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Transformation of Natural Ecosystem to Agricultural Land and Implications on Environmental Integrity and Rural Livelihood in Lower Irangi, Semi-arid Central Tanzania

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Abstract

This article attempts to establish environmental changes in the Lower Irangi, Central Tanzania with specific focus on deforestation due to expansion of cultivated land and land degradation, associated with inappropriate land husbandry such as cultivation and livestock keeping. It also looks at resources use conflicts as a response to diminishing natural resources in the area. Implications of such environmental degradation and the diminishing natural resources on the livelihood of the society are analysed. Also, strategies developed to cope with such changing environment are discussed. This study has established that the environment continues to be degraded due to population increase, coupled with stagnant technology in land management. Farm sizes are becoming small because there is no more land for further expansion. However, the communities have developed strategies to cope with the degrading environment and diminishing natural resources. It was, however, established that despite the diminishing natural resources, people are sharing these resources regardless of administrative boundaries like village boundaries, thus enhancing depletion of these resources in resource-rich villages.

Keywords: *environmental changes, land degradation, resource use conflicts, poverty, livelihood strategies, natural resources sharing.*

1. Introduction

Environments of rural areas of developing countries have been changing over time as a response to over-utilisation of natural resources for socio-economic development. However, factors influencing these changes are location specific. In some areas, such environmental changes have led to the depletion of natural resources and the general environmental degradation, thus threatening livelihoods of the present and future generations. Some studies have established that environmental degradation has contributed to rural poverty (Leach & Mearns, 1996; Fairhead & Leach, 1996).

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Many poor African pastoralists and farming households respond to declining land productivity by abandoning existing degraded pasture and cropland, and moving to new lands for grazing and cultivation. It is cheap to bring new land under cultivation and/or grazing because the rural poor majorities are 'capital deficient', which results into cumulative causation of land degradation, conversion, and poverty (Barbier, 1999). Agricultural and economic policies reinforce the earlier linkages rather than encouraging small holders to invest in improved land management. This suggests that the design of better economic and agricultural policies could go a long way to ameliorating some of the worst aspects of land degradation and conversion in Africa, thus also improving the economic livelihoods of the rural poor (Barbier, 1999).

Many examples of degraded environment can be cited in Tanzania. For example, Kondoa Irangi Hills are known to have been severely degraded leading to formation of rills and gullies on pediments (Christiansson, 1972 & 1988; Payton et al., 1992; Payton & Shishira, 1994; Yanda, 1995 & 2000; Mun'gong'o, 1991). Other degraded areas such as Sukumaland is also severely denuded of vegetation leading to the exposure of soil to water and wind erosion (Kikula et al., 1992).

Land degradation in Tanzania has had severe impact on the livelihood of the rural communities in various ways. Land degradation has led to the deterioration of soil fertility, thus causing the decline in productivity. Similarly, shortage of pastures is reported in such areas, thus causing pastoralists to move with their cattle searching for pastures and water. Presently, pastoralists from Mwanza and Shinyanga in northern Tanzania have moved with their cattle as far as Rukwa Region in southern Tanzania.

Shifting of pastoralists with their livestock can be seen as a livelihood strategy of the pastoral community by moving from degraded areas to the less degraded areas where pastures are still available. Similar strategies are seen for agricultural communities as they have been abandoning degraded areas and clear virgin land which is still productive. Intensification was also practiced in areas where land was limited and condition was favourable for such practice. Kilimanjaro region, particularly on the slopes of Mount Kilimanjaro, is an example.

Land degradation has often been associated with mismanagement of land resources. Such mismanagement has been linked to lack of ownership in natural resources. It is from this basis that the concept of '*Tragedy of the Common*' was developed. In Tanzania, lack of land ownership has been referred as disincentive to the investment in land management. New land law attempts to address this problem by providing the opportunity for villages to own land and the associated resources. Also, boundaries of some villages like the ones in Kondoa

District have been surveyed and demarcated. Furthermore, the current Local Government Reform Programme aims at empowering local governments to sustainably manage their natural resource without degrading the environment. It is, however, important to note that natural resources pattern in a landscape does not conform with administrative boundaries such as village, ward, district, and region. These resources are also not evenly distributed in a landscape. The challenge is how such resources will be managed on the basis of these strict administrative boundaries.

This study is based on the hypothesis that population increase in the Lower Irangi has contributed to environmental degradation, consequently leading to changes in community livelihood strategies. It is for this reason that this study has been undertaken so as to ascertain environmental changes and livelihood strategies to cope with these changes. Also, the study looks at the distribution pattern of these land resources in the study area, and how these are currently being managed and utilised in the presence of village boundaries delineating land owned by each village.

2. The Study Area

This study was conducted in Lower Irangi, Kondoa District. Four villages—namely Busi, Kwadelo, Jangalo, and Itolwa—were selected for data collection (Figure 1). The study area is part of the Maasai Plains, and is characterised by scattered hills interspaced with extensive plains.

The area receives rainfall at the range of 400-700mm per year, and comes mainly in one short unreliable season, with seasonal rivers. Secondary vegetation is common in the area, indicating that primary vegetation has been cleared. Soils in the area occur in catenary sequences; with thin, stony soils on the hilltops, hill slopes, and upper pediments. The soils on the plains surrounding the hills are sandy with low water storage capacity. Flat depressions characterised by *mbuga* soils are also found in the plains. This is similar to the soil sequence established in Kondoa Hills (Payton et al., 1992; Payton & Shishira, 1994; Yanda, 1995; 2000). The soils are reddish sandy clays of low fertility formed on basement complex rocks, and susceptible to water erosion due to surface sealing.

3. Materials and Methods

Three approaches were used in undertaking this study. The first approach looked at temporal and spatial changes of land cover/use in the area. This was undertaken through comparing land cover/use in 1972 and 2000 by using Landsat MSS and Landsat TM7 respectively. These two sets of remotely sensed data were visually interpreted. Change analysis between these two periods was made through the application of Geographic Information System (GIS).

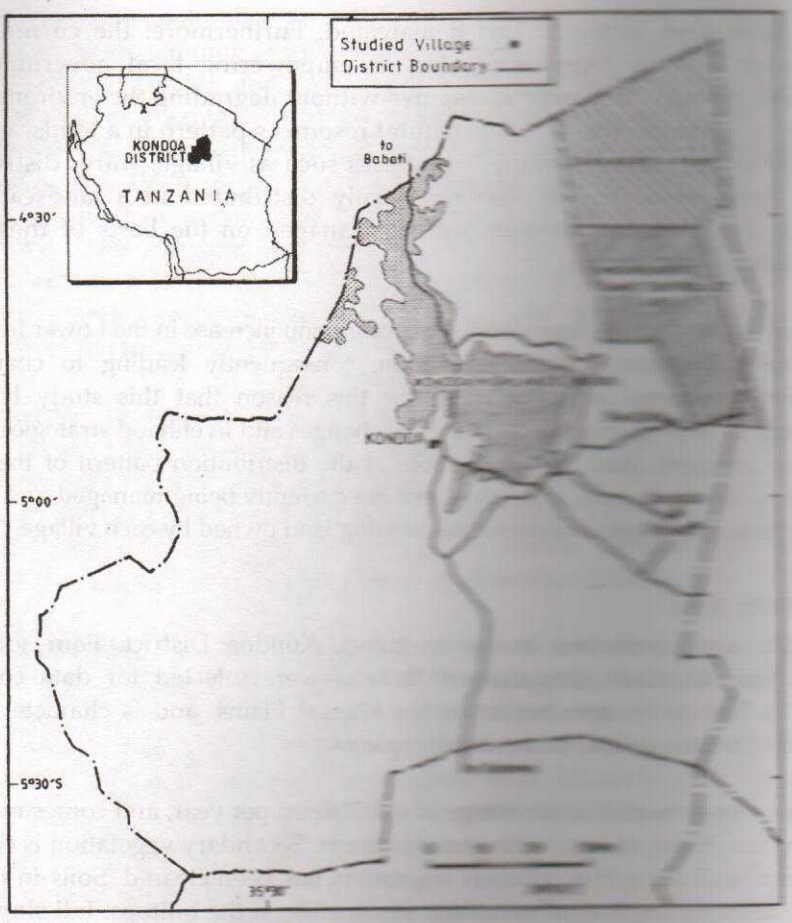

Figure 1: *Location of the Study Area*

The purpose was to establish the expansion of cultivated land from 1972 to 2000 (the time when the remotely sensed data were registered) into areas that were vegetated in 1972. Furthermore, the analysis provides the status of areas that were under cultivation in 1972.

Hard copies of rectified satellite images for 1972 and 1995 were acquired and interpreted before going to the field. Classification was based on major land cover/use classes. These are such as woodland, bushland, cultivated land, scattered cultivation, and swamps. Tonal signature and texture formed a basis for classification. Fieldwork was undertaken for ground verification. Information on changes in land cover/use was also verified in the field through talking to villagers.

The second approach was field qualitative analysis of magnitudes of land degradation features such as sheet, rill and gully erosion; soil compaction, exposure of the subsoil (B horizon) as a reflection of the complete removal of top soil (A horizon). The aim was to ascertain the effect on the land resulting from a combination of vegetation clearance and land mismanagement.

The third approach looked at the land resource management aspects, including the associated socio-economic variables. This aspect was undertaken using structured and unstructured questionnaire survey. Structured questionnaire survey was undertaken for 5% of randomly selected households in the four villages surveyed. The unstructured questionnaire was used to key informants such as village government leaders, elderly villagers, and agriculture and livestock extension officers in the villages surveyed. This was carried out through discussions, using a checklist of issues as a guide to the discussions. During discussions, more focus was put on the temporal and spatial changes in land resources use such as agricultural expansion and the associated implications on the landscape such as deforestation; agricultural practice in historical perspectives; livestock keeping; current availability of pastureland, agricultural land, forest products for various uses, etc. Discussions also centred around the implications of diminishing land resources on the livelihoods of the rural communities in the study area. Fieldwork was carried out between 10th and 30th March 2001.

4. Results and Discussion

4.1 Environmental Changes and the Associated Factors

4.1.1 Land Cover/Use Changes

It is evident from the land cover/use change detection analysis that cultivated land has expanded eastwards through clearance of natural vegetation. There are number of factors associated with the expansion of cultivated land in the area. Firstly, population increase due to both natural growth and in-migration has contributed significantly to such changes (see Table 1).

With population increase, more land is required to meet the needs of the increasing population. Most of the people who migrated into the area from the then degraded Kondoa Irangi Hills and have in different phases spread over the Kondoa Irangi Hills, and eventually also out on the plains to the east (Eriksson, 1995). They moved into these areas in search of agricultural land (Mung'ong'o, 1995).

Extensive cultivation has been the predominant farming system in the area. Such farming practice has led to extensive clearance of natural vegetation for crop growing. This process has led to the encroachment of Mkungunero Game Reserve. Motive behind extensive farming was the availability of ample land.

Table 1: Population Growth in Kondoa Irangi Hills and Kondoa Lower Irangi

Wards	1978	1988	2002	Growth Rate (1978-1988)	Growth Rate (1988-2002)
Kondoa Lower Irangi					
Busi	8586	11640	15810	3.0	2.2
Kwadelo	5633	7104	8889	2.3	1.6
Jangalo	14046	15546	21432	1.o	2.3
Kondoa Irangi Hills					
Haubi	8221	11007	12894	2.9	1.1
Kalamba	9077	11975	12770	2.8	0.5
Kolo	8148	7646	8268	0.6	0.5

Source: URT (1981, 1991 & 2003)

Note: Growth rate was established based on the following formula:
r = 1/n log (Pt/Po) x 100; where r = Growth Rate; n = Length of time/difference in years
Po = Population at the earlier census; Pt = Population at the later census.

Such process started in late 1940s. For example, in Kwadelo Village, people moved into the area in 1957 immediately after the area was cleared as part of the tsetse fly eradication exercise. During that time the rest of the area was densely vegetated. In those days people could not see a need for intensification while there was opportunity for opening up a new land and abandon the degraded land for recovery. The practice is, however, no longer viable because there is no more land for further expansion, except in Kwadelo Village, where there is still ample land for cultivation. This is further illustrated in Table 2, which shows that average farm sizes per households in Kwadelo Village are bigger than those in other villages.

Table 2: Percentage of Ownership (Household)

Farm Size (ha)	Villages			
	Itolwa	*Jangalo*	*Kwadelo*	*Busi*
(1-5)	13	33	3	23
(6-10)	52	33	19	45
(11-15)	13	10	16	5
16 and above	22	24	62	27
Total	**100**	**100**	**100**	**100**

The other reason behind extensive clearance of natural vegetation and the associated land degradation has been the poverty prevailing in the communities. Some people are poor to the extent that possibilities for investment on land are limited. Such people cannot afford farm inputs for agricultural intensification. It is cheaper for them to clear a new land and abandon a degraded one, as it will only require labour to clear vegetation. However, such farming system is presently

practiced only in Kwadelo where there is still ample land, although distance from the village is becoming a limiting factor. It is the energetic people in the village who are able to travel such a long distance to open up new land.

The ongoing expansion of cultivated land into Mkungunero Game Reserve (encroachment) has been facilitated by the lack of physical boundary of the reserve. Also, the status of the reserve was promoted from game controlled area to game reserve in 1989, and villagers may not be aware of the conditions governing game reserves. However, experiences elsewhere in Tanzania have shown that villagers may be aware of management conditions of the protected areas, and yet get involved in encroachment. Examples are Pugu and Kazimzumbwi Forest Reserve (Shishira et al., 1998), where people encroached to meet livelihood needs. A similar practise was observed in Busi Village where some villagers are opening up farms on the escarpment which is part of the area that was excluded from human interference in the Kondoa Irangi Hills in 1972 for environmental recovery. These people are clearing vegetation not because they like doing that, but rather is a response to the shortage of land for crop production.

Table 3 shows that Busi village has the smallest farm size per household, thus indicating the magnitude of the problem. As a result, areas allocated by the village government as pasture land in 1960s have already been cultivated. People are now going as far as Kiteto District searching for agricultural land. They acquire land either through renting on short-term basis, or through purchase with a condition of registering as a member of the respective village.

Table 3: Average Farm Size

Villages	Average Farm Size per Household (ha)
Itolwa	10.3
Jangalo	9.2
Kwadelo	14.9
Busi	9.8

Unlike in Mrijo where farming is operated commercially, the four villages are practicing farming mainly for subsistence. One of the reasons is limited land for agricultural expansion, particularly in Busi. Another reason is inaccessibility to the market. In Mrijo Chini for example, there is still ample land and a market for the produce, thus encouraging further expansion of farms.

4.1.2 Land Degradation

Land degradation is an environmental change that is pronounced in the study area, in the form of soil erosion, overgrazing, and depletion of soil nutrients. Some of the indicators of land degradation are exposure of the sub-soil signifying the removal of

the top soil, rill and gully formation in farms and along cattle truck, and decline of crop yield as a reflection of the depletion of nutrients. Also, soil compaction and disappearance of palatable species are indicators of overgrazing.

Land degradation in Itolwa village has been caused by overstocking due to large herds of cattle from neighbouring villages, and Maasai and Barbeig nomads. These cattle come in the village searching for water, particularly during the dry season. It is only in Itolwa Village where there is reliable water source during the dry season.

Ploughing along the slope direction is a common practice in the area, and has enhanced land degradation. Owners of the farms hire tractors to till the land, and tractor owners find it convenient and economical to plough along the slope direction. This is because farms are often longer along the slope, and thus tractor drivers make fewer turnings if they plough along the slope than across the slope. This approach is faster and energy serving. The implication of this practice is that tilled soil (including top soil) is washed away by rainwater thus exposing the sub-soil, which is often less fertile. But also, rills are immediately formed along the trenches formed during ploughing. These rills eventually develop into gullies, thus destroying part of the cultivated land and limiting mechanization.

Poor land husbandry such as repeated cultivation without fertility restoration measures has also enhanced land degradation through continued depletion of soil nutrients. This is particularly the case for those who have no enough land for fallowing and resources for purchasing new land. Also, this practice has been facilitated by the division of labour in the households. Women spend more time in fuelwood and water collection, and less time in crop production. It is the women who are mainly involved in crop production.

4.2 Resource Use Conflicts

Diminishing natural resources like pastoral and agricultural land have increased competition over resources. There is now a tension between Rangi agro-pastoralists on one side, and Maasai and Barbeig pastoralists on the other, because of the competition over the use of pastureland. One of the areas where there is such severe competition was set aside by Itolwa village government as pastureland for livestock from the village. Unfortunately, the area was invaded by Maasai pastoralists, thus leading to overstocking and degradation of pastures. These pastoralists used to bring their cattle in the area temporarily. They have now settled and are involved in crop production, thus reducing the size of the allocated pastureland.

Ethnicity has contributed to the current conflicts over the sharing of resources. It was established that neighbouring villages are sharing both pastures and water harmoniously. This is partly because these villages are dominated by one ethnic group, *the Rangi*. These *Rangi* have social ties regardless of the village they belong

to. They consider themselves as one entity. They see no reason for not sharing natural resources, which are unevenly distributed in the study area. For example, Mabula area is a pastureland shared between Jangalo and Itolwa. Also, Mbuga kwa Delo and Mbuga kwa Kisai were set aside by Kwadelo village as pastureland for their livestock. People in these two villages responded that they allow residents from other neighbouring villages to bring in their livestock for grazing during the dry season when there is shortage of land in other areas. Similarly, it is only in Itolwa where there is water during the dry season. Residents from other villages depend on those sources of water for domestic use and livestock watering during the dry season. Their strong argument is that resources are unevenly distributed in their landscape, and the only option is to share them regardless of administrative boundaries.

It was, however, established that the sharing of natural resources between villages is governed by rules and regulations set as checks and balances. These checks and balances are effective among the Rangi community. For example, each village has the so called *"Kamati ya mila na utamaduni"* – a committee whose members are elderly men in the village, and are specifically responsible for maintaining traditional and cultural rules and beliefs in the community. This is outside formal committees of the village government. The committee has the responsibility of penalising a person who violets culture and traditions in the village. For example, if a person cuts a tree at the water source, s/he deserves a punishment because such areas are believed to be holly places, and are therefore not supposed to be destroyed. Since Rangi acknowledge and respect this institutional mechanism, they often accept the penalty given by the committee. However, this mechanism cannot work if a person from other ethnic group, e.g., a Maasai, is implicated for violating these rules and regulations.

4.3 Implications on Poverty Levels

Agricultural land, particularly in Itolwa and Jangalo, is increasingly becoming fragmented due to population increase and limited land for expansion. This is further illustrated in Table 1 and 2 which shows average farm size per household. It is also evident that there is a decline in crop yield due to continuous cultivation without application of fertility restoration measures. It is also established that those who have small farm sizes and have no livestock are the poorest in the society because the major economic activities for the majority of the residents in these four villages are agriculture and livestock keeping (see Table 3). These poor people have no livestock, which would have been a source of farmyard manure (see Table 4). Also, the poor cannot afford to purchase inorganic fertilizers as they have no source of income. As a result, their farms cannot be well-managed; and thus continue to be degraded through repeated cultivation without soil fertility restoration measures, thereupon enhancing the poverty circle.

Table 4: Occupational Percentage

Occupational Activity	*Villages*			
	Itolwa	*Jangalo*	*Kwadelo*	*Busi*
Pastoralism	0	0	3	0
Farming	53	62	47	64
Pastoralism and Farming	44	38	50	32
Other Activities	3	0	0	4
Total	*100*	*100*	*100*	*100*

Source: Survey (2001)

Shortage of fuelwood and water is seen as a burden to women who spend more time travelling in search for these resources. It was reported in Kwadelo, Jangalo and Itolwa that women spend between 6 and 8 hours to collect fuelwood. This is done three days per week for the family of 10 people in the household. This is the time that could be allocated for land husbandry. It was reported in Kwadelo that although in the Rangi culture, it was women's responsibility to collect water. But the problem has reached to the stage where men are also fully involved in fuelwood collection. More involvement in fuelwood collection and fetching of water reduces time for other economic activities, and therefore enhances poverty in the society.

Although villagers acknowledge receipt of funds as part of revenues accrued from Mkungunero Game Reserve, they also acknowledged of the ongoing encroachment through expansion of cultivated land. The above-mentioned villages will not get these benefits if this game reserve in not sustainably managed. The funds accrued are currently used for the improvement of socio-economic services in the villages such as dispensaries, schools etc.

Poor people also spend more time working as labourers in others farms so as to meet daily needs in the household. This is particularly common during extreme drought periods. This reduces time that would have been used to attend their farms. As a result, their farms are poorly managed, thus enhancing poverty in the society. Also, children do not go to school because they are involved in household activities to assist parents in meeting household needs.

4.4 Livelihood Strategies

It was learned in this study that neighbouring villages are jointly managing shared resources like pastureland, forests, and water sources. This is based on the fact that natural resources are unevenly distributed. People interviewed responded that cross-border resources at the village level are jointly managed. A typical example was a natural forest that is jointly managed by two villages, Itolwa and Jangalo.

This is on the realisation that such a resource has to be managed in totality as one ecological unit. Subdivision of such a resource on the basis of administrative unit would not make any sense. So, if this resource is to be used it has to be shared by the two villages, thus calling for joint management.

This study established that fallowing is a common practice for those who have enough land. Fallow period range between three years and one year, depending on the size of the land owned. This practice allows for natural recovery of soil fertility. It is evident that those with limited land cannot afford this practice because they do not have land to fallow. As a result they will continue using the same piece of land, thus degrading it further.

Crop rotation is another way of improving soil fertility by growing different crops for different periods. This is a common practice in all the villages studied. Tree planting was also established to be a strategy to curb shortage of fuel wood. This approach has not been taken up seriously.

Farm leasing is one way of getting funds for those who do not have money for other needs. But also, it is a way of acquiring land for agriculture to those who have no land. A price ranges from Tsh1,500 to Tsh5,000 per acre per year.

As already pointed out, the sale of labour is also a common practice in the villages studied. Although this was seen to enhance poverty, the practice could also be looked at as a livelihood strategy. The sale of labour is practiced in farms and other activities like brick-making. It was revealed in Kwadelo that such a strategy is particularly common during the drought period when farmers have no food. But it is also practised by those who cannot make a living without external help like sale of labour even during good years. There are some who are engaged in non-farm activities like small businesses (shops, sale of vegetables), and beekeeping. It was clear that villagers are aware of climatic fluctuation in the area. They particularly pointed out that the normal pattern is four years of drought, followed by four years of good rains. They have, therefore, developed knowledge of selecting crops to be grown on the basis of the amount of rains in a particular season. Also, drought resistant crops are grown on sandy soils if there is no enough rains in that particular season. Good years are assessed based on dates of the onset of first rains.

5. Conclusion

This study has demonstrated that population increase has contributed to the extensive clearance of natural vegetation, thus exposing soil to water erosion. In areas where there is still ample land, extensive farming is practiced, while intensification is practiced in areas where land shortage is experienced. However,

such intensification is not supported by appropriate land husbandry such as soil nutrient replenishment. Continuous cultivation without fallow period and inappropriate tillage system has led to development of gullies.

Encroachment of Mkungunero Game Reserve through expansion of cultivated land is attributed to a number of factors. One, is the lack of awareness by local communities on the boundary of the game reserve. Second, and most important, is a limited knowledge by local communities on the benefits to be accrued from the game reserve. Although the country's wildlife policy advocates for community involvement in wildlife management and benefit-sharing, people seem not to have been sensitised enough. Also, the need to meet livelihood necessities is another reason that leads to encroachment.

It is also apparent that diminishing natural resources is leading to resource use conflicts. However, such conflicts are fuelled by ethnicity and incompatibility of the different land management practices.

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