REPUBLIC OF KENYA

MINISTRY OF AGRICULTURE

Land Development Extension Division

Technical Study on Cost Estimates for four Rice Schemes in Nyanza Province

Valley Bottom Development in the Lake Victoria Basin

1. Main Report

(final)

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1. INTRODUCTION

Rice production by smallholders in Nyanza Province, Western Kenya has been declining over the past two decades, both in production per hectare as in area under cultivation. Main reasons for the decline are unfavourable physical and economical conditions. Physical constraints constitute frequent and prolonged flooding, erosion, and inadequate water control.

The government of Kenya, through the Ministry of Agriculture, therefore has started the Smallholder Rice Rehabilitation Programme (SRRP) in Nyanza Province. During phase I of the programme covering the years 1981 - 1984 four schemes will be rehabilitated and extended, being the areas covered by this study. They are the smallholder schemes Kore, Awach Kano, Wasare and Maugo.

The Terms of Reference for the study were drafted in June 1980 and submitted to the European Development Fund. In October 1980 NEDECO was informed by the Commission of the European Communities that it was selected by the Kenyan Government to carry out the study. NEDECO submitted a cost proposal in November 1980. After approval procedures a representative of the consultant visited Nairobi to discuss the contract in January 1981. During his stay in Kenya he used the opportunity to visit all four schemes. His findings in the field and the discussions with the client resulted into a formal proposal, describing consultant's approach. The proposal was submitted in March 1981 and was accompanied by a draft text of the contract. The contract was revised by the client and signed early June 1981 in Nairobi.

Field work started in the second half of May 1981 and was concluded early September 1981.

The results of the study have been compiled in the following reports:

1. Main Report;
2. Hydrology Report;
3. Soil Report;

4.1. Design Report with cost estimates for the Kore Scheme;
4.2. Design Report with cost estimate for the Awach Kano Scheme;
4.3. Design Report with cost estimate for the Wasare Scheme;
4.4. Masterplanning and preliminary cost estimates for the Maugo area, together with an alternative masterplanning.

2. LOCATION OF THE SCHEMES

The locations of all four schemes have been shown on drawing no. 1.1. in the back of this report.

Of the four schemes under this project three are located in the Kano Plains. They are the Kore, Awach Kano and Wasare area. The fourth scheme Maugo lies about 25 km from Homa Bay.

The Kore scheme consists of two parts Kore I and Kore II. The scheme is located between the southern boundary of the Ombeyi-Luanda Swamp and the Ahero Pilot Scheme.

The Awach Kano area is situated along the asphalted road Ahero -Kisii north of the present course of the Awach Kano River.

The Wasare area is located south east of the Meruka Swamp along the swamp's boundary. The main population centre nearby is the village of Papondíti.

The Maugo area is spread out along the Maugo River. The main population centre in the neighbourhood is the village of Nyangweso. The Maugo River debouches into the Awach Tende, which carries its water to the Lake Victoria. Topographically the Maugo area is a valley, surrounded by hills; the lower boundary of the valley touches the road Kendu Bay - Homa Bay.

3. SCOPE OF WORK

The work performed during the study consisted of the following major items:

- Collection of data;
- Topographical work;
- Soil survey;
- Hydrological survey;
- Detailed designs with cost estimates, for the areas Kore, Awach Kano and Wasare;
- Preparation of two masterplannings, of which one as an alternative, with preliminary cost estimates.

3.1. Collection of data

No major difficulties were encountered in the collection of data. The Ministry's assistance during this phase of the work is greatly appreciated. However, it has not been possible to study the Sir Alexander Gibbs report on the drainage of the sugar belt. This report is of interest, regarding the future planning in the Kore area. Although the report was available in Kenya there was no authorization to hand it over to the Ministry or to the consultant.

A general feature of the Valley Bottom study is, that the study is concerned with rather small areas. Particularly with respect to hydrological phenomena, it appeared that most of the data available are not detailed enough to apply specifically to the areas under study. Such data have been collected within the frame work of large scale studies and are generally suitable for projects of a different scale.

3.2. Topographical work

The topographical work consisted of two major parts:

- the preparation of topographical plans;
- field measurements on alignments, rivers and water courses.

In an early stage of the study the client made available topographical maps, scales 1:5,000 and 1:2,500 with contours partly in local levels and partly in absolute levels derived from aerial photographs. In addition farm holding maps were received, scale 1 : 1,000.

According to the Terms of Reference the consultant was requested to produce so called topographical plans 1:2,500 to serve as base maps for the designs. For all areas such maps were prepared. As many maps had contourlines in local levels, these local levels were reestablished into levels related to the National Railway Datum (NRD).

The second part of the topographical work consisted of carrying out detailed topographical measurements on which the designs had to be based. The topographical measurements mainly consisted of measuring alignments, longitudinal profiles and cross-sections of major rivers, canals, gullies, drains and alignments of future protection works. Bench marks had to be checked and their levels and coordinates recomputed when necessary. This part of the work was subcontracted to a local survey company Wapi Maji (Surveyors) Ltd. in Nairobi. No survey work was carried out in the Maugo area by the consultant.

3.3. Soil survey

A detailed soil survey was carried out in all four areas with an average density of approximately 1 observation per 2 ha. The requirements put on the soil survey were established in close cooperation with the Kenyan Soil Survey. Soil samples were delivered to the National Agricultural Laboratories for detailed analysis. Field measurements on infiltration rates and hydraulic conductivity were carried out.

During the survey assistance was obtained from the laboratory of the Ahero Irrigation Research Station. At the station conductivities (EC) and pH of a large number of soil samples were determined. This assistance has been greatly appreciated.

The way the actual soil survey has been carried out deviates from the requirements laid down in the Terms of Reference. In the Terms of Reference it was envisaged first to carry out a semi-detailed survey over the full area. Where soil conditions appeared to be heterogeneous a detailed survey had to be carried out. In view of the observation density required for a semi-detailed survey, the small size of the areas involved and the scales at which the soil maps had to be worked out, it was decided to carry out detailed surveys only over the full 100% of the area. The gross areas mapped were as follows:

- Kore I and II		116 ha
- Awach Kano		194 ha
- Wasare		164 ha
- Maugo		286 ha
	Total	760 ha

The areas to be surveyed have been indicated by the client on the topographical plans, scale 1:2,500, as produced by the consultant.

3.4. Hydrological study

Hydrologically the Kore area is the least complicated of the four projects. The area is located on the edge of the Ombeyi-Luanda swamp, which is fed by the water of the Oroba River. During periods with heavy precipitation, waterlevels in the swamp rise and the swamp floods its surroudings, including the Kore schemes. As the swamp acts as a retention reservoir of considerable size, the Kore area can be protected by dykes against flooding without upsetting the hydrology of the surrounding areas.

The other three schemes are all located in the flood plain of rivers; the areas are not swampy in nature. Based on rainfall data, discharge data of other rivers and available hydrological information on watersheds in Western Kenya, peak discharges and base flows have been estimated. It appears that the existing river beds by far cannot carry the estimated peak flows.

Another factor of importance is that the river beds in the three areas are eroding. It was considered a matter of urgency that the erosion of the rivers should be controlled, where it endangers soil and water conditions within the schemes.

The erection of flood protection dykes along the rivers will be very costly. Also such dykes will have to be extended over stretches considerably longer than the immediate environments of the schemes.

It is feared that flood protection measures would change hydrological conditions extensively, while the consequences of such changes in view of continuing erosion cannot be predicted.

The approach to the improvements to be carried out in the rivers therefore is based on the following principles:
- flooding cannot be prevented unless at excessive costs;
- the erosion of the river beds has to be stabilized, in so far as it endangers present conditions within the project areas;
- in designing provisions on the river beds the present capacity of the rivers should be maintained, to avoid changes in hydrology;
- although flooding cannot be prevented, the duration of the floods can be decreased, by improving drainage conditions in the areas Awach Kano and Wasare.

During drought periods river discharges become low. As prolonged droughts may occur in almost any season during the year, the minimum flow has to be established at which irrigation is still possible. Based on the waterlevels occurring during the minimum flow inlet structures have been designed. In addition the minimum flow gives an indication how many hectares can still be irrigated during prolonged droughts.

4. THE PROJECTS

4.1. The Kore area

4.1.1. Topography

As mentioned before the Kore area is located on the southern edge of the Ombeyi-Luanda swamp. The swamp recieves its water from the Oroba River. It is drained by several rivers, one of which is the Ombeyi River. The Ombeyi River forms the northern boundary of the Kore I area. The northern boundary of Kore II is not defined; there is no clear distinction where Kore II ends and the swamp starts.

South of the schemes Kore I and Kore II the soils are higher and less subject to flooding. Part of the higher soils consist of levees of the rivers Kigoche, Miriu and Badjo, that have their course there.

The Kore I and II areas measure 116 ha gross within their project boundaries. The area between Kore I and II covering approximately 50 ha gross is probably suitable for rice growing but no soil survey has been carried out. The area at present is partially in use by the farmers for growing rice. During periods of floods the whole area, including Kore I and II, may be 0.6 - 0.8 m under water. Such floods generally occur in April, May. The general topography of the Kore area is rather flat but the area slopes with a gradient of approximately 1.5 ‰ (1.5 m/km) from east to west. The same applies to the Ombeyi-Luanda swamp. It has to be assumed therefore that the water in the swamp is not stagnant but passes through it at very low velocities. So swamp water-levels in the east are higher than those in the west.

The accessibility of the Kore areas is limited. The distance to the asphalted road Kisumu - Ahero is 5 - 6 km. The present track to Kore I from Lela is winding and in bad condition during rains, moreover the Badjo River is an obstacle to enter Kore I. There is a possibility for better access at least to the Kore II scheme from the road passing from Ahero to Miwani at Kigoche. However, there is no road there at present.

4.1.2. Hydrology

During periods with heavy rains, when the water in the Ombeyi-Luanda swamp is high, the swamp overflows into the rivers south of the schemes. Under normal conditions, there is no connection between the swamp and these rivers.

These rivers, Kigoche, Miriu and Badjo, draw their water from very limited areas and their discharges are low. In addition flow velocities are low as the river beds are very winding and fully grown with vegetation.

The topographical and hydrological situation as described renders it possible that farmers draw their irrigation water for the rice from the swamp. The excess water is drained into the southern rivers as well as into the Ombeyi River. The farmers use several inlets. This may have reasons of internal organization among the farmers themselves. Another reason, however, is that during dry periods water-levels in the eastern part of the swamp may drop faster than those to the west. The eastern inlets therefore may fall dry sooner than the western inlets. This leads to the conclusion that one single irrigation inlet serving the whole area, may make the irrigation vulnerable.

The farmers do not use separate systems for irrigation and drainage. The water is conveyed to the fields and drained from them by the same canal system. This is possible as the areas served by each of the inlets are small, while the organization among the farmers apparently is good. There are no concrete structures in the area, neither at the supply side nor at the drainage side. Dykes are almost absent; the only dykes present are the bunds around the rice fields. So during periods of floods rice growing is not possible.

4.1.3. Soils

During the Pleistocene the Kano Plains were part of the Lake Victoria. When water levels fell gradually, clay sediments were deposited, which cover at present large parts of the plains, the so called lacustrine sediments. After the plains had fallen dry, rivers carried new materials and reworked lacustrine sediments and created alluvial plains and levees. These sediments are called fluvial.

The Kore area forms a transition between the swamp with low lying lacustrine deposits and slightly higher elevated areas with fluvial deposits on top of lacustrine sediments. The lacustrine sediments cover more than 90% of the total area. They are highly suitable for rice cultivation because of their chemical properties and their very slow hydraulic conductivity.

The remaining 10% of the area is covered by fluvial deposits over lacustine sediments, which are moderately suitable for rice. Main restrictions are texture and hydraulic conductivity. Only two mapping units have been distinguished as soils are rather homogeneous.

There are no reasons to expect that soils in between the two Kore areas will be markedly different. So outside the areas mapped more potential is available for intensified rice production in the area.

4.1.4. Works to be carried out

The works proposed in the Kore area consist of a protection dyke along the northern boundary of the schemes, including the area in between Kore I and II, connected to the higher grounds. In this way the existing connection between the swamp and Ombeyi River with the Miriu and Badjo River will be blocked. The high grounds, at the southern side of the area, will then provide sufficient protection against possible flooding, resulting from back-up water of the Miriu and Badjo rivers.

The protection dykes will have to be built through difficult terrain, while the material out of which the dykes have to be built is difficult to obtain and transport. There is a preference to build the dyke in hand labour. It should be realized that this way of working will take several years, while the schemes remain unprotected in the meantime. At the other side direct involvement of the farmers with such works will constitute a positive development effect. The dyke along the northern boundary is about 5,800 m long. As such dyke construction will determine the total duration of implementation; a phasing of all works recommended will be required.

Access to the area can be improved by constructing a road from Kigoche to the Kore II scheme. This road will partly serve as a dyke as it will block at that place overflow from the large swamp via the Kigoche into the Miriu River, so that flooding in Kore II from the south can be prevented.

From Kore II a road can be constructed over the high grounds towards Kore I, improving the accessibility of the area in between as well. This road will block the Miriu-Ombeyi connection on the southern side. Where crossing the Badjo River a culvert will have to be built, serving as a drain outlet for the area between Kore II and Kore I.

There is a rural access road, recently constructed, which starts about 4 km north of Rabuor and runs south of the Ombeyi-Luanda swamp to the Ombeyi River bordering the Kore I scheme, where it stops. In order to establish a connection with the road system of the Kore area a crossing of the Ombeyi River is recommended. This crossing has not been designed as it is considered by the client to be outside the scope of the project. Consultants are of the opinion that a link up between this rural access road and the road in the Kore area would be of benefit to the whole area.

Works on the irrigation and drainage system of the Kore area have been kept to the minimum. The system seems to work all right, while it is completely managed by the farmers themselves. As the area is small the construction of a separate irrigation and drainage system has no great urgency.

Because of the construction of the dyke and road, gated pipes will be used on the irrigation inlets and the drainage outlets. By manipulating these gates the inflow of irrigation water and outflow of drainage water can be controlled. If the surrounding waters are high these gates should be closed so that major floods can be kept out.

4.1.5. Costs of the works

Implementation costs for the Kore I an II areas and the area in between (approximately 165 ha gross) have been estimated in Ksh. at 1981 pricelevel and can be summarized as follows:

- Phase I works (Kore II)	
culverting	154,000.--
flood protection dyke	401,000.--
access road	70,000.--
main farm road	78,000.--
infra-structure	6,000.--
Total	709,000.--
- Phase II works (area between Kore II and Kore I)	
culverting	89,000.--
flood protection dyke	120,000.--
main farm road	157,000.--
Total	366,000.--
- Phase III works (Kore I)	
culverting	334,000.--
flood protection dyke	135,000.--
main farm road	115,000.--
Total	584,000.--
Grand total	1,659,000.--

4.2. The Awach Kano Area

4.2.1. Topography

The Awach Kano area is located east of the asphalted road Ahero-Kisii, behind the Awach market. The area is bordered both in the north and the south by a river. The southern river is the present course of the Awach Kano River; the northern bed is an old course of the Awach Kano, which was dammed off a great number of years ago but which still drains a part of the original catchment area. The area is flat and slopes from east to west with an approximate slope of 1.5 ‰ in the west increasing to 3 -5 ‰ in the east. Except for Awach Market, which is declining, there are no population centres of importance in the neighbourhood of the area. The project area which covers 194 ha gross is part of a larger area, which stretches between the two river beds up to the point where the two come together. As can be concluded from the presence of rice bunds, canals and drains, rice has been grown on considerable proportions of the area. Some rice in still being grown, but many fields have been abandonned as well. One reason is that hydrologically the area is changing. Due to erosion, changes in water courses etc. the water situation is uncertain, which has its influence on the attitude of the farmers to grow rice.

4.2.2. Hydrology

The hydrology of the Awach Kano area is rather complex, mainly because of the many changes that have taken place and still are taking place. Many of those changes are caused by human interference in existing rivers and watercourses. The southern river itself is in the process of eroding heavily and changing its course. As a result existing facilities for watersupply loose their function, while also drainage conditions change.

The reasons why most of the rice fields have been abandonned is related to this. Due to erosion of the main river and supply canals, the water has started flowing at a lower level and farmers are no longer able to bring the water to their land by gravity. In addition, a main inlet point in the eastern part of the river has silted up recently.

The estimated discharge capacity of the southern river course of the Awach Kano at the location of the project area varies from 2.5 - 10.5 m3/sec depending on the cross sectional area. Peak flows with an approximate frequency of once per five years, exceed this capacity by far and are in the order of magnitude of 125 m3/sec. The area is regularly flooded to depths up to 1.0 m above ground surface.

The area is bordered in the west by the asphalted road, which constitutes a barrier to undisturbed drainage. Under the road main culverts have been placed at two locations, one in the present riverbed in the south, the other in the riverbed in the north. The first one consists of 7 culverts each with an elliptical diameter of 1.60/1.90 m, the second has 7 culverts each with a circular diameter of 1.77 m. In addition to that minor culverts have been laid under the road, but they contribute little to the drainage of the area. The discharge capacity of the culverts is limited mainly because of downstream conditions and partly as a result of the culvert siltation. It has been reported that occasionally the water of the river floods the road, although this has not been observed during the study.

As for the irrigation and drainage system, no structures have been found in the area, no inlet structures, no drainage structures, no protection structures against erosion. With the prevailing slopes in the eastern part of the area and the low stability of the soils, water erosion is a constant thread. Considering the alignments of existing supply canals, there are no indications that the erosion hazards have been fully understood in the past. Some canals run down slope and have lowered their bottom level to unmanageable depths.

4.2.3. Soils

The center of the Awach Kano Area is covered with the heavy clays of the lacustrine sediments. These soils cover about 60% of the project area. The soils are highly suitable for rice growing.

Along the river courses north and south of the project, fluvial sediments occur on top of lacustrine deposits at depths varying between 0.5 - 1.5 m. Three mapping units have been distinguished among the soils on the fluvial sediments. One is marginally suitable for rice cultivation, one is moderately suitable and one is highly suitable. This renders the total area either moderately or highly suitable for rice to 178 ha or 92% of the total area.

Limitations for rice production on the other soil are texture and hydraulic conductivities.

4.2.4. Works to be carried out

Consultants consider it important that the Awach Kano River is stabilized in order to create stable hydrological conditions in the area. The works required are extensive and need to be carried out by a qualified contractor. Besides stabilizing the riverbed, side gullies have to be controlled in order to safeguard the land against the erosion which still proceeds.

In designing the works the discharge capacity of the river has been adopted at 8.5 m3/sec. This is in accordance with section 3.4. of this report, stating that the designs proposed should not basically change the hydrology of the area.

No flood protection works as such have been designed. Flooding therefore will remain a natural phenomenon in the area, be it that the removal of bottle necks in the river will reduce the frequency of minor floodings. Flood protection could be carried out but will be extensive. In addition it is learned that by protecting the project area against floods, these floods will be shifted to surrounding areas, which is undesirable.

By improving the drainage capacity of the culverts under the asphalted road, the duration of the floods can be shortened, however only in case the downstream swamp conditions are favourable.

There is a possibility to supply some 170 ha gross of the actual project area and some 115 ha gross outside the project boundary with water from the Awach Kano River by gravity. The supply canals have been given a minimum slope in order to prevent erosion. From the supply canals branch canals take off and follow the ground levels along the northern and southern boundary. Drop structures combined with check structures have been designed in these branch canals on places where tertiary canals take off into the area. Those tertiary canals have in general little slope and run more or less parallel to the contour lines.

The proposed irrigation systems will be flooded occasionally. By designing the tertiary canals along the contours, floods will not cause erosion in those canals. The branch canals are partly located above flood level as they are positioned on somewhat higher soils.

The present drain in the middle of the area will be maintained. As the drain runs down slope it will be most exposed to erosion and protection stuctures have to keep this drain in shape.

One should realise that the occassional floods will not leave the irrigation and drainage system untouched. The floods will cause damage which needs repair by the farmers and will cause siltation of canals, which have to be cleaned. The flow velocities during overland flow are low and as such not erosive. The construction of canals along the contours and the numerous rice bunds will further decrease the risk of erosion.

Extension programmes should be developed instructing the farmers to do regular maintenance. The maintenance on structures can not be done by the farmers as it involves masonry work. Farmers should be instructed to report damages on structures to their management committee, which is responsible for further action. In addition the extension should be aimed at explaining to the farmers relations between erosion and down slope water courses, in order to avoid farmers taking risky measures in the future.

4.2.5. Costs of the work

Implementation costs for the development of 196 ha gross within the project boundary, inclusive a main supply for development of additional 117 ha gross outside this boundary have been estimated in Ksh. at 1981 price level and can be summarized as follows:

River stabilization works	4,250,000.--
Construction of the irrigation system incl. appurtenant structures	1,865,000.--
Improvement of internal main drainage system, construction of appurtenant structures, cleaning up main road culverts incl. placing of provisions	1,185,000.-
Total of estimate	7,300,000.--

4.3. The Wasare area

4.3.1. Topography

The Wasare area is located on the eastern border of the Meruka swamp, separated from this swamp by a sandy ridge. It is bordered in the east by a field road, in the north by the course of the Asawo river and its swamp, and in the south by the higher grounds of Paponditi. The area is sloping towards the Meruka Swamp. Slopes vary between 3.5‰ and 10‰ .

Within the project area, which covers 164 ha gross, relatively high soils occur, with a rather light texture. Soils suitable for rice growing occupy about two third of the total area. They are mainly located along the western boundary towards the swamp.

Along the western sand ridge a drain has been dug in the past with the aim to create a main outfall drain. The drain is connected to the Meruka swamp by a breach in the sand ridge about 600 m north of the northern project boundary.

The rice fields receive their water from the rivers Ochuoga, Omondo and Asawo. The Ochuoga and Omondo fall dry frequently. The Asawo river carries water during longer periods. Its location however is unfavourable with respect to the major rice area. There is a possibility to let water in at the location where the Asawo enters the project area. Farmers use that location as well as a location more downstream to divert the water, but no inlet structures have been made. The water diverted travels a considerable distance through the project before it reaches the rice fields.

Flooding occurs by flash floods from those rivers. The catchment areas are rather small in size, have relatively steep slopes and are susceptible to erosion. As a result large amounts of sediment are carried into the area and deposited there. The sediment may be very coarse. Out of these sediments the higher soils have been built up.

Within the project area erosion is limited. The higher soils are infrequently flooded by the rivers. The lower soils have numerous rice bunds which control erosion. The canal system carrying the water to the rice fields consists of a network of small canals that seem to be properly controlled.

Access to the area is reasonable under dry circumstances. There is a field road along the eastern boundary of the project, with two branches into the project. In addition it is possible to reach the sand ridge by car from the south, which makes it possible to drive along the western boundary as well.

4.3.2. Hydrology

As with the other projects the discharge capacity of the riverbeds is not able to carry the flash floods. In addition the large amounts of sediment cause a continuous silting downstream of the Ochuoga and Omondo; they change their lower course occasionally. The lower course of the Asawo river is stable partly because the sediments are being dug out by the local population. Flood protection measures must be considered to be outside the scope of the present study. They will be very costly, while it can not be predicted what the effect of any measures will be, certainly when taking into consideration the heavy sediment transport. As erosion in the project area itself is well under control there is no need to interfere with the present system.

The lower area is flooded rather frequently and the floods require a long time to be drained off. The reason is that the sandy ridge between the project area and the swamp acts as a barrier. The breach in the sandy ridge through which the area drains, has a limited discharge capacity. This is also valid for the drain itself, which is rather winding, full of vegetation and with little slope.

The duration of the floods may last 20 - 30 days according to the farmers. As with the Awach Kano area improvements can be found in increasing the drainage capacity of the outlet in the sandy ridge into the swamp and of the drain itself.

The main drain could also be given an outlet towards the swamp south of the sandy ridge. However the extra capacity that could be obtained by that is not significant (2 m3/s only) and is in no relation to the costs as the construction of an outlet at that location requires expensive technical measures.

4.3.3. Soils

The physiography of the Wasare area is similar to that of Awach Kano. The difference is that in the Wasare area fluvial sediments are thicker and generally of a coarser texture. This is related to the behaviour of the rivers flowing through the Wasare area. Floods are flashy and carry much coarse sediments. As a result the overall suitability of the Wasare area is less than that of Awach Kano or Kore. Highly suitable is 50% of the area (82 ha), the remaining part is mainly unsuitable or marginally suitable. The restrictions with respect to the suitability for rice are again texture and hydraulic conductivity.

4.3.4. Works to be carried out

At the two locations where the farmers divert the water from the Asawo River, no inlet structures are available. The farmers do build primitive barriers in the river which are washed away ever so often. Inlet structures have been designed, which will enable the farmers to divert the water easier. The inlet structures are able to stand high discharges, without being a bottle neck for the discharge capacity of the riverbed.

No inlet structures have been designed for the Ochuoga and Omondo Rivers. Their courses are too erratic and shift too often to design any structure. In addition to that the Ochuoga and Omondo Rivers run dry too frequently.

In order to reduce the duration of the flooding, it is proposed to enlarge the breach in the sandy ridge in such a way that no erosion is introduced and that no extensive digging far into the Meruka Swamp will be required. The breach will have to be widened while deepening is limited. The duration of the flooding will be reduced to about ten days.

In order to improve the normal drainage of the project the main drain parallel to the sandy ridge will have to be rehabilitated. This work could be carried out in hand labour by the farmers. Special attention should be given to locations where tertiary drains discharge water out of the area into the main drain. Those places will be susceptible to erosion and need to be protected.

As mentioned in the previous section no design has been made for creating an outfall of the main drain at the southern side of the scheme. The drain would have to be cut up to 3.50 m deep at one location. The amount of earth work is considerable, while construction will be rather complicated. It is feared that side slopes of the drain will not be stable due to the sandy underground and the ground water present. In addition a large culvert or bridge would have to be built in order to maintain the accessibility to the sandy ridge.

4.3.5. Costs of the works

Implementation costs for the development of 106 ha gross have been estimated in Ksh. at 1981 price level and can be summarized as follows:

Irrigation inlet structures	162,000.--
Irrigation canals	157,000.--
Irrigation structures	820,000.--
Drainage structures	588,000.--
Improvement of tertiary drains, main drain and passage through sandy ridge	861,000.--
Access roads	254,000.--
Total of estimate	2,842,000.--

4.4. The Maugo area

4.4.1. Topography

The Maugo area is the only real valley bottom of the four schemes of this study. The area is surrounded by hills, the bottom of the valley has an overall slope of approximately 5 ‰ (5 m/km). The valley is rather narrow over most of its length. Only in the downstream section, where the project is bounded by the Awach Tende, a relatively wide plain exists, 1.5 km wide and less that 1 km in length. Within the valley very flat stretches of land occur, where rice is grown. Most of these lands are located in the narrow middle section of the area. The downstream plain would be suitable for rice growing, but the area is damaged by extensive gully erosion. The total area measures 286 ha gross within the scheme boundaries.

In the past the winding course of the Maugo river has been changed and straigthened at several places by human efforts. Flow velocities at present apparently exceed non-erosive limits at a number of places and the river is cutting itself deeper. This in its turn causes the loss of water supply to potential rice areas, because water levels have fallen.

Besides the gully erosion in the downstream part of the valley and the erosion of the river itself, no other apparent signs of erosion have been noted in the valley.

4.4.2. Hydrology

The Maugo area is the most downstream part of a watershed of about 170 sq.km. Floods with an return period of approximately 5 years carry between 75 - 90 m3/sec, while the capacity of the riverbed itself is less than 10 m3/sec. Flooding, therefore, is common in the valley and the floods cover large parts of the land.

The Maugo River carries water all through the year. Low flow is estimated to be between 0.3 and 0.4 m3/sec, which is sufficient for the irrigation on an area of about 250 ha.

4.4.3. Soils

Despite the somewhat higher topographical position of the Maugo area, large parts are still covered with lacustrine sediments, more or less similar to the Kano clays. The project apparently has been part of the Lake Victoria in the Pleistocene. As in the other areas these lacustrine sediments have been partly covered by sediments of fluvial origin.

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Along the sides of the valley soils appear that have been developed on parent material originating from the hill sides.

In places, soils on old alluvial sediments have been encountered, which are distinctly different from the other soils in the area.

Due to this varied physiography, the number of mapping units distinguished in the Maugo area is 16. Of these a total area of about 250 ha is either moderately or highly suitable for rice cultivation. This comes to about 85% of the total project area.

The main factors that limit the suitability of the soils in the Maugo area, are texture and hydraulic conductivity. In few instances the soils are too shallow or the soil reaction is too alkaline to make rice production profitable.

4.4.4. Masterplannings

Two masterplannings have been prepared

In the first one the emphasis is primarily put on controlling the unstable Maugo river courses and gullies over their full lengths in the project area in order to save the area as a whole from further erosion hazards. This will require, beside the gully protection works, a reduction of the riverbedslope with consequent riverbed enlargement together with the construction of about 27 river drop structures. The capital investment for these river and gully training works amounts to about Ksh. 8 million.

Further in this planning rice growing areas are selcted on the basis of soil suitability and topographical limitations. These limitations do exclude, for the purpose of erosion control, areas steeper than 5 ‰ from irrigation for the time being until such time that farmers have gained sufficient experience in handling irrigation water. The result is a number of areas, small in size and scattered over the valley with a total acreage of about 150 ha.

In order to avoid considerable lengths of through going irrigation canals and drains to serve these scattered areas, individual irrigation of these areas from the controlled river via small offtakes and short canals has been considered as much as possible because it will benefit and facilitate the operation and maintenance. A total of 25 intake structures will thus be required of which about 12 can be combined with the above mentioned river dropstructure. Implementation costs for the irrigation and drainage systems included in this planning are estimated at about KSh. 3.5 million.

In the second masterplanning, which is an alternative to the first one, the criterion for the unstable Maugo river is the control of actual erosion only, hence the stabilization of only those places where the river has been disrupted by human interference. This will require beside the gully protection works a limited number of protective dropstructures and a limited amount of river modification works. The estimated capital inventment for the river and gully training works included in the alternative is Ksh. 1.5 million.

Further in this alternative planning the criterion on which areas for rice growing have been selected, separate from soil suitability, is the fact whether the soils have been under rice previously. On that basis larger and joint areas can be established resulting in six individual rice growing areas with a total acreage of about 185 ha.

Each area is seperately irrigated via a supply canal with an offtake from the river. The offtake sites have been selected independant from locations of drop structures. The supply canals run mainly along the foothills and branch into a network of irrigation canals in the areas itself. The irrigated areas per offtake are substantially increased compared to the solution in the first masterplanning making the operation more complex. Implementation costs for the irrigation and drainage systems included in the alternative planning are estimated at about Ksh. 4.8 million.

After discussions with the client on the two masterplannings it was decided to proceed with the detailed design for the Maugo area on the basis of the alternative masterplanning.

4.4.5. Additional topographical data

The topography of the project area has been derived from aerial photographs and not from terrestrial survey. Such topographical information is not sufficient for detailed design work. It will be necessary, therefore, to carry out additional terrestrial surveys.

In the first place a survey is required along the main water courses in the area and along the gully systems. Such a survey is necessary to determine the location of protection structures in the river and the gullies and to design these structures. Also the locations of the irrigation offtake structures will have to be checked against the main river survey data. In addition the alignments of the irrigation supply canals proposed in the Maugo report have to be surveyed.

4.4.6. Works to be carried out

1. Irrigation and drainage

A number of six individual areas can be developped with a total acreage of 185 ha gross. Each individual area will be served by a single irrigation supply canal running more or less along the foothills. These supply canals draw their water from the main river course through offtake structures. Tertiary irrigation canals take off from these supply canals by means of turn out gates; the tertiary canal interval is about 200 m. Farmers can draw their irrigation water form these tertiary canals. The irrigation canal system will be provided with the necessary drop and check structures and with outlet structures to drain off excess water. The dimensions of the canals and their structures can be standardized to a large extent. The total length of the irrigation canals designed in the alternative masterplanning is about 18 km.

The drainage system has been integrated where possible into the existing system of watercourses and old riverbeds. The system drains back into the main river at many places. Most of the drains have standardized dimension. Where slopes become too steep drop structures will be designed. The total length of new drains to be constructed is about 17 km inclusive drains running parallel to irrigation canals but exclusive existing watercourses. Such courses will have to be cleaned, which should be left to the farmers.

The alignment of irrigation canals and drains indicated in the masterplanning are approximate. Final alignments can be established after detailed topographical survey data have been collected and after consultation with the farmers.

2. Provisions on the Maugo River

The present bedslope of the Maugo river has to be reduced where necessary in order to keep flow velocities down to stop the actual erosion. This can be achieved by designing drop structures in the river on the required places. The total number of drop structures may vary from 3-12. Due to the decrease of flow velocities the cross sectional area of the river has to be enlarged on places in order to maintain the present discharge capacity. This means that some land along the river has to be acquired which will have to be negotiated with the farmers. Final positions of the drop structures and their exact dimensions can be given when detailed topographical date are available.

3. Stabilization of gullies

Detailed designs of the structures needed to stabilize the gullies can be worked out if the detailed topography is known. Estimates of costs have been made. Structures will be necessary where the gullies enter into the Awach Tende and at the upstream end of the gullies. At present the river flows partly through the gullies, at depths of 1-2 m or more below groundlevel.

To further protect the gully areas, surrounding zones have to be established in which no irrigation is allowed. Such zones should be used to plant trees or to take other soil conservation measures to prevent the gullies from further retrograding erosion.

Also along the Awach Tende lands should be reserved on which no agriculture is allowed. This strip should also act as protective zone against further advancement of the erosion.

4. Roads

No new roads have been designed in the area. At present vehicles can not enter the project. Provisions to allow vehicles will be costly due to the many water courses that have to be crossed. When the need for motorized transport arises in the future, access to the area should be realized along the foot hills with a few short roads crossing the valley.

4.4.7. Costs of the works

Implementation costs for the development of 185 ha gross have been preliminarily estimated in KSh. at 1981 price level and can be summarized as follows:

River and gully training works	1,444,000.--
Irrigation inletstructures	514,000.--
Irrigation canals and drains	1,391,000.--
Irrigation and drainage structures	2,955,000.--
Total	6,304,000.--

4.4.8. Recommendations

Extension of rice production in the Maugo area is considered technically possible. Detailed designs can be worked out after topographical field data have been collected. It is recommended to limit the topographical work to measurements on the main water courses and on the existing gully systems and on the proposed irrigation supply canals.

As most of the tertiary irrigation canals and drains proposed in the masterplanning do not require extensive engineering work, it is proposed to shift topographical surveys along their alignments to the implementation stage. By that time proposed alignments can be talked over with the farmers.

The river and gully training works, as well as all structural works require construction by a qualified contractor. Farmers can participate in the earthwork construction of canals and drains.

Consultant recommends to rehabilitate and expand rice cultivation in first instance on suitable soils with slopes less than 5 ‰ (5 m/km) in view of the apparent erosion hazard. The steeper areas can be developed later, when farmers have acquired more skill in handling water in sloping areas. The limit of 5 ‰ is somewhat arbitrary. On the other side most of the lands under rice at present are located in areas flatter than that.

5. SUMMARY OF COST ESTIMATES

The estimated implentation costs of the four schemes in Ksh. at 1981 price level are as follows:

-	Kore scheme	1,659,000.--
-	Awach Kano Scheme	7,300,000.--
-	Wasare Scheme	2,842,000.--
-	Maugo Scheme	6,304,000.--
	Total	18,105,000.--

6. OPERATION AND MAINTENANCE

6.1. General background

In Technical Note no. 15, chapter 4, of May 1980, the Small Scale Irrigation Unit (SSIU) sketches the frame work, within which the projects have to function in the future.

At present the Provincial Irrigation Unit (PIU) is in charge of the schemes. When it comes to implementation a central management of the programme will be established, which will supervise the implementation. After construction has been completed, the schemes will be handed over to the farmers, represented by their Scheme Management Committees. The Scheme Management Committee will be responsible for operation and maintenance, assisted in this by the Ministry of Agriculture. As far as technical maintenance is concerned, the Scheme Management Committees will be assisted by the Central Management, which will have available for this purpose a mobile maintenance unit, consisting of a hydraulic excavator and some tractors with implements.

6.2. Operation

All schemes discussed in this report are small in size with a limited number of farmers. The farmers should be able in mutual co-operation and understanding to take their own daily decisions with respect to irrigation, drainage and small maintenance. The responsibility for such decisions rests with the Scheme Management Committees. In case of differences of opinion among farmers the Scheme Management Committee should have the possibility to discuss their matters with a representative of the Ministry of Agriculture preferably at district level or as the case requires at provincial level.

6.3. Maintenance

The upkeep of the works proposed in this study requires different types of maintenance.

1. Small maintenance

   Minor earth work, clearing of vegetation on berms and in canals and drains, cleaning of sediment from canals and structures. This maintenance task should be left to the Scheme Management Committees. Either the farmers make arrangements among themselves and divide tasks or the committees pay for labour recruited among the farmers.

In the latter case the committees have to raise funds from the farmers to pay for the labour. The individual schemes can afford only small amounts of hired labour. Communal maintenance therefore is preferred, with no financial consequences.
There should supervision as to the quality and frequency of this maintenance. This supervision should be charged to a person who visits the areas frequently, for instance an officer who participates in extension activities. If delays in small maintenance become serious he should report to the Central Management.

2. Maintenance of minor structures

Minor structures are considered all structures in the irrigation and drainage systems including the intake structures. The maintenance of such structures is important as negligence of for instance drop structures may lead to erosion. This maintenance is relatively frequent at low costs. The responsibility of notifying the Central Management about the need for such maintenance rests with the Scheme Management Committees. The farmers however can not carry out the maintenance themselves, as this requires skilled input. If the Central Management resides in Kisume it will be too costly to dispatch every time masons and their crews. It would be better to have the maintenance carried out at local level for instance by agreement with local contractors, if available. Another solution could be to train some farmers in each scheme as a mason to carry out minor repair works.

The costs of such repair works are difficult to predict. Yearly maintenance costs can be estimated as a percentage of investments. In this case the percentage would be about 5. The maintenance cost of minor structures will be charged to the farmers. It will appear, however, that in the cases of Awach Kano and Maugo for instance, these costs are already heavy. Together with the other charges, to be made to the farmers, they may exceed what is possible within the farmers budget. The high maintenance costs are caused by relatively high investments on only a small number of productive hectares. A better approach to charging maintenance costs could be to study what a farmer reasonably can contribute. The remaining costs uncovered may be considered as subsidy.

A different subject is how maintenance charges or any other charges are going to be levied. The Central Management, does not seem to be equipped for this task as it is mainly concerned with technical maintenance.

3. Maintenance of major structures

The maintenance costs of major structures such as drops in the Maugo River, erosion control structures, roads etc. should not be charged to the schemes. They should be considered infra-structural works that serve a wider purpose than the rice areas alone.

A consequence of this position is that consultations should take place between the Ministry of Agriculture and other ministries about the works to be constructed. Formal approvals will have to be obtained before construction, while agreements have to be made with respect to the maintenance methods and costs.

6.4. Central management

According to technical note 15, mentioned earlier, the Central Management will have available two tractors and a hydraulic excavator. It should be realized however that the schemes are far apart at distances too large for tractor driving. In addition, the schemes Awach Kano and Maugo are barely accessible for tractors and will remain so for the time being.

Taking the position that most of the operation and maintenance should be organized at local level, it seems advisable to supply every scheme with one tractor or to supply no tractors at all. The number of tractors in the area is on the increase. If tractor work is required the Scheme Management Committees can rent them. In doing this, they are relieved from all tractor maintenance sorrows, upkeep of a shed, spare parts, fuel, lubricants, mechanics etc.

Something similar applies to the hydraulic excavator. The excavator will not be able to operate on the majority of the canals as no maintenance strips are present. For transport of the excavators from one scheme to the other a deeploader is necessary, while the plant is expensive in maintenance.

As all schemes function as local schemes, maintenance should be organised locally as much as possible. Therefore it may be more advisable to give the central management a function, which is more administrative then technical.

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VALLEY BOTTOM DEVELOPMENT PROJECT

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Date 26-10-'81

Dr. J.B.M.

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VALLEY BOTTOM DEVELOPMENT PROJECT

98035.01

LOCATION OF SCHEMES

Date 26-10-'81
Dr. J.B.M.
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