

## **Human and Natural Factors in the Deterioration of Indigenous Irrigation Furrows in Marakwet, Kenya**

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### **Abstract**

*This paper examines factors influencing deterioration of Marakwet irrigation furrows drawn from Embobut River, Kenya. The furrows are located at 1°12'N to 1°15' N and 35° 35' E to 35° 40'E and flow along Sibow, Sagat and Kapchubai Escarpments to crop fields in the Kerio Valley. In total, there are fourteen furrows tapped from the upper and lower part of the perennial river. They were constructed with inferior materials such as wood, leaves, grass and mud. Today, a number of the structures are broken, leaking, silted, eroded and blocked by mud and rock debris and no longer efficient in their function as in the past. Both climatic and human factors have contributed to decay of the systems.*

**Key Words:** Marakwet, indigenous, irrigation, deterioration, furrows

### ***1. Introduction***

Marakwet irrigation furrows were built about four hundred years ago and have since then been passed down from generation to generation. The furrows form the tangible cultural heritage of the Marakwet people and continues to be used for food crop irrigation in the semi-arid valley. Moore (1986) reports that the constructions of the furrows are linked with the traditions of Marakwet clans, especially during the migration and settlement in the late 18<sup>th</sup> Century. According to the oral traditions some of the Marakwet clans jointly constructed some of the furrows and have been sharing the water in the irrigation of the food crops. Other clans solely constructed theirs and do not share the furrow water with others. The furrows are prone to damage and regular maintenance is undertaken to restore flow of the water to the crop fields (Kipkorir, 1973; Kipkorir and Ssenyonga, 1985; Moore, 1986; Adams *et al* 1997). Traditionally, men highly participated in the maintenance works because the systems are associated with the clan in which men command authority and power. The furrows flow through steep and rocky escarpment and often get damaged from mud and rockslides. The major cause of damage is the heavy rains which trigger siltation, breakages and dislocation of the intakes at the Embobut River. This is made worse by environmental degradation which has induced heavy rain-runoff and breakage of the furrows. This paper discusses the human and natural factors which precipitate deterioration of the irrigation systems thereby exposing the marakwet to livelihood risks because of insufficient water for irrigation in the semi arid valley.

### ***1.1 Methodology***

The study was undertaken in November and December 2008 in five sub-locations of Tot Division namely, Sibow, Sagat, Kisiwei, Talai and Barkelat. A descriptive research design was used and the population of the study comprised all households that used irrigation systems drawn from the Embobut River. A sample of 230 households was randomly selected and a semi-structured questionnaire was administered to collect data. In addition, key informant interviews were carried out with a number of knowledgeable individuals in the community. The individuals included elders, community leaders, furrow repair technicians and managers of Non Governmental Organizations (NGOs). Respondents were also invited for focus group discussion and direct observation of the furrows was made to identify factors influencing the deterioration.

## 2. Findings and Discussions

### 2.1 Factors causing the Deterioration of the Embobut Furrows

From the study 90.9% of the respondents stated that deterioration is caused by rains, 5.7% cited environmental degradation including quarrying, deforestation, uncontrolled cultivation, overgrazing and increased settlements, while 3.5% stated contravention of furrow taboos (Table 1).

### 2.2 Rain run offs

A majority of the respondents (90.9%) identified rain as the major cause of the deterioration of the furrows. Rains saturate soils and generate heavy run-offs which consequently detach and erode furrow construction materials such as stones, poles, leaves and grass. Since the furrows are built along the steep escarpments of Kapchubai, Sagat and Sibow the gradient in the escarpments contributes to massive downward movement of debris which drain directly into the furrows causing huge overflows and breakages.

The run-offs also trigger mudslides which block the furrows and disrupts the flow of water. Observation of the Kasukut furrow in Barkelat Sub-Location for example, showed blockage of the furrow by mud from heavy rains of October 2008 (Plate 1). In the focus group discussion in the five sub-locations studied, it emerged that rain cause severe flooding which then erodes the soils, causes mud slides and uproots trees along furrow embankments leading to breakage, erosion, siltation and overflows of furrow structures. Run-off also dislocates furrow intakes. The intakes are built of wood and small stones which do not withstand the flooding of the river during rainy seasons. The research concurs with the findings by Soper (1982) on the survey of the Marakwet irrigation systems which had similar findings.

### 2.3 Environmental Degradation

The key informants and group discussions pointed at environmental degradation such as deforestation and soil erosion in the division as the main factor influencing deterioration of the furrows. Marakwet community over-exploit the escarpment areas for local resources such as poles, building stones and thatch grass. This has in turn transformed the areas into bare grounds, hence increased run-offs and damage to the furrows. Observations made on the Kapchubai escarpment, where furrows flow, show that the area is severely degraded from overexploitation of thatch grass and poles (Plate 2).

Of the 230 respondents, 95.65% had at one point obtained resources from the escarpment areas while only a minority (4.35%) had not (Figure 2). Figure 2 shows that a majority of the respondents (95.7%) obtain resources which include building stones, poles, pasture, and twigs from the escarpments. The high percentage of respondents exploiting the resources from the escarpments means that the conservation of the furrows is threatened.

The resources obtained by the respondents from the escarpment include building stones (46.5%), poles (18.3%), thatch grass (13%), wood fuel (6.1%), twigs (4.8%), livestock pasture (3.9%), medicinal herbs (1.7%), "ornamental plants" (0.9%) and wild fruits (0.4%).

Many (46.5%) of the respondents get building stones from the escarpment which is then used for construction activities in Tot Division. Some individuals have come up who engage in quarrying not for personal use but as a business venture leading to over-exploitation. This means that in a division with a sharp land gradient of >50%, the exploitation of stones for construction degrades soils making it susceptible to water run-offs during the rainy season thus contributing to deterioration of furrows by erosion, siltation and blockage from rocks and mud. The poles cut from the escarpment are mainly from the following tree species: *Tamarindus indica*, (oron) *Grewia bicolor* (sitet), *Ficus thonningii*, (simotwo) *Berchemia discolor* (muchukwo) and *Ficus sycomoru* (makany). Poles are used for the construction of houses, goats' pens, field crop fences and repairs of the damaged furrows. Besides twigs from the tree species of *Harrisonia abyssinica* (sewerewa) and *Dodonaea angustifolia* are used in the construction of houses. The twigs are twined with the poles to make the roof rafters for houses. This leads to further exposure of the area to soil erosion.

The ritual plants used in the community include *Ficus sycomorus* (mokongwo), *Olea chrysophylla* and *Ficus thonningii*.

*Ficus thonningii* (simotwo) is used in the performance of traditional wedding ceremonies which is prescribed by the Marakwet cultural practices and is important for recognition of marriage. The wild fruits are collected from *Vangueria madagascanesis*, *Ficus sycomorus*, and *Pavetta abyssinica*. Wild fruits are important food source for the marakwet people during times of food shortage and are an auxiliary source for poor households even in normal times. The medicinal plants are from *Ziziphus Mauritania* (tilomwo), *Ficus thonningii*, and *Ritchea albersii*. The herbs from *Ziziphus Mauritania* are used in the treatment of bronchitis. *Ficus thonningii* is used in the treatment of diarrhoea in goats while *Ritchea albersii* is used in the treatment of stomach-ache in adults. However, the Marakwet take a conservation approach in the exploitation of fruit and medicinal trees and avoid unnecessary felling of such plants.

The collection of natural resources is organized along gender lines. A majority of men (59.9%) exploit the escarpment for building stones as they are mostly engaged in the construction activities for which the stones are mainly used. The men also collect ritual plants because they are responsible for conducting ceremonies associated with the use of the ornamental plants. A majority of women engage in the collection of medicinal herbs as among the Marakwet they are specialists in traditional medicine. They also cut thatch grass for the construction of huts and collect firewood for domestic use.

The findings show that in the Barkelat Sub-Location 32.2% of the respondents exploit the escarpment for building stones, 24.2% for thatch grass, 11.3% for poles, 11.3% for wood fuel, 8.1% for livestock pastures, 3.2% for twigs, 3.2% for medicinal herbs, 1.6% for ornamental plants and 4.8% do not obtain resources from the escarpment. In Talai Sub-Location, 53.7% of the respondents exploit the escarpment for building stones, 17.1% for poles, 9.8% for thatch grass, 7.3% for wood fuel 2.4% for livestock pastures, 2.4% for medicinal herbs 2.4% for ornamental plants and 4.9% do not obtain resources from the escarpment.

In Kisiwei Sub-Location, 72.7% of the respondents exploit the escarpment for building stones, 9.1%, for poles, 9.1% for thatch grass, 2.3%, for wood fuel 2.3% for medicinal herbs and 4.5% do not obtain resources from the escarpment. In Sagat Sub-Location, 50% of the respondents exploit the escarpment for building stones, 38% for livestock pastures, 26.9% for poles, 11.5% for thatch grass, 3.8% for wood fuel and 3.8% do not obtain resources from the escarpment. In Sibow Sub-Location, 35.1% of the respondents exploit the escarpment for building stones, 29.8% for poles, 15.8% for twigs, 7.1% for thatch grass 3.5% for livestock pastures and 3.5% do not obtain resources from the escarpment.

Exploitation of thatch grass is higher (24.2%) in the Barkelat Sub-Location. This is because thatch grass is abundant in the sub-location as a result of a favourable ecology. The exploitation of ornamental plants is higher in Barkelat and Talai Sub-Locations and this means that the communities in the sub-locations still perform traditional ceremonies by using the plants while in other areas other decoration alternatives are used in the ceremonies. The exploitation of poles and twigs is highest in Sibow sub-location because of high construction of huts and goats' pens. This is attributed to the re-occupation of the area after restoration of peace with the Pokot community across the Kerio River. Many people had fled the area some years ago because of ethnic conflict that was largely triggered by cattle rustling. Of the 230 respondents, 26.5% exploit resources that are between 700 metres and one kilometre from the furrow, 24.3% exploit resources that are from 401-700 metres from the furrow, 23% exploit resources that are farther than a kilometre from the furrow and 21.7% exploit resources that are 1-400 metres from the furrow as indicated in Table 4.3.

Table 3 shows that a majority (72.6%) of the respondents exploit resources within a distance of a kilometre which is too close to the furrows. This degrades the furrow areas and transforms them into bare grounds consequently exposing them to deterioration from erosion, breakages and blockages from rock falls and mudslides during the rainy season. Of the respondents who exploit the resource within a distance of a kilometre from the furrows 36% are from Barkelat Sub-Location. This is because the natural resources are abundant along the furrows in the Barkelat Sub-Location and this is attributed to the rich riparian ecology of the sub-location.

Asked whether the exploitation of resources in the escarpment contributes to the deterioration of the furrows, 67.39% of the respondents were aware the activities contribute to the deterioration of the furrows while 32.61% were not. A majority of the respondents (67.4%) concurred that their exploitative activities contributes to environmental degradation which in turn lead to deterioration of furrows.

This means that the respondents know the consequences of their actions on the furrows but have to rely on the resources because a majority of them are poor. Subsistence is their priority and there is very little they can do to reduce environmental degradation. An estimated 60% of the division's population is categorised as poor. Poverty is attributed to factors such as poor and inadequate education and high unemployment rate (GOK:2002). The findings concur with those of Barrow (1991) on land degradation. According to Barrow, land degradation is mainly caused by poverty for the poor often exploit the natural environments and are quite aware of effects of their activities on conservation of such environments.

Of the 230 respondents 50.9% stated that the escarpment area needs to be cared for in order to ensure effective conservation of the furrows while 49.1% stated that the Embobut Forest which is the catchment area for the Embobut River should be conserved. Table 4 shows that 50.9% of the respondents were of the opinion that the escarpment should be conserved. The escarpment area is fragile in terms of erosion and mud/rockslides and thus need to be effectively conserved so as to protect the furrows from deterioration from breakage and blockage.

## 2.4 Quarrying

Quarrying has also contributed to the deterioration of the furrows. The stones quarried are of basalt and trachite lava and are extracted using mattocks and iron anvils into the required sizes. The materials are used in the construction of modern iron-roofed houses, churches, schools, shops and the repair of the furrows. This explains the high exploitation of building stones in the division as shown in plate 3.

The study showed more stones are being used for the repair of the furrows as compared to the past years and this has contributed to the degradation of the areas and consequently to the deterioration of the furrows. Observation made on the Kapsyoi furrow shows an increased use of the stones for the repair of the furrows and it has in turn degraded the furrow lines (Plate 3).

The increased use of the stones in the repair of the furrows is attributed to the exhaustion of the following trees species: *Olea chrysophylla*, *Acacia lahai*, *Berchemia discolors* *Ficus sycamorus* and *Acacia tortilis*. These trees were traditionally used in the repair of furrows and it got exhausted from overuse in other activities such as construction of houses, granaries, and kraals.

The introduction of cementing technology led to the increase in the use of stones in furrow repairs. It was noted that the increased exploitation of stones in the area has caused blockage of the furrows. The rocks often roll down from the quarries and block the furrows. Observation made at Kaptebeko furrow showed blockage of the furrow by rocks as a result of quarrying activity (Plate 4).

## 2.5 Deforestation

Deforestation is the other factor contributing to deterioration of Embobut River furrows. The local population exploit the forest products for consumption and also for commercial purposes. The increased exploitation of the escarpments has been due to increased population and poverty. The informants pointed out that the exploitation of resources in the area is for satisfying basic needs such as food, shelter and health. Forest products exploited include poles, twigs, grass and logs for charcoal burning.

The deforestation of the escarpment has turned the area bare and exposed it to rainfall erosion which has consequently caused the breakage and siltation of the furrows. Observation made at the Kasukut furrow along the Kapchubai escarpment shows damage of the furrows by effects of breakage triggered by deforestation (Plate 5).

In the same area, observation made at the Kabarmwar furrow showed a total of six severely eroded areas that are attributed to deforestation of Kapchubai escarpment. The areas included Embokolion, Solion, Kiptor, Chemutuwei, Embokakanar and Leketetwo. The Embokolion area has been intensely eroded into bare rocks and is no longer holding the furrow repair.

Furrow technicians suggested drilling of the rock faces and installation of pipes in the site as a mitigation measure. 400 bags of cement were used to rehabilitate the furrow in the Embokolion area in 2001 but the material went into waste when the furrow collapsed following the heavy rains. The Chemutuwei area is bare rock with algae of about 50 metres long. Observation made at the Kabarmwar furrow in the Kiptor area in Kapchubai escarpment shows erosion of the furrow from the effects of environmental degradation (Plate 6).

In the focus group discussions in Sibow, Sagat, Kisiwei and Talai Sub-Locations, charcoal burning was identified as a major factor contributing to deterioration of the furrows. It was noted that tree species of *Acacia tortilis* and *Acacia lahai* are highly exploited for charcoal. The trees along the furrow lines are cut to make charcoal for sale to the residents of the local centres and traders in the division. The consensus was that:

The forest exploiters have cleared the forests along the furrow lines leaving it bare. The furrows have been eroded and broken because there are no trees to prevent erosion and the breakages of the furrow embankments (a male discussant in a focus group discussion)

An estimated 40% of the total households in the division engage in charcoal burning to obtain cash for the purchase of basic household commodities like sugar, cooking oil and soap. An observation made during the study showed that the exploitation of trees for charcoal making is highest in Sibow and Sagat Sub-Locations. This is attributed to the growth of small centres such as Tot and Soko Mjinga where there is a high demand for charcoal used domestically as well as in hotels and institutions in these centers including: the Tot Police Camp, Kerio Valley Secondary School, Tot Sub-District Hospital and areas further afield including Eldoret Town.

In addition to the environmental degradation of the Tot Division, the key informants pointed at the destruction of the Embobut forest in Tirap division as one of the contributing factors to the deterioration of the Embobut River furrows. Embobut forest is the main catchment area for the Embobut River. The informants observed that the forest has been under destruction from the communities in the division. They noted there has been increased felling of trees particularly *Oxytenathra abyssinica* in the forest an activity that has disrupted hydrological regimes resulting in reduced discharge that cannot adequately feed the river furrows in the valley.

During the focus group discussions, it emerged that deforestation of the Embobut Forest in neighbouring Tirap Division is the other factor causing deterioration of the furrows. The respondents were mostly concerned about the destruction of the forest which is the main catchment for the Embobut River. The deforestation of the Embobut Forest has reduced the volume of water in the Embobut River. In the past, the water was sufficient for crop irrigation in the area. Measurement of Embobut River water, at the top above all the furrows and at the bottom below all the furrows was estimated at 1227 l/sec and 477 l/sec; respectively (Soper, 1982). Observation of the river flow at Sagat gorge shows little water that does not adequately feed eight furrows (Plate 7).

The respondents noted that if measures are not undertaken to evict people from the Embobut Forest, the Embobut River will dry up and thus there will be no water in the furrows for use in crop irrigation in the valley. The discussions pointed out that the reduction of the Embobut River water has led to water conflicts at the furrow intakes. In the lower intake the Kabarumba clan often vandalise the Kasike clan furrow intake, while the Kapsiren and shaban clans often vandalise the Kapsogom and Kaptebeko clans intakes. In the upper intake the Kamariny clan often vandalise the Marich and Kapterik clan furrow intakes. In the near future, the reduced flow of water in the Embobut River may trigger intra-marakwet conflicts between the valley and the highland communities. A meeting was convened by valley community at Chebilil Centre in October 2007 to discuss reduction of waters at the Embobut River. It was resolved that should the highland communities not stop the destruction of Embobut Forest, valley community would invade and settle in the highland zone

## 2.6 Overgrazing

The overgrazing of Tot division contributes to the deterioration of the Embobut River furrows. According to the informants most areas of the division are accessible for communal grazing. Over the years, the communities have been overgrazing the areas particularly in the months between December and March when the area becomes dry and competition for grazing resources intensifies.

The key informants in Sibow and Sagat Sub-Locations noted that the overgrazing in the area became acute in 1998-2002 period when cattle were confined in the escarpment to protect them from the Pokot cattle rustlers. During the period, most of the furrows deteriorated from breakages, erosion and siltation arising from cattle tramping. In this case conflict begets environmental degradation. The furrow embankments of the Shaban and Kapsiren clans in Sibow Sub-Location were severely damaged by cattle in this period. Currently the livestock grazed in the area are mostly goats. Unlike sheep which are browsers, goats feed on shrubs and have a high likelihood of exacerbating tree cover destruction.

With the restoration of peace in the division, cattle are herded along Kerio River which is expansive and has plenty of grass and water. In Sagat sub-location, Sagat Hill, and Korocha areas have been overgrazed by cattle and goats. The grazing has stripped the plant cover and accelerated soil erosion which has cut through furrows and disconnected flow of water.

## 2.7 Uncontrolled cultivation

In the focus group discussions, uncontrolled cultivation in areas near the systems were identified as another factor causing damage. It was observed that the communities cultivate too close to the furrow lines as the intra-community enforcement of by-laws to safeguard the immovable artifacts is weak. In Sibow Sub-Location the cultivation in the Kokwo Turetwa and Kokowo Ses areas is identified as the cause of damage to the furrows. The cultivation in these areas has increased soil erosion and sliding of rocks consequently blocking and silting the furrows. The area has sharp land gradient and soils are frequently eroded causing blockage and siltation of the furrows. Although terracing was done during the colonial times, it is nowadays neglected by the agricultural officers in the area. Respondents noted that the agricultural officers do not engage much in the issue of the conservation of the soils and water in the region where the irrigation systems are located.

During the focus group discussion in Barkelat and Talai Sub-Locations discussants were of opinion that highland communities, particularly the Sengwer clans in neighbouring Tirap Division cultivate too close to the furrows. The activity has contributed to deterioration of furrows from erosion and siltation. Observation on the Kabarmwar furrow in the Kapchubai Escarpment showed heavy damage from cultivation. The weak enforcement of by-laws to restrict cultivation near the furrows has contributed to the increased cultivation along furrow lines and caused severe damage.

## 2.8 Increased Settlements

Settlement along the furrow lines has contributed to the deterioration of the furrows. The clans settle in their respective clan territories except in Sibow Sub-Location where three clans (Kapchepsom, Kapsyoi and Kapsiren) are intermixed because of historical reasons and affinal ties (Moore, 1986). The study found that each clan furrow does not entirely flow through own clan territory but through other clan territories as well. For example in Sagat Sub-Location, the Kapsogom and Kasike furrows flow through the Kaptebeko and the Kabarsumba lands. In Sibow Sub-Location, the Shaban furrow flow through the Kapsyoi, Kapchepsom and Kapsiren lands while in Talai Sub-Location, the Kabarmwar/ Kamariny furrow flows through the Kasike land, and so on. This creates a situation in which clans can cultivate close to a section of a furrow which passes through their land but which belongs to a different clan without much sanction in a case of rent seeking and exportation of costs to others.

In the past Kapsogom clan used to pay tribute (inform of goats) to the Kaptebeko clan to safeguard its furrow route across the Kaptebeko land. In the 1950s, a local council (*kok*) was convened and the Marakwet elders ruled that no more tribute payment for the furrows in the area will be made. Instead, it was resolved that the Kaptebeko and the Kabarsumba clans uses the Kapsogom water furrows for domestic purposes such as cooking, drinking, bathing and washing of utensils. This explains why a majority of the Kaptebeko clans settle not only near their furrow but also that of the Kapsogom as observed in Embomir, Chepter, Nonoiwa and Kapkitany areas along Sagat Escarpment.

Of the 230 respondents, 36.5% reside less than a kilometre from the furrows, 32.6% reside a kilometre from the furrows, 20.9%, reside 1-5 kilometres from the furrows and 10% reside over 5 kilometres from the furrows as presented in Table 4.5.

A majority (69.1%) of the respondents resides within a kilometre from the furrows, a distance too close to the furrows. The increased settlement is due to culture change and population increase. Traditionally, the Marakwet customs prescribed that households should live a safe distance (at least two kilometres) away from the furrows to minimize damages arising from tramping and erosion of the furrows. According to the clan elders interviewed the use of contemporary domestic material culture objects such as plastic and aluminium containers, has forced people to reside near the furrows. The contemporary material culture objects require frequent washing compared to the traditional ones such as pots and gourds and this has forced people to reside near the furrows so as to utilize the water for the washing of the containers and clothing.

In the focused group discussions it emerged that for the last few years, the increase in population has forced people to settle near the furrows. The demographic statistics show that between 2002 and 2008, the population in Tot division increased from 17,744 to 21,787, an increase of 22.7%. In the five sub-locations studied, the population increased from 7,768 to 9,458, an increase of 21.7% (GOK:2002). The population pressure has increased settlements in the area and the conservation of the furrow areas has been affected. Observation made on the Kasukut furrow showed increased settlements near the furrow line (Plate 8).

The increased settlements along the furrow lines has caused damage in that rain water drains from the roofs add to the flows into the furrow causing huge overflows, breakage, siltation and erosion. The study found that the problem is intense in Sibow Sub-Location because of the construction of modern iron-roofed houses whose rain water collection is higher than the traditional grass thatched houses.

Besides the houses, human and livestock tracks have also accelerated soil erosion and caused breakage of the furrows. The study found that the sub-locations have few designated routes for people and livestock. In Sibow Sub-Location, the study showed that only the Kapsiren clan has two livestock routes in Socho-Kesem and Kewa-Busaa areas. The Kapsyoi and Kapchepsom clans have no designated livestock tracks, a factor which has contributed to deterioration of the furrows from cattle tramping

According to the Divisional Agricultural Officer (DAO), the problem of drainage and erosion in the division is being mitigated by water harvesting. According to the official the Ministry of Agriculture is constructing a water pan in Kapkobil area to harvest the flood waters from the iron-roofed houses in the escarpments. The pans will be used by the herders and thus minimize the deterioration of the furrows from cattle tramping.

## **2.9 Contravention of Furrow Taboos**

The clan elders believe that contravention of furrow taboos is a contributing factor to deterioration of the furrows. Elders observed that a majority of women in the community are contravening furrow taboos. Customarily, women (except those in menopause) are forbidden from bathing and washing clothes directly in the furrows (Cheserek 2005). Women are required to fetch the furrow water and use it a distance away from the furrow. This taboo had the practical effect of limiting damage on furrows through a restriction of such frequent domestic activities taking place on embankments. They were also forbidden from diverting water to crop fields because furrows are believed to be clan assets. Marakwet is a patriarchal society and men own furrow resources through inheritance. From the focus group discussions it was stated that women are unclean because of menstruation and are not permitted to directly bathe in the furrows. Observation of taboos is however varied from one clan to another. In the Marakwet culture, red colour denotes danger and because menstruation discharge is of red colour, it is believed to be a dangerous substance. The Marakwet believe that menstrual blood pollutes the furrow waters and causes leakage and breakage of furrows.

Among all the Marakwet irrigation furrows, the Kasukut furrow is highly tabooed because of sacred groves along the furrow embankments. The trees are used for performances of traditional ceremonies and have thus been conserved for many generations. Women who bathe in it are often cursed by the Kasukut elders. The culprits often experience miscarriages and infertility due to contravention of the furrow taboos. The taboos have been transformed into a clan rule and are being sensitized through the Catholic Youth Camp in the Endo Mission. In the five sub-locations studied, it was found that taboos minimises deterioration of furrows from natural causes such as erosion, siltation and leakages. The empirical reasons for not allowing women to directly use the systems is to enhance the protection of furrows and limit deterioration from erosion and tramping. The study found that furrow taboos are observed only to a small degree by the community because of culture change, for example, the influx of modern clothing and containers that require frequent washing. Observation made on the Kapsyoi, Kaptebeko and Kapsogom furrows showed women washing clothes directly from the furrows (Plate.9).

The clan elders interviewed in Talai, Barkelat and Kisiwei Sub-Locations noted that they often caution women against contravention of the furrow taboos. The elders expressed concern that their effort to protect furrows through taboos is being frustrated by few rich men and women who influence some clan elders against performance of cursing ceremony on those contravening furrow taboos. Decay of Materials The focus group discussions and key informants revealed that decay of the materials used in the construction of the furrows has caused deterioration of the furrow artifacts.



Like other indigenous irrigation systems in Eastern Africa, Mararakwet people used logs, together with grass, leaves and stumps for repair of furrow embankments and on the gullies to provide access across the escarpments and other steep areas. In the steep areas logs of 15-20 meters in diameter were used (plate 10).

It was noted that wooden materials used for construction remain buried for prolonged periods in wet environment and decay. This has weakened the furrow artifact. Scientifically, wood materials suffer drastic decay because cellulose components of cell walls undergo biological degradation. Studies show that white fungi (*Ganoderma colossum* and *phanerochaete chrysosporum*) and brown fungi (*Wolfipora cocos* and *Fomitopsis pinicola*) causes loss of starch, hollocellulose and lignin in wooden materials both on the exposed and waterlogged environments (Florian, 1977; Barbour *et al* 1981; Blanchette, 1993; Eriksson *et al.* 1990). According to the key informants, wood from *Olea chrysophylla*, *Berchemia discolors* *Ficus sycamorus* and *Acacia tortilis* tree species used in furrow construction has been infested with moulds and insects. Observation made on the Kapsogom clan furrow at Elilwo and Chepter areas showed that the wood materials used in the construction of the furrows has powdery stuff which is an indication of insect infestation a pointer to the damage of furrow artifact. In addition, the same was observed on the Kasukut clan furrow at Kong'asis area in the Kapchubai escarpment.

Intervention on the decay of Marakwet furrows was first undertaken during 1950s. British colonialist introduced piping technology to restore the furrows (Plate 11). In late 1980s, the pipe was again dismantled and a concrete floor supported by stone pillars of upto 10 meters was reconstructed by the Kapsyoi clansmen ( Plate 12)

### Conclusion

Until 1980s and late 1990s, the Embobut River furrows were sufficiently used to irrigate adequate food in the Tot Division. Most of the households in the area produced adequate food crops and surplus that was traded with the neighbouring communities. Olenja (1982) reported many granaries in Marakwet, an indication that food was plenty. Surplus grain was exchanged for meat and milk from the Pokot and poisoned arrows from the Tugen people.

Following deterioration of Embobut River furrows, production of food crops in the division gradually declined. In the years 2004, 2005, 2006 and 2007, production of food particularly cassava, maize, finger millet and sorghum decreased by an average of 2.8%, 15%, 21.3%, and 30.8% respectively (Marakwet District Agricultural Report, 2008). Currently, 61.3% of the subsistence farmers receive insufficient water for crop irrigation; hence are incapable of producing adequate food for household's consumption. In fact, 94.8% of the respondents concurred that the deterioration of the systems have reduced crops production in the division. Based on this, the division has been receiving highest quantity of the total relief food distribution in the district at an annual average of 44 % (Marakwet District Development Report, 2002-2008). Human and natural factors which lead to the deterioration of the furrows can be contained if appropriate measures are taken. This calls for cooperation and concerted efforts between the community and the government to ensure sustainable and appropriate use of the furrows. Besides their practical utility for food production, the systems are also a valuable cultural heritage which should be safe guarded.

In order to counteract food insecurity situation in the division, Embobut River furrows should be adequately repaired. The local leaders should lobby for the allocation of the Constituency Development Fund for purchase of repair materials such as cement and pipes. In addition leaders should assist the community to fund raise for rehabilitation and expansion of furrows so as to safeguard food security in the division as it was some decades ago.

**Table 1: Respondents perception of the causes of the deterioration of the furrows**

Causes	Frequency	Percentage
Contravention of furrow taboos	8	3.5
Environmental degradation	13	5.7
Rains	209	90.9
<b>Total</b>	<b>230</b>	<b>100.0</b>

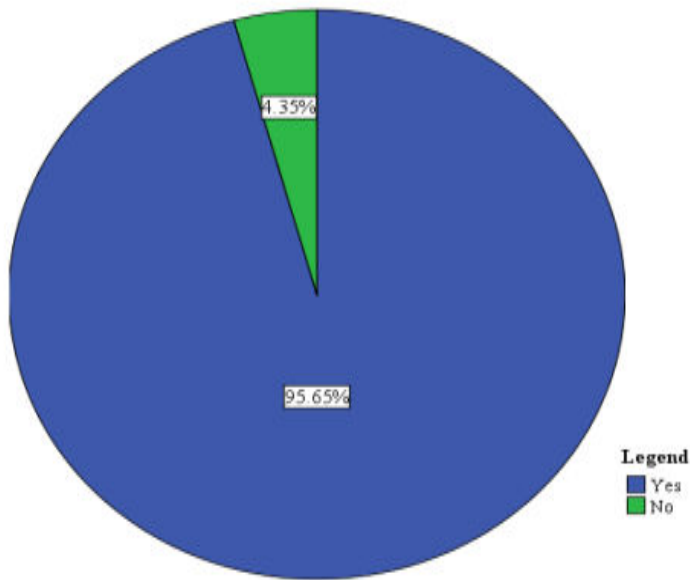




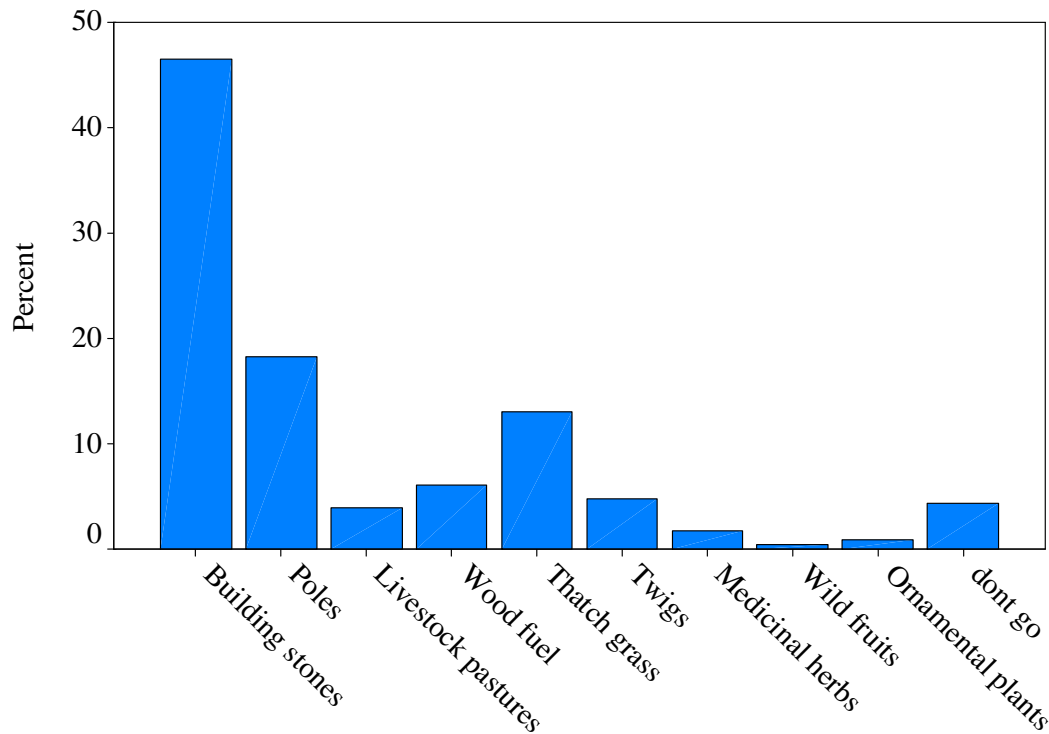
**Plate 1 Blockage of the Kasukut Furrow by Mudslides**



**Plate 2 Ecological Degradation of the Kapchubai Escarpment**



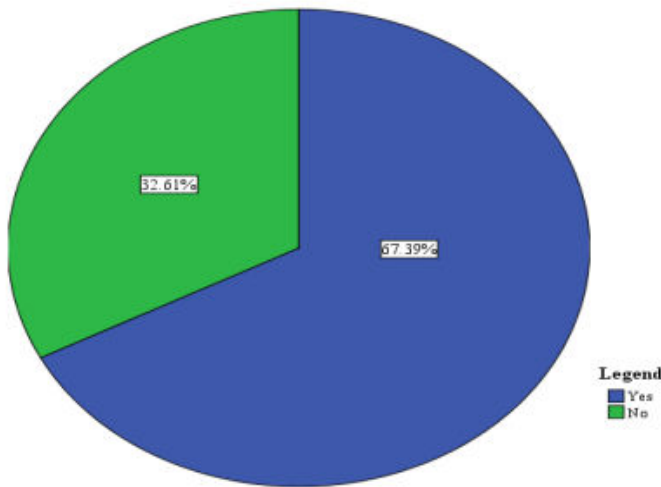
**Figure 2: Respondents participation in resource exploitation from the escarpment areas**  
Yes: Participates in resource exploitation  
No: Do not participate in resource exploitation



**Figure 3: The Most Exploited Natural Resource by the Respondents from the Escarpment**

**Table 3 Distance of the Furrows from the area where natural resources are collected**

Distance of the furrow from where the resources are harvested	Frequency	Percentage
1-400 Metres	50	21.7
401-700 Metres	56	24.3
701 Metres-1Km	61	26.5
Above 1 Km	53	23.0
None	10	4.3
Total	230	100.0



**Figure 4: Knowledge of respondents on the effects of harvesting of natural resources on the Furrows**  
 Yes: Have Knowledge of effects  
 No: Have no knowledge of effects

**Table 4 Respondents opinions on area that needs to be cared for to ensure effective conservation of the furrows**

Conservation Area	Frequency	Percentage
Escarpment	117	50.9
Embobut Forest	113	49.1
Total	230	100.0



**Plate 3 Quarrying along the Kapsyoi Furrow**





**Plate 4 Blockage of the Kaptebeko Furrow by Rock Falls**



**Plate 5 Breakage of Kasukut Furrow in the Kapchubai Escarpment**





**Plate 6 Erosion of Kabarmwar Furrow at Kiptor in Kapchubai Escarpment**



**Plate 7 Reduced Water level in the Embobot River**

**Table 5 Distance of the Furrow from the Respondents' Home**

Distance	Frequency	Percentage
Less than 1km	84	36.5
1km	75	32.6
1-5km	48	20.9
Over 5km	23	10.0
Total	230	100.0





**Plate 8: Settlement along the Kasukut Furrow**

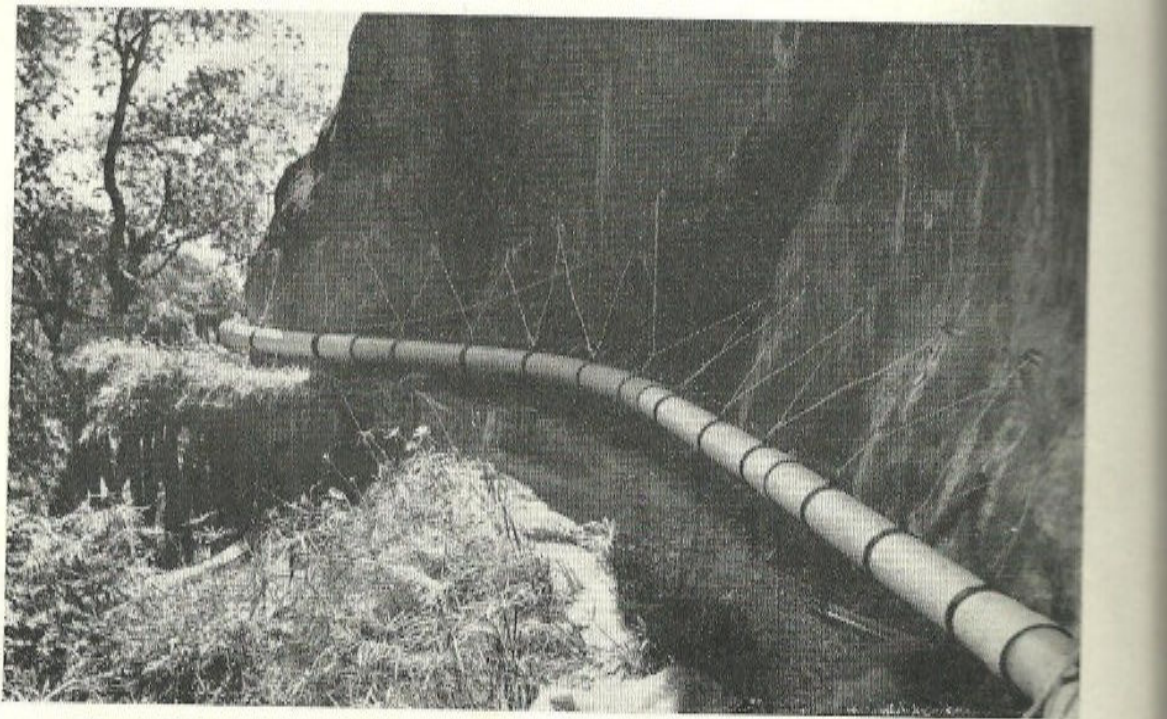


**Plate 9. A woman washes clothes directly in the Kapsyoi Furrow**





**Plate 10. The rehabilitated Kapsyoi furrow, 1940s**



**Plate 11. The rehabilitated Kapsyoi furrow 1959**





**Plate 12. The Concreted Kapsyoi Furrow at the Baon Cliff constructed in 1980s**

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