Application of Local Knowledge in Land Degradation Assessment in the Bawku East Municipality

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Abstract

A number of scientific methodologies have been used in assessing land degradation globally. However, the use of local knowledge in eliciting indicators of land degradation has seen little application by scientists and policy makers. Researchers believe the two approaches could complement each other to provide a holistic assessment of land degradation. The objective of the study was to find out local approaches used in assessing land degradation by farmers of the Bawku Municipality. Secondly, we investigated farmers' perception of the causes of the problem and their coping strategies. The study was conducted using questionnaires, interviews and focus group discussions. Farmers perceived degradation in the soil and vegetation which is explained by population growth, bush burning,

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overgrazing, fuel wood harvesting, expansion of farmlands and drought. Degradation in soil and vegetation took the form of soil erosion, soil compaction, loss in soil fertility and deforestation. The lack of proper coordination among stakeholders (farmers, Non-governmental Organizations and local authorities) in the locality has resulted in poor planning and implementation of land degradation intervention measures. Also, some intervention measures are instituted without public consultation, hence the unwillingness of the people to implement them. The primary effects of land degradation include scarcity of wood products for building and domestic energy supply, less pasture for animals and low crop yield which worsens poverty and hunger amongst the people. The strategies for coping with this environmental challenge include inorganic fertilizer application, organic manure application, diversification of crops, planting of early maturing/drought tolerant crops, dry season gardening/irrigation and mixed cropping.

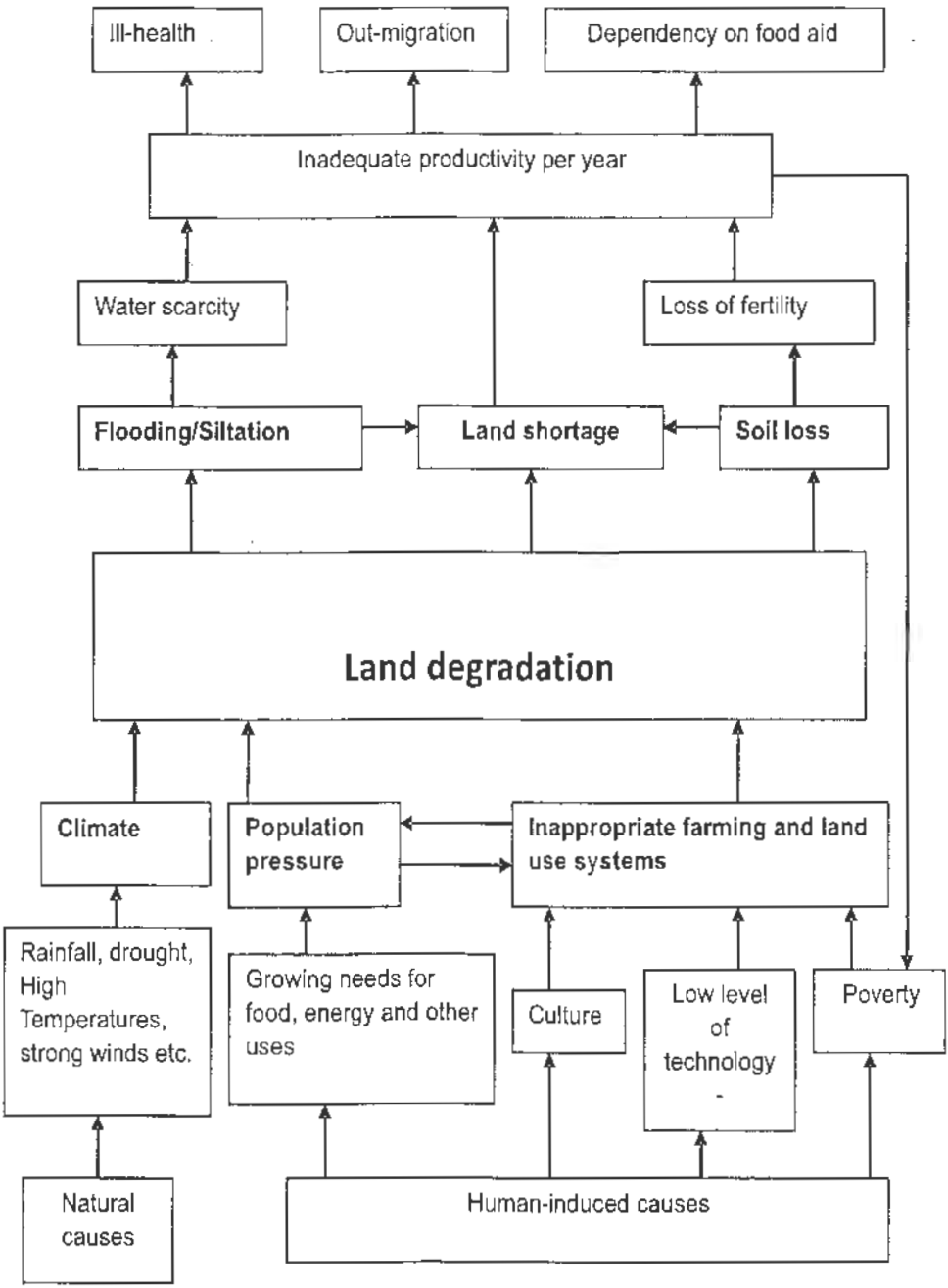
Keywords: Bawku; Land Degradation; Local Knowledge on Land Degradation; Farmers' Perception regarding Land Degradation.

Introduction

Land degradation may be defined as "the aggregate diminution of the productive potential of the land including its major use (rain-fed, irrigated, arable cropping, rangeland, inland fishery and forestry), its farming systems (e.g. smallholder subsistence) and its value as an economic resource" (UN/FAO definition, cited in Stocking and Murnaghan, 2001, p.9). It involves soil erosion, desiccation of soils, reduction of soil fertility, soil compaction, destruction of natural vegetative cover and acidification (Benneh and Agyepong, 1990). If the degradation occurs in arid or semi-arid areas and dry sub-humid areas, the process is described as desertification (UNCCD, 1994).

Land degradation is induced by both natural and human factors. These factors are complex and interrelated, as depicted diagrammatically (Fig.1). The natural causes involve climatic conditions such as rainfall variability and intensity, drought, flood, temperature and wind. In fact, adverse climatic conditions are increasingly seen as a major cause of land degradation (Dahlberg, 1994). Land degradation also results from social and economic factors such as poverty, inequitable distribution of land resources, inappropriate land use and farming systems and growing need for food and energy, and from other uses as a result of population increase (Fig.1). Desertification and land degradation cause or aggravate famine, malnutrition, poverty and migratory movements and lead to crises, conflicts and instability (Holtz, 2003).

Fig. 1: A Diagrammatic Representation of causes and effects of Land Degradation



(Source: Authors' own construct)

Scientific techniques such as satellite remote sensing and geographic information system (GIS) involving land use and land cover change analysis (e.g. Prakash and Gupta, 1998; Lillesand and Kiefer, 1994; Al-Quraishi et al, 2004; Braimoh and Vlek, 2005), ecological assessment (e.g. Stringer and Reed, 2007; Reed et al, 2008) and the measurement of soil properties (e.g. Stringer and Reed, 2007; Reed et al, 2008) can be used to study land degradation. For instance, in a land cover change trajectories studies in Northern Ghana using satellite remote sensing, Braimoh and Vlek (2005) found that increase in population density is an important determinant for trajectories involving agricultural extensification and intensification which is associated with low soil quality.

Research has however shown that science has its limitations and cannot always provide an accurate diagnosis of or solution for all the driving forces of land degradation (Thomas and Milddleton, 1994; Fairhead and Leach, 1996; Thomas, 1997 cited by Stringer and Reed, 2007). There is therefore the need to integrate scientific and local knowledge bases, so that communities are able to fully realise their capacity to monitor and respond to the challenges of degradation and change (Stringer and Reed, 2007). Agyemang et al (2007) employed both Geographical Information System (GIS) and community truthing tools such as key informant interviews, focus group discussions, participant observation and participatory research in soliciting societal responses to measure the indicators of the Driving force–Pressure–State–Impacts–Response (DPSIR) assessment framework in Northern Ghana. The study showed a marked decrease in vegetative cover and an increase in built-up and barren environment in a 14 year period from 1990 to 2004. In a similar study a participatory research tool and GIS were combined to investigate land use problems which entail causes, effects and possible solutions in Burkina Faso (Hessel, 2009). The study confirmed the

importance of integrating scientific and local knowledge to develop concrete options for sustainable land use that fit local realities and aspirations. Also Stringer and Reed (2007) and Reed et al (2008) employed a hybrid approach of scientific (soil sampling analysis, land cover analysis, line intercept method) and local knowledge methods (participatory research involving household surveys, questionnaires, focus group discussions, indepth semi-structured interviews, mapping of ecological assemblages and resource use patterns) in land degradation assessment in Bostwana and Swaziland. According to them, by combining scientific and social science methods, they were able to produce more accurate and relevant results on local knowledge bases for land degradation assessment than either method could have achieved alone.

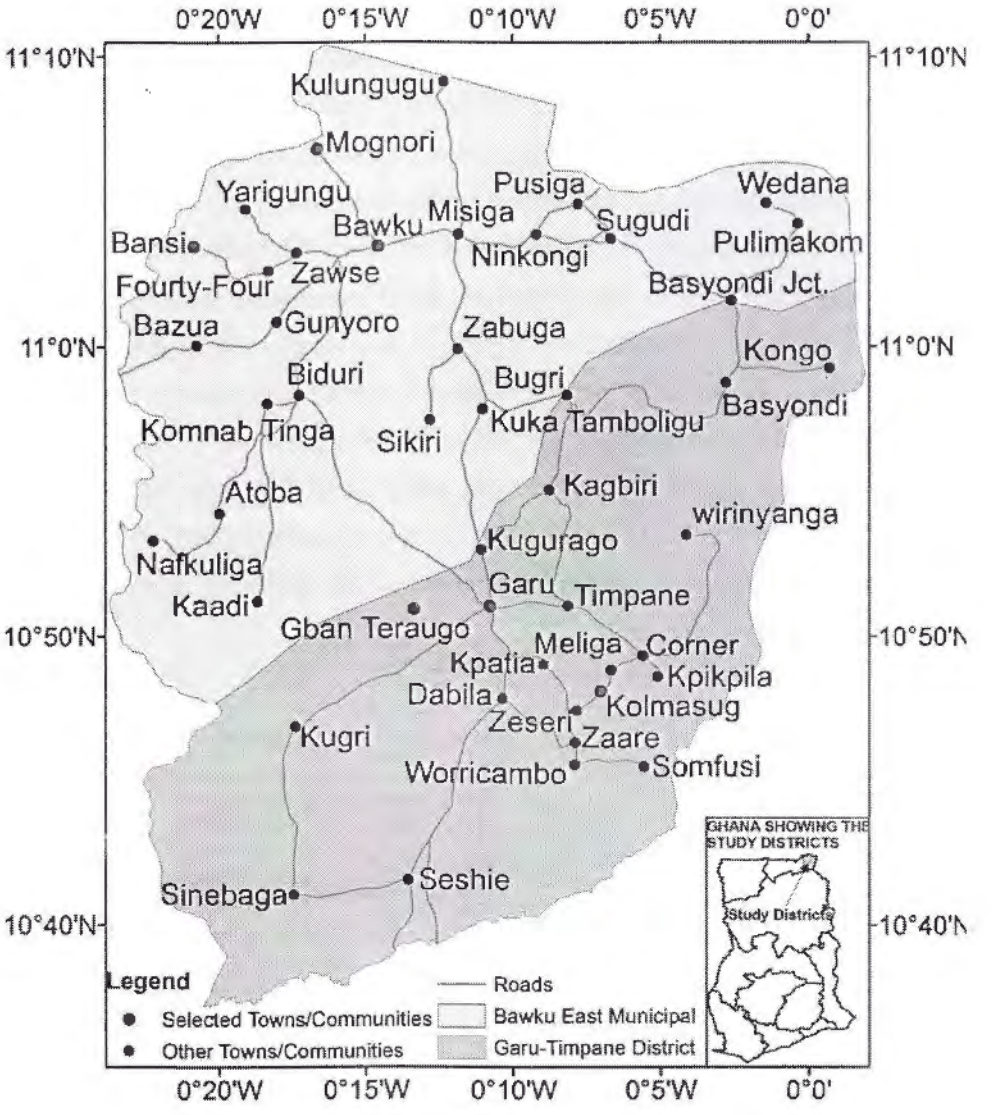
Other scholars have used only qualitative and quantitative methods including interviews, focus group discussions, household surveys and questionnaires to collect and analyse data from stakeholders, farmers and community members on indicators of land degradation in Ghana and other parts of Africa including Mali, Botswana, Swaziland etc (Reed et al, 2006; Dembélé, 2006; Moges and Holden, 2007; Bugri, 2008). In all these studies, these qualitative instruments of data collection were found to be effective in eliciting land degradation indicators. For instance, Moges and Holden, 2007 indicated that farmers in the Sidama zone of southern Ethiopia are able to identify soil erosion and fertility loss indicators, take a holistic view of soil degradation and have a broad knowledge of the reasons for soil degradation. Farmers perceived soil degradation mainly by reduced yields, or by soil changing in appearance and becoming stony or coarse.

The land degradation process is not well understood, because most studies have centred on the physical aspects of the process (Dejene et al, 1997). In

fact, local peoples' perception of what is happening to their land serves as an indicator of land degradation (Reining, 1970; Dregne, 1983; both cited in Nsiah-Gyabaah, 1994) because it is at this level that most fruitful causal explanations lie. Land degradation may be a physical process, but its underlying causes are firmly rooted in the socio-economic, political and cultural environment in which land users operate. Analysing these root causes and effects of land degradation, based on local perception and coping strategies, will provide information that is essential for sustainable land use planning. This agrees with Reed et al's (2006) views that sustainability indicators based on local data provide a practical method to monitor progress towards sustainable development. Therefore, the collection of information on land degradation should include local knowledge gathered by involving the people. Since understanding the dynamics of land degradation at the village and farm level enhances the success of policies and programmes to address land degradation (Dejene et al, 1997), the study examined local approaches used in detecting and analysing land degradation at the community level. The causes and socio-economic effects of land degradation and the coping strategies of the people in the changing physical environment were also investigated.

Background Information on the Study Area

The Bawku East Municipality is located in the north-eastern part of Ghana between latitudes 10°15N and 11°12N and longitudes 0°03E and 0°23W (Fig.2). It is bounded to the west by Bawku West District, north by Burkina Faso, east by Togo and to the south by the Northern Region.



The District is now divided into the Bawku East Municipality and the Garu-Tempane District (Fig.2). The area is under the influence of the interior savannah climate, characterized by a single rainy season from May to October and a long dry season from November to April. Mean annual rainfall is about 1000 to 1150mm with monthly temperatures varying from 36°C in March to about 27°C in August (Dickson and Benneh, 1995).

In the dry seasons, particularly between December and February, the dry and dusty harmattan winds from the Sahara Desert are very intense while the warm humid and wet monsoon winds which blow across the Atlantic Ocean bring rains in the wet season (Senayah, 1994). The long dry spell promotes the activities of bushfires, exposing the soils to erosion by wind and run-off.

The vegetation of the District is Sudan Savannah which is characterized by very short grasses and widely scattered dwarfish trees. The trees are deciduous, shedding their leaves in the dry season, while the grasses wither. There are however some gazetted forest reserves, some of which have been seriously encroached upon.

The topography is gently rolling with isolated hills or inselbergs with average heights of between 180 and 300m above sea level (Dickson and Benneh, 1995). The soils are laterites and ochrosols weathered from granites and Birimian rocks which form the base rocks. They have low organic matter content due to rapid decomposition, overgrazing and bush burning and are droughty in the surface horizons (Adu, 1969). The low organic matter content, coupled with the continuous disturbance of the soils, weakens the soil structure and makes it susceptible to erosion and leaching.

The Bawku East District is the highest populated district in the Upper East Region (Fig.3). Over 80% of the people are rural dwellers and their economy is largely land based (Ghana Statistical Service, 2002), which exerts much pressure on the land in the form of over-cultivation, overgrazing, expansion of settlements, fuel wood fetching, etc.

The main economic activity in the Municipality is agriculture. According to the 2000 Population and Housing Census (Ghana Statistical Service, 2002), about 68 percent of the labour force in the region is actively engaged in agriculture, including animal husbandry and forestry. The agricultural activities comprise farming of staple food crops (millet, sorghum, maize, groundnuts, beans etc), animal rearing (cattle, goats, sheep etc) and poultry (Department of Geography and Resource Development, 1992).

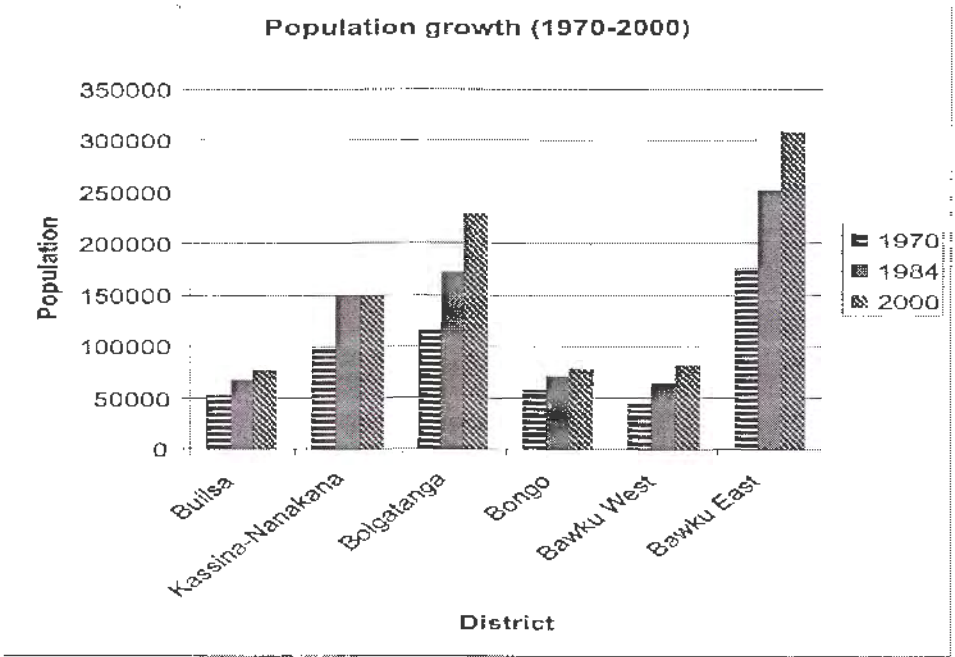


Fig. 3: Population Growth from 1970 to 2000 (Ghana Statistical Service, 2002)

The livestock population has increased tremendously over the years (Benneh and Agyepong, 1990), putting pressure on the limited rangelands, which results in overgrazing. Other land based economic activities that employ significant numbers of people include construction, weaving and pottery (Ghana Statistical Service, 2002). Almost all these activities derive their raw materials from the local environment. However, due to the extension of

farmland, overgrazing and bush burning, a greater proportion of the raw materials for baskets and hats are now imported from the southern sector of the country.

The main system of farming that existed in the past was shifting cultivation, which was practised because of the low population pressure at the time (Gyasi and Uitto, 1997). As population pressure increased and settlements became more consolidated, shifting cultivation gave way to bush fallowing and land rotation which has now evolved into continuous cultivation.

Land degradation is occurring everywhere in Ghana but the Upper East Region is the highest hit. The semi-arid region is ranked as the most threatened desertification region in Ghana (Environmental Protection Agency, 2005). Land degradation manifests itself in the region in the form of low agricultural productivity due to low soil fertility and adverse climatic conditions, soil erosion and loss of vegetative cover. This has significantly affected food productivity which has declined from about 1.5 to 0.8 tonnes per hectare (Ministry of Food and Agriculture, 2006). Low production also increases the poverty situation of farmers. In fact, the region is ranked as the poorest region in Ghana where nine out of every ten people are poor (National Development Planning Commission, 2005). This is attributed to its dependence on land-based economic activities. In the Bawku East Municipality, agriculture employs about 68% of the active labour force (Ghana Statistical Service, 2002), thus land degradation poses a threat to livelihood.

Research Materials and Methods

The study focused on the Bawku East District, now separated into the Bawku East Municipality and the Garu-Tempane District. Six communities in the District were selected for a questionnaire survey (e.g. Dembélé, 2006; Dejene et al, 1997). The selected communities are Bansi, Bawku and

Mognori in the Bawku East Municipality; Garu, Gban Teraugo and Kolmasug in the Garu-Tempane District (Fig. 2 and Table 1). The selection of the communities was based on a lottery system, with the assistance of an agricultural extension agent in each District who provided the names of the communities in the District.

One hundred and fifty (150) questionnaires were administered to collect information relating to land degradation from farmers (e.g. Stringer and Reed, 2007; Reed et al, 2006; Bugri, 2008). The respondents consisted of farmers who were thirty-five (35) years and above. People in this age group were chosen because they will be able to give an account of the environmental situation of the area for the past 15 years. Eighty (80) questionnaires were administered in the Bawku East Municipality and seventy (70) in the Garu-Tempane District. This was done arbitrarily because the District was divided in 2005 after the release of the latest population census (2000), and therefore it was not possible to obtain data on the population for each District. The reason for selecting more people from the Bawku East Municipality was due to its large land mass of 1097 square kilometres and urbanized nature as compared to the Garu-Tempane District which is 985 square kilometres (land size calculated in ArcGIS 9.2). All rural communities in both Districts were administered an equal number of questionnaires because their primary economic activity is farming. Bawku and Garu were given more questionnaires because they are the District capitals and are more populated (Table 1). In addition to the questionnaire survey, two communities namely Wiidi in the Bawku East Municipality and Kolmasug in the Garu-Tempani District were selected for focus group discussions (e.g. Dembélé, 2006; Olson, 1994; Reed et al, 2008; Stringer and Reed, 2007; Agyemang et al, 2007) to collect information on local knowledge and perceptions about land degradation and its socio-economic impacts. Each group was made up of 20 people, comprising 12 men and 8

women. Participants in the group discussions were also thirty years and above for both sexes. Proceedings of the discussions were recorded.

Table 1: Distribution of Questionnaires among the Communities.

Community	District	No. of Questionnaires	Percentage of Sample
Bawku	Bawku Municipality	40	26.8
Bansi	Bawku Municipality	20	13.3
Mognori	Bawku Municipality	20	13.3
Garu	Garu-Tempane	30	20.0
Gban Teraugo	Garu-Tempane	20	13.3
Kolmasug	Garu-Tempane	20	13.3
Total		**150**	**100**

Source: Fieldwork, 2007

Personal in-depth interviews using semi-structured questionnaires (e.g. Dejene et al, 1997; Stringer and Reed, 2007; Dembélé, 2006; Agyemang et al, 2007) were used to collect data on problems of land degradation. The interviews were conducted with the two District Assemblies, one district officer of the Ministry of Food and Agriculture in each district, one traditional authority in each district, the District Forest Office in Bawku, the Department of Urban Roads, the Adventist Development and Relief Agency (ADRA) and the Zuuri Organisation for Vegetable Farmers Association (ZOVFA).

Data from the questionnaire survey and interviews were analysed using the Statistical Package for Social Science (SPSS) software while focus group discussions were transcribed to augment findings from the questionnaires and interviews.

Results and Discussion

Indicators of Land Degradation

Soil and vegetation were used as indicators of land degradation by the people. These components (soil and vegetation) possess the visible signs of land degradation as well as effects which are felt immediately by the local people since they constitute the major resource of the inhabitants.

Soil Degradation

Soil degradation was identified by local residents through changes in crop yield as well as physical changes in the soil from questionnaire survey analysis. Local people associated reduction in crop yield with depletion of soil nutrients and rainfall variability (Table 2). As shown in the table, the majority (73.3%) of respondents attributed a reduction in crop yield to low soil fertility.A farmer described the state of the soil on his farm this way: "*my land is dead because it no longer has food for the crops*". What this farmer wanted to say was that because the land is no longer fertile, the crops do not grow well to produce good yields. This idea was widely expressed in all the focus group discussions.

Table 2: Causes of low crop yield as perceived by Farmers.

Cause	No. of Respondents	Percent	Cumulative Percent
Low soil fertility	110	73.3	73.3
Low rainfall	24	16.0	89.3
Rainfall and low fertility	6	4	93.3
Old age	1	0.7	94.0
Disease	1	0.7	94.7
Continuous Cropping	1	0.7	95.4
No. reduction	7	4.6	100.0
Total	**150**	**100.0**	

Source: Fieldwork, 2007

Thus once the land is not able to produce as it used to, it is degraded (i.e. 'dead' as they put it). In fact, the farmers said that crop yield on plots of land had generally reduced over the past 20 years. More than 95% of farmers said that their crop yield was decreasing while less than 5% said there was no change. Some farmers estimated the reduction in production to as low as more than half or less than one-third their initial production from the same plots of land they have been cultivating. Farmers who had stable yield were those who could afford fertiliser and animal manure on their farms. Reduction in yields was perceived by farmers as soil degradation in Southern Ethiopia (e.g. Morges and Holden, 2007). Similar observations were made by Stringer and Reed (2007), where reduction in crop yield was used as an indicator of soil fertility decline.

Farmers recognised that one of the reasons for low soil fertility is continuous cropping. Box 1 explains the underlying factors for continuous cropping as expressed by farmers in focus group discussions.

Our forefathers had small numbers of mouths to feed and therefore could afford to fallow as long as they wished but their lineage has more than quadrupled. We have occupied all that our ancestors had acquired and the land is no longer enough to feed us and supply other needs because the land has been divided severally among generations after them (the ancestors) and has now become too small to support a household. We therefore have to continually farm on the same land or move into any available land (or areas that were initially not suitable) to farm in order to meet our basic needs.

Box 1: Response of participants at focus group discussions

With regard to physical changes in the soil, the local people identified soil erosion and soil compaction as major indicators of land degradation. Analysis of questionnaires indicated that 97% of respondents were aware that soil erosion is taking place on their lands while about 3% did not observe erosion occurring on their lands. Farmers who did not observe erosion on their land said there is no serious run-off on their farms due to the relatively flat nature of the landscape. For these farmers, erosion is only evidenced by rill or gully (Fig. 4) and since these processes were not occurring on their farms, they concluded that no erosion had taken place. The farmer on whose land gully erosion was found said that it started as a small gutter but is developing into a big river in the rainy season. The farmers' perception regarding erosion is reflected in the way they ranked the types of erosion in the area.

Fig.4: Gully Erosion near Garu (Yiran, 2007)

Farmers ranked sheet erosion as the number one on their farms (Table 3). Sheet erosion was identified through a lot of indicators which include the levelling of ridges and mounts constructed prior to planting, the accumulation of soil particles behind obstacles, the appearance of stones on farms and the washing away of plants or the exposure of plants' roots (e.g. Dejene et al, 1997; Morges and Holden, 2007). During group discussions, most farmers indicated that the roots of their crops get exposed or carried away by run-off.

Table 3: Ranking of types of erosion by farmers

Type	Rank	%	Cumulative Percentage
Sheet	1st	94.3	94.3
Rill	2nd	4.2	98.5
Gully	3rd	1.5	100.0

Source: Fieldwork, 2007

Some of the respondents said that after heavy rains, they have to gather soil around the crops whose roots have been exposed. Farmers in valleys reported that soils are usually carried from uplands and deposited on their farms after heavy down pours, sometimes burying their crops. Other farmers explained that though sheet erosion may not be visible on their lands, the number of pebbles and stones on their farms are increasing, indicating that these stones which were formerly buried are now being exposed as the soil is gradually eroded (Fig.5).

Fig.5: Appearance of stones on a farm at Mognori (Yiran, 2007)

The farmer whose land is shown in Fig.5 said that when he started farming on the land, the stones were not as many as they are now. Morges and Holden (2007) also found out that farmers in Southern Ethiopia perceived soil degradation on the basis of the changing physical appearance of the soil, that is, when it is becoming stony or coarser. It was however found in Tanzania that the level of stoniness was not a good indicator of land degradation, largely because most of the stones are found on uncultivated hilltops (Dejene et al, 1997).

Another type of sheet erosion reported by farmers was wind erosion. According to them, during the dry season, winds blow over the land and carry soil particles away. Farmers noted that the winds get stronger when there are no physical structures to break it. Soil erosion as an indicator of land degradation was also perceived by farmers in Southern Ethiopia through the processes of the soil becoming coarse and stony, the formation of rills, the

dissection of fields and gullies and topsoil removal (Moges and Holden, 2007).

Farmers detect soil compaction through the resistance of the soil to work or its inability to support plant life. Soil compaction was observed along footpaths, trekking lines and places where animals usually gather to rest, and sand winning areas. The compacted soils become very hard and agriculturally unproductive. It was observed that excavated patches for building and road construction are not reclaimed after the sand has been wined; they are abandoned and come under the vagaries of the weather; erosion by rains and heating by the sun, which harden the surface. In contrast to the above, 'soil looseness' was cited as a degradation indicator in Botswana (Stringer and Reed, 2007, p.9). The 'soil looseness' was explained by the low organic matter content of the soil.

Vegetation Degradation

As the soil is being degraded, so is the vegetation. This is because vegetation and soil are inherently linked and therefore the degradation of one leads to the degradation of the other. Local people depend on the vegetation for their domestic energy requirements, building materials as well as pasture for their livestock. The local people detected that their environment is degrading through changes in the quality, quantity and diversity of the vegetation. They perceived a reduction in the quantity of the vegetation particularly around their immediate environs. About 93% of interviewed farmers asserted that the number of trees within 50 metres from their homes has decreased. According to them, they have witnessed two or more trees dying within this buffer, and in most cases they are not replaced either by tree planting or natural growth. One of the farmers said, "*I had three dawadawa (Pakia biglobosa) trees on my land which provided shade for me and my household and I also harvested the fruits for food and the seeds for preparing seasoning*

ingredients (dawadawa) for cooking, but now all these trees are gone". It was further revealed that roofs of homes are more frequently ripped-offby storms in recent times than in the past because the trees that served as wind breaks are no more. This relates to findings of Reed et al (2008) and Stringer and Reed (2007), where land degradation was inferred from a decrease in vegetative cover and a decline in the 'umbidvo' vegetable.

Scarcity of firewood was another indicator used to conclude that the plant population is decreasing. Women now spent more time searching for firewood than 20 years ago. Increasing distance to firewood locations and a decreased abundance of firewood and timber (*Acacia davyi, A robusta, A. Gerrardii and A. Karroo*) were also considered as indicators of land degradation (Reed et al, 2008; Stringer and Reed, 2007). Farmers added that the quantity and quality of firewood obtained currently is low compared to two decades ago. Certain tree species, particularly those of economic and medicinal value, were getting scarce. They include the Shea nut (*Butyrospermum parkii*), Dawadawa (*Parkiabiglobosa*), Ebony, Blackberry (*Vitex doniana*), Baobab (*Adansonia digitata*), Fig (*Ficus species*), *Acacia species*, Siis, Kunkpera, Neleg. Puopinlenga and Gbere trees (underlined names are in the local language). According to Reed et al (2008) and Dejene (1997), the reduction in the abundance of the following floristic species served as indicators of land degradation: *Oxygonum stuhlmanii, Tagetes minuta, Ximenia spp., Cenchrus ciliaris, Acacia hebeclada, and Cleome gynandra, Dichrostachys cinerea, Sporobolus fimbriatus, and Acacia tortilis*. Similarly, a reduction in medicinal plants in Botswana was also cited as an indicator of land degradation (Stringer and Reed, 2007).

Degradation of vegetation also affects the variety, quantity and quality of grassland. Scarcity of grasses for roofing and grazing was considered as a sign of grassland degradation by the local people. Farmers indicated that thatch grasses were easily and freely obtained from their surroundings but

now they have to travel several kilometres to obtain them. The quantity obtained is less than what they could get 20 years ago due to one or a combination of the following factors: increase in distance to location of thatch grasses, bush burning, overgrazing, extension of farmlands and drought. During focus group discussions, one of the respondents said, "*because of scarcity of thatch grasses, they are becoming expensive and virtually, there is no difference in terms of cost between using thatch and roofing sheets for roofing. So, many people are shifting to the use of roofing sheets*". Some of the grass species which were becoming extinct include Mokpam, Sabiraug, Saad, Chemok, Moor Zieg (all in local language) and Vertiva Pitima. These are important grasses for roofing and grazing. Farmers said the scarcity of these plant species, particularly those used for thatch, has forced them to use grasses that were regarded as inferior for roofing, a situation which affects the quality of roofs. Sometimes the thatch is bought from outside their localities, from areas such as the Northern Region and Burkina Faso. These findings are at variance with those of Reed et al, (2008), who observed a negative correlation between the abundance of the thatching grass E. Pallens and distance from village of pastoralist.

The quantity and quality of pasture have also reduced and this serves as an indicator (e.g. Dembélé, 2006; Dejene, 1997). Farmers said their animals are not able to get enough feed because most of the grazing lands have been converted to farms and invaded by unpalatable grass, hence animals (sheep, cattle) have to trek for pasture daily. According to the farmers, these unpalatable grasses are spreading quickly and are a source of worry to them because their animals are left with no option than to feed on the unpalatable grass which sometimes results in deaths. The following were the views of a farmer to buttress the point of livestock reduction: "*In those good days, one household's cattle could form a long queue but because of deaths and poor growth resulting largely from lack of pasture, they had to sell them so you can*

hardly count 10 cows per household now".Decline in livestock condition (weight loss), less milk and increasing livestock mortality were some of the consequences of the invasion of unpalatable grasses in the range land of Botswana and Mali (Stringer and Reed 2007; Dembélé, 2006). Some of these weeds in the Bawku East Municipality, according to farmers, are difficult to control and retard the growth of crops. An example of such notorious weeds mentioned by farmers is *striga species*. The invasion of unpalatable grasses (e.g. *Striga asiatica and acacia mellifera*) was reported to be a major constraint to farming and cattle rearing (e.g. Dejene et al, 1997). *Striga asiatica, Xanthium Strumarium, Schmidtia pappophoroides, Eragrostis lehmanniana and Acacia mellifera* were found to be increasing in abundance in degraded arable lands in Swaziland and Botswana (Stringer and Reed, 2007; Reed et al, 2008). Dembélé (2006) also reported a reduction of some palatable species such as Tiekala (*Cympopogon gyganteus*), Tomono (*Ziziphus mauritania*) and Kaye (*Andropogon gayanus*) and the appearance of some unpalatable species such as fogofogo (*Calotropis procera*), *Prosopis procera and Acacia tortilis* as signals of land degradation among the agro-pastoralists in Nara, Mali.

Causes of Land Degradation

The causes of degradation of the land are identified under the following thematic areas; climatic variability, agricultural activities and institutional factors.

Climate variability

Generally, farmers are aware that their environment is becoming drier. "Drought causes deforestation since it reduces crop production and plant regeneration" (Dembélé, 2006, p.18), (Fig.1). From questionnaire survey, about 52% of respondents stated that the number of rainy months has reduced from about 8 to 4 months (Table 4).

Table 4: Number of rainy months as indicated by farmers

No. of Months	No. of Respondents	Percent	Cumulative Percent
3 months	42	28	28
4 months	78	52	80
5 months	24	16	96
6 months	6	4	100
Total	150	100	

Source: Fieldwork, 2007

Table 5: Average Monthly Summary of Observations (1990 – 2000)

LONG-TERM MEAN VALUES FOR SELECTED ELEMENTS												
Element	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum temperature	35.2	37.6	38.9	38.2	36.0	33.0	31.2	30.4	31.2	34.2	36.2	35.1
Minimum temperature	19.5	22.0	25.0	26.1	25.1	23.3	22.6	22.3	22.1	22.2	20.1	19.0
Mean temperature	27.3	29.8	32.0	32.1	30.5	28.2	26.9	26.3	26.7	28.2	28.1	27.0
Total rainfall (mm)	1.0	3.7	18.3	57.4	90.9	125.2	193.9	265.5	173.6	48.4	4.8	3.4
Number of Rain days	0.1	0.3	1.8	4.5	7.6	10.0	13.2	17.4	14.0	6.1	0.7	0.3

Source: Station 04003NAV Navarongo Meteorological Station.

Another 28% indicated that it has reduced to 3 months. According to respondents, planting used to start in March, but now they plant towards the end of May or June. The perception of farmers corroborated average climatic values from the Meteorological Services Department of Ghana (Table 5).

Rainfall data show that rainy months are from June to September with total average rainfall values between 120 and 270 mm and it is within this period that there are more than ten days on the average with rain. The study affirms the perception of pastoralists in Nara (Mali) that the lack of rains is aggravating the severity of land degradation (Dembélé, 2006). Similarly, adverse climatic conditions (unreliable and inadequate rainfall) were listed as one of the causes of environmental degradation and poor agricultural production in Northern Ghana (Bugri, 2008). Local people also recognised that temperatures in recent times have been on the rise. As shown in Table 5, maximum temperatures are high, above 30°C with the highest, 39°C, occurring in March. These adverse climatic conditions affect agricultural productivity.

Agricultural Activities

Continuous cropping without nutrient replacement was identified by farmers as the major cause of soil fertility decline. They said because the land is cropped every year, the nutrients in the soil are used up and therefore the soil can no longer provide nutrients for the crops. Low fertility has the effect of reducing crop productivity which implies low income for the farmers, thus perpetuating poverty as illustrated in fig. 1. Population growth and the consequent increase in demand for homesteads, continuous cultivation and farm expansion to feed the growing population, deforestation from timber harvesting for the building industry and firewood fetching have been outlined as the causes of land degradation (e.g. Stringer and Reed, 2007; Dembélé, 2006; Olson, 1994; Bugri, 2008; Fig.1). Fires, which are often used to reduce the incidence of livestock diseases, clear land for farming and for the early growth of pasture for grazing, can destroy vegetative cover and soil organic matter; lower the diversity of soil fauna and increase erosion (e.g. Dembélé, 2006; Dejene et al, 1997; Bugri, 2008). Extension of farms into

virgin lands was also seen as one of the causes of land degradation. Farmers indicated that much of the bush is being cleared for farming.

Secondly, soil erosion was also negatively impacting on soil fertility as the rich top soils are removed due to the exposure of the land for more than half of the year. Farmers said bushfires were the number one factor that exposes the soil to erosion (e.g. Dejene et al, 1997). Other factors that expose the soil were overgrazing (e.g. Dejene et al, 1997), sand winning, land clearing or the 'gather and burn' practice of land preparation (Table 6) (e.g. Dejene et al, 1997) and over harvesting of farm residue. According to Illius and O' Connor (1999, 2000; quoted by Reeds et al, 2008), livestock can induce vegetation degradation in a dry land environment through overgrazing. "Villagers see livestock as a sign of wealth, and would like to maximise their herd size for their own social, cultural and economic reasons and this perception tends to encourage overgrazing and land degradation" (Dejene et al, 1997, p.ix).

Table 6: Causes of vegetation degradation as seen by farmers

Causes	No. of Respondents	Percent	Cumulative Percent
Bush fires	51	34.0	34.0
Extension of farms	44	29.0	63.3
Firewood Fetching	24	16.0	79.3
Overgrazing	13	8.7	88.0
Low rainfall	13	8.7	96.7
Low soil fertility	4	2.7	99.0
Can't tell	1	0.6	100
Total	150	100	

Source: Fieldwork, 2007

Institutional Factors

From the in-depth interviews held with stakeholders on land use and management, institutional barriers were identified as another cause of land degradation in the Municipality. Poor coordination between farmers, traditional/local authorities and NGOs was seen as a major barrier to land management in the area. Reasons assigned for the lack of coordination were conflict of interest (in terms of control and use of land or projects)among stakeholders, especially regarding resource use and control, the seemingly entrenched stance of some traditional or local authorities on issues relating to land and its use, and the difficulty in convening meetings of all stakeholders to identify priority projects to be undertaken. The lack of coordination among stakeholders (farmers, traditional authorities, governmental agencies, NGOs, etc) sometimes results in duplication of projects in some areas whereas other places receive little or no attention at all. It has also resulted in the design and implementation of plans that are not in conformity with the land policy and that therefore fail to properly address the issue of land degradation. The general feeling among stakeholders was that it has become very difficult to bring all of them together to develop a common action plan towards sustainable development.

The ineffective implementation of policies has also exacerbated land degradation in the area. Policies on land (e.g. agriculture, forestry, biodiversity, bushfires etc) have not been effectively implemented. Reasons given for the ineffective execution of these polices include the lack of funds and other logistics and the failure to enforce environmental laws. An example given was the inability of the Assembly to prosecute contractors who fail to reclaim pits after winning sand for construction. Another instance of policy failure was the inability of the Ghana Land Policy to give legal backing and resources to the Environmental Protection Agency (EPA-Ghana) which is mandated to coordinate the activities of other players.

One other major barrier that was mentioned by the people and institutions is

the inability of stakeholders to share data. These institutions (the Ghana Statistical Service, the Lands Commission, the Forestry Commission, etc.) are mandated to collect specific data sets. These agencies shelve their data and are often reluctant to give them out even for a fee. Data sharing is necessary because it may not be possible for one institution to collect all the data it will need to plan its activities and therefore it will have to acquire such information from other institutions.

Furthermore, the lack of consultation between local communities, NGOs and Governmental Agencies who undertake developmental projects is hindering sustainable land management in the Bawku East Municipality. This situation often results in a top-down approach to planning. For example, experts/authorities design plans with the scientific knowledge available and then take them to the people for implementation, a process which usually leads to improper implementation or to the failure of some developmental projects. Also, a top-down approach may result in the location of projects at sites that may not be convenient or beneficial to the inhabitants. The household survey found that most projects which did not involve the local people at certain levels of planning failed. Ninety-two percent of the interviewed farmers held the view that their knowledge is very relevant to any intervention exercise and therefore should be sought before any plan is implemented, whereas 8% held a contrary view. Those who saw the relevance of local participation in land management stated that local people should not only be viewed as a labour pool for conservation projects but as people whose experience in the area as land users has given them enough knowledge to share. Respondents in group discussions mentioned that if assisted with what is available in the scientific domain, for instance, soil analysis and an inventory on vegetation, they could rank the indicators of degradation and therefore prioritise to mitigate the problem. This observation by farmers is consistent with an existing collaboration between

scientists in Latin America and the Caribbean-LAC (Honduras, Nicaragua, Colombia, Peru, Venezuela, Dominican Republic), and Eastern Africa (Uganda, Tanzania, Kenya, Ethiopia) for the empowerment of local communities to develop a local soil quality monitoring and decision-making system for better management of soil resources (Barrios et al, 2006). The initiative was found to be effective in the identification and classification of soil quality indicators and possible soil management options.

Besides the above problems, residents also indicated the complexity of some intervention measures as a cause of their failure. They said some conservation measures are so complex that they do not understand exactly how to go about their implementation. This arises due to lack of consultation with the community in enacting the policies. This point is consistent with the view of Rogers (1995, quoted by Reed and Dougill, 2009; Reed et al, 2006), that innovations which are difficult to understand and implement are less likely to be adopted than technically simple innovations, although the scientifically rigorous indicators used in the top-down paradigm may be quite objective, they may also be difficult for local people to use. It was reiterated that some of these measures require financial investment which they do not have, and therefore they are unable to implement them. This buttresses Dejene et al's (1997) findings that the poor face financial and socio-economic constraints which seriously impede management practices and innovations. This lowers the productivity and income of the poor and reinforces the "vicious cycle" of poverty and natural resource degradation. This means that if land degradation is to be managed sustainably, then the communities need to be involved in the planning process and resourced to implement projects introduced by authorities.

Environmental and Socio-economic effects of Land Degradation

Land degradation in the Bawku East Municipality has diverse effects on individual farmers, the community and the environment. The effects include loss in soil fertility, siltation of water bodies, low agricultural productivity, famine, mal-nutrition and poverty (Fig.1). Soil erosion results in siltation of rivers and loss in soil fertility. Erosion washes away the top fertile soil and organic matter, making the upland soil less fertile. These eroded materials are deposited at the base of uplands and, in most cases, such materials are unproductive. Also, farmers in the valleys loseparts of their lands because of the depositing of coarse sand from uplands. Sediments are also entrained to water bodies, silting them up. Questionnaire survey analysis showed that 43.3% of farmers saw erosion as having a negative impact on the land (Table 7). In Kolmasug (Fig.2), the people said the town was named after a pond but this water body has dried up due to siltation, a reduction in rainfall amounts and an increase in evaporation. This has affected their domestic water supply as well as water for dry season gardening.

Table 7: Effects of Soil Erosion

Effects	No. of Respondents	Percent	Cumulative Percent
Silting/drying up of water bodies	83	55.4	55.4
Making fertile land unproductive	65	43.3	98.7
Increase the fertility of the land.	2	1.3	100
Total	**150**	**100**	

Source: Fieldwork, 2007

Both water and wind erosion prevail in the area but water erosion is more pronounced than wind erosion because of the high intensity of the early rains which occur at a time that the entire land is virtually bare. Soil erosion causes soil loss, with socio-economic and environmental consequences which vary among the soil types and communities. The major effect is a reduction in soil depth which poses a serious challenge to crop production. As soils are carried away, the nutrients associated with them are also carried away, resulting in a reduction in soil fertility which will impact negatively on crop yield. As shown in Table (2), about 73 percent of farmers attributed the low crop yield to a loss in soil fertility. These farmers argued that even years of good rains in recent times do not give them good crop yield as it pertained 20 years ago. The farmers' assertion corroborated studies conducted in the area by Senayah (1994); Nye and Stephens (1962); Adu (1969); Boateng and Ayamga (1992); and Asiamah et al (1996) which show a declining trend in soil fertility.

The low crop yield has affected farmers' income and food security. Most farmers said they could not meet their food requirements, especially in the lean season. Some said they eat twice a day while others eat once a day during this time of the year. This has nutritional implications, especially for pregnant women and children. Low productivity has also affected the farmers' income since agriculture is their main economic activity. These findings are consistent with those of Dembélé (2006) in Mali, where low agricultural productivity, famine, mal-nutrition and poverty were enumerated as impacts of land degradation (Fig.1). It has also been noted by Dejene et al (1997) that loss in soil productivity leads to reduced farm income and food insecurity, particularly among the rural poor. The economic hardship is compelling the local people in the study area to migrate to the southern sector of the country for alternative livelihoods (Fig. 1).

Vegetation degradation has a negative impact on the livelihoods of the people and livestock (e.g., Dembélé 2006). According to farmers, it had led to a

scarcity of wood products, thatch grass and pasture for animals and a loss in biodiversity. As a result of the scarcity of firewood, there is an increasing usage of farm residue and cow dung for domestic energy as reported by more than 70% of the people interviewed. In fact, the majority of farmers said millet stalks have become their main source of energy for cooking rather than firewood because the latter is scarce. Some even mentioned cow dung as becoming a major source of domestic energy. Reasons given for the shift to stalks and cow dung were cost and availability. While 54% said they use stalks because they are less expensive, about 41% attributed their shift to stalks to availability. The use of farm residue as fuel wood reduces the amount of organic matter to be decomposed as humus to enrich the soil. According to Dejene et al, (1997), crop residue and manure, which were once a major source of enriching soil fertility, are being used as fodder and fuel wood and this considerable nutrient loss is reflected in the widening gap between the actual and potential yield for all the major food crops in Sub-Saharan Africa (SSA). Vegetation degradation also causes the reduction in quality and quantity of grass for thatch and grazing. Grass species are replaced by unwanted or unpalatable ones, a trend which affects farming, animal grazing and building. This makes residents use for roofing inferior grass species which are susceptible to leaking during the rainy season. The people said their animals have also lost weight because they do not get enough feed and some are starved to death during the dry season because of lack of good and enough pasture.

Coping Strategies

From the preceding discussion, it is clear that land degradation poses a serious threat to the livelihoods of the people of the locality. However, the people have adapted to the adverse effects of degradation in the environment by means of certain strategies. The adaptation strategies mentioned by farmers include the application of chemical fertilisers and organic manure,

diversification of crops, planting of early maturing/drought tolerant crops, dry season gardening/irrigation, mixed cropping and integration of animals with crops, among others.

The traditional system of leaving economic and medicinal plants on farms to grow was seen as an adaptation to minimise vegetative loss in the area. Trees left on farms are not cut down but only pruned from time to time. Other trees that are not of economic value but provide shade for farmers are also left on farms. This system of leaving trees on farms, which may be called agro-forestry, is seen as a good practice to combat desertification. Similarly, the people preserve certain places which are considered sacred. These sacred groves are hedged by uncultivated land stretching for some distance, where farming or logging activities are prohibited. Women are also not allowed to pick wood from the groves as firewood.

Farmers adapt to drought through irrigation and dry season gardening. The Government of Ghana, through the Agricultural Sub-Sector Services Improvement Project (AgSSIP) and some other NGOs, has constructed small dams and hand dug wells to harvest water for small scale irrigation and also to serve as source of water for animals, particularly in the dry season. These water bodies are used mostly for production of vegetables such as onions, pepper, tomatoes, okra, 'alefu', local jute, and fruits such as water melon, mango, etc. In villages where dams are not yet constructed, hand dug wells are used for dry season gardening as in Fig.6.

Though some of these adaptive strategies were their own initiatives, most were introduced to farmers by scientific experts through the agricultural extension agents and some NGOs in the communities. They however indicated that those measures that demanded more resources (i.e., that were capital intensive) could not be adopted by them because they lacked the means.

Fig.6: Dry season gardening at Gban Teraugo (Yiran, 2007).

To improve soil fertility and crop yield, farmers apply chemical fertilizers (e.g. Dejene et al, 1997) to their crops, but due to financial constraints most farmers are unable to afford the required amount of fertilizers for their farms. To complement this, farmers often collect animal droppings from kraals and pens and spread them on compound farms as organic manure to improve soil fertility. Farmers practice the mixed/inter cropping system of planting which involves planting many crops on the same piece of land. For example, a combination of two or more of the following crops and cowpeas could be planted together on the same piece of land: early millet, late millet and sorghum (Kadaga and Local 29). These crops are harvested at different times of the season, thus ensuring food security. Newly introduced crops by the Ministry of Food and Agriculture like soya beans, some varieties of the millet and sorghum (global 2000 and Naga white) take less time to mature, thus reducing the effects of erratic rainfalls. Drought resistant and early maturing crops (3 months) are sometimes introduced to agro-pastoralists (e.g. Dembélé, 2006).

Conclusion

The study showed that farmers perceived a degradation in their physical environment, particularly in soil and vegetation. The changes observed include soil erosion, loss in soil fertility and deforestation. The underlying forces for these changes are the increasing human and animal population; rising temperatures; and unreliable and declining rainfalls resulting in widespread environmental and socio-economic problems such as bushfires, overgrazing, fuel wood fetching, land clearance for farming, food insecurity, low levels of income and drought. Institutional barriers such as poor coordination, ineffective implementation of policies, lack of data sharing and lack of consultation amongst stakeholders are also militating against sustainable land use planning in the Municipality.

The effects of land degradation are diverse and include scarcity of wood products for building and domestic energy supply, less pasture for animals and low crop yield which is increasing poverty and hunger amongst the local people. The coping strategies regarding this environmental challenge include the application of fertilizers, planting of early maturing/drought tolerant crops, dry season gardening/irrigation and mixed cropping.

The study showed that sustainable land use management in the community requires the involvement of the local people at both the drafting and implementation stages of policies as these farmers possess rich knowledge about their physical environment that could be tapped to enhance policy formulation and implementation.

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