and to assess alternative demands within those basins on such resources as *electric power, irrigation, wildlife* and *land.*
- To co-ordinate studies and schemes in the two river basins in relation to human resources, animals and land.
- To *monitor the design and execution of planned projects* within the two river basins.

- To ensure close co-operation between all agencies concerned with the abstraction and use of water within these river basins, especially in the setting up of effective monitoring of such abstraction and use.
- To collect and keep data on resource use, for the purpose of efficient forward planning for the two river basins.
- To "maintain a liaison between the Government, the private sector and foreign agencies in the matter of the development of the Area with a view to limiting the duplication of effort and to assuring the best use of technical resources".
- To render assistance to operating agencies in their applications for loan funds if required.
- *To cause the construction of any works necessary for the protection and utilization of the water and soils* of the two river basins.

Note must be taken of the very wide mandate of TARDA, in relation to the carrying out of development projects in the two river basins. There is no doubt that TARDA is the Government's lead agency as regards planning and development in the two river basins. The only other agencies which have a parallel role are the various Ministries whose portfolios coincide with the spheres of resource management in the two river basins. But the detailed empowerment of TARDA suggests that where such overlaps occur, the primary responsibility falls on TARDA. TARDA is, moreover, entrusted with responsibility for co-ordinating both public as well as private initiatives.

The stipulated membership of TARDA, for the purpose of governance, further underlines the broad development mandate which this organization carries. The members include:-

- The Permanent Secretary in the Ministry responsible for Agriculture;
- The Permanent Secretary in the Ministry responsible for Economic Planning;
- The Permanent Secretary in the Ministry responsible for Finance;
- The Permanent Secretary in the Ministry responsible for Natural Resources;
- The Permanent Secretary in the Ministry responsible for Power;
- The Permanent Secretary in the Ministry responsible for Wildlife;
- The Permanent Secretary in the Ministry responsible for Water Development;
- The General Manager of the National Irrigation Board (appointed by virtue of the Irrigation Act (cap. 347);
- The Chairman of the Kenya Power and Lighting Company Limited;
- The Director of Water Development.

Such a composition in the governance setup suggests that TARDA is the Government's principal instrumentality for the development of all the vital resources of the Tana and Athi River Basins. It suggests, besides, that the subject of hydropower development, which is the critical question in respect of the Mutonga and Grand Falls Project, falls squarely under the jurisdiction of TARDA which acts, in that regard, as an agency of the Government.

From the foregoing account, certain inferences may be made regarding the instructions involved in an environmental monitoring programme, in the case of the Mutonga and Grand Falls Hydropower Project. These are as follows:

- The Mutonga and Grand Falls Hydropower Project will form part of the scheme of national development, and on this account the Government, through its relevant Ministries, will have a fundamental interest in its execution. The Ministries primarily involved will be those responsible for:-

  Energy
  Water Development
  Natural Resources
  Agriculture
  Economic Planning
  Finance

- The main Government agent for the accommodation of the various national interests in the Mutonga and Grand Falls Hydropower Project will be TARDA;
- TARDA's position as a legal entity, and its special mandate in relation to developments in the Tana and Athi River Basins would have necessitated its close involvement from the time of investigations on the project; and in any case, the monitoring process once the project is established, will primarily depend on TARDA's active role. The Act squarely places monitoring responsibilities, in respect of development projects, upon TARDA, quite apart from the fact that TARDA is the only permanent institution in place carrying the functions and powers that can facilitate the monitoring process;
- Since TARDA's functions are carried out on behalf of the Government, there is a clear policy and administrative basis for involving the National Environment Secretariat (NES) in the process of environmental monitoring;
- Between TARDA and NES, it is the former which has a definite statutory authority; and for this reason, the role of NES is likely to be a supportive one of providing expertise for employment and advice for TARDA;
- The environmental monitoring process would also involve the specialist sections in the Ministries which participate in TARDA's governance;

- Utility provision organizations, such as the Kenya Power and Lighting Company Limited (which is also represented in TARDA's governance) may also play a significant role in the monitoring process.

In this setting, as affairs stand at the present time, arrangements for environmental monitoring should be made within the framework of TARDA. Such arrangements, with the applicable reporting procedures, would have to be worked out specially, since there is at present no legal instrument sanctifying such monitoring and prescribing its machinery of implementation.

Major projects like the Mutonga and Grand Falls Hydropower project unavoidably entail major contributions by foreign donor agencies. Just as the donor will be keenly interested in the process of environmental impact assessment, so will he have a major stake in the environmental monitoring process. Under the law as it currently stands, the donor's input in the monitoring process would ideally have to be made at the TARDA level. Such an input can, at that stage, be worked into the procedures and reporting arrangements relating to the monitoring process.

The monitoring process, it should be recalled, seeks to ensure the project's continued compliance with the terms of the initial approval for establishment. The main concern here is the continued environmental safety of the project. It follows that the monitoring process must be linked to the working of a legal body which can invoke legal mechanisms or even sanctions, where the original conditions are not compiled with. There is no doubt that such a legal body is currently TARDA, and that it will serve as the institution primarily in charge of the monitoring process.

The task of environmental monitoring is likely to be more effectively discharged if Parliament proceeds soon to enact the proposed central environmental statute. The statute would not only sanctify the monitoring process, but would also establish appropriate institutions, and prescribe standards and procedures regulating both environmental impact assessment, and environmental monitoring. The new law would also prescribe a wide range of sanctions for ensuring the efficacy of the assessment and monitoring processes.

25.2.2 The International Perspective

International law's interest in environmental monitoring falls within the context of global initiatives, which have taken the form of many important treaties to conserve and protect the resources of the environment. Kenya, as a party to treaties of this kind, such as the Convention concerning the Protection of the World Cultural and Natural Heritage (1972), the Convention on Biological Diversity (1992), the United Nations Framework Convention on Climate Change (1992) and the Convention on Wetlands of International Importance Especially as Water-fowl Habitat (1971), has assumed major international obligations to work towards the conservation of natural resources and sustainable development.

Thus in the carrying out of a project with such significant environmental consequences, as the Mutonga and Grand Falls Hydropower Project, Kenya is expected to put in place all appropriate safeguards for the environment. Apart from installing suitable mitigation measures, to limit the risks involved in the construction of such a project, Kenya is obliged to put in place an effective monitoring scheme, for the purpose of ensuring the continued safety of the project.

The United Nations Environment Program (UNEP), which is one of the United Nation's principal agencies entrusted with responsibility for environmental protection, has issued a set of "Environmental Law Guidelines and Principles", which require, among other things, that:

> "States should establish appropriate national monitoring systems including monitoring agencies equipped with the requisite instruments and trained personnel for monitoring the effects of operations and processing and evaluating data".
>
> "States should, where appropriate, enter into bilateral, and multilateral, in particular regional, agreements providing for a co-ordination of monitoring of the effects of operations on the environment".

It should be noted that such broad international obligations, in relation to environmental protection, can only be realized through the national legal system and its machinery of implementation. Hence these principles should be appreciated within the context of Kenya's existing legal and management setup in relation to environmental monitoring. Kenya's institutional setting at present, and as it may be in the future if a central environmental statute is passed, has been considered above.

25.2.3 Administrative Arrangements

As already noted, Kenya at present lacks a law to govern the subject of environmental impact assessment and environmental monitoring. So long as this situation prevails, the objects in question, if they have to be realized, must be sought through administrative arrangements. Although TARDA is duly established and empowered under the law, and thus it has legal authority to undertake appropriate environmental safety measures, its mode of functioning in relation to environmental impact assessment and environmental monitoring has not been defined.

The performance of these tasks is thus left to administrative arrangements. It is for TARDA itself to work out a comprehensive set of administrative procedures to govern its work in relation to environmental assessment and monitoring.

Environmental monitoring is an open-ended activity in terms of time limits. On this account it takes the contribution of may agencies, performing different roles, securing relevant information, and fitting into a scheme of co-ordinated initiatives. Since these elements are not, at present, defined in any parliamentary enactment, the matter is left to administrative arrangements. Such arrangements will continue to play the role of legal regulation until such time that a comprehensive statute is passed which regulates environmental monitoring.

Such administrative arrangements will play a vital role in the safe operation of the Mutonga and Grand Falls Hydropower Project. For this reason, it will be desirable that the formulation of the arrangements should accommodate inputs by as many people or organizations as possible. All persons who hold a stake in the hydropower project should have an opportunity to make a contribution to the formulation of such administrative arrangements.

25.3 INSTITUTIONAL REQUIREMENTS

25.3.1 Legal Constraints

It is a logical consequence of the conduct of environmental impact assessment, for the Mutonga and Grand Falls Hydropower Project, that the setting for environmental protection be taken a stage further - to the stage of a close monitoring of the project and of the safety measures which will have been put in place. The effectiveness of environmental monitoring however, depends on certain factors. The principal such factors are: the legal framework for the conduct of the monitoring process; the appropriateness of the institutions entrusted with responsibility by the monitoring process; the mode of co-ordination amongst the responsible institutions; the character and effect of the sanctions provided to back up the exercise of environmental monitoring.

Most of these factors which affect the effectiveness of environmental monitoring are closely linked to the state of the law. The state of the law can become an impediment to the process of environmental monitoring. Indeed, as has already been noted above, the most remarkable characteristic of the present law is its absence. There is no law establishing all the required environmental management agencies. There is no law defining and giving binding authority to the concept of environmental monitoring. There is no law specifying the procedure of environmental monitoring, and there is no law providing sanctions against violations of the terms of the monitoring process. This state of the law is a constraint on the effective conduct of environmental monitoring.

25.3.2 Workable Arrangements, in the Light of Current Legal Constraints

Pending the enactment of new legislation, the process of environmental monitoring should draw on the inputs of the various stake-holders. The stake-holders, in this context, are: the relevant Government Ministries; TARDA; donor agencies; inhabitants of the Tana River Basin; non-Governmental organizations involved in environmental protection. Stake-holders should have an opportunity to make suggestions to be incorporated in the management regulations that will guide the process of environmental monitoring.

The working arrangements, under the present state of the law, should recognize TARDA as the principal monitoring agency. TARDA, in this regard, should work closely with donor agencies, with the National Environment Secretariat (NES), with relevant Government Ministries, and with any specialized bodies dealing in particular utilities or economic or social development projects in the Tana River Basin.

It should be noted that such a scheme can not work effectively unless the agencies that will conduct the monitoring process are involved in the project at an early stage. Ideally these agencies should be kept abreast of developments at the environmental impact assessment stage. This is because the conduct of environmental monitoring must rest on risks and mitigation measures which had been identified during EIA. The process of EIA will have made concrete suggestions on important mitigatory measures and indeed the very approval and perhaps even commissioning of the project may have been based on the specific safety measures elaborated in the EIA. In that case, the recommendations of the EIA should be the starting point for the process of environmental monitoring.

While the EIA document alone can, in theory, serve as a foundation for effective environmental monitoring, in practice it is desirable that there should exist a working relationship between those primarily involved in the EIA process, and those who will principally be responsible for the monitoring process.

25.4 RECOMMENDATIONS

This section has considered the legal framework and institutional arrangements for environmental management in general and environmental monitoring in particular, in relation to the project Mutonga and Grand Falls Hydropower plant. The concern of the Report is to provide information on the present legal position, and to advise on the legal aspect of further courses of action, the object of which is to achieve an effective environmental monitoring. Under this heading, the main profiles of this Report are elicited and formulated as specific, itemized recommendations. The recommendations are set out under particular sub-headings.

25.4.1 Legal and Administrative Aspects

- In the event of the proposed central environmental statute being passed soon, the task of environmental monitoring will be regulated in detail under the new law. The most notable aspect of the new law would be the establishment of a national environmental agency, with responsibility for the setting of quality standards, and the monitoring, in co-ordination with relevant lead agencies, of the compliance of projects with the safety measures proposed under environmental impact assessment.
- Without the enactment of the proposed central environment statute, the Mutonga and Grand Falls Hydropower project would have to be operated under the existing state of the law. As the current state of the law has certain notable shortcomings, it is recommended that an administrative arrangement be established which would facilitate the conduct of environmental monitoring.
- In the proposed administrative arrangement, the primary responsibility for environmental monitoring should fall on the Tana and Athi Rivers Development Authority (TARDA), which is the legal entity entrusted with the co-ordination and control of development projects in the Tana River

Basin. While TARDA takes the primary responsibility for environmental monitoring, it should work closely with the National Environment Secretariat (NES), the various Ministries having a stake in the development of the Tana River Basin, and the donor agencies.

- The rules and procedures governing the process of environmental monitoring should be formulated on the basis of co-operation between TARDA and the various stake-holders of the hydropower project.
- Since effective environmental monitoring will have to be conducted on the basis of the recommendations contained in the environmental impact assessment, it is important that the agencies that will be responsible for the task of monitoring, should be introduced to the formulation of the project at the earliest stage possible, and preferably at the stage of environmental impact assessment.
- The current state of the law, in which neither the conduct of EIA nor of environmental monitoring has a statutory basis is highly unsatisfactory, as it leads to a position in which monitoring agencies have no sanctions to buttress their decisions in the enforcement of the prescribed safety measures. In as much as the Government, and all the stake-holders have an interest in the enforcement of the environmental safety measures, they should consider what measures they can take to facilitate the enactment of a law giving legal validity to the processes of EIA and of environmental monitoring.
- In the absence of a specific law sanctifying the environmental monitoring process, the statutory framework of TARDA may be employed to create calculated disincentives against non-compliance with the safety requirements attached to the Mutonga and Grand Falls Hydropower Project.

25.4.2 Technological Requirements

The proposed institutional arrangements will not by themselves lead to the realization of an effective environmental monitoring process. The actual conduct of the monitoring process will require expertise and appropriate technological aids. It has to be determined where these resources are to be based - whether at TARDA, at NES, at the respective stake-holder Ministries, or through contract to other capable bodies. The location of these resources may not be the most important thing, provided that they are assuredly available and are managed under the direction of one particular agency. This particular agency will have to take responsibility for keeping such technological needs under constant review, and ensuring constant availability. Such appraisal of technological capacity should be done as far as possible in consultation between relevant stake-holders.

25.4.3 Capacity Development

In order to carry out the task of environmental monitoring with regularity and effectiveness, the agencies responsible will have to undertake specialized training for technical staff. Such training may be conducted either locally or abroad. There will have to be a clear training policy, to ensure that the monitoring process is not impeded by shortage of knowledge and experience.

The required expertise falls on two levels. Firstly, it will be important to have knowledgeable scientists, some of whom may be irrigation engineers, water engineers, botanists, zoologists, ecologists, environmental auditors, soil scientists, social scientists etc. This category of staff will provide the scientific knowledge required for monitoring the various impacts of the hydropower project on human life, fauna and flora. And secondly there will need to be qualified technicians who will conduct the actual sample tests on water, soils, etc. They should be knowledgeable in the use of scientific equipment and in the derivation of data and essential information. It is therefore a logical evolution of the above that donor agencies should be especially concerned with the the development of the necessary skills and technical capacities both to carry out the monitoring process and to manage and evaluate its findings.

25.4.4 Sustainable Management of the Hydropower Project

A careful monitoring of the operation of the hydropower project will facilitate enlightened planning adapted to the continuing needs of humans, fauna and flora. The success of such monitoring depends on the practicality of the management institutions put in place, and on the development of appropriate skills for ensuring the stability of the affected ecosystems as much as possible. This approach to management would promote the sustainable utilization of the hydropower project.