



JJEOSHS

ISSN: 2618-1517

Jumuga Journal of Education,
Oral Studies, and Human Sciences (JJEOSHS)

editor@jumugajournal.org

<http://www.jumugajournal.org>

Volume 3, No. 1, 2020

Environmental Reconstructions in the Upper Tana region, Kenya

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Abstract

This article sets out to unravel aspects of environmental changes in the Upper Tana during the second millennium AD. This aspect has not been adequately addressed in the Upper Tana. This makes it clear that a lacuna exists in the study of communities of the Upper Tana and the way they interact with their environment in the past and present times. The objective of this article is to evaluate the relationship between human activities and environmental change in the Upper Tana from AD 1000 to 1950. It is hypothesized that the advent of iron technology and its attendant economic activities led to the depletion of indigenous forests and the general environmental degradation. The article has employed archaeological, ethnographic, oral and historical methodologies to gather data on vegetation change in the Upper Tana and other related regions. It argues that livestock grazing, iron smelting, slash and burn agriculture, and the clearing of forests for housing are key contributors to vegetation change in the Upper Tana. Results from oral reconstruction of the past vegetation of the area, and using the plant succession theory, shows that the lowland area of the Upper Tana is actually savannah with scattered trees probably inhabited by grazers. It is posited that the above factors, together with persistent droughts have altered the vegetation cover of the area. What we have today is colonization of less desirable stunted growth. The theory advanced here is that the vegetation change has been a result of human activities. Overwhelmingly, results the study that the researcher carried out, showed that the causes of these changes have been socio-economically associated with the expansion of agricultural communities into the area; rather than through climatic factors. Colonisation and other forces of modernisation have also contributed to the underlying problem. The article concludes that anthropogenic factors have greatly contributed to environmental change in the upper Tana. Certainly, environmental change is a global phenomenon that has elicited research interests due to its negative impacts on human population. It is recommended that knowledge of environmental change in the past should be used to extrapolate modern environmental challenges affecting African ecosystems.

Key words: Environmental reconstruction, ecological concerns in upper Tana, Agricultural activities, Vegetation change.

Introduction

The article discusses aspects of environmental changes in the Upper Tana during the second millennium AD. This discussion is informed by archaeological and ethnographic data, as well as historical sources on vegetation change in the Upper Tana and other regions of comparable environments. In subsequent sections, I discuss the role of livestock grazing, slash and burn agriculture, and the clearing of forests for housing and iron smelting in vegetation change in the Upper Tana.

Methodology

The article employed archaeological, ethnographic and historical methodologies. Archaeological investigation entailed field survey, which included locating previously discovered and studied sites, as well as the discovery of new ones. It involved the location of as many new sites as possible for provision of environmental data for analysis of the various dimensions of site distribution across the landscape. Ethnographic data was obtained through observation of the spatial distribution and characteristics of the present vegetation, as well as human activities such as traditional iron smelting, farming and other land use practices that may have threatened the flora of the area. The second type of ethnographic information was obtained through oral interviews on ancient iron-working practices. Historical data entailed comprehensive review of historical works on the Upper Tana and other related studies.

Theoretical framework

The role of humans in changing environment of the Upper Tana was interpreted by adopting the theoretical perspective that fires, grazing, slash and burn agricultural activities contribute to vegetation change (Butzer 1974; Dasmann 1974; Heady and Heady 1982; Chaparukha 1999). This approach is supported by Hamilton (1982) who indicates that during the last 1000 years, there were no significant climatic changes in East- Africa. The changes in vegetation that may have taken place were caused by human activities mainly mixed farmers and pastoralists.

Research Area

The Upper Tana basin comprises the area drained by Tana River and its tributaries. The area is located to the South East of Mount Kenya and the Nyandarua ranges, which form the bulk of the River Tana catchment. The catchment covers approximately 100,000 km², stretching for about 1,000 km between the Mt. Kenya Highlands with the peak of Ol-dolinyo (5,199m ASL) and the Indian Ocean (JICA, 1997:5-3). It flows eastwards as it drains numerous rivers and streams in Nyeri, Kirinyaga, Muranga, Mbeere, Tharaka and Mwingi, cutting through the Garrissa and Tana River District before entering the Indian Ocean (Figure.1.1).

The altitude of both Tharaka, Mbeere and Mwingi regions are low (366-912m) compared to the region close to Mount Kenya (5199 m) and Nyambene (2514 m). Nevertheless, there are a few hills, which rise to heights of over 1200 metres above sea level. These are Kiangombe, Kianjiru and Kiambere in Mbeere and Kijege in Tharaka, and the Mumoni hill series in Mwingi. These hills have low temperatures and relatively higher precipitation compared to the rest of Savanna woody lowlands. Generally, the rainfall of this region is low and unreliable meaning that the area is very dry. It ranges from 255mm in the eastern side to 1015mm in high-elevated areas. The mean is between 510 - 760 mm. There are two rain seasons, March to May (long rains) and October to November (short rains).

Altitude, temperature and soils have contributed to the vegetation cover of the area. This is characterised by, woodland zones with a canopy cover of more than 20%; wooded grassland and wooded bushed vegetation with a canopy cover of less than 20%. Thorn, bush and thicket characterise the lowlands while luscious vegetation is found in the highlands and near River Tana. Tree vegetation has a

height of up to 18 metres and in the past provided charcoal fuel needed during iron working. The woody vegetation is dominated by, commiphora, Acacia and allied genera, mostly of shrub type.

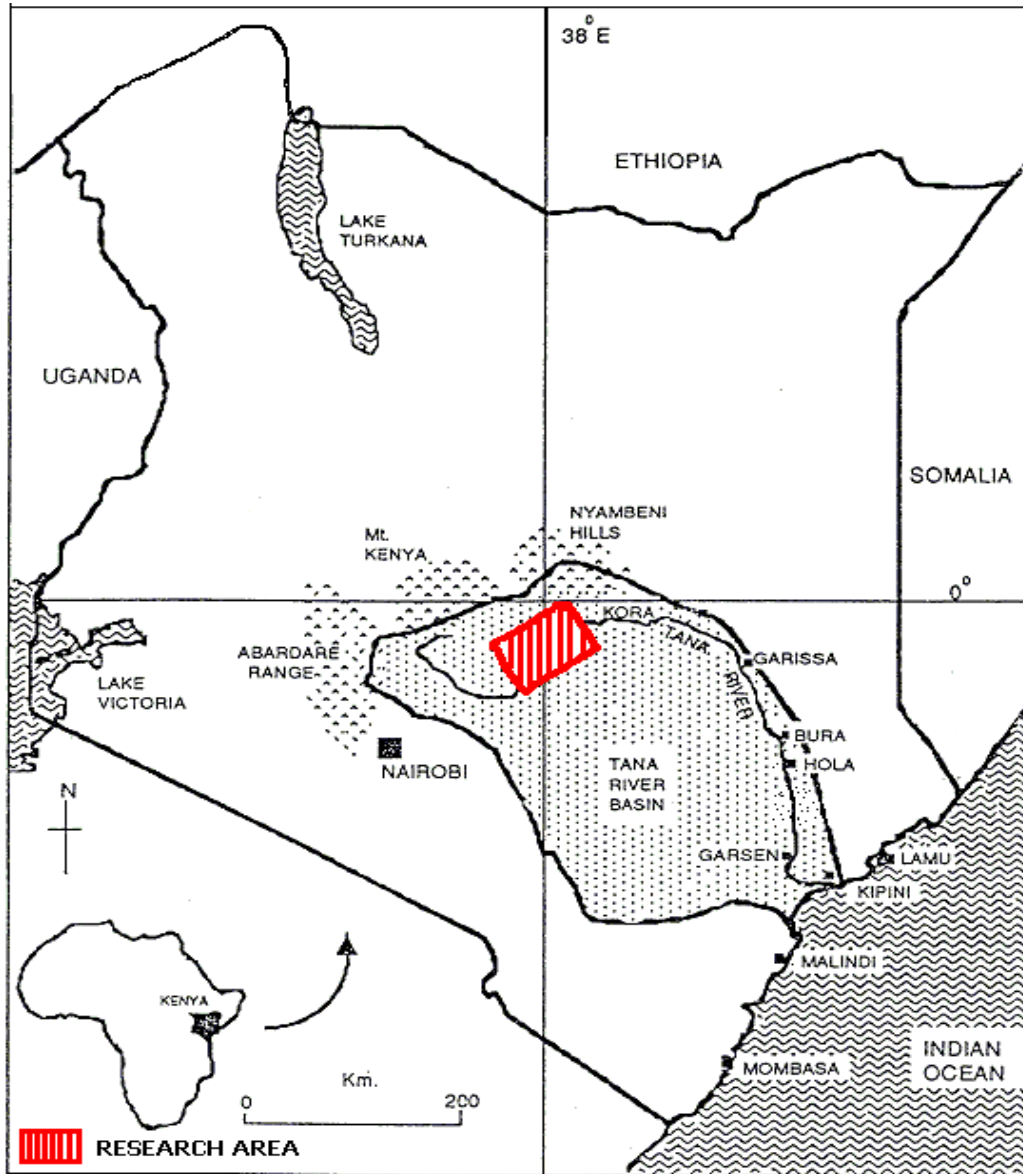


Figure 1.1 A Map of Kenya showing the area drained by Tana River

Results and Discussions

Present vegetation of the area

An understanding of present vegetation is vital if we have to hypothesise how it changed over time. Most of the archaeological sites are located on the hilltops or on the hill slopes. These areas are characterised by a woodland savannah vegetation with *Acacia nilotica* and *Acacia tortilis - Combretum* as the dominant tree species. The vegetation seems to have withstood pressure from land use for many years. However, because of land adjudication in the recent past, the area has been opened up to increased settlement and cultivation, posing a threat to the natural vegetation.

The vegetation of the lowlands is derived secondary made of *Acacia-Commiphora/Combretum* resulting from changes in land use. The area has become degraded over time due to overgrazing and slash and burn method of cultivation. Additionally, the species are dwarfed since they are over harvested giving

them no time to regenerate. The widespread distribution of *Acacia* species could be as a result of its mode of regeneration. The species usually produce buds from injured parts of the roots and branches. This provides a rapid method of vegetative regeneration and spread (Heady, 1982).

The dominant natural vegetation of the research area is *Acacia/Commiphora* bushlands giving place to *combretum* woodland grassland on the more acidic volcanic soils at higher elevations. *Commiphora* tends to disappear in more alkaline areas leaving *Acacia* dominant. Vegetation densities varies from thicket to open grassland (JICA 1997:2-6). Removal of ground cover by grazing and cultivation has led to serious erosion in many areas with isolated bushes of limited palatability to stock left perched on islands of soils surrounded by lower eroded areas (Ibid).

The research area has significant (10%) coverage of densely vegetated hills of which the more significant examples like Kijege and Kiangombe hills are gazetted as forest reserves. These areas are important for watershed protection and are closed to settlement, though they may be used for regulated dry season grazing and fuel wood collection. Recent satellite imagery shows that the vegetation of the main forest reserves (Kijege and Mumoni) was in good condition with little or no evidence of encroachment or degradation (Ibid). However, any increase in land pressure on remaining forest is likely to result on a greater pressure on remaining resources.

A narrow band of evergreen riverine vegetation fringes the Tana and its tributaries and this habitat includes a majority of the larger trees within the area. These include *Acacia elatior*, *A. robusta*, *Mimusops*, *Fruticosa*, *Newtonia hildebrandtii*, *Ficus sycomorus*, *Tamarindus indica*, *Sopum ellipticum*, *Hypaene compressa* and *Phoenix reclinata*. There is, however, one particular area around the Grand Falls where there is a slight expansive forest. This may be explained by, the branching of the river into several big streams, which later form the many falls, termed as Grand Falls. In addition, there seem to be an expansive flood plain before the waterfalls. This forest is fragile and is dependent on Tana River flooding regime. This forest may thus be compared to the rare and unique Gallery forest in lower Tana, (Nderitu 1999). The Tana River Gallery forest is a magnified beautiful environment compared to the adjacent areas. It is amazing to observe the subtlety in ecological difference in such a short distance and one is always startled of the gallery forest since one minute you are in a very dry bush and in the next in a cool magnificent bush. This is home to various apes, birds, plants and other mammals (Nderitu, 1999:7).

Vegetation change

It is apparent that the vegetation of Upper Tana has changed within the period covered by this study. This change is attributed to changes in land use and increased human and animal densities. From an oral reconstruction of the past vegetation of the area, and using the succession theory, it appears that the lowland area of the Upper Tana were actually savannahs with scattered trees probably inhabited by grazers. On the moister and fertile hill slopes, woodland and wooded savannah grassland was common. The remnant of wooded grasslands is evident from the forest reserve at Kiangombe hill established in 1942 (Brokensha and Riley 1977). Such vegetation exists in Mumoni in Mwingi and Kijege in Tharaka.

Evidence of vegetation change

The evidence of vegetation change is based on oral accounts as well as observations from documented past vegetation types and plant species (Brokensha et al. 1977; Riley et. al., 1988). Oral accounts of the Mbeere people, which I collected, confirm the above opinion that there has been a change in vegetation types. They confirm that certain tree species that were once dominant have today become rare. Brokensha et al. (1977) have documented that they found some species in protected areas (Sacred groves and Kiangombe Forest Reserve) that were non-existent in other parts of Mbeere. They also found that *Ficus sycomorus* (Mukuyu), *Syzygium guineense* (Muriru) and *Croton marcostachyusi*, though widespread in other areas, were much smaller in size than in the protected areas. This is an indication

that the plants may have been used extensively. During my survey in October 1998, among the species Brokensha and Riley had found to be widespread in 1977, only *Ficus sycomorus* was found among the riverine vegetation.

According to Brokensha and Riley (1977) the present vegetation cover is different from what it was once, or even what it could now be, were it not for the impact of cultural practices which have imposed changes on its original characteristics. Although the authors recognized the contribution of human effect on the vegetation, they did not consider the influence of human activities on the climate via the vegetational change.

Two ecological constitutions; broadleaved *Combretum-Acacia* open wooded savanna in the moist areas and dry thorn-bush scrub *Acacia-Cammiphora* savanna, were described from Mbeere district, Brokensha et al; 1977. Today, the vegetation has greatly changed with the *Combretum Acacia* wooded savanna being replaced by cropland with scattered *Acacia* species that are mostly dwarfed. On the lowlands, in place of *Acacia Commiphora* savanna, one finds a semi-desert or bare ground.

The influence of human activities on the vegetation is further confirmed by the fact that among the 38 plant species that I collected during my survey, the community listed utilization for each. There was a clear preference for each plant species to a particular use. It was established from oral interviews that it was only after a specific plant species became rare that the next plant species in rank was sought. This put heavy utilization/harvesting pressure on that particular species. It is this process that has led to reduction of some species and degradation of the vegetation.

In 1925, the then Governor of East Africa Protectorate/Kenya colony (Edward Brandis Denham, 1876–1938) noted that firewood was easily obtained in Mbeere unlike in other districts (Maher 1938). During the October 1998 survey, it was observed that firewood was scarce and people resorted to use of maize stalks for cooking. Therefore, eighty-two years ago, trees for firewood were readily available, but not so today. In the absence of an adverse change in the local climate, this is further evidence that there has been vegetational change influenced by human activities. Further, Maher (1938) provides evidence of a once richer and more abundant plant resources than is the case now.

In terms of population density, Ishiara is more densely populated compared to Kamanyaki location, hence a lesser pressure on the plant resource utilization/harvesting in Kamanyaki. In addition, land adjudication has been completed in Ishiara while it was found to have just started in Kamanyaki in Tharaka district. It has been argued that land adjudication resulted in protection of plants in Mbeere district. However, this was found not to have had any positive impact on the vegetation. In most cases, it is believed to have accelerated the degradation process, as new homesteads that followed land adjudication required raw materials that were harvested from the allocated plots.

A comparison of the vegetation of Ishiara, Katama, Tharaka and Kamanyaki locations further reinforces this theory. It was observed that whereas the Ishiara area was devoid of large trees Kamanyaki location on the other hand had high tree cover. It is however expected that once land adjudication is complete, a large number of trees will be felled for construction, charcoal burning, as well as to give way for cultivation, leading to a situation similar to that in Ishiara. Thus, vegetational change has greatly been influenced by human activities. This observation confirms the findings of Brokensha and Riley (1977), that the derived nature of the vegetation in Mbeere has been predominantly, the result of Mbeere people's traditional cultural activities, and changes of these activities, for which, they are largely responsible. These changes began quite early. These changes can be traced back to the early part of the second millennium AD associated with expansion and settlement of populations ancestral to the present day groups.

During the Iron Age, major activities that may have impacted negatively on the environment were livestock grazing, cultivation, iron working and wild fires. Among the industrial activities was iron smelting. Most iron smelting sites are located on the hill slopes. This was probably due to the abundance of firewood on the hill slopes. Lowland areas had savannah grasslands and were therefore unsuitable for

the location of iron smelting that required a lot of charcoal. This activity required specific plant species as argued in ethnography.

Many of the mentioned trees are not ubiquitous indicating that though present they seem to have been over utilised in charcoal production. However, an oral communication on 24/4/1999 with Chaparukha, who has done a related research at the coast, suggests that the role of fire might be more important in molding tropical environments than domestic and industrial activities. Burning to eradicate pests like ticks or clearing land for agriculture (slash and burn) seem to have played a more important role; many African communities did not cut trees for wood fuel as dry wood was readily available. He thus differs with Van der Merwe (1982) and Schmidt (1978) hypothesis that iron working and the subsequent agriculture revolution it brought in tropical Africa degraded the environment. Oral evidence has it that the area now occupied by Mbeere and Tharaka had a lot of grass (Savannah and wild animals) and that the present stunted acacia and other scrub vegetation are a new colonisation in the region. This type of vegetation can support browsers, hence the presence of more goats than sheep and cattle, which used to be vice versa in the past.

For me, I consider the role of humans and that of fire to have played a similar role in determining vegetation change. Vegetation reflects a balance between climate, soil, water, animal life and pressure exerted by man over time. Grasslands, scrub Lands and open forests in the tropics have evolved with periodic fires. This is one of the regular characteristic features of tropical savannah (Heady & Heady, 1982). Fire has been extensively used in the savannah to clear vegetation for cultivation, grazing and to control pest. It is believed that most savannah are anthropogenic systems derived from deforestation and repeated burning (Clayton, 1961). The combination of fire and grazing influences are the determinants of the species composition of grasslands.

Frequent burning affects the development of species and the composition of the vegetation. The interaction of climate and soil tend to make recovery much slower, and with some kinds of vegetation, resilience may be non-existent (Dasmann et al., 1974). In semi-arid or arid areas like Mbeere, recovery is slower since succession is slowed down by the absence of adequate soil moisture, and the presence of relatively small numbers of species adapted to arid conditions (Heady & Heady, 1982).

The Mbeere, Kamba and Tharaka people were mixed farmers, hunters and gatherers as confirmed by oral traditions. The three communities are confined to lowland areas and remnant hills whose original vegetation was forest and savannah grassland. They kept goats, sheep and cattle. In addition to domestic animals, there were numerous wild animals. Probably due to stability, the number of both domestic and wild animals increased significantly. The human population also increased tremendously during peacetime. The result of high animal population/density was that the area became overstocked, and this led to vegetation degradation. The Mbeere people for example, could not move to the highlands where the Embu, who were agriculturists, had settled as this would have caused conflicts on land resources utilization. The Mbeere were also driven out of the Igairori and Mt. Kenya region. This led to concentration of the Mbeere people on the lowlands. In response to increased population density, the Mbeere started cultivating more food crops resulting in clearing of large areas. The tool used to clear land was fire, which was also used to control pests (Personal observation and communication with local farmers).

Wild fires were also responsible for much of the vegetation change that has occurred in Mbeere. It has been established that the Mbeere people practiced shifting cultivation with slash and burn as the mode of cultivation. This practice was observed during the study. In addition, fire was used to control pests. Uncontrolled use of fire in rangeland areas elsewhere in the tropics has led to degrading of the vegetation, especially when the timing is before the vegetation has set seeds. Maher (1938) noted that there were frequent uncontrolled grass fires in Machakos and Embu (Mbeere) districts.

The Mbeere before land adjudication farmed a parcel of land for two seasons and then moved away. Due to increased population, the land became scarce, forcing people to remain in one place. As a result, there was heavy pressure on the vegetation that led to disappearance of some grass and tree species that could not withstand heavy grazing pressure. In response to scarcity of grass, the number of sheep and cattle that are mainly grazers decreased while that of browsers like goats increased. This situation remains the same today.

Any industrial action necessarily causes an environmental impact. However, the magnitude of the impact depends on the size of the industry, and the impacts of the manufactured products. For this study, raw materials in the industrial process are assessed together with other land-use activities that the iron using population used to impact negatively on the Upper Tana environment.

The negative environmental impact of upper Tana bloomer process would have been considerable were it not that there were few Aturi's (blacksmiths) in the past. There were two blacksmiths per sub-location, serving a population of about 800 people. This however does not mean that there wasn't any environmental change in vegetation cover as discussed here. According to oral evidence, areas like Igamba Ng'ombe (meaning, where cattle, mows), had many cattle. The characteristic vegetation according to oral evidence was rich Savannah grass particularly *Heteropogon contortus* (used for thatching and grazing) interspersed with big trees on river courses (Riley and Brokensha 1988). Iron working, together with poor farming methods, over-grazing and persistent droughts have altered the vegetation cover of the area. What we have today is colonization of less desirable stunted growth.

It is argued here that a combined effect of overgrazing, slash and burn cultivation, and wildfire may have caused large areas to be deprived of its vegetation. This led to erosion and soil infertility. In response to the grazing pressure and burning, those species that could not withstand become replaced by more tolerant species. These are opportunistic species that were either unpalatable or annuals which germinated and produced seeds within the rainy season. As such, the ground was bare of vegetation most of the time. Archaeological evidence exists where early man used fire on grassland to help hunters and surround game animals in order to kill them more easily (Heady & Heady, 1982). Fire may result from farming activities in the course of burning dry vegetation to give way to agriculture. The neighbouring forest or grassland may catch fire and burn extensively. Fire tends to destroy bush and promote growth of grass. It also favours those species that best resist damage (Jones, 1987). If set at the wrong time of the year, fire can encourage the invasion of savannahs by shrubs and trees. The results of fire are usually long lasting. In case of savannah, biotic succession sets in and follows a more or less regular and predictable sequence after burning. Grazing, too, favours those species of grasses and fords that are least damaged by defoliation. However, most of these species may be of no economic significance to the animals as they are unpalatable. This situation was made worse by introduction of money economy in the 20th century. There was a need to produce more crops and rear more domesticated animals to pay taxes, purchase merchandise produced by European industries, educate children among other demands.

The theory advanced here is that the vegetation change has been a result of human activities. The oral account indicated that the climate of the area has not changed much in the recent past but has become hotter and drier (personal communication with chief Njagi). Those species that initially thrived in moist/cool conditions became replaced, by those species that can withstand dry soil condition. It is therefore, observed that it was human activities that initially prompted ecological change. This in turn modified the microclimate of the area triggering vegetation change as a feedback. Evidence of this climatic change is also, shown by the absence of seasonal course streams that were abundant in the past.

This could have been, brought about by the increased areas of bare ground, which reflect back much of the solar radiation as heat. The vegetation has the opposite effect of absorbing most of the radiation. This is because chlorophyll has a light harvesting complex (LHC) which contains chlorophyll

a and b. In this case, there is little light reflected back. On the other hand, bare ground reflects more light with the resultant increase in evaporation. This reduces the soil moisture and increases the air temperature that results in change in vegetation type (Dassmann 1974).

Utilization of land resources has always had ecological effect on the various types of vegetation in Mbeere and elsewhere. This has led to the replacement of those species that were ecologically dominant, with other species that become dominant in the changed microclimate.

Socio-Economic changes in the Upper Tana

Table I. Chronology of the peopling, vegetation and subsistence-change in the Upper Tana

TIME PERIOD	VEGETATION	SUBSITENCE-ECONOMY
Post 1950 - (Contemporary Tharaka, Mbere, Kamba)	Mostly stunted shrub vegetation. Isolated forests on hilltops and River valleys. Exotic tree species on farms	Some opportunistic hunting/gathering. Herding (40 animals on the average) for both commercials and domestic needs. Shifting/ slash-burn agriculture (2year cycle). Intensive/Commercial exploitation of plant resources.
1900-1950 AD (Early colonial period)	Grassland dominated vegetation, With baobab as the dominant tree species. Fairly dense forests at High elevations and along rivers.	Hunting and gathering beginning to diminish, hunting for commercial items fairly common; Intensive herding and farming significant. Slash and burn agriculture fairly common with a 5-10 year cycle.
1600-1900 AD (Expansion and settlement populations ancestral to present day groups)	Dense forest vegetation in higher elevations and river valleys. Trees interspersed with bush grassland in open areas as a consequence of increased settlement and shifting cultivation.	Hunting for animal products in regional and international trade very common. Hunting/ gathering a significant component for subsistence, slash and burn Agriculture. Trade with the coastal people
1000-1600 AD Gumba who were probably the incipient Bantu people settle here. They may also have been Cushitic.	Minimal effect on natural environment, since many these people mainly exploited natural resources.	Hunter-Gatherer and probably incipient agriculture. They gathered honey and were probably the first smelters.

Table II summarises the socio-economic adaptation of the Upper Tana communities. It should however be noted that the interpretation of this sequence of events, particularly for the period prior to 1900's is hypothetical and has little archaeological and historical data.

The subsistence economy of the period between 1000-1600AD was mostly hunting and gathering and probably incipient agriculture. The earliest inhabitants namely the Gumba together with Athi hunted and foraged as suggested in chapter one of this thesis. It is argued here that the Gumba practised agriculture.

The period between 1600-1900 AD witnessed the expansion and settlement of populations ancestral to the contemporary groups including Mbeere, Tharaka, Kamba, Meru and Embu. These people continued to hunt and gather, in addition to practising agriculture and exchange with their neighbours and distant communities. The replacement of sharpened sticks for cultivation which

had minimal impacts on the environment (“humans co-existing with nature”) and their replacement with iron tools developed by local ironsmiths (and which had greater impacts on biodiversity----“humans against nature”) may have also contributed to environmental change during this time. The iron-using Bantu speakers therefore began to accelerate environmental change even at this early period.

The period between 1900-1950 AD was a period of formal colonisation in Kenya. The period witnessed commercialisation of all aspects of production to meet colonial demands such as paying taxes. These activities included slash and burn agriculture, herding and to a lesser extent hunting and gathering. Also the period 1800s to 1950, saw new comers Arabs-Swahili traders, missionaries and British colonialists who introduced new species of plants which became established in the area and thus displacing the original vegetation. I believe the above data provides a meaningful relationship between peopling, environment and subsistence pattern of the Upper Tana Communities.

Environmental Conservation

Iron using communities have a potential of destroying the vegetation and the general environment by cutting trees to smelt and forge tools and to practice agriculture.

Whereas this would have been destructive, it was not as disastrous as it would be today. Why?

(a) Smelting required some particular species of trees. This indicates that there was selectivity and all attempts were made to ensure only mature trees were cut. These species were also not harnessed for other purposes save for those with medicinal value, for example, *terminalia kilimandscharica Engl. (Mi-ruruku)* which was used as a cure for coughs.

(b) Sacred forests/grooves: All hill forests were considered as iri (sacred groves) among the Tharaka. Among the Mbeere, there were sacred groves also on hill-tops where sacrifices to God and ancestors were conducted. This is because God and ancestors were thought to have been higher in the hierarchy of beings than humans have. There were also pronounced myths and totems in the upper Tana Communities that had a bearing on survival of some indigenous biodiversity to the present day. It was a taboo to cut or cultivate in these forests. Additionally, I was informed that if an elephant died at a place in Tharaka, that place was considered sacred, therefore neither cultivation nor tree cutting was done there. This demonstrates conservation of wildlife.

(c) Further, there were certain plant and animal species that were considered sacred. Sacred trees like fig and baobab, could not be cut. It was believed that ancestral spirits resided in them. Herbal plants like *Erlangea Cordifolia (Karuta)* used to treat eye diseases and Kamama used for cleansing and curing sorcery could not be carelessly cut. It was considered that cutting such plants could endanger the survival of the society. Big reptiles, for example the Pythons (0.1⁴ M'Rutare 10/3/97) among the Tharaka of Mwingi district were considered sacred and therefore their habitat were not interfered with. This enhanced environmental preservation.

By and, large these iron using communities avoided environmental degradation by using indigenous sanctioning systems. This however, does not mean that slash and burn techniques which they used did not sometimes destroy these forests nor that this industry did not degrade the environment to some degree.

Summary and Conclusion

The Upper Tana has undergone vegetation changes over the past millennium. The main causes of these changes have been socio-economic activities associated with expansion of agricultural communities into the area rather than through climatic factors. However, indigenous systems of adaptation also provided for means of controlling resource utilization for posterity and sustainability. These systems were by no means adequate; hence environmental degradation persisted, albeit to a lesser degree than is today in 2020.

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