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# The Contribution of Herbal Medicine to the Welfare of Local Communities: A Case Study of Babati District, Arusha, Tanzania

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**Abstract**

Most local people in developing countries depend largely on medicinal plants to treat common diseases compared to modern medical services. To assess the contribution of medicinal plants to the welfare of local communities surrounding Duru-Haitemba in Babati district, we carried out a study using PRA and household surveys in forty-five randomly selected households. It was found that local people use medicinal plants directly to cure common diseases, and indirectly as symbols to settle psychological and moral sicknesses. In both cases, it was found out that roots were the dominant plant part used. The frequency with which the various parts of the plant are used for medicine ranges from 37% for roots, 31% for leaves, 20% for barks, 5% for exudates, 5% for fruits, and 1% for flowers, spines and wood. The excessive use of roots for medication may threaten the ecosystem since plants are often destroyed completely. The study found that seven species are threatened and/or are very rare in this woodland as a result of over-exploitation for medicinal uses. These include *Achyranthes aspera, Zanthoxylum chalybeum, Euphorbia tirucalli, Commiphora africana, Cordia africana, Mimosa pudica* and *Terminalia sericea.*

## 1. Introduction

For thousands of years, people all over the world have been largely relying on plants—and to a lesser extent on animals—for their medicine. Only during the recent few decades did the highly complex and scientific synthetics take over modern or western medicine. However, the great majority of local people in developing countries still largely depend on traditional medicine either totally or partially for medicare (Hamza, 1997). According to Mahunnah and Mshigeni (1991), the World Health Organization (WHO) estimated that 80% of the world population rely on traditional medicine for primary health care. Hence, the WHO believes that proper utilization of the traditional medical system by developing nations could make valuable contribution to the implementation of WHO's Health For All (HFA) program by year 2000.

It is reported that there are almost 60,000 traditional healers in Tanzania, against 600 western-trained doctors who are concentrated in urban areas (Hines & Eckman, 1994). These traditional healers attend about 80% of the rural population. Makonda (1997) found that, a household member in Geita district, Mwanza Region, Tanzania, has an average frequency of only two visits to a western medical clinic in a year. Thus, most of the time local people visit traditional healers. Safowora (1993) commented that local people rely heavily on traditional medicines

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because they are relatively accessible, inexpensive, locally available, and more acceptable as compared to conventional medicines. Kayombo (1992) pointed out that rapidly increasing prices of imported industrial drugs, coupled with the removal of Tanzania's free medical services in 1993, compelled many people residing in rural areas to use local medicines. FAO (1991) reported that there is a growing market in the western world for some specific herbal material in preference to synthetic pharmaceuticals.

Kajembe (1994) deplores the fact that Tanzania has a rich cultural heritage in which the role of the traditional healer has been important, but sadly has not yet been given the recognition it deserves. The few contacted traditional healers showed that they have a vast knowledge of medicinal plants, their immediate environment, and community. Kessy (1998) claims that forests are good source of products with medicinal values (leaves, bark, roots, fruits, sap, etc.). The collection of traditional medicine takes place at two levels: the specialized healer and the household member. Most household members share the knowledge of plants that treat most common diseases in a certain area, making it necessary to consult a specialist (*mganga*) only when the case is complicated.

Kajembe (1994) found that the concept of forest for both the Gogo of Dodoma and Shambaa of Lushoto is connected to traditional medicine. Most indigenous tree species have something to do with provision of medicine. This characteristic is found in a few exotic tree species such as *Azadirachta indica* that is believed to cure over forty different diseases. Somehow, the concept of traditional medicine is also connected to water and fertility in a very general meaning. The generative and healing powers of nature that are associated with water do not thrive in the domesticated sphere, and traditionally one goes to the wild to sacrifice for rain as well as for people who are ill.

Leaf harvesting for medicinal uses rarely harms the tree. However, Gathaara and Kahuki (1997) reported that extraction of medicinal plant materials may be extremely destructive, particularly where the bark and/or roots are required. Storrs (1982) reported that bark and root harvesting can damage plants and lower their survival rates. Thus, in areas of high demand, it is common to find dead medicinal trees due to debarking and root harvesting. Local trade on medicinal plant materials also has a destructive effect on the distribution of medicinal plants within their natural habitats. WRI *et. al.* (1992) reported that many villagers in Africa could no longer find medicinal plants because commercial collectors have over-harvested them to meet demand in the cities. Hence, numerous medicinal plants are facing the threat of distinction in the wild. As these plants die out, local communities loose the cornerstone of traditional medicine; and humankind loses the stuff of which new pharmaceuticals could be developed.

Despite of the importance of medicinal plants to local communities and the development of medicine worldwide, basic information on their distribution and contribution to the livelihood of various local communities is still poor or lacking. This paper reports on the contribution of medicinal plants to the welfare of local communities surrounding Duru-Haitemba forest in Babati district, Arusha, Tanzania.

## 2. Materials and Methods

### *2.1 Study area*

The study was carried out in Duru-Haitemba community forest in Babati district. The forest has approximately an area of 90km$^2$, and is situated in the southern part of the district, about 20km from Babati town. The forest falls within clearly demarcated boundaries of eight registered villages: Bubu, Endanachan, Gidas, Duru, Riroda, Endagwe, Hoshan, and Ayasanda.

The forest is situated between and alongside two main gravel roads, which start from Babati town leading to Kondoa on the eastern side, and the other to Katesh in the western side. The total population around the area is estimated to be 21,000 with 3,500 households, with an average of six people per household. Ethnic groups in the area include the Fiome, Iraqw, Mbugwe, and the Rangi (Orgut, 1997).

The annual rainfall varies from 600 to 800mm (URT, 1976). The soil is loamy with good drainage, and the vegetation is typical dry miombo woodland.[1] The Duru-Haitemba forest is located within the rift valley, and the dominant species include *Brachystegia microphylla, Brachystegia spiciformis, Julbernardia globiflora,* and *Albizia versicolor* (Kajembe & Mgoo, 1999). The main economic activities of local people of Duru-Haitemba villages are agriculture, livestock keeping, and fishing from Lake Babati. The major crops are maize, beans, and pigeon peas. The average number of cattle is about 10 heads per household. There are two secondary schools: one in Riroda village, and the other in Gidas village. There are three dispensaries in Gidas, Endagwe, and Riroda villages. Services in these dispensaries are free, even though the services are limited to primary health care for minor diseases. Critical cases are referred to either the district hospital in Babati town, or to the Dareda missionary hospital in Hanang district.

### *2.2 Methods*

The study was conducted in two phases. Phase one was Participatory Rural Appraisal (PRA) that aimed at generating information on the community and their perception on forest resources over time. Phase two carried out socio-economic surveys that were expected to indicate the society-forest relationship.

A total of forty-five households in four villages (Ayasanda, Riroda, Endagwe, and Duru) were randomly selected from village registers, and were surveyed using a pre-tested structured questionnaire. Households were stratified into wealth categories using criteria set by the villagers themselves during the PRA. "Poor" households were those with less than 2ha of land, and less than 5 cattle. "Moderate" households had less than 5ha of land, and not more than 20 cattle. All households with more than 5ha of land, more than 20 cattle, and expensive assets such as motorcycles, shops, and/or bars were considered to be "rich". Five percent of households were taken from each wealth category. Other methods used to gather information about the society-woodland relationship included participant observation, and checklists for key informants.

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[1] Although strictly speaking the terms "woodland" and "forest" have different meanings for ecologists, in this paper the two terms are used interchangeably.

### 2.3 Data analysis

Descriptive statistics were used to analyse collected data. The data were explored for distribution of responses, central tendency, and dispersion. For every question asked, the study wanted to know the range of distribution of responses given by villagers, the existence of any concentration or central tendency, and the shape of distribution or extent to which responses were clustered around the central point.

## 3. Results and Discussion

### 3.1 Types of medicinal plants

The study identified two types of medicinal plants:

1. *Medicinal plants used directly to cure physical ailments.* These were further grouped according to their importance to local people. The most important species were those used to cure serious diseases. These were used mostly by the traditional herbalists. The other group was of common medicines for common ailments. These could be used by anyone because they did not need any special treatments prior to use, and are easy to prepare.

2. *Medicinal plants used for emotional therapies.* Emotions come in variety of forms: fear, love, confidence, and security enhancement. In this category, plants are used in charms and as symbols to settle psychological strains. Certain species are tied in charms to guard homes and family members against diseases, witchcraft, and such other mischief. Local people relate success in the physical world to spirits, believed to exist somewhere. These are believed to have good or evil impact in the daily life of the people, including socio-economic success. In order to win the approval of the spirits, elders in the community usually perform traditional rituals to appease them.

### 3.2 Diseases Prevalence and Visits to Physicians

The most prevalent diseases within the study area include malaria, abdominal complications, and skin infections (Fig. 1). Susceptibility to the diseases within the household differs with age and sex (see Fig. 1).

Children under ten are the most vulnerable to skin infections and diarrhoea. This might be caused by the dirty environment in which they play, and being less resistance to infectious un-boiled drinking water. Mothers are also significantly affected by abdominal and skin infections, though not severely like children. The fact that women are the traditional attendants of children increases the chances of contagious diseases like rashes and scabies passing from children to their mothers and vice versa. Furthermore, village women are much occupied with regular domestic activities, and this deprives them of ample time to maintain their regular hygiene.

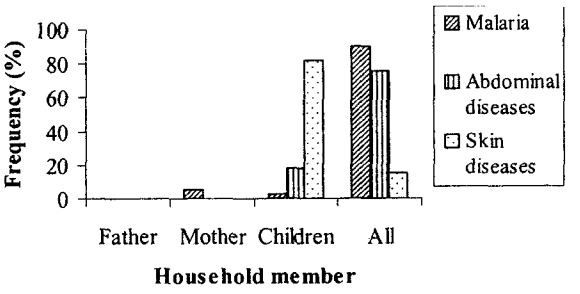



**Figure 1:** *Susceptibility to prevalent diseases*

In Fig. 1, one can note that malaria is not restricted to age and sex: all members of the household are equally vulnerable to it. Communities in the study area either depend on dispensaries or local herbs to treat mild sicknesses. Serious cases are taken to Babati district hospital, or to specialized traditional healers. Figures 2, 3, and 4 show that for common sickness cases, the decision on whether to use local herbs or to attend dispensary is dependent on the type of disease.

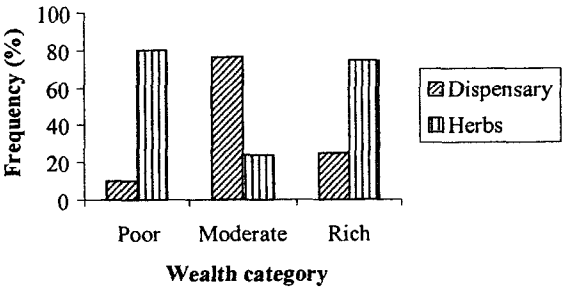



**Figure 2:** *Fast cure for malaria*

Malaria cases are normally taken to the dispensary due to the lack of substantial traditional cure. However, the commencement of malaria ailment (locally known as "*homa*"), especially for poor and rich households, is at first treated by using local herbs. Moderate households use dispensaries more frequently than poor and rich households. Out of the 7 rich people interviewed, one was a local professional herbalist, and the rest were farmers and livestock keepers. The rich herbalist declared that except for maternal cases, he did not to take any sick member of his family to hospitals.

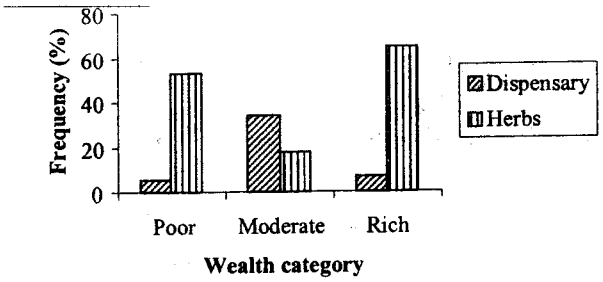



Figure 3: *Fast cure for abaominal infections*

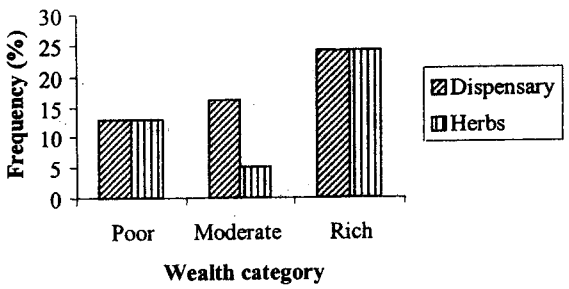



Figure 4: *Fast cure for skin infections*

Generally, rich people are members of various local institutions within the village, and also have enough money to spend outside their home. These circumstances keep them away from home, and less aware of mild sicknesses that inflict their family members. The mother is always the one available and responsible for all troubles at home during daytime. So long as the father is the one keeping the family's money, and because he cannot be traced every time malaria hits a household member, the mother tends to opt for the easy way out, which is herbal treatment. On the other hand, the study revealed that richer households have higher frequency of visiting big hospitals per year (3 times or more), while poor and moderate households have relatively less visits to hospitals (2 times or more per year). The majority of the middle wealth category (about 73%) are young people between 30 and 40 years old. This class uses western medical services more frequently than old and wealthy people who are still conservative on traditional life values. Figures 3 and 4 indicate that poor and rich households use medicinal plants more frequently for treatment of skin and abdominal infections than moderate households. Moderate wealth households use dispensaries more often for both cases. The explanation for this may be similar to the one given for malaria.

The location of the respondent was also found to influence the use of herbal therapy. Respondents living in village centres have less use of medicinal plants. Out of the total sampled population, 20 respondents were from village shopping centres. About half of them claimed to use herbal treatment only occasionally, although they had reasonable knowledge of ethnomedicinal plants. Despite of their relative less-use of medicinal plants, the study showed that the majority of local people (including at village centres) visit traditional practitioners to get cleared out of misfortunes in their social interactions, love affairs, economic activities, and protection of new borns. Kajembe (1994) claims that traditional healers and traditional birth attendants are all respected in the villages. They play important roles within the rural communities because they are channels through which the involvement of supernatural forces enters daily existence.

### *3.3 Gender Issues in the Collection of Medicinal Plants*

The collection of medicinal plants from the forest entails a set of gender responsibilities of both males and females within the household. Fig. 5 shows that women are the more frequent collectors of medicinal plants than men, while children are almost not involved at all. This is due to their ignorance to ethno-medicinal plants.

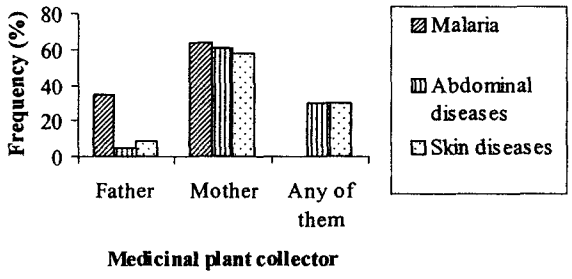



**Figure 5:** ***Frequency of collecting medicines within the household***

The high frequency by women in the collection of medicinal plants within the household may be attributed to the nature of prevalent diseases, which mostly inflict children and mothers than fathers. As argued above, children are the ones most vulnerable to diseases, and the mother is the closest daily attendant to the child, and hence acts as a family doctor for minor illnesses. The study revealed that the father is involved in the collection of medicines when a medicinal plant is not found close to the residence, or if harvesting of medicines is labour intensive, as is the case for the herb *Ansellia africana* that grows on canopy trees as an epiphyte.

However, 30% of the sampled population indicated that both men and women collect medicines at the same rate, and the issues of who goes to the forest only depend on the opportunity and the knowledge to the required medicine. Kessy (1998) reported a similar observation: that as a general trend, both men and

women collect medicine from the forest and their farm. In case of emergency, whoever is closer to the incidence and has the knowledge of the plant would go for it.

Six exotic plant species, but now naturalized in Tanzania, were found to be used as medicine. These were *Azadirachta indica, Ricinus communis, Senna spectabilis, Eucalyptus saligna, Psidium guajava* and *Jatropha curcas*. Nine plant species were reported as being used for ritual purposes. Plant species used for ritual applications are mainly indigenous species. However, under exceptional cases, two naturalized exotic species were also found to being used as ritual plants. These are *Jatropha curcas* (*mbono kaburi*) and *Ricinus communis* (*mnyonyo*). The former is used to mark graves, while the latter is used to wrap local medicines. *Ricinus communis* was found to be the dominant plant in over 80% households.

Women are responsible for tending *R. communis*, and its presence in the homeyard is an evidence that the household enjoys the services of traditional medicine. Men are responsible for planting *J. curcas* at burial sites. The periodic cleaning of graves and replacement of the plant (for dead plant) is done either by the father or mother depending on the close blood relationship to the dead. The two plant species (*R. communis* and *J. curcas*) are among the naturalized species in the area, and are regarded as "local". Kajembe (1994) found that many exotic plant species in Tanzania, such as *Mangifera indica, Citrus lemon, Carica papaya,* and *Lantana camara,* were naturalized and are now regarded as local.

### *3.4 Impact of the Use of Medicinal Plants to the Ecosystem*

There are seven rare plants species, which were mentioned by villagers to be among the widely used medicinal plants for both human and livestock diseases. These are *Achyranthes aspera, Zanthoxylum chalybeum, Euphorbia tirucallii, Commiphora africana, Cordia africana, Mimosa pudica,* and *Terminalia sericea*. These plants were not found anywhere in the woodland during the forest inventory (Kajembe *et al.*, in press.). It was speculated that their absence might have been a result of over-exploitation for medicinal purposes.

This speculation is supported by the fact that harvesting of these rare plants for medicines involves bark stripping and root digging which are destructive to plants. Two species were proved to be prone to harvesting for medicinal use. A shrub *Katchi* (Gorowa language), which is used by traditional herbalists for spiritual healing, was found twice with all branches pruned and stem cut very short, possibly to accelerate coppicing. It was not possible to collect samples for identification because of the lack of foliage due to over-exploitation. Another shrub, *Fagoda stenophylla,* was found once with most roots dug out (the plant is used to improve fertility to women). In both cases, the plants were not killed completely, but allowed to regenerate for future exploitation. The observation testifies that local people do not kill plants for medicinal uses. Kessy (1998) made a similar observation that nobody would kill a plant essentially for medicinal use. However, even if local people do not kill a plant for medicinal uses, excessive cutting of medicinal components from a tree may render the plant susceptible to natural stresses like long periods of drought, forest fires, and pathogenic infections (Kajembe, 1994).

### 3.5 Proportion of the Parts of the Plant Used for Medicine

Roots were found to be the most used plant component for medicine (37%), followed by leaves (31%). Table 1 shows the proportion of other plant components used for medicine.

**Table 1: Proportion of plant parts used for medicine**

| Plant part | Percentage use frequency (%) | Rank |
|---|---|---|
| Roots | 37.0 | 1 |
| Leaves | 30.5 | 2 |
| Bark | 19.9 | 3 |
| Exudates | 5.0 | 4 |
| Fruits | 4.6 | 5 |
| Flowers, spines, wood | 1.0 | 6 |

Comparable results were reported in Zambia by Storrs (1995) who, in studying 106 trees reported to have medicinal values, found that the frequency with which various parts were used for medicine ranged from 4% for wood, 9% for fruits/seed, 50% for leaves, 66% for bark, to 74% for roots.

### 4. Conclusion and Recommendations

Local people have tremendous emotional and health uses of medicinal plants. Emotions come in variety of forms such as fear, love, confidence, and security enhancement. These are prime issues that affect everyday life of local people. To solve these problems, plants are used directly or indirectly. In whatever use, some medicinal plants are important and more utilized than others. The distribution of the most preferred medicinal plants is now very poor and uneven within the forest. Furthermore, the impact of the use of medicinal plants to the ecosystem is crucial because roots are the most frequently used plant part, and the use of roots has been reported to be often destructive.

Local people are aware of the threatened medicinal plants, which are so useful to them, and thus would like to find these plants always available. Therefore, we recommend that the government involve local people in the identification and restoration of absent species, which were previously found in the woodland. If well protected under community management, the woodland could function as a big natural botanical garden. Some medicinal plants, which have disappeared from the woodland as a result of over-exploitation, would need to be regenerated artificially and then reintroduced. More research on ecological and silvicultural requirements of most useful indigenous medicinal plants is also recommended.

urbanization is rooted in the colonial economic legacy under the labour reserve and the settler plantation economic interlock (Mbonile, 1993). However, over the past 40 years urbanization has risen rapidly in the developing world due to adverse "push factors" in the rural areas, and attractive "pull factors" in urban areas (Kironde, 1996:22). The major adverse push factors in the rural areas include outmoded peasant agriculture wholly dependent on the population pressure on rural arable land, low food production due to unscientific farming methods worsened by frequent severe droughts (Krokfors, 1995:55-63). In contrast, attractive pull factors include relatively modern facilities in urban centres attracting investment and offering a base for the informal sector, which in turn attracts rural-urban migrants. Employment in urban areas means regular cash, comparatively high wages, social amenities, etc., and thus better prospects and living conditions compared to the underdeveloped agriculture based rural life. Unfortunately, however, these "urban lights" are overwhelmed by the great tide of intercity migrants of desperate, energetic young people pouring into urban centres. As an outcome, urban authorities are saddled with unprecedented population increase far beyond their financial capacity. Consequently, there is a marked deterioration in the quantity and quality of public utilities and the urban environment, and a host of other negative effects.

Some of the negative effects of pervasive rapid urbanization in the developing world include shortage of surveyed land, squatter settlements, lack of basic public utilities, poor housing, poor sewage and solid waste disposal (Tabibzadeh, Espagnet & Well, 1989:29-30). In Tanzania, financial constraints have "made it difficult for both the government and the city council to provide or expand and maintain infrastructure and services to the required standard. Sanitation and solid waste management has been left neglected for periods "(*Sunday News*, 1993).

### *1.1 Objectives of the Study*

Using a case study of Moshi municipality, this study applies both of quantitative and qualitative methods to analyse sewage and solid disposal problems associated with rapid urbanization in developing countries.

## 2. Theoretical Framework

For the last two decades, both social and natural scientists have attempted to advance frameworks and models for examining the relationship between population and the environment. This is a continuation of earlier efforts began around 1950 to study all the basic perspectives developed in human ecology (Hawley, 1950; Duncan, 1964). Basically, two perspectives that constantly interact have been identified: population, and environment. The interaction between the two is a constantly ongoing process, and is guided by two mediators: organization and technology (hence the acronym POET).

The thrust of the argument is that all forms of life have a population-environment interaction; except in non-human forms of life where organization

and technology are genetically programmed (Ness, 1994:10), i.e., they change spontaneously at a slower but steady pace compared to population and environment. In essence POET is a generic model with the basic framework from which different models concerned with various population-environment interactions can be developed and mediated by some form of organisation and technology. This analogy rules out the assertion that there is direct relationship between population and the environment and vice versa are products of social organisation and technology prevailing in a given human society at a given place and time.

Several models have been developed from POET that deal with various issues of population-environmental interactions at varying degrees and levels. All these reflect the basic human ecology proposition bound by technological and organisational aspects that guide the nature of population-environment relationships.

Since it is not possible to discuss all POET models in this article, we will consider only one model developed by Commoner (1972) and Harrison (1992), which is related to this study and is postulated as follows:

$$\text{Population} = \text{Population} \times (\text{Goods/Population}) \times (\text{Pollutant/Goods})$$

Where, Goods/Population ratio represents consumption, and the Pollutant/Goods ratio represents technology. Harrison (*op.cit.*) used this model to estimate the impact of changes in population, consumption, or technology on the environment. This has been applied to estimate four types of environmental impact in the developed and developing countries linked with the application of technology. These included the environmental impact resulting from destocking animals on grazing land and the outcome of increased yield per area; reduction rate of air pollution in various Organization for Economic Cooperation and Development (OECD) countries after the introduction of air cleaning technology. Others, the environmental impact as a result of recycling domestic wastes into useable by-products to increase consumption, income and protection of the environment against pollution; and the impact of adopting family planning technology in large population societies as developing countries on the environment.

The Rio de Janeiro Earth Summit of June 1992 agreed that large populations are detrimental to the environment due to pressure on limited resources. The World Bank, (1984:79) has observed that "...population growth at rates above 2% ... act as a break to development." Although Boserup argues that overpopulation stimulates technological innovation, she overlooks the problem of overshoot characterised by stress-and-relief in the trade off between overpopulation and environmental interaction before technological discovery is achieved (Ness, 1994:15).

Experience shows that, overuse of resources by whatever cause, without due replenishment, gives way to depletion of the environment. One of the concepts of the population and development question as related to environmental problems is the "Environmental Concern of Rapid Population Increase Effect" (ECRPIE) (Mtatifikolo, 1992: 4-9), which is a brain child of the POET generic model.

ECRIPIE asserts that where policy permits, a rapid and unchecked population increase beyond the carrying capacity of land—a state known as population pressure—may cause ecological, biological, and food problems. Such cases include intensification of land use for agriculture and wood harvesting for various purposes, and this may lead to severe drought, and ultimately desertification. This concept can be applied to study the urban context. For instance, similar stress in an urban environment can lead to shortage of housing, inadequate social services, etc. Therefore, the concept was employed in this study to investigate problems of urban pollution and domestic waste management in Moshi Municipality.

## 3. Literature Review

Adequate removal and safe disposal of solid wastes need proper information on the quantity and type of wastes generated in a given area. This is important in the determination of methods and equipment required for proper handling of different types of wastes—domestic, commercial, industrial hazardous or non-hazardous (Ngiloi, 1992:52). These precautions are necessary for human life and environmental protection (WHO, 1972).

Literature shows that cities in the developing countries face rapid urbanization beyond their ability to cope with the collection and safe disposal of solid waste, resulting in serious urban environment pollution. The generation of solid waste, both in developing and developed countries, increase with the economic level of countries and cities. Studies show that the range of generation of solid waste per capita per day in cities/municipalities in industrialised countries is 1.9-0.7kg, while in low income countries it is 0.6-0.5kg (Cointreau, 1982:10). Another study showed that industrialised countries generate 0.75-2kg and developing countries 0.2-0.5kg of solid waste per capita per day (Haskoning, 1989:10-15).

Tanzania, like other Sub-Saharan countries, has urban sanitation problems due to acute financial and organisational constraints facing municipal councils that are trying to cope with waste management in the context of rapid urban population increase. For example, it has been noted that in 1986 all regional headquarters required 164 cesspit emptier trucks to adequately remove sewage in their respective areas. Of these, the government could only afford 29%, of which only 50% were in good working condition by the year 1998 (MLGC, 1990).

## 4. Hypotheses

1. Domestic sewage and solid waste collection and disposal facilities, specifically trucks in the Municipality, are overwhelmed by the large quantities of wastes generated by its rapidly increasing urban population.
2. Low level of formal education, poverty, acute shortage of potable water are dominant in the high density/squatters areas of Moshi Municipality, and to a great extent are responsible for the poor sanitary conditions (of pit latrines) in these areas as compared to the low/medium density residential areas.

3. There is an inverse relationship between the municipal's financial resource allocated to the collection and safe disposal of domestic waste service, and the great demand by its rapidly expanding urban population.
4. Poor collection and disposal of domestic sewage and solid waste in the municipality has a negative impact on the protection of its urban environment.

*List of Variables*

The study considered 9 variables, some of which were computed in the multiple regression analysis to come up with the various decisions as explained under methodology. These variable were:

(a) Sewage generated per capita in cubic litres/metres per year multiplied by the population size.

(b) Solid waste generated per capita in kilograms per year multiplied by size of the population under consideration.

(c) Total quantities of sewage collected and disposed of by the municipality in a year is obtained by computing: number of cesspit emptier trucks x @ capacity (in cubic litres) x number of trips/week/year less total sewage generated in the whole year.

(d) Total quantities of solid waste collected and disposed by the municipality is: number of trucks x @ capacity (in metric tons) x number of trips/week/year minus the total solid waste generated in the entire year.

(e) Funds allocated to the municipality for collection of domestic wastes in respective annual budget.

(f) Ability of the one sewage Trickling Filter Plant (TFP) to treat sewage in the municipality. This was determined by comparing its designed capacity and any overflow caused by the sewage overload.

(g) Education of residents in the different residential areas of the municipality assessed in terms of the number of years completed in formal schooling.

(h) Latrine condition assessed with reference to whether or not roofed; walled and roofed; type of thatch material, e.g., corrugated iron sheets or scrap, rags, etc.; state and condition of the floor, i.e., concrete or earth.

(i) Condition of the urban environment. This was reached by considering the backlog of uncollected waste computed under (c) and (d) above. Where the percentage of backlog greatly exceeds the amount collected it was assumed that the urban environment was polluted in one way or another.

## 5. Conceptual Framework

The conceptual framework is shown in Figure 1, and labelled 1-9. Rapid population increase (1) is the source of increased generation of solid and sewage wastes (2). Efforts to remove and safely dispose wastes assumes two things: first, the financial position of the municipal government budget for such social services; and second, urbanites' educational level and attitudes towards handling their domestic wastes in order to assist the municipal government. If one or both of this mechanisms work well—e.g., the municipality has better and adequate waste clearing and treatment facilities, i.e., adequate funds and good waste management—and a literate, self-mobilized urban community to assist it in this task (9), then a protected and health environment can be expected (4,5).

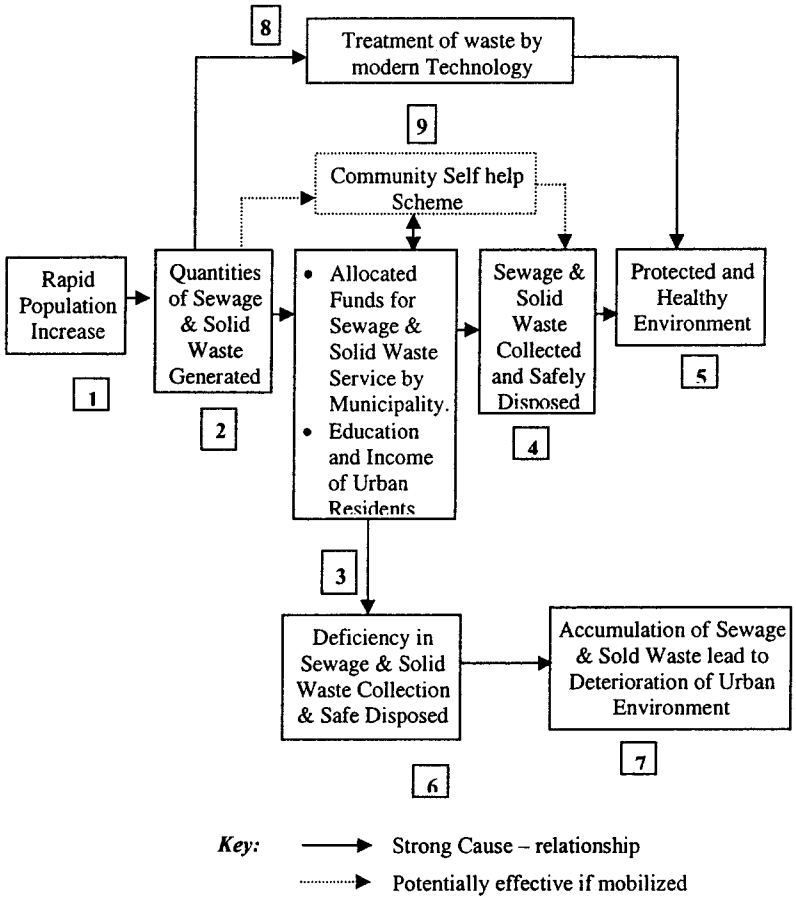



**Fig 1:** ***Conceptual Framework for Prevention of Domestic Waste from Polluting Moshi Urban Environment***

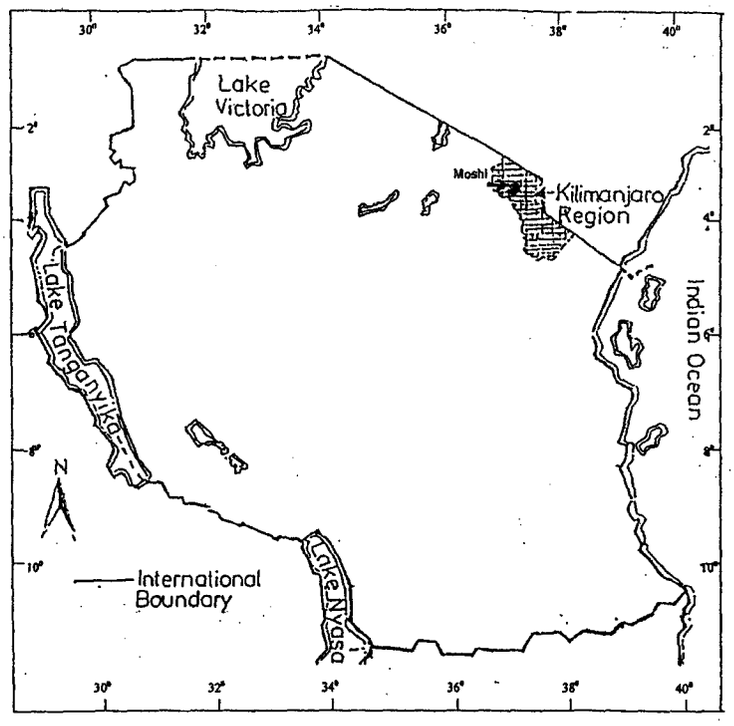
Contrary to this, collection and disposal of domestic wastes lag far behind, and hence get out of control (6); resulting into deterioration (pollution) of the urban environment (7). The model suggests that the environment could be saved from contamination by preventive measures or precaution given under (2) and (3).

This framework can be implemented if (a) there is adequate investment in modern technology for waste treatment and recycling; and (b) modern technology in waste treatment is supported by community-based action for a cleaner and healthier environment.

## 6. The Study Area and Research Methodology

### *6.1 The Study Area*

Kilimanjaro region is located in North Eastern Tanzania, and lies between 2°50′ 4°30′ latitudes south, and 37° and 38°20′ longitudes east (see Fig. 2). Moshi Municipality, with an area of 77km², is part of the foothills of Mount Kilimanjaro, the highest mountain in Africa towering at 5,600 metres above sea level.




Source: Kilimanjaro Region Planning Office

Map 1: *Location of the Kilimanjaro Region in Tanzania*

The relief rainfall (mean annual of 860 millimetres), and the fertile volcanic soils—both originating from the mountain—form a naturally rich agricultural land surrounding the municipality. These qualities account much for the abundance of food; mainly bananas, maize, and beans which feed the largely expanding population. This has led to a culture of high fertility as revealed by the 1978 and 1988 National Population Census (NPS) when the Total Fertility Rate (TFR) for the Kilimanjaro was the highest at 7.0 and 6.6 respectively. The long sustained high fertility in the area has resulted into population pressure over the limited arable land (Maro, 1975). Consequently, population pressure, *inter alia,* is the major push factor in the rural-urban migration in Kilimanjaro region.

### *6.2 Research Methodology*

The sample size comprised 8 out of 15 wards, covering 410 (2.05%) households with a total population of 2027 people living in differentiated residential settlements, i.e., low, medium, high densities, and in squatter areas. The latter were further re-grouped into two main categories related to similarities of socio-economic status for simplicity of the study, namely, low/medium density; and high density/squatter. The generation, collection, and disposal of sewage and solid waste were estimated using the "Environmental Empirical Models" (Gauff, Brown & Partners, 1980:13; Haskoning, 1989:15; CODESTRIA, 1986: 22). While comparative analysis was employed to compare population change and the municipality's budgets, multiple regression analysis was applied to determine relationships among different variables.

## 7. Data Presentation

### *7.1 The Demographic Factors of Moshi Municipality*

Moshi Municipality had a total population of 96632 people in 1988, with the following composition: 38.1% children, 59.7% working people, and 2.2% elderly (Bureau of Statistics, 1990:2, 36). The sex ratio was almost 1:1 with slightly more females. The 1993 Moshi Municipality Survey (TDHS, 1991/1992:8) obtained roughly the same population proportions.

Three major components of the urban population change were studied: natural increase, migration, and boundary re-classification. Findings showed that Moshi municipality experienced rapid urbanization. The main sources of population increase were natural increase by 45%, and rural-urban migration by 43.1%. The fact that natural increase was slightly higher than rural-urban migration emphasizes the high fertility rate in the area. The role of Moshi boundary reclassification was traced by comparing the total populations of the 1978 (52223) and 1988 (96645) national censuses, which showed dramatic change. The population change occurred when some former rural villages were incorporated into Moshi Municipality, raising the number of wards from 13 to 15.

It is clear from the above that Moshi Municipality is facing rapid urbanization caused by three factors ranging from natural increase, rural-urban migration, and boundary reclassification. This fast increase in urban population has a detrimental effect in the provision of basic social services, including solid waste management.

### *7.2 Quantity of Solid Waste Generated*

The total waste generated per annum in 1993 by the sample population of 2027 people was 388 metric tons. Of this, 1649 people in high density/squatter areas generated 81.4%, while 378 people living in low/medium density area produced 18.6%. The high percentage of domestic waste generation in the high density/squatter area is mainly a function of population increase. Municipal officials revealed that at the time of the survey, only 1 truck out of 5 bought in the 1980s was in working order serving the entire region, while funds allocated for domestic waste service were only Tshs. 1,200,000/=. There was thus an acute shortage of facilities and financial resources needed for the collection and disposal of increased solid wastes generated by the expanding urban population.

### *7.3 Relationship Between Population and Collection of Solid Wastes*

There was a negative relationship between population increase and the collection of solid waste, funds, and vehicles allocated for the service. This relationship was found out by computing the total quantity of solid waste generated for year 1978 and 1988 less the total quantity of solid waste collected and disposed by an average of 4 trucks. It was found out that despite the increase of trucks from 3 (1978) to 5 (1988) for the collection and disposal of waste, over 82% of solid waste remained uncollected. This was partly due to meagre funds allocated for waste management: from Tsh 650,000/= (1978) to Tsh 1,200,000/= (1988), which was a negligible financial increase when compared to the population increase and inflation rates. Regarding the number of vehicles (5), these were inadequate to cope with the increased waste output.

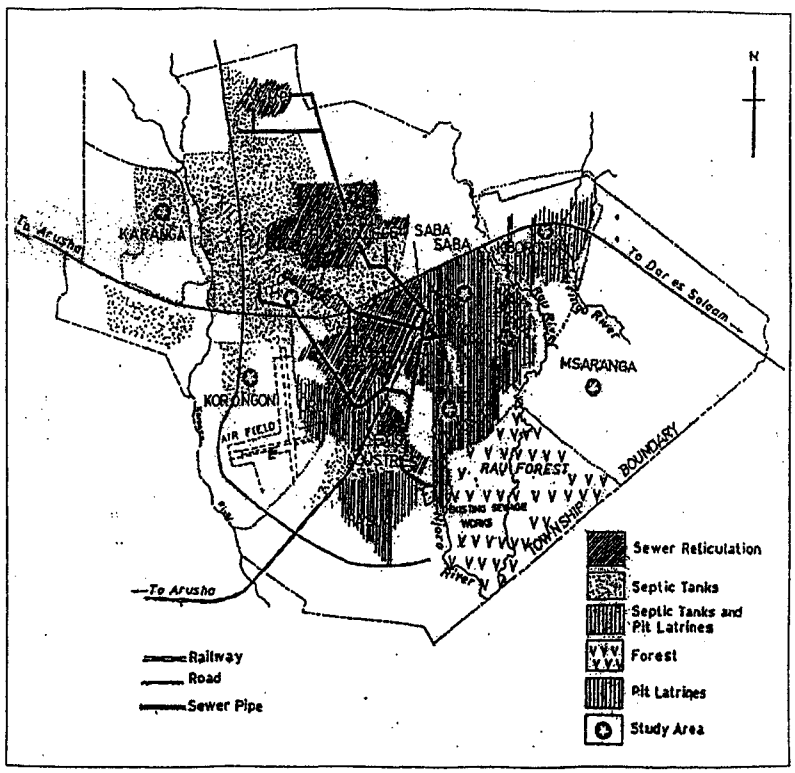
Furthermore, the results were confirmed by a multiple regression analysis suggesting that rapid population increase had negative relationship with cash and number of vehicles that the municipality provided for solid waste management. Consequently, the urban environment was polluted in one way or the other by a huge backlog of solid wastes.

### *7.4 Relationship Between Population and Collection of Sewage*

Negative relationship existed between population increase, collection of sewage, funds and the number of cesspit emptier trucks allocation for sewage service in the Municipality. The findings further showed that the collection and disposal of sewage generated by the rapidly increasing urban population overwhelmed the municipal collection facilities, averaging 3 cesspit emptier trucks, and the meagre financial resource

### *7.5 Ability of the Municipal Sewage Trickling Filter Plant (TFP)*

The TFP plant is connected to the one public sewer occupying the centre of Moshi town as appears on Map 2, before it was recently extended to the Cooperative College and Kilimanjaro Christian Medical Centre (KCMC). Initially, in the early post-independence era, the TFP served a relatively small urban population in the low/medium density area. With the passage of time, the population increased due to spontaneous rural-urban migration and natural population increase while the TFP capacity remained constant, i.e., 13.5 cubic metres. Frequent breakdowns of the plant were reported due to sewage overload from public sewers. Some sewage started overflowing into Njoro River, where the plant is situated, thus polluting the river.




*Source: 1993 Moshi Municipality Survey*

**Map 2:** ***Administration and Sanitation Diagram of Moshi Municipality***

### *7.6 The Municipal Solid Waste Dumpsite*

The refuse dump is located in the southern fringes of the Municipality near the TFP, and has an area of 4 acres. The survey noted that there was uncontrolled dumping of waste: domestic, commercial, and industrial refuse were often

dumped together and rarely covered with earth to reduce risks of scattering and contaminating the surrounding areas. Foul smell and smoke from spontaneous fires of burning refuse were common pollutants. The uncovered dump became one of the main sources of environmentally associated diseases affecting mostly children from poor families who were seen scavenging around the dumpsite. In addition, run-off and wind further spread the waste into surrounding areas, rivers, and wells; hence contaminating the very sources of domestic water for neighbouring residents, notably in Njoro, Mji Mpya, etc.

### *7.7 Attitudes and Practices of Urbanites Towards Management*

Pit latrines are the usual toilet facilities for squatters in high-density area, where 69% of the residents had only primary education, of which only 25.8% had health care education. Some 45% of the low-income earners could not afford to install flush toilet facilities. Around 74.4% of the pit latrines were found to be in bad sanitary conditions, i.e., they were dirty, shabby, roofless, or made up of scrap and old materials. In contrast, 46% of the urbanites living in the low/medium residences had at least secondary education, primary health education, and relatively higher income. Most of them possessed decent flush toilets connected to the public sewer or septic tanks. The study revealed that the latter's good education, income, and managerial positions influenced the installation of high quality toilet facilities, and the frequent availability of the Municipal sewage and solid waste collection services in their residential areas. It was noted that these privileges were also part of the legal rights given to residents living in planned areas.

Attitudes and practices of urbanites concerning collection or treatment of domestic wastes where municipal facilities were not provided differed between the high density/squatter and low/medium density residents. The former simply dumped the uncollected wastes haphazardly on the ground, hence increasing the chances of polluting the environment. Moreover, pit latrines were substandard, and were usually abandoned once filled due to the inability by majority of the poor squatters to hire private cesspit emptier trucks. Furthermore, over 50% of 410 households in the high density/squatter areas were not surveyed, and thus not accessible to the municipal's waste collection trucks.

The urbanites had the mentality/attitude of placing the whole domestic waste collection responsibility on the Municipal's shoulders simply because they paid multiple taxes to it. Implicitly, community mobilization or cost sharing is yet to be appreciated. This is further complicated partly by ignorance and poverty, whereby cost sharing is seen as another form of tax to the already overtaxed community. In contrast, there was great awareness and demand by the low/medium density residents for a healthy environment, facilitated by access to public waste collection facilities. Partly due to this public health awareness, those who could afford—mainly those living in the medium/low density areas—were willing to hire private waste collection vehicles.

## 8. Discussion

### *8.1 Components of Rapid Urbanization*

Rural-urban migration has for long been cited as the main source of rapid urbanization in developing countries (Maro & Mlay, 1979), and in developing countries generally (Todaro, 1982:213). However, other scholars have also argued that natural increase is the leading component in rapid urbanization in Tanzania and LDCs in general (Hayuma, 1979:119; Lugold *et. al.*, 1977:76). Boundary reclassification also contributes in the expansion of the urban population as has been in the case of Moshi Municipality, and this concurs with other studies in developing countries, e.g., Thailand (Goldestein, 1978:239-258). The foregoing arguments show that rapid urbanization is a result of several population components interacting at varying magnitudes in different places, depending on the social, economic, and political conditions prevailing in a specific area.

### *8.2 Impact of Rapid Urbanization on Urban Environment*

The TFP in Moshi Municipality failed to treat sewage efficiently because of being overwhelmed by a rapidly increasing urban population. This phenomenon is observed in most of the developing countries, which were former colonial dominions whereby such plants were purposely designed for a small urban elite, i.e., Whites and Asians under restrictive colonial population policies (Wekwete, 1992: 130-135). The lifting of such policies at independence opened the floodgates for rapid urban population growth that was not matched by increased capacity of sewage treatment plants. As an outcome, water contamination by sewage and solid waste has become a common problem in many LDCs, made even worse by grinding poverty and rampant illiteracy. This situation had taken a heavy toll on human life due to endemic water-borne diseases such as cholera. Uncontrolled throwing of refuse into Rau, Njoro, and Kisiringo rivers in Moshi urban by nearby squatters has polluted these rivers, posing a constant threat to the health of the urbanites. When combined with sewage escaping from the TFP, the nearby dumpsite together with the construction of pit latrines near the and Njoro river has further contaminated the river which is the main source of drinking water for the ignorant and poor squatters. An earlier research by the National Environmental Management Council (NEMC) had a similar conclusion:

> Sanitation conditions in Moshi i.e. sewage, seepage from pit latrines, run-off drainage and solid waste, do not differ from other towns in the country. Generally the conditions are poor hampering the life quality of the town dwellers through filth, pollution and spreading of diseases. There have been cases of cholera. Njoro is the main recipient of the town effluent (NEMC, 1989:3).

Human sufferings from the polluted urban environment were also confirmed by the 1993 Moshi Municipal Survey, which cited the presence of 4 out of the 15 leading environmental killer diseases: cholera, skin diseases, diarrhoea, and intestinal worms (Moshi Municipality Records, 1991 & 1992:7 & 5). This is indicative of the serious

The above observation tallies with global experience as documented in other studies, for example that of UNCHS in 1994 which concluded that: "Environmental hazards endanger lives, health and livelihoods of urban populations. Consequently...affect the urban poor, who often live and work in ...the vicinity of dump sites for refuse and major industrial polluters" (UNCHS, 1994:14). According to this study, the possible causes of urban environmental pollution were mainly two. First, rapid urbanization, coupled with municipals' limited budgets to cope with large quantities of domestic wastes. The government of Tanzania supports this in its observation that, "The social sector has lagged behind because... Government's ability to finance these services is very limited...due to rapid increase in population" (URT, 1990:49-50).

Secondly, urban residents—especially the majority who are both economically and educationally disadvantaged—have not been sensitised and motivated enough to know, appreciate, and assume their roles as primary beneficiaries of an aesthetic environment. Most of them still wait for the municipality to remove and dispose domestic wastes since, in their perception, they pay enough taxes for the Municipality/government to carry out such tasks. The policy of economic liberalization of 1984, which advocates cost sharing following the shrink in public expenditure on social services, has not spelt out clearly how to prepare and empower people to undertake greater responsibilities in solving their own social problems. There is need, therefore, to establish better community participation strategies for solving socio-economic problems to ensure sustainable development (Ngware, 1996: 17-78). This view supports conclusions of the WHO Review Team's Report of 1987 after a tour of Tanzania, specifically as a follow-up on community participation in primary health care matters:

> The National Primary Health Care (PHC), underscores the importance of community involvement in planning, implementing and evaluating health activities. Mechanisms exist in Tanzania for Mass mobilization and effective community involvement, they... include the basic Ten Cell Unit and the development Committee at regional and district levels. During the PHC review it was observed that the health sector does not fully exploit these mechanisms for health action except during crisis situations (WHO, 1987: 225).

Likewise, we cannot win the battle against urban pollution single-handedly by leaving the task to the government in a traditional or conventional approach where the local authority alone is expected to have both operational and institutional responsibility for waste management service (Halla & Majani, 1999:351). Other key partners —including the central government, the private sector, the community at large, and other interested stakeholders—have also to come in. In addition, we have to adopt modern technology in the management of large quantities of waste resulting from rapid urbanization. Modern technology is needed to transform the otherwise garbage and sewage to fertilizer for agriculture; or to reusable metal, plastics; paper, or methane. This is possible with LDC's through a number of ways; one being the establishment of technological cooperation with developed countries in the spirit of sharing knowledge for mutual benefits of social and economic development.

An example of such cooperation is the Thies Abattoir in Senegal. This abattoir once polluted the environment through decomposing animals' stomach contents, blood, and visceral matter. Senegal managed to adopt modern technology by installing a waste treatment plant through technical cooperation between a home-based company, SERAS, and a foreign international firm, CIRAD (Farinet & Forest, 1993:6). The effect of the plant was felt only six weeks from its installation – 90% of the pollution dropped. In addition there was compost, biogas, and energy for a 20KW generator used to supply electricity to the slaughterhouse.

**9. Conclusion and Recommendations**

This study has established that Moshi Municipality, like most urban centres in developing countries, is experiencing rapid urbanization caused mainly by rural-urban migration and natural increase. As a result, there is rapid growth of sprawling squatter settlements. The low levels of education and income among the residents in the squatters contribute greatly to urban environmental pollution. The municipal's limited financial resources and waste management capacity are overwhelmed by the large quantities of wastes generated by its rapidly increasing urban population, leading to environmental pollution.

The Municipality, however, cannot escape the blame on contributing to urban pollution by not utilizing appropriate methods of safe disposal of wastes. For example, refuse is often left uncovered by earth at the dump site, sometimes commercial and domestic wastes mix together, there are spontaneous fires left to pollute surrounding areas, and so on. This renders the Municipality prone to environmental diseases, and thus urgent measures are needed to contain the environmental pollution particularly in surrounding residential areas where the poor live. Permanent strategies to alleviate the problem and create a healthy sustainable environment are not available, apart from sporadic crisis campaigns at the outbreak of epidemic environmental diseases, e.g., cholera, skin diseases, etc.

From the above, we recommend the following to policy makers, and stakeholders in general, on containing domestic wastes problem in LDCs' urban centres:

1. Mobilization of community participation by sensitising the people to be conscious of their environment, and to take the initiative of improving and developing it for the people's common good.
2. Utilisation of modern technology to arrest the situation, because reliance on collection and disposal of wastes in open dumpsites is a menace to nearby residents.
3. Good governance to tackle a number of socio-economic and environmental problems, e.g., the alleviation of the rural/urban economic imbalance that creates the rural-urban pull factors. This can be done through modernization of the rural agricultural economy to reduce or reverse the trend.

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