ECOLOGICAL STUDIES OF THE FLORA OF AFRAM EAST HEADWATERS FOREST RESERVE

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DECLARATION

I do hereby declare that this submission is my own work towards the award of MSc Environmental Science degree and that, to the best of my knowledge, it contains no materials previously published by another person nor material which has been accepted for the award of any other degree of the university, except where due acknowledgement has been made in the text.

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ABSTRACT

Ecological studies of the flora of Afram East Headwaters forest reserve was conducted from August, 2010 to July, 2011. Two sampling sites including Forest Reserve and Farmland were selected for the study. Plant species diversity and distribution in each of the sites were studied using random sampling technique. The different life forms, namely, Trees, Shrubs, Herbs and Climbers were sampled using the 25m x 25m quadrats. Household surveys using structured questionnaire were carried out to elicit information on the effect of activities of the fringe communities on the Forest Reserve. From the results, a total of 102 species in 90 genera belonging to 33 families were documented in the study area. The Forest Reserve recorded a higher species diversity (Shannon index = 1.333) than the farmland (Shannon index = 0.764). The species distribution patterns per site were as follows; farmland (aggregated = 42 and random = 24) and Forest Reserve (aggregated = 21 and random = 47). The dominant life form was tree species though most of them were in the seedlings and saplings stages. These were followed by climbers, herbs and shrubs (i.e. 47.06%, 19.85%, 19.12% and 13.97%) respectively. The study found out that farming was the major occupation of the people with slash and burn land preparation as the most common method practiced in the area. Food crops grown include cassava, maize, plantain and other vegetables. Illegal logging and the exploitation of other plant materials for shelter are the major threats to the Forest Reserve. Environmental problems in the area included deforestation, bushfires and soil erosion. The study shows that the fringe communities are not fully involved in the management of the forest reserve.

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DEDICATION

This work is dedicated to my father, Isaac Gerru Abu and my mother, Beatrice Naane-a Abu, all of blessed memory. It is also dedicated to my wife, Regina and my lovely son, Bede Fube-mwine Abu.

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INTRODUCTION

1.0 The Forest as a Life - Support Ecosystem

As the world population increases and millions demand a higher standard of living the problems of resource use takes on added importance. We are managing our environment as never before in history, and if we are to manage it wisely we must do so based on a sound foundation of ecological knowledge.

In this era of space travel, ecological studies have continued to gain relevance as the science of the "Spaceship Earth". In this context, it can be said to have a mission, which is to understand the complex network of the life-support systems that keep biospheric processes operating in a way suitable for sustaining living organisms and their environment (Odum and Sarmento, 1997).

The natural forest is one of the most important ecosystems for the well being of mankind and many other life forms. It provides products such as timber, fodder, fuel-wood, fruits and medicines. It is a refuge for a large variety of wildlife (Hawthorne, 1994). Forest ecosystems also play key roles in the regulation of climate, radiant energy flows, hydrological cycles (it protects watersheds that supply freshwater for the sustenance of terrestrial life), soil nutrient re- cycling, soil erosion and sedimentation processes and natural hazard (e.g. landslides and storms) mitigation (Verweij, 2002). Specifically, the forest; Protects the soil against direct impact of rainfall to prevent erosion. It also Enhances infiltration so that the water table is replenished. Regulates stream flows so as to reduce peak flows and flooding during the rainy season and ensures dry period flows and Shelters agricultural crops from drying winds.

In the light of the roles mentioned above the loss of the forest cover has serious environmental and socio-economic implications (FAO, 1990). In addition to the environmental services, tropical forests supply products and support livelihood for millions of people. According to Kerkow (2003), about 240 million people in the tropics around the world live in or close to forests. In many cases these people are among the poorest and usually run a subsistence economy. They therefore fall back on products of the forest, especially during war, economic crises or drought when there is food shortage or no safe access to markets. Human life – support activities such as mentioned above do, as a matter of fact, impact negatively on tropical forest cover as in the Afram East Headwaters Forest Reserve.

1.1 Loss of Forest Cover

About 12 million hectares of rain forest are lost worldwide every year (Kerkow, 2003) due to human activities especially unsustainable farming practices, wild fire and unsustainable logging. A World Bank report estimated that by 1988 Ghana was losing her forest at the rate of 750Km^2 annually (Upton, 2001). The world's forest is under increasing pressure from population pressure, timber exploitation, wildfires, infrastructural development, cattle ranching and arable farming. Much destruction of the forests, often quite unnecessary, has accompanied the spread of what is called civilization throughout the world (Douglas and de Hart, 1985). Typical instances of such past folly caused the barren hillside of Greece, the degradation of Southern Italy, the arid waste of Spain and the ruins of the Scottish highlands. Following a similar trend, the dry forest zone of West and Central Africa is rapidly becoming grassland. This is believed to be accelerating the expansion of the Sahara (Douglas and de Hart, 1985).

According to Douglas and de Hart (1985), the well known forester, Richard St. Barbe Baker, who founded the "Men of the trees Society" in 1922, stated that for minimum safety, a country should have about 30% of its surface under tree cover. In many countries tree cover is well below this figure: For instance, Great Britain has 6.5% (Douglas and de Hart, 1985). Ghana in 1992 is estimated to have had only 7% of the total land area intact as closed forest (Upton, 2001), while several countries in the drier part of Africa even have much lower tree density per hectare.

It is a truism that the country's biodiversity is threatened as the physical environment gets degraded. It is estimated that Ghana loses between 20,000 and 25,000 hectares of her forest annually (Biodiversity Strategy and Action Plan, 1999). Anytime a portion of the forest is lost, a habitat for various species of animals and plants get destroyed. At the same time, a few species, including rare, endemic and already threatened ones, also perish and die out.

It is in the light of this that, this research was conducted to ascertain the plant resource distribution in the study area and again assess the effect of human activity on plant diversity in the area.

1.2 Implications of Forest Loss

1.2.1 Physical implications

The impact of forest loss is widespread, affecting the livelihoods of local people, disrupting important environmental functions and severely disturbing the biological integrity of the original forest ecosystem. According to Platais (2002), the hydrological services provided by forests, such as clean and regulated water flow, and reduced sedimentation, for example, are only noted when natural disasters such as flooding, siltation of reservoirs and scarcity of water occur as a result of the removal of forest cover. The rapid exploitation of tropical forests is known to affect the water balance components, namely runoff, rainfall, evapo-transpiration etc., (Reynolds and Thompson, 1988). According to Kunkle (1974), forest activities can often be undertaken in an environmentally sound manner provided operations are designed to protect water bodies. Thus, the role of the forester in the protection of the aquatic environment and water supplies is crucial. This implies that water systems depend on whatever activities take place on land part of which is forest.

The presence of forest cover in catchment areas slows down rates of run-off (Covich, 1988) reduces siltation and improves water quality (Kunkle, 1974). In the major river systems in Ghana several thousand hectares of forest lands have been reserved to provide a protective cover to ensure permanent flows and quality of these river systems. Lists of such reserved forest are shown in table 1.

Table 1: List of some forest reserves with corresponding river system

Forest Reserve (F/R)	River System(s)	Area (Km^2)	Region
Attandansu/ Kakum Resource Reserve	Kakum River	153.59	Central
Yenku F/R	Yenku River	21.24	Central
Sapawaso F/R	Sapawaso River/Volta Dam	15.31	Eastern
Atiwa Range F/R	Densu River	232.32	Eastern
Atiwa Range F/R	Birim River	232.32	Eastern
Southern Scarp F/R	Pra River	154.62	Eastern
Boti F/R	Pompom River/Boti Falls	1.30	Eastern
Tano-Offin F/R	Offin River	402.23	Ashanti
Bosomtwe Range F/R	Lake Bosomtwe	78.70	Ashanti
Afram Headwaters F/R	Afram River	201.24	Ashanti
Oda River F/R	River Oda	164.20	Ashanti
Bosomkese F/R	Tano River	138.31	Brong Ahafo
Goa Shelterbelt F/R	Goa River	23.83	Brong Ahafo
Daka F/R	Daka River	145.66	Northern
Draw River F/R	River Draw	235.43	Western
Subri F/R	River Pra	587.93	Western
Asukwakwa F/R	Asukwakwa	116.03	Volta

Source: Forest Information Systems Unit, Resource Management Support Centre, Kumasi.

1.2.2 Socio-economic implications

Deforestation causes water tables to fall and consequently leads to water shortage, compelling rural women and children to travel long distances in search of water (Barlertey, 1997). According to Allen and Barnes (1985), rural people in most deforested regions spend a lot of time travelling long distances (up to 10km from their homes) for fuel- wood. In addition to water shortage, the destruction of the forest seriously affects other socio-economic activities of the rural poor. For instance sources of wild fruits and fodder and important medicinal plants are also destroyed or lost completely (Muthoo, 2002). Consequently rural incomes derived from the sale of Non-Timber Forest Products (NTFP) are reduced and quality of life is greatly affected (Barlertey, 1997). When water quality is degraded due to forest loss, the health of humans and livestock are threatened. Lack of perennial water supply puts enormous pressure on the rural population to migrate to watersheds in search of arable land.

One approach to the restoration of water supply is forest reservation and reforestation. Such schemes/projects are attempts to protect or restore forest cover thereby increasing water supplies for irrigation, domestic and industrial use and lessening the burden on both the rural and the urban folks, especially in the driest months of the year. It is evident that man must cease to regard water resources as an inexhaustible gift of nature. Our water resources can best be preserved only if used with the greatest care and if proper attention is paid to forest conservation (Barlertey, 1997).

1.3 Watershed Management

Natural vegetation cover in the water catchment areas helps maintain hydrological cycle, recharges underground water table, stabilizes water run-off and acts as a buffer against extreme events of flood and drought. Changes in the forest cover can have a considerable effect over a whole watershed with time. According to Kunkle (1974), any vegetation removal results in siltation of catchment water ways, loss of water yield, degradation of aquatic habitat etc.

There is growing evidence that undisturbed forest helps maintain rainfall in its immediate vicinity and moderate local climate. Forest management contributes to and has a continual influence on the hydrological regime of whole drainage basin. The Forester is therefore the primary manager of water supplies throughout his area and for great distances downstream, places that he may never visit or that may even be beyond the political frontiers of his country (Kunkle, 1974). Larson and Albertin (1984), recommended reforestation to reserve a threefold increase in sedimentation in the Alhajuela reservoir in Panama following the clearing of 18.2% of watershed.

The loss of forest cover and conversion to other land uses can adversely affect freshwater supplies and compound human disasters. Kunkle (1974) opined that since man's freshwater flows initially from forest; any careless timber harvesting practice can lead to severe sediment problems and these have far-reaching implications or great costs to communities.

Since the earliest times man has maintained a love-hate relationship with his greatest natural benefactor, the forest. He has from time to time indulged in orgies of destruction of the original forest leading to erosion, desiccation of the soil, creation of desert conditions and even the disappearance of whole civilization (Douglas and de Hart, 1985). One of the most serious problems facing many countries, including Ghana is the inefficient management and conservation (irrational use) of forest resources.

In Ghana, forests along the banks of many rivers (e.g., Afram, Ankobra, Densu, Kakum, Offin, and Tano) have been destroyed through several land use practices which have negatively affected water supply and water quality. The last two decades have seen years of significant decline in stream flow of these rivers affecting the domestic water supply of many cities and towns drawing water from these river sources (Barlertey, 1997). Log extraction has consistently been undertaken in the Afram Headwaters forest reserve and within the off-reserves along the Offin watercourse. Loggers are expected according to logging regulations to maintain a prescribed stretch of unlogged land as buffer. Despite these regulatory measures, rivers/streams have become irregular in flow. It appears logging is not being conducted according to the standard practice. Consequently the livelihood of the riverine communities may depend on the need to understand the effects of forest removal on river flow, water quality, etc. in order to develop appropriate prescriptions for sustainable and environmentally responsible logging.

Development in any form must be in harmony with the natural environment. It is therefore pertinent that periodic studies are carried out to monitor and review the ecological status of our forest areas to ensure ecologically sustainable development.

Objectives of the Study

In line with the above general objective, this study is conducted to;

i. Assess floral diversity and their distribution in the Afram Headwaters Forest Reserve.

ii. Identify the effects of human activity on the flora of the Study area.

It is hoped that the outcome of this study would provide a priceless early warning system to the appropriate authority to deal with environmental threats to our forest areas before they become catastrophic thereby helping to avoid or minimize potential conflicts between conservation and development and make the forest a haven both for wildlife and humans.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Complexity of the Tropical High Forests

The tropical high forest consists of a mass of luxuriant vegetation and rich diversity of living species, which represent an ecosystem that is unrivalled on earth. It provides not just a magnificent spectacle and a sanctuary for an incredible array of plants and wildlife (Hall and Swain, 1981) but the exuberance of plant life in the humid tropics continues to dazzle scientists from the more sober temperate biomes. Trees have a great diversity of form and size with uniquely tropical attributes of huge buttresses or trunk-borne flowers. Bamboos, Palms, cyclanths, pandans, stranglers and banyans add peculiar extra dimensions while some genera are distinguished in the forest by details of bole, bark, buttresses and leaf. Tropical rain forests are indeed fabulously rich in animal life. Just how many species the world's rain forests contain after many centuries of pioneering work is still a matter of rough conjecture (Whitmore, 1998). The tropical forest of Ghana is characterized by a rich and complex floristic composition. There are over 2,100 plant species, out of which 730 are tree species (Hall and Swain, 1981), 420 of these species are common and of wide distribution. Of the most common species 126 grow to timber size and 82 are currently considered merchantable timber species (FSD, 2001).

According to Whitmore (1998), it is estimated that in 1990 the total remaining area of the world's tropical forest was 1756 million ha, (86%). Within moist forests, lowland rain forest totaled 715million ha, with roughly three-fifth, one-fifth and one-quarter in America, Africa and Asia respectively.

2.2 Forest and Forest Soils

The forest floor of the high forest is especially vulnerable to damage when suddenly exposed. The forest offers protection to fragile soils against erosion and degradation by the torrential rainfall that sustains these very forests. Most of the roots are concentrated in the top 30 centimetres of the soil (Bruijnzeel and Proctor, 1993). The roots form a distinct superficial 'root mat' and damage to the soil by machinery causes disturbance to the root mat, and this in turn, impedes nutrient uptake by the trees and therefore their growth (Bruijnzeel and Proctor, 1993). The forest floor also constitutes the seed bank from which new trees are recruited and it takes little imagination to picture the consequences of soil disturbance for seedling survival. In the undisturbed forests, the litter on the surface plays a vital role in preventing splash erosion from the raindrops falling from the canopy. The ground vegetation in undisturbed tropical forests is rather sparse due to the low levels of light at the forest floor and removal of the forest expose the bare soil to the direct impact of the rain. The removal of forest cover increases overland flow, resulting in high surface erosion and loss of precious topsoil and nutrient (Bruijnzeel and Proctor, 1993).

2.3 Forest and Water Yield

The relationship among forests, atmospheric moisture and water yield has long been controversial. The natural coincidence of forest cover and higher precipitation is at least partly responsible for the popular notion that forest increase or attract rain, which leads to the assumption that their removal would significantly diminish precipitation (Lee, 1980). However, there are circumstances in which forest intercept fog or low clouds (cloud forests), which add moisture to sites that would have otherwise remained in the atmosphere (Lee, 1980). The quantity and quality of water available is always important for the day-to-day activities of man and life in general (Shaw, 1988). The table below shows the distribution of the world's water.

Table 2: Estimates of the world's water.

Water bodies	Volume ($10^4 Km^2$)	Percentage (%)	Rate of exchange (yrs)
Oceans	1370	94.2	3000
Groundwater	60	4.13	5000
Ice sheet & glaciers	24	1.65	8000
Surface water on land	0.28	0.01	7
Soil moisture	0.08	0.0055	1
Rivers	0.0012	0.00008	0.031
Atmospheric vapour	0.014	0.00096	0.027

Source: Hydrology in practice by Elizabeth M. Shaw (1988)

Man exercises some influences on the hydrological cycle through the way he uses land. Through arable and pastoral farming activities as well as lumbering, man may exert some influence on the local and often regional hydrological cycle. Thus, water supply may be affected. However, there is uncertainty of the hydrologic consequences of land use changes under tropical conditions, partly due to the fact that only very few field studies have been documented on the subject. In Ghana, the encroachment on watersheds by farming activities, overgrazing by livestock, felling of trees for timber, fuel wood and biomass burning is steadily increasing (UNEP, 199O). The Environmental Action Plan of 1991 also acknowledges that inappropriate land use may constitute a serious threat to water resources as well as serious land degradation inclusive of erosion (Bekoe, 1998).

Forests transpire a lot of water because of their deep rooting systems and the large transpiring surface area presented by the leaves. Trees are able to tap water at considerable depths especially during the dry season. However, soil water absorption and transpiration are necessary to ensure healthy tree growth. The presence of forest cover reduces direct evaporation from soil surfaces. When forest is cleared, there is reduction in evaporation and transpiration which may lead to a rise in the water table. This can cause problems in areas of saline groundwater as spring in such areas can destroy vegetation around (Bekoe, 1998). On the other hand, chemicals transported up the soil profile as a result of rise in water table could leach into streams and rivers, which might negatively affect their quality status. This results in high cost for water treatment for human use.

Forest clearance can also result in a drop in the water table because of decrease in infiltration. This makes the hydrological characteristics of forested catchment as well as hydrological consequences of replacing such forest with other land use rather complex. Therefore the benefits of forest cover, such as reduction in storm runoff and erosion must be weighed against its demerits such as high water use rate and reduction in total stream flow, which may constitute serious disadvantages in areas of water shortage (Bekoe, 1998).

According to Kunkle (1974), the greatest depth of precipitation usually falls on forested land because forests are often located at higher elevation, initially capturing and gradually releasing water to vast areas below. Also, forest cover is almost always the best and the most natural protection for streams because it maintains good water quality and stabilizes flow. Forests are thus the main source areas for man's supply of fresh water.

Cloud forests intercept atmospheric moisture (horizontal precipitation) that condenses on and drips from foliage, adding moisture to the soil. There are several examples of how fresh water is augmented by cloud forests. For instance according to Harr (1982) and Ingwersen (1985), the removal of old-growth conifer forests from the municipal watershed of Portland and Oregon, reduced summer stream flow, but the re-growth of vegetation caused stream flow levels to return to normal within five to ten years. However, water augmentation by tropical montane cloud forests varies with altitude, location and season (Bruijnzeel and Proctor, 1993). For instance the ratio of horizontal precipitation to annual rainfall has also been shown to vary between 4 to 85 per cent, with higher values corresponding to dry seasons, while average horizontal precipitation varied between 0.2 and 4mm per day. It is also reported that annual stream flow from tropical montane cloud forest for a given rainfall can be higher than that from other tropical forests (Bruijnzeel and Proctor, 1993).

With the exception of fog or tropical montane cloud forest regions, forests generally consume large quantities of water. More than 100 watershed experiments around the world have shown that forest removal increases stream flow, which varies in magnitude with climate and forest type and diminishes as forest regenerate (Bosch and Hewlett, 1982; Whitehead and Robinson, 1993; Bari *et al*., 1996; Lesch and Scott, 1997; Verry, Hornbeck and Todd, 2000). When other land uses replace forests, flow increases are sustained. With few exceptions, results show the following; Removal of forest cover increases annual water yield by 60 to 650 mm. The size of the increase is generally proportional to the amount of biomass removed and is greater in wetter areas. Also, Flow during dry seasons generally increases after forests are thinned or removed. Again Forests with high interception rates (e.g. conifers) or high transpiration rate (e.g. eucalyptus) yield less water than those with lower interception rate. Water yield would therefore be expected to increase when broadleaf forests replace conifer forests and to decrease when broadleaf, conifers replace shrubs or grasses. In Fiji, afforestation reduced water yield to a water supply reservoir and an afforestation on the leeward side of two of the largest Fiji islands with 60,000ha of *Pinus caribaea* reduced downstream dry season flows by 50 to 60 percent (Drysdale, 1981).

2.4 Effects of Forests on floods and sedimentation

Forests produce low levels of storm flow and greater soil stability than any other vegetation type because of their high infiltration rates, protective ground cover, high consumption of soil water and high tensile strength of roots. These attributes are beneficial in mountainous terrain that is subject to torrential rainfall. Forest removal and road construction are problematic in such areas because they increase the frequency and magnitude of landslides and debris flows (Sidle, 2000). According to Kunkle (1974), man's fresh water flows initially from forests, and water quality begins there. This explains why exceptionally high quality of water discharged from forested watersheds is the main reason why protected forests are preferred for municipal watersheds. Sedimentation is the most familiar form of water pollution and the eroded soil results in serious and costly damage downstream in terms of siltation of reservoirs and heavy loads which harm fish (Lee, 1980,) as well as added treated costs for municipal water supplies; damage to irrigation canals, bridges and other structures; siltation of river channels which raises flood level; aesthetic and biological damage to lakes; and a tendency for eroded lands to yield higher run off and lower dry season flows, which means that pollution will be more severe during low flows because of less dilution.

Careless timber harvesting practices can lead to severe sediment problems, but the forester is in a position to control most of these (Kunkle, 1974). For example, in one logging study, turbidity in the stream below a clear cut area reached 56 000 parts per million (ppm), compared to only 5 ppm in adjacent unlogged streams. This and other studies have shown that if logging is done in conjunction with suitable conservation measures, turbidity will remain almost as low as those for streams in undisturbed areas.

The necessary conservation measures include; leaving uncut strip along streams (i.e. buffers), selecting logging machinery which is less damaging to the soil, moderation of road gradients, usually to less than 10 percent and designing of road layouts and drainage installations to avoid the channeling of overland flow (Larson and Albertin, 1984).

Of course there are limits, and certain forest areas are simply too steep and erosive for such measures to be effective or economical, in which case logging is not advisable.

Bekoe (1998) and Kunkle (1974) opined that the harvesting of forests could also increase stream temperatures, if trees are cut along their banks. For example, in one research project logging was to raise stream temperatures more than 6^oC above normal, which exceeded acceptable levels for trout. However, when the stream bank vegetation was left intact stream thermal pollution did not occur.

According to Bruijnzeel and Proctor (1993) clear cutting of forests in some cases may add nutrients to streams, lakes and groundwater by disrupting the nutrient cycle in a forest ecosystem or by increasing surface run off and sediment inputs into streams. Research in north-western North America showed an increase in stream dissolved chemicals following experiments in clear cutting and slash-burning of Douglas fir forests. During the 12 days following the slash-burning, a stream below one experimental clear-cut showed a distinct increase in nutrient content, while an adjacent control stream was unaffected. For two years following the cutting and slash-burning, while re-growth occurred, the differences in nutrient content between the two streams decreased. It is important to note that cutting alone without burning, added less nutrients; for example the phosphorus in the stream did not increase and also the nutrient input was attached to sediment particles from erosion. Kunkle (1974) indicated that with careless forest cutting procedures, water pollution by nutrients may occur; some basins, because of inherent soil properties and other characteristics are more likely to release nutrients after cutting; and suitable stream protection measures during cutting including uncut strips along channels may avoid any significant problems. Hence, protective measures ought to be taken during logging.

Forests efficiently cycle nutrients and chemicals and decrease the sediment exported, thus reducing pollutants (FAO, 1990). Watersheds with healthy forests export the lowest levels of sediments of any cover type; consequently it is not surprising that forest are often looked upon as a means of reducing levels of downstream sediment in water supply (Brooks *et al*., 1991). Well-managed forested catchments above reservoirs can result in minimal requirements for water treatment (FAO, 1990). Echavarria and Lochman (1999) reported that US$ 1 billion spent on improved management at New

York City watersheds over ten years could save an outlay of US$4 billion to US$6 billion for construction of new water treatment facilities. Larson and Albertin (1984) recommended reforestation to reserve a threefold increase in sedimentation in the Alhajuela Reservoir in Panama following the clearing of 18.2 percent of the watershed. Few such studies exist, and people suggest that the benefits from forest cover in reservoir protection have been overestimated (Echavarria and Lochman, 1999). Reasons for such skepticism include; inadequate monitoring and therefore limited empirical evidence linking forest changes to reservoir sedimentation levels. Another reason is the fact that forest cover changes have occurred over such small areas of watershed that little effect has been observed and the recognition that the other factors, such as non-forest land use, can increase stream flow peaks and affects sedimentation.

Tabacchi (2000) and Rosgen (1994) reported that sediment levels of rivers are determined by both sediment availability and stream flow discharge. The most effective discharge for transporting sediments over time is that associated with the bank-full stage (when the river channel is full but not over flowing), usually corresponding approximately to the average annual peak flow. When land use increases the sizes of these flows, the stream channel becomes unstable and sediment levels increase, regardless of whether erosion rates have been reduced. Healthy riparian can also reduce sediment levels by filtering out soil erosion inputs to channels and by maintaining stable stream banks. Forest loss over both upland riparian forests can therefore combine to increase sediment delivery to reservoirs.

According to Davies (1997), extreme hydrological events are the result of natural processes of erosion and sediment motion interacting with human systems.

Where land scarcity concentrates people and their dwellings in hazardous areas, disasters will occur whether uplands are fully forested or not. For example in Taiwan where population density of about 600 inhabitant per square kilometer occurs on steep slopes in the mouth of small drainage basins and in floodplain, the areas are considered vulnerable to landslides. In such situations only integrated watershed management programme among government agencies can address this threat for both upstream and downstream communities (Lu *et al*., 2001).

2.5 Effects of deforestation on catchment land use

Change in land use can rapidly alter nutrient inputs to tributary drainages and associated downstream rivers, lakes and wetlands. Field experiments from temperate zone catchments demonstrate that after small storms, peak flows associated with erosion and nutrient losses and flooding of tributaries are increased after deforestation. Reforestation can increase water storage and slow down rates of runoff (Covich, 1988). In response to long-term large scale deforestation in many tropical areas, there are projects attempting to restore forest cover and thereby increase water supplies for irrigation and urban use, especially in the driest months of the year and to reduce flooding during the wettest months.

Deforestation is often associated with increased frequency and intensity of floods in tropical catchments, although interpretations of existing data sometimes vary greatly. The loss of forest cover leads to increase in soil erosion and sediment transport (river load) from intense rains with many attendant problems for aquatic organisms.

Erosion and siltation eliminate hard, stable substrata required by many bottom- dwelling fish species. Rapid rates of bank erosion, subsurface flows through ‘macro-pores’ (burrows, crevices, root-generated cavities), and overland flows can move large quantities of sediment and modify downstream habits. Even in undisturbed forested catchment, major storm event can cause landslides and stream bank erosion in steeply slope regions. Covich (1988) concluded that as managers seek to reduce flooding and soil erosion, to provide more water for irrigation and drinking, and to restore biotic diversity of forests, wetland, and stream, they face difficult decision regarding land use, especially in steeply sloped catchment areas. In many developing countries, the food and resource need of the rural poor, coupled with land scarcity and institutional limitation, constrain efforts to protect forested watersheds for municipal water supplies. However, the problems of polluted drinking water and associated diseases significantly jeopardize the welfare of rural population and urban communities alike. Water storage and transport facilities are surely needed in many areas along with improved sanitation and water (FAO, 1990).

2.5.1 Effects of Land Use on Biodiversity

The main threat (see table 3) to biological diversity in tropical forests in Ghana (Hawthrone, 1994) and all over the world (Stanners and Bourdeau, 1995) are increased incidence of annual wildfires and increased exploitation and clearing of forest for agriculture. For instance logging activities may result in the disappearance of some tree species thus reducing species diversity (Abdulhadi *et al*., 1981).

Plant and animal lives depend on the quantity and quality of water for their existence (Barlertey, 1997). Thus forest cover is desirable in catchments, especially in areas of high rainfall and rugged topography: because it reduces high flows and subsequently reduce floods. The forest does this by intercepting the precipitation and delaying the period of the raindrops from reaching the land surface that would otherwise have hit the land surface directly, consequently causing erosion and high run-off (Bekoe, 1998). This could be understood from variation between the forest regions where most streams are perennial and savannah vegetation where streams are seasonal. According to Kunkle (1974), forest cover is almost the best and most natural protection for stream because it maintains good water quality and stabilizes flow. Hence, forests are the main source areas for the supply of fresh water for living organisms.

Table 3: **Impact of land use on biodiversity**

Type of Activity	Impact on Biodiversity
Land use change; clearing, ploughing and drainage of land. Move away from traditional farming systems to intensive systems.	Loss of natural and semi-natural habitat; 80% of land area under agriculture uses extensive systems which maintain semi-natural habitats(dehesa,moor land, health land) being loss due to intensification or conversion to plantation forestry
Increased use of nitrates, pesticides	Eutrophication, pesticide recidues –loss of genetic biodiversity;
Introduction of high yielding varieties Exotic monocultures and Genetically Modified Organisms (GMOs)	Loss of genetic biodiversity;
Abstraction of water	Drying out of wetlands, desertification, soil erosion, saline intrusion, forest fires leading to loss or changes of landscape, habitats, species and genetic diversity
Increased stocking rates (overgrazing, methane emission contribute to climate change)	Desertification, soil erosion, forest fires leading to loss or changes of landscape, habitats, species and genetic diversity.

Source; EEA, 1995; 115

Forest buffers and agroforestry systems along water bodies improve water quality. Long neglected and often exploited, riparian forests helps to stabilize stream banks, reduce waste water and chemical discharge into water bodies from upland areas and maintain cooler water temperatures, thus improving dissolved oxygen levels in water (Brooks *et al*., 1981). The water quality can be enhanced for human consumption, leading to better health and productivity and greater diversity of aquatic ecosystems including mangrove forests. Consequently, healthy riparian forest increase fish production (FAO, 2003)

2.5.2 Land use and watershed

Dependable fresh water supplies and the ability to cope with the extremes of too little or too much water are requisites for sustainable human development. Warnings of fresh water scarcity issued at the end of the twentieth century (Falkenmark, 1989; Kundzewics, 1997; Vorosmarty *et al*., 2000) are proving to be accurate to the point that lack of water now threatens food security, livelihoods and human health (UN, 1992; IFPRI, 2001). Worldwide fresh water supports about 40 percent of all food-crop production via irrigation, support 12 percent of all fish consumed by humans and generates 20 percent of all electric power (Johnson *et al*., 2001). In addition to the direct impact of water scarcity its impaired quality endangers human health. The extensive loss of life and economic productivity result each year from rain-induced landslides. Floods and torrents in developed and developing countries alike are due to forest removal. Water and its management are therefore strategically important to economies and well being of people, and forest and water management have become major challenges of this century (Brooks *et al*., 1981).

Although land use and fresh water are inextricably linked, they are rarely managed in concert. Upstream use of land and water can affect downstream communities and their use of water. The health of downstream dweller is seriously impaired as a result of polluted water usage. The converse is also true. Such linkages are readily seen with a watershed perspective, but are not always fully taken into account when responses are being developed at the local, national and international levels (Kundzwewics, 1997). They concluded that as mountains or highlands form the headwaters for all major rivers of the world, many of which are or were at one time forested, these watersheds are a key to freshwater management. The exceptionally high quality of water discharged from forested watersheds is the main reason that protected forests are preferred (Lee, 1980; Kunkle, 1974). The relationship between forests and freshwater in both tropical and temperate regions, therefore needs to be understood if forests are to be managed to sustain the productivity of uplands without affecting humans and the soil and the water on which they depend. The loss of forest cover and conversion to other land uses can adversely affect freshwater supplies and compound human disasters resulting from hydro-meteorological extremes (Lee, 1980). According to Lee (1980), watershed conditions can be improved and overall water resource management facilitated if forests are managed with hydrological objectives in mind. While not a panacea for resolving water issues, forests can provide tangible economic and environmental benefits and a watershed framework helps identify these benefits in both upstream and downstream areas.

According to Lee (1980), forests are found where there are large quantities of water, normally where precipitation is abundant or in riparian areas where soil moisture is high.

Perception of the influence of forest on water led to the establishment of the national forest system in the United States, as forest cover was considered vital to sustain river flow. Lee (1980), concluded by summarizing the impact of forest on freshwater to include the following; strong influence on the quality of water yields from watersheds, discharge of the highest quality of water, discharge of lower storms flow peaks and volume for a given inputs of rainfalls, provision of the greatest soil stability and the lowest levels of soil mass movement, gully erosion and surface erosion and the export of the lowest levels of sediment downstream

2.6 Practices that reduce forest cover

Deforestation is the process of clearing forests for other land uses like agricultural farming and human settlements among others. It is a phenomenon that is on the increase in Ghana (Bekoe, 1998). Two main operations of cutting trees are employed. They are the chainsaw operator's methods and the mechanized operator's methods, which employs heavy machinery. The former process is known to be environmentally friendlier as it does little to disturb the ecology. The mechanized scheme is very detrimental to the ecology. This is because studies have shown that it disturb the vegetation around, compacts soil during the movement of tractors and other machinery and loosens soil structures in certain instances during the haulage of felled trees. These effects largely affect the quality of water that gets to the various water systems namely the lakes, rivers and the oceans. Compaction of soil arising from trampling results in dramatic reduction in infiltration rates.

These events lead to the following deleterious effects; preventing the build-up of soil moisture reserves for use during the dry seasons by plants. They adversely affect the recharge of groundwater systems with consequent fall in groundwater table. They also lead to increase in overland flow which might cause flooding and increase rate of erosion of loose soil and sediment yield of rivers.

Other modes of clearing forest cover are through wildfires and overgrazing. Wildfires have lately gained prominence in the country. Unlike felling that is carried out selectively, clearing through fires is done wholesale. This means every forest cover is gotten rid of and creates bare land surfaces and soot. Bare land surfaces enhance run off from the watershed and infiltration for improving groundwater is reduced. On the other hand, the soot from the burnt fields finds their way into the water systems and pollutes them (Bekoe, 1998).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Area.

The study area, called Afram East Headwaters Forest Reserve, falls within the moist semi-deciduous vegetation zone of Ghana. This zone is known to harbour unique biodiversities inclusive of Ghana's prime economic floral species, such as *Triplochiton Scleroxylon* (wawa), *Celtis Milbraedii* (Esa), *Entandrophragma angolensis* (Edinam), the khayas etc. and rare fauna lives (Taylor, 1960). Additionally, this forest reserve serves as a catchment area for the River Afram in the Ashanti Region of Ghana.

3.1.1 Location and Extent.

The Afram East Headwaters Forest Reserve is bounded by the co-ordinates; latitude $7^{o}0'$N and $7^{o}15'$N and longitude $1^{o}32'$W and $1^{o}48'$W.

Figure.1 is a map of the Study area and covers a land area of about 86.3km^{2} which forms part of 201.24km^{2} of the Afram Headwaters forest reserve. This study site was selected and demarcated as a reserve in 1927 and the survey of the boundaries was done the same year. Farm demarcations were carried out between 1928 and 1930 and a resurvey and re-demarcations of the farms was done in 1951 (Asumang, 1963). The western boundary of this forest reserve is lying adjacent to the main Kumasi-Techiman road, Kumasi. Offinso, Ejisu and Agona Stools claim ownership of the Afram Headwaters Forest Reserve. However, politically this reserve falls within the Offinso South Municipality with its administrative capital at Offinso. The main communities within the study area are Kwapanin and Asuboi. About 967 peoples constitute the population within this study area (2000 population & housing census, Offinso District).

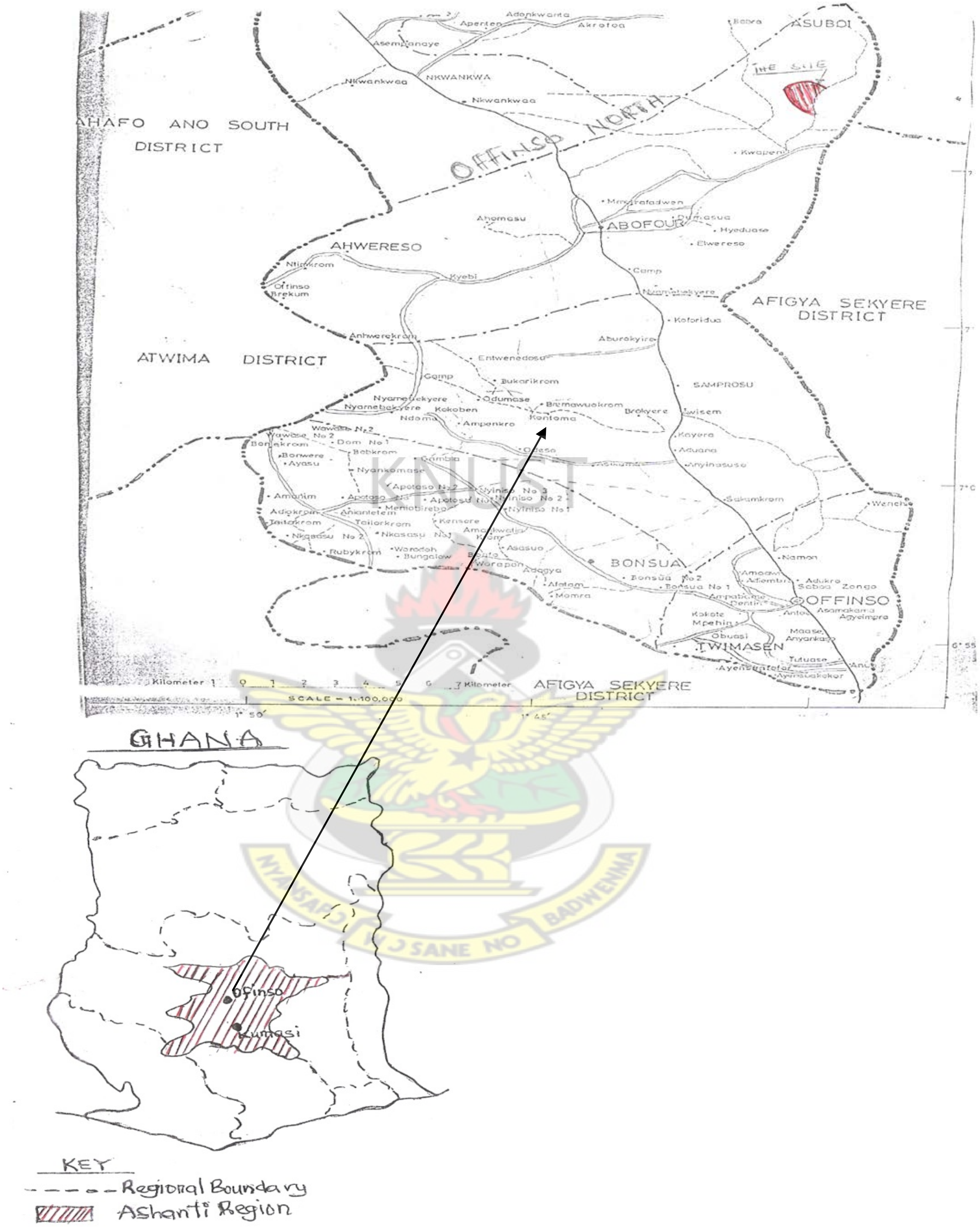


Fig.1: Maps of Study site; Ghana map showing regional boundaries with region where study was conducted highlighted

3.1.2 Climate

The Afram Headwater Forest Reserve found within the moist semi-deciduous forest zone of Ghana has a mean annual rainfall between 1500mm and 1750mm. Temperatures are uniformly high with 36.1^{o}C and 21.7^{o}C as the mean maximum and minimum respectively. The maximum monthly average of 32.8^{o}C normally occurs in March while the minimum of 19.9^{o}C occurs in January (Ellis, 1958). Relative humidity ranges between 60% and 85%, which is high though somewhat below the figure for Kumasi. At the height of the dry season, the humidity may fall considerably for brief periods due to the effect of the harmattan. The prevailing wind is north-easterly during the harmattan and south-westerly during the rainy season (Obeng, 1971).

3.1.3 Geology and soils

The geology and soils in this forest reserve have been described by Ellis (1958), which is similar to the Cape-Coast granite complex zone. The western end of the reserve over-lies rock of the upper and lower Birrimian series, and the rest of the reserve over-lies rocks of the Upper Voltain sandstone and granite (Obeng, 1971).

The soil is a sandy loam with particles of clay and varies from reddish to reddish-brown in colour. The soil developed from the Lower Birrimian rocks are silky light clay in texture and the soils from the Upper Birrimian rocks are likely to have a higher base status than those developed from the lower Birrimian rocks.

Obeng (1971) described soils from the Voltain areas as generally poor in nutrient reserve and also have a low water holding capacity. Most of them, however, have good capacity to utilize added fertilizer.

3.2 Selection of Study Sites and Data Collection Procedures in the Study Area.

Two study sites namely- Forest Reserve (FR) and Farmlands (FL) were selected for this study. The Forest Reserve was selected for the study because it is a site within the Study area where there had been little or no human activity compared to the two selected Farmlands (located North and South of FR) where human activities like farming is being carried out. In the FR and FL, 4 plots each of dimension 50m X 50m were randomly laid with the help of measuring tapes and pole, while in the two Farmlands; two plots each were laid. Using a measuring tape and wooden pegs, each plot was sub-divided into four sub-plots (quadrats) of dimension 25m X 25m. One quadrat out of each set of four quadrats was selected for identification and counting of each species therein. Figure. 2 shows a layout of the quadrats at the Study Sites.

For each quadrat, a species list was prepared to include trees (T), shrubs (S), climbers (Cl) and herbs (H).

The classification into these four life forms was based on the following descriptive features; A tree is a woody perennial plant with a single trunk or bole, growing to a considerable height and bearing lateral braches;

A shrub is has a woody stem with a relatively low growth habit and generally produces several basal shoots instead of a single bole;

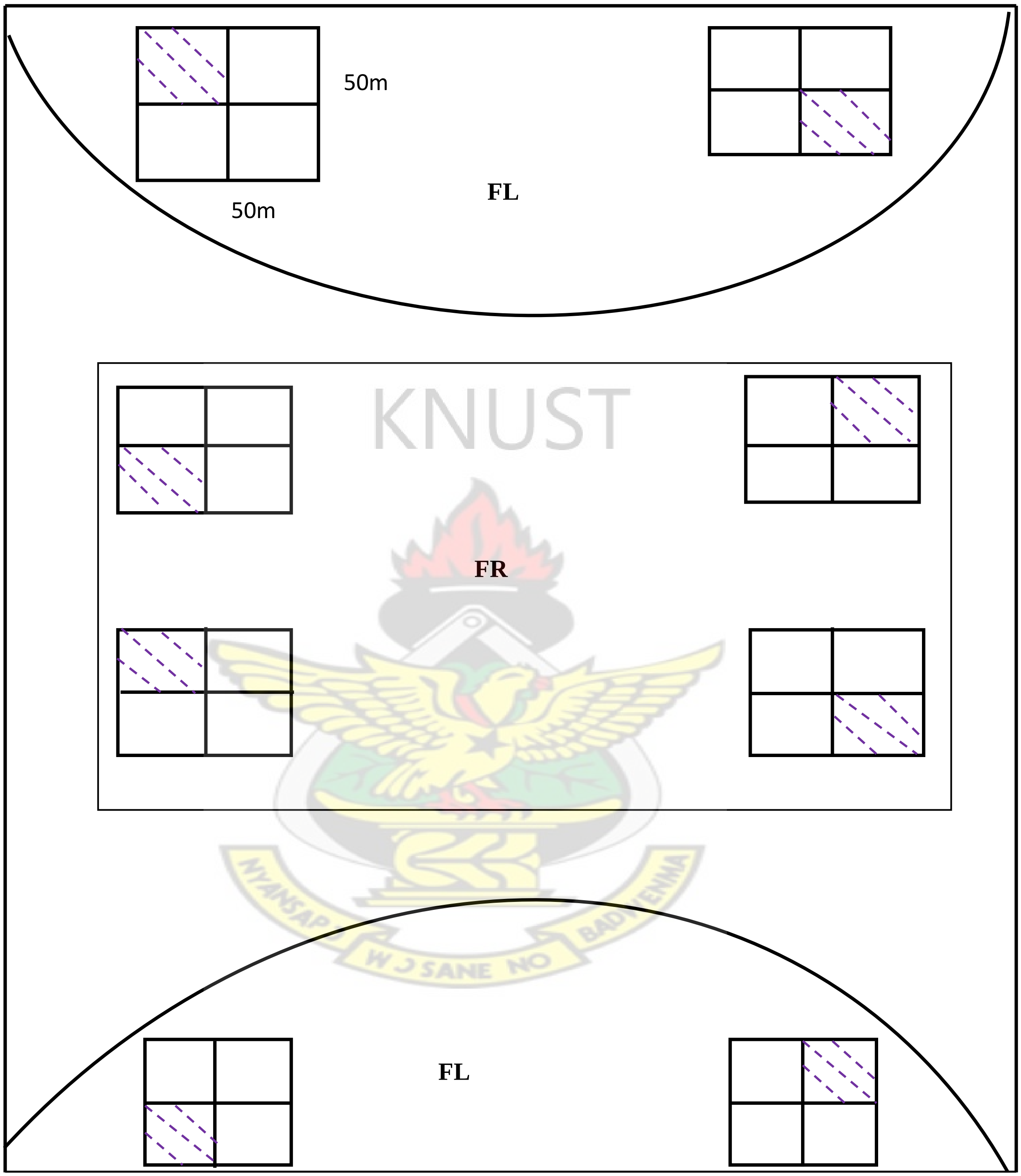
Herbs are non-woody annual plants which die down to the ground after flowering and Climbers are plants that require a tree or shrub as a support (host). Plates 1a & 1b depict the forest type in the selected FR and Plates 2a & 2b indicate the vegetation type in the selected FL.

Plate 1a: Secondary forest dominated by *Broussonettia papaverifera* with few Shrubs and Climbers.

Plate 1b: Secondary Forest thicket dominated by shrubs and climbers

Plate 2a: Farmland with food crops (*Musa* sp.) intercropped with *Tectona grandis* in Taungya farming.

Plate 2b: A food crop farm invaded by opportunistic plant species



KEY

FR = Forest Reserve

FL = Farm Land

= Selected 25m x 25m quadrat at the sampling sites

Fig. 2: Design of Quadrat layout at the study sites

3.2.1 Species Identification

Species were identified as far as possible on site with the assistance of a Taxonomist. The natural classification approach was used where plants were classified by their family or genus name and later their morphological features were compared with pictures of plant species in a textbook titled 'Woody Plants of West Africa' (Hopkins and Johnkind, 1995). Those of unknown identity were collected as whole plants or parts and pressed for later identification at the herbarium of the Department of Theoretical and Applied Biology, Kwame Nkrumah University of Science and Technology (KNUST).

Within each quadrat sampled, species abundance was determined by counting individuals of the same species and their frequencies recorded (i.e. Dominant, Abundant or frequent and occasional or rare). For the purposes of this study, a species is described as dominant if the number of individuals is 500 per plot or more. They are abundant, when they are between 50 and 499 per plot and are occasional when the number is less than 50 per plot.

The numbers of life forms of trees, shrubs, herbs and climbers encountered in both the Forest Reserve and Farmland were recorded.

3.2.2 Species Diversity

The Shannon diversity index (H') and Simpson's index (D) were used to determine the species diversity of the two study sites. Shannon diversity index (H') is based on the assumption that individuals are randomly sampled from an infinitely large population. It accounts for both abundance and evenness of the species present in a community. Simpson's index (D) is a measure of diversity that takes into account both species richness and evenness. Simpson's index (D) measures the probability that two organisms sampled from a community will belong to the same species. The value of D ranges between 0 and 1 where 0 represents infinite diversity and 1, no diversity. Thus the larger the value of D, the lower the diversity, and the smaller the value, the higher the diversity.

Species richness is a relative term that refers to the number of species in a community and Species evenness defines the number of individuals from each species in a given area or community. The species diversity of the two study sites were determined using a software known as Biodiversity Professional, version 2.0.

3.2.3 Species Distribution Patterns

The distribution of individuals of a population may be one of three patterns, namely; random, uniform and aggregate (Ewusie, 1980). According to Kershaw (1973) individuals are randomly distributed when the variance mean ratio is 1 but aggregated when the ratio is greater than 1. On the other hand when the ratio is less than 1, individuals are uniform. The distribution patterns of the species sampled within the study sites were classified into mainly random and aggregated patterns and the analysis were conducted using Microsoft excel and ANOVA.

3.3 Assessment of the Effect of Activities of the Fringe Communities on the Afram Headwater Forest Reserve.

A total of one hundred (100) members drawn from the two main communities (i.e. Kwapanin and Asuboi) were interviewed. The convenience or 'accidental' sampling technique was used. This technique involves choosing the nearest or available individuals to serve as respondents and continuing the process until the required sample size has been obtained.

The interview was conducted using structured questionnaire (see appendix13) and the data so generated were analyzed using descriptive statistics.

The questionnaire covered the following main issues;

A. Biodata.

B. Employment status.

C. Livelihood that is derived from the Afram Headwater Forest Reserve.

D. Perception of respondents on the effects of farming on water quality.

E. Perception on effects of logging on farmland.

F. Compliance of logging rules.

G. Impact of logging on forest fringe communities.

CHAPTER FOUR

4.0 RESULTS

4.1 Life Form Abundance of the Forest Reserve

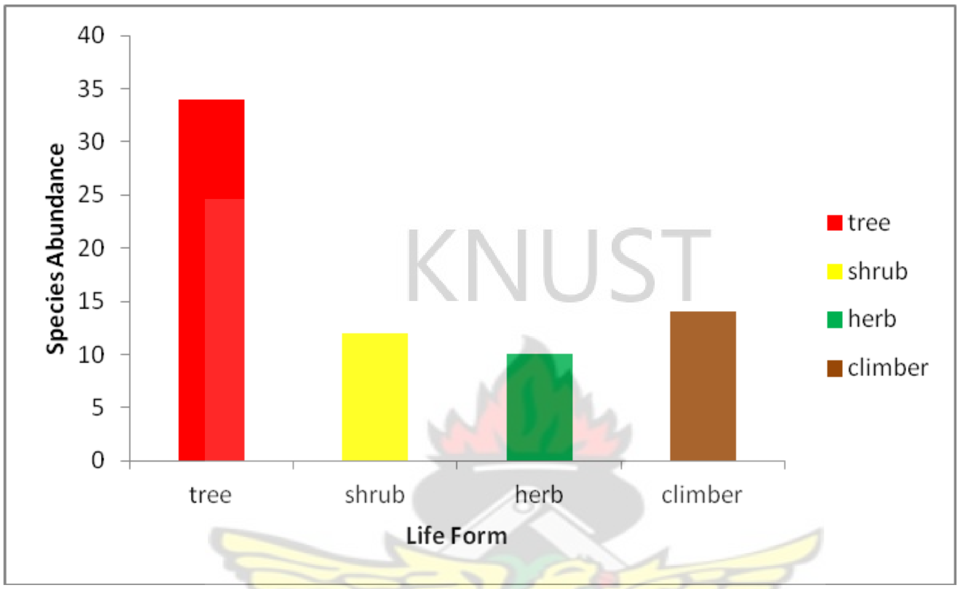


Fig. 3: Life Form Abundance in the Forest Reserve

Fig. 3 shows the Life form composition of the Forest Reserve (FR) during the study period which lasted between August 2010 and July 2011. All the four life forms including Tree (T), Shrub (S), Herb (H) and Climber (Cl) species were found within the F.R. Tree species recorded the highest number of 34 species out of the 70 species recorded in the F.R. This represented 48.6% of the total number of species in the FR. This was followed by Climber species which recorded 14, representing 20.0%. Shrub recorded 12 species representing 17.1% and Herb species recorded the lowest number of 10 which represents 14.3%.

4.1.2 Floristic Composition and Distribution of the Forest Reserve

Table 4: List of Plant Species, Life Form, Abundance and Distribution Patterns in the Forest Reserve.

Family	Genus, Species	Life form	Number of plants/ plot	Pattern
Malvaceae	*Achomanes difformis* DA.	*H*	*20*	Aggregated
	Sida acuta Hasok.	*H*	*14*	Random
	Sida cordata	*H*	*6*	Aggregated
Combretaceae	*Aframanum latifolium* DA.	*H*	*12*	Aggregated
	Terminalia superba WH.	*T*	*6*	Aggregated
	Combretum sp. Vent	*S*	*4*	Random
	Ptychopepterum ancepts Oliv	*S*	*3*	Random
Moraceae	*Antiaris toxicaria* Engl.(Lesch)	*T*	*66*	Aggregated
	Morus mesozygia Stapt	*T*	*1*	Random
	Trilepisium madagascariense WH.	*T*	*11*	Random
Euphorbiaceae	*Bidens pilosa* Linn	*H*	*70*	Aggregated
	Phyllantus discoideus (Bail) Wild	*S*	*3*	Aggregated
	Ricinodendron heudelotii Bail Pierre exPax	*T*	*1*	Random
Sapindaceae	*Blighia sapida* Lodd (Konig)	*T*	*9*	Random
	Blighia unijugata (Bak) Rodil	*T*	12	Aggregated
	Gongronima latiflora Benth	*CL*	*2*	Random
	Lecaniodiscus cupanioides Planch ex.Benth	*T*	*20*	Random
	Paullinia pinnata Linn	*CL*	*24*	Aggregated
Bombaceae	*Bombax buonopozense* Beauv	*T*	*3*	Aggregated

Meliaceae	*Calicobolus heudelotii*	*CL*	*18*	Aggregated
	Calicobolus africanus	*CL*	*4*	Aggregated
Meliaceae	*Khaya grandifoliola* (Welw) C. DC	*T*	*1*	Aggregated
	Trichilia monadelpha	*T*	*4*	Random
	Trichilia prieuraina A Juss	*T*	*41*	Random
Ebenaceae	*Alaphia barteri* Oliv	*CL*	*3*	Random
	Alaphia wightii	*CL*	*5*	Random
	Cnestis ferruginea	*S*	*15*	Aggregated
	Diospyros mespiliformis Hochst	*T*	*1*	Aggregated
	Diospyros heudelotii Hiern	*T*	*10*	Aggregated
Papilionaceae	*Baphia nitida* Lodd	*T*	*14*	Random
	Millettia zechiana Harms	*T*	5	Aggregated
	Cajanus cajan (Linn)	*S*	5	Aggregated
	Dalbergia setifera Hutch & Dalz	*S*	*13*	Random
	Dalbergia welwitschii Bak	*S*	*2*	Random
Asclepiadacea	*Secamone afzeli*	*CL*	*5*	Aggregated
Mimosaceae	*Albizia zygia* Mac Bride	*T*	*4*	Random
	Piptadeniastrum africanum (Hook.f)	*T*	*1*	Random
	Tetrapleura tetraptera(Schum&Thonn)	*T*	*1*	Random
Olacaceae	*Aptandra zenkeri* Engl	*T*	*5*	Random
	Olara latiflora	*S*	*28*	Aggregated
Acanthaceae	*Ataenidia conferta*	*H*	*28*	Random
	Justicia flava T.Aud	*H*	*40*	Random
Sterculiaceae	*Cola gigantea* A Chev	*T*	*13*	Random

Sterculiaceae	*Nesogordonia papaverifera* A Chev	*T*	*24*	Random
,,	*Sterculia tragacantha* Lindl	*T*	*3*	Random
,,	*Triplochiton scleroxylon* K Schum	*T*	*1*	Random
Dichapetalaceae	*Dichapetalum madagascariense*	*S*	*18*	Random
Annonaceae	*Enantia polycarpa*	*T*	*2*	Random
Apocynaceae	*Funtumia elastica* Preuss Shapf	*T*	*3*	Random
,,	*Holarrhena floribunda* Stapf	*T*	*12*	Random
Caesalpiniaceae	*Griffonnia simplicifolia* Bail	*CL*	*29*	Random
,,	*Motandra guineense*	*CL*	*10*	Random
Bignoniaceae	*Markhamia lutea*	*T*	*1*	Random
,,	*Newbouldia laevis* Seem	*T*	*1*	Random
Pandaceae	*Microdesmis puberula* Hook & ex Planch	*T*	*17*	Random
Rubiaceae	*Morinda morinioides*	*CL*	*15*	Random
Solanaceae	*Mosoneron sp.*	*CL*	*3*	Random
,,	*Solanum erianthum* Swartz	*S*	*2*	Random
Sapotaceae	*Pachystela brevipes* Engl	*T*	*3*	Random
,,	*Gluema ivorensis* Aubrev & Pellegr	*T*	*2*	Random
Craminaceae	*Setaria barbata*	*H*	*6*	Random
Sterculiacea	*Broussonettia papaverifera*	*T*	*117*	Random
"	*Carpolobia lutea* G.Don	*T*	*11*	Random
Malvaceae	*Ceiba pentandra* (Linn) Gaertn	*T*	*3*	Random
Asteraceae	*Chromolaena odorata* (L.)	*H*	*118*	Aggregated
Not identified	*Leptoderis marcantha* Dann	*CL*	*5*	Aggregated
"	*Leptoderis meigae*	*CL*	*3*	Random

Sapotaceae	*Pouteria altissima*	*T*	5	Random
"	*Psychotoria penducularis*	*H*	*18*	Aggregated
Apocynaceae	*Rauvolfia vomitoria*	*S*	*2*	Random
Total			*1006*	

Source of Scientific names and Authors: Woody Plants of Ghana by Irvine (1961) and Field guide to the Forest trees of Ghana by Hawthorne (1990).

A total of seventy (70) plant species in sixty-four (64) genera belonging to twenty-five (25) families were encountered in this study site (Table 4.).

An examination of the numbers recorded for each species in the Forest Reserve revealed that, *Broussonettia papaverifera* (117), *Chromolaena odorata* (118), *Antiaris toxicaria* (66) and *Bidens pilosa* (70) were abundant while most of the species encountered here were occasional or rare. A total of one thousand and six (1006) plants were recorded in the Forest Reserve (Table 4.).

In terms of life form, 34 tree species, 12 shrub, 10 herb and 14 climber species were recorded (Fig. 3).

The distribution patterns of the species in the Forest Reserve were as follows; twenty-one (21) showed aggregated pattern while forty-nine (49) were randomly distributed. Majority of the species in the Forest Reserve showed random distribution.

4.2 VEGETATION OF FRAMLAND

Herbs were the predominant natural life form in the Farmlands, though there were abundance of the seedlings of some tree and climber species. Crops cultivated included the following: *Zea mays, Dioscorea alata, Solanum* sp., *Musa* sp. and *Carica papaya*

4.2.1 Life Form Abundance of the Farmland

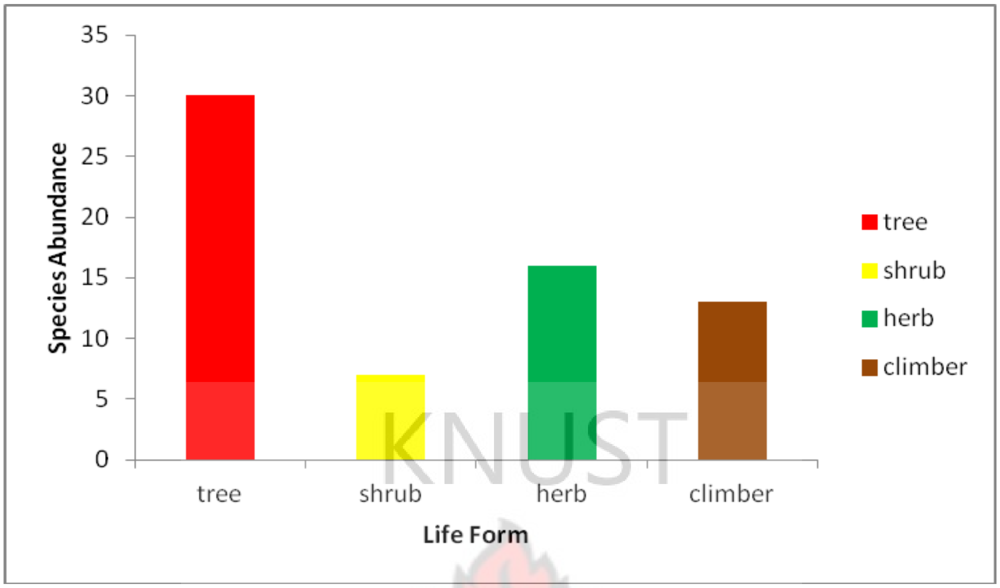


Fig. 4: Life Form Abundance in the Farmland

Fig. 4 shows the Life form composition of the Farmlands (FL). All four life forms namely Tree, Shrub, Herb and Climber species were also found in the Farmlands (FL). In this study site, the Tree species again recorded the highest number of 30 species out of the 66 recorded in the FL. This represented 45.5% of the total number of species in the FL. This was followed by Herbs species which recorded 16; representing 24.2%. Climber species recorded 13 species, representing 19.7%. The Shrub species recorded the lowest number of 7, representing 10.6%.

4.2.2 Floristic Composition and Distribution of the Farmland.

Table 5: List of Plant Species, Life Form, Abundance and Distribution Patterns in the Farmlands

Family	Genus,Species	Lifeform	Number of Plants/ plot	Pattern
Combretaceae	*Aframonum latifolium* DA.	*C*	*13*	Aggregated
	Centrocema pubecense	*S*	*5*	Aggregated
	*Combretum sp.*Vent	*S*	*16*	Aggregated
Moraceae	*Antiaris toxicaria* Engl (Lesch)	*T*	*160*	Aggregated
	Ficus exasperata Vahl Baule	*T*	*12*	Aggregated
	Milicia excelsa (Welw) Benth	*T*	*3*	Random
	Morus mesozygia	*T*	*1*	Random
	Trilepisium Madagascariense	*T*	*1*	Random
Papilionaceae	*Baphia nitida* Lodd	*T*	*102*	Aggregated
	Dalbergia oblongiphora	*H*	*2*	Aggregated
	Dalbergia welwitschi	*S*	*10*	Aggregated
	Dalbergia saxzatilis Hook f Dagm	*CL*	*3*	Random
Euphorbiaceae	*Biden Pilosa* Linn	*H*	*100*	Aggregated
	Bridelia Ferruginea Benth	*H*	*5*	Random
	Phyllantus discoideus	*S*	*5*	Aggregated
Sapindaceae	*Blighia sapida* Lodd (Konig)	*T*	*15*	Aggregated
	Blighia unijugata (Bak) Radil	*T*	*45*	Aggregated
	Paullinia pinnata Linn	*CL*	*60*	Random
Ulmaceae	*Celtis milbraedii* Engl	*T*	*3*	Aggregated

Araceae	*Colocasia esculenta*	*H*	*4*	Aggregated
Graminaceae	*Digitaria insularis*	*H*	*7*	Aggregated
	Paspalum virginatum	*H*	*20*	Aggregated
Palmaceae	*Elaeis guineense* Jacq.	*S*	*2*	Aggregated
Laueaceae	*Euphorbia hirta* Linn	*H*	*20*	Aggregated
	Persia Americana Mill	*H*	*10*	Aggregated
Sapotaceae	*Gluema ivorensis* Engl	*T*	*5*	Aggregated
Anacardiaceae	*Lannea nigritana* (Sc Elliot) Keay	*T*	*10*	Aggregated
Pandaceae	*Microdesmis puberula* Hook. f ex Planch	*T*	*3*	Aggregated
Rubiaceae	*Morinda morinoides*	*CL*	*2*	Aggregated
	Psychotoria ankasensis Benth	*H*	*10*	Aggregated
	Morinda lucida Benth	*T*	*20*	Random
	Rothmannia longiflora Salsb	*T*	15	Random
	Tricalysia pallens Oliv	*T*	*5*	Random
Sterculiaceae	*Nesogordonia papaverifera* Engl	*T*	*1*	Aggregated
	Sterculia tragacantha Benth	*T*	*170*	Aggregated
	Triplochiton scleroxylon K. Schum	*T*	*4*	Random
Mimosaceae	*Parkia filicoidea*. Keay	*T*	*1*	Aggregated
	Albizia ferruginea Benth	*T*	*4*	Random
	Albizia zygia Mac Bride	*T*	*7*	Random
Malvaceae	*Sida acuta* Hasok	*H*	*130*	Aggregated
	Sida alba	*H*	*50*	Aggregated
Solanaceae	*Solanum erianthum* Swartz	*S*	*15*	Aggregated
Ebenaceae	*Alaphia barteri* Oliv	*CL*	*17*	Random

Flacourtiaceae	*Calancoba gilgiana* Oliv	*T*		Random
Caesalpiniaceae	*Celestia elligance*	*CL*	*2*	Random
	Amphimas peterocapoidis Harms	*T*	*6*	Random
	Daniella ogea (Harms) Rolfa ex Holland	*CL*	*1*	Random
	Griffonnia simplicifolia Baill	*CL*	*190*	Random
	Motandra guineense DC	*CL*	*220*	Random
Meliaceae	*Calicobolus heudelotii*	*CL*	*8*	Aggregated
	Trichilia prieuraina A Juss	*T*	*5*	Random
Not identified	*Broussonettia papaverifera*	*T*	*2800*	Aggregated
	Cardiospernum grandifllorum Baill	*CL*	*6*	Aggregated
Caricaceae	*Carica papaya* Baill	*T*	*4*	Random
	Carpolobia lutea	*T*	*10*	Aggregated
	Clerondendron sp.(Willd) Schum & Thonn	*CL*	*5*	Random
Asteraceae	*Chromolaena odorata* (L.)	*H*	*2520*	Aggregated
	Erigeron floribunda	*H*	*1*	Aggregated
	Labiati sp.	*H*	*100*	Aggregated
	Landophia hirsute Baill	*CL*	*7*	Random
	Luceana lucucephala L. alauca Benth	*T*	*1*	Random
	Pouteria altissima	*T*	*8*	Aggregated
Apocynaceae	*Rauvolfia vomitoria*	*S*	*1*	Aggregated
	Stachytarpheta angustifolia (L.)	H	40	Aggregated
Asteraceae	*Tridax procumbens* (L.)	H	*130*	Random
Total		7306		

The Farmlands recorded a total of sixty-six (66) species in sixty (60) genera belonging to twenty-three (23) families. The recorded numbers for each species in the Farmlands revealed that, *Broussonettia papaverifera* (2800) and *Chromolaena odorata* (L) (2520) were dominant, whiles *Motandra guineense* (DC) (230), *Griffonnia simplicifolia* (Baill) (190), *Sida acuta* (Hasok) (130) and the seedlings of *Sterculia tragacantha* (170), *Antiaris toxicaria* (Engl) (160), *Stachytarpheta sp.* (140) and *Bidens pilosa*(Linn) (100) were abundant. Most of the other Species encountered in the Farmlands were occasional. A total of seven thousand, three hundred and six (7306) individual plants were recorded in the Farmlands (Table 5).

Life form abundance in the Farmlands was as follows; Tree species (30), Shrub (7), Herb (16) and Climber species (13).

The spatial distribution of species within the Farmlands recorded on Table 5 revealed that, Thirty-nine (39) species showed aggregated pattern while Twenty-seven (27) showed random distribution pattern.

4.3 COMPARATIVE STUDY OF THE TWO STUDY SITES

4.3.1 Comparison of the Life Form Abundance of the Two Study Sites.

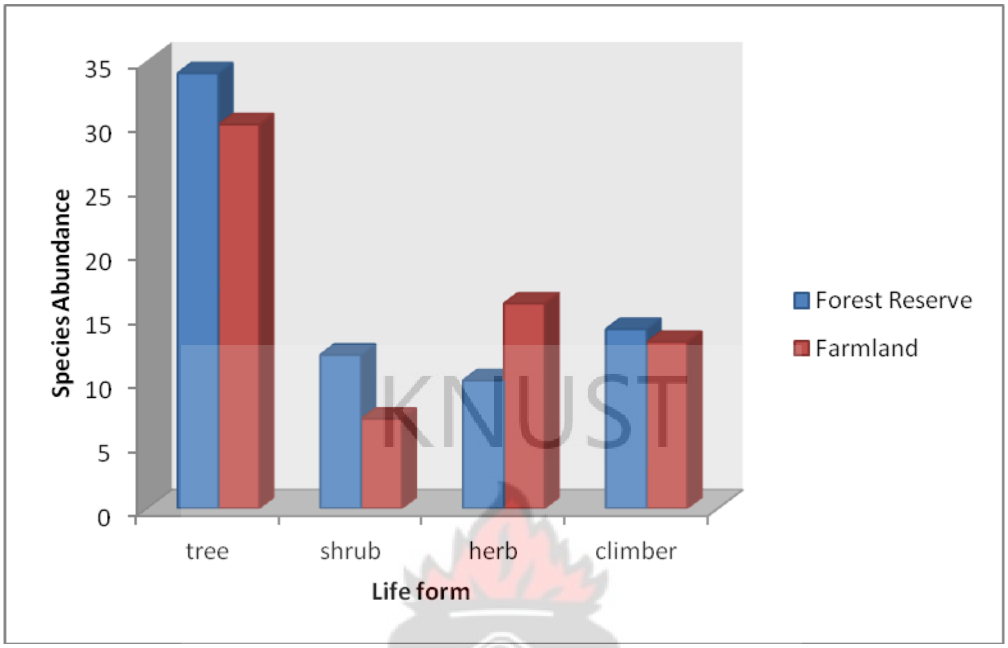


Fig 5: Life Form Abundance (Number) of the two Study Sites

The representation of the different life forms in the two sites showed some marked variations in the number of tree, shrub and herb species as shown in Fig. 5. Generally, apart from herbs, the Forest Reserve recorded higher numbers for the other Life forms than the Farmland. The numbers recorded for the tree species (34) and shrub (12) in the Forest reserve were higher than those obtained in the Farmland, with tree species recording (30) and shrub (7). However, the Farmland recorded a higher number of (16) for the herb species than the Forest Reserve which recorded (10) herb species.. For climbers, the number recorded in the Forest Reserve (14) was slightly higher than that recorded for the Farmland (13).

4.3.2 Species Diversity

TABLE 6: Species Diversity Analysis of Study Sites

Index	Fores Reserve(FR)	Farmland(FL)
Shannon Diversity (H')	**1.333**	**0.764**
Simpson's Diversity (D)	**0.068**	**0.312**

Table 6 shows the species diversity of the two study sites. The FR recorded a higher value for (H'=1.333) compared to that for the FL (H'= 0.764). For the Simpson's index (D), the FR recorded a lower value of (D = 0.068) against a(D = 0.312) value for the FL.

4.3.3 Species Encountered in the two Study Sites

Table 7 shows all the species that were encountered in the Forest Reserve (FR) and the Farmland (FL). A total of 104 species were recorded for the two study sites, eliminating duplication of species names. However, 70 species were recorded for the FR and 66 species for the FL. Thirty-one (31) species were identified as occuring in both the FR and FL.

Table 7: List of Species Encountered Separately and again together in the Forest Reserve (FR) and on Farmlands (FL).

Species	Forest Reserve (FR)	Farmland (FL)	Both
Achomanes difformis	+	_	_
Afrannanum latiforluim	+	+	+
Alaphia barteri	+	+	+
Alaphia wightii	+	_	_
Albizia ferruginea	_	+	_
Albizia zygia	+	+	+

Amphimas pterocapoidis	_	+	_
Antiaris toxicaria	+	+	+
Aptandra zenkeri	+	_	_
Ataenidia conferta	+	_	_
Baphia nitida	+	+	+
Bidens pilosa	+	+	+
Blighia sapida	+	+	+
Blighia urijugata	+	+	+
Bombax buonopozense	+	_	_
Bridelia ferruginea	+	_	_
Broussonettia papaverifera	+	+	+
Cajanus cajan	+	_	_
Calancoba gilgiana	_	+	_
Calicobolus africanus	+	_	_
Calicobalus heudelotii	+	+	+
Cardiospernum grandiflorum	_	+	_
Carica papaya	_	+	_
Carpolobia lutea	+	_	_
Ceiba pentandra	+	_	_
Celestia elligance	_	+	_
Celtis milbraedii	_	+	_
Centrocerna pubecense	_	+	_
Chromolaena odorata	+	+	+
Clerondendron sp.	_	+	_

Cnestis ferruginea	+	_	_
Cola gigantea	+	_	_
Colocasia esculenta	_	+	_
Combretum sp.	+	+	+
Dalbergia oblongiphora	_	+	_
Dalbergia saxzatilis	_	+	_
Dalbergia setifera	+	_	_
Dalbergia welwitschii	+	+	+
Daniella ogea	_	+	_
Dichapetalam madagascariense	+	_	_
Digitaria insularis	_	+	_
Diospyros heudelotii	+	_	_
Diospyros mespiliformis	+	_	_
Elaeis guineense	_	+	_
Enantia polycarpa	+	_	_
Erigeron floribunda	_	+	_
Euphorbia hirta	_	+	_
Ficus exasperata	_	+	_
Funtumia elastica	+	_	_
Gluema ivorensis	+	+	+
Gongronima latiflora	+	_	_
Griffornia simplicifolia	+	+	+
Justicia flava	+	_	_
Khaya grandiflora	+	_	_

Labiati sp.	_	+	_
Landophia hirsuta	_	+	_
Lannea nigritana	_	+	_
Lecaniodiscus cupanioides	+	_	_
Leptoderis marcantha	+	_	_
Leptoderis meigae	+	_	_
Luceana lucucifera	_	+	_
Markhamia lutea	+	_	_
Microdesmis puberula	+	+	+
Milicia excelsa	_	+	_
Millettia zechiana	+	_	_
Morinda lucida	_	+	_
Morinda morinioides	+	+	+
Morus mesozygia	+	+	+
Mosoneron sp.	+	_	_
Motandra guineense	+	+	+
Nesogordonia papaverifera	+	+	+
Newbouldia laevis	+	_	_
Olara latiflora	+	_	_
Pachystela brevipes	+	_	_
Parkia sp.	_	+	_
Paspalum virginatum	_	+	_
Paullinia pinnata	+	+	+
Persia americana	_	+	_

Phyllantus discoideus	+	+	+
Piptadeniastrum africanum	+	_	_
Pouteria altissima	+	+	+
Psychotoria ankasensis	_	+	_
Psychotoria penducularis	+	_	_
Ptychopepterum ancepts	+	_	_
Rauvolfia vomitoria	+	+	+
Rothmannia longiflora	_	+	_
Ricinodendron heudelotii	+	_	_
Secamone afzeli	+	_	_
Setaria barbata	+	_	_
Sida acuta	+	+	+
Sida alba	_	+	_
Sida cordata	+	_	_
Solanum erianthum	+	+	+
Stachytarpheta angustifolia	_	+	_
Sterculia tragacantha	+	+	+
Terminalia superba	+	+	+
Tetrapleura tetraptera	+	_	_
Tricalysia pallens	_	+	_
Trichilia monadelpha	+	_	_
Trichilia prieuraina	+	+	+
Tridax procumbens	_	+	_
Trilepisium madagascariense	+	+	+

Triplochiton scleroxylon		+	+	+
Total	104	70	66	31

KEY: + = Present - = Absent

4.4 Assessment of the Effect of the Activities of Fringe Communities on the Afram Headwaters Forest Reserve.

4.4.1 Questionnaire Survey

A total of one hundred (100) structured questionnaire were administered to inhabitants of the fringe communities by random sampling. The communities were Kwapanin and Asuboi. A sample questionnaire is in appendix 5. Core responses of respondents are presented in sections 4.5.1.1 to 4.5.1.4

4.4.1.1 Livelihood Derived from Afram Headwaters Forest Reserve

Fig.6 shows respondents to the statement how important the Forest Reserve was. Those who viewed the Forest Reserve as being important them constituted 86% while 14% of the respondents were of the view that it was not important to them. Therefore majority of the respondents from the fringe communities were of the view that the Afram East Headwaters Forest Reserve was important to them.

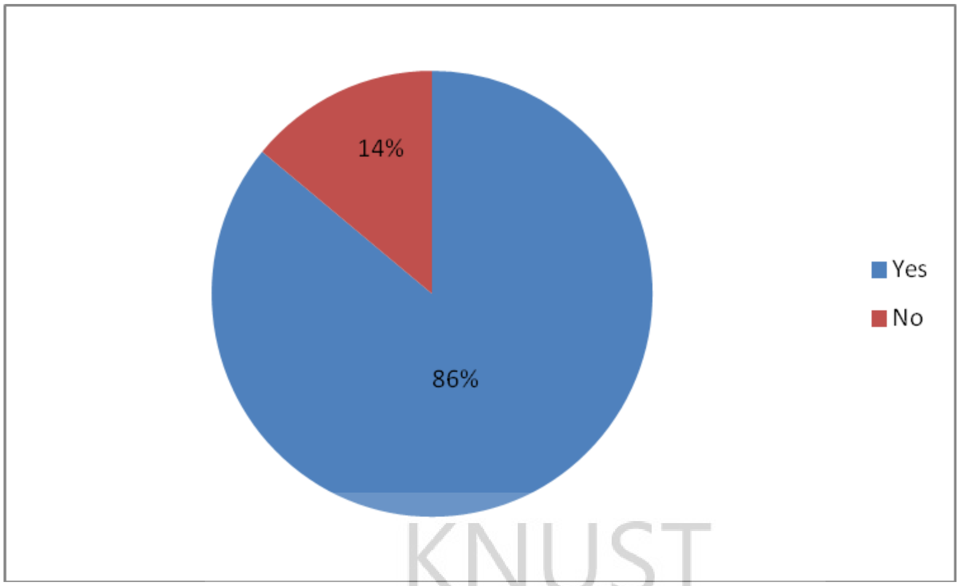


Fig. 6: Importance of Afram Headwaters Forest Reserve

From the 86% of respondents who agreed that the Afram Headwaters Forest Reserve was important, views about some type of benefits they derived were illustrated in Fig. 7 as follows; Shelter constituted 68%, Medicine 21%, Fuelwood 7% and Food 4%.

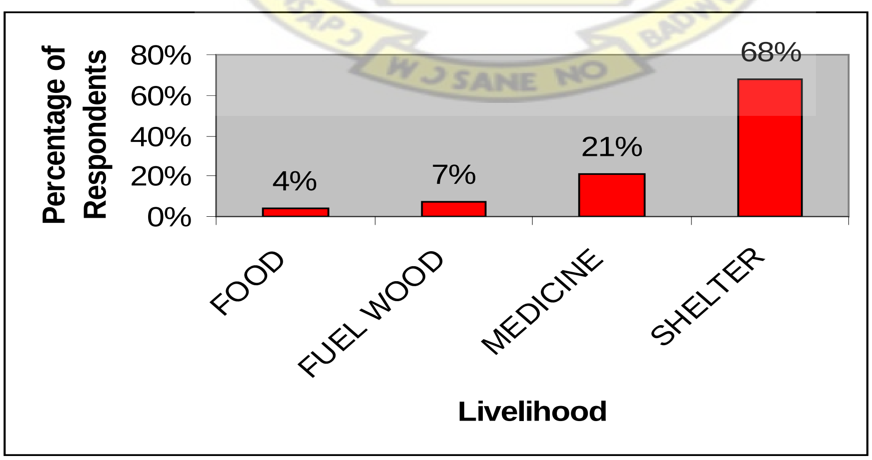


Fig. 7: Livelihood Derived from Afram Headwaters Forest Reserve

4.4.1.2 Resource Availability to Community Members

With regard to resource availability outside of the Afram Headwaters Forest Reserve, 88% of the respondents agreed that the resources could not be accessed outside the Forest Reserve. On the other hand, 12% claimed that the resources were readily available outside the Forest Reserve (Fig. 8).

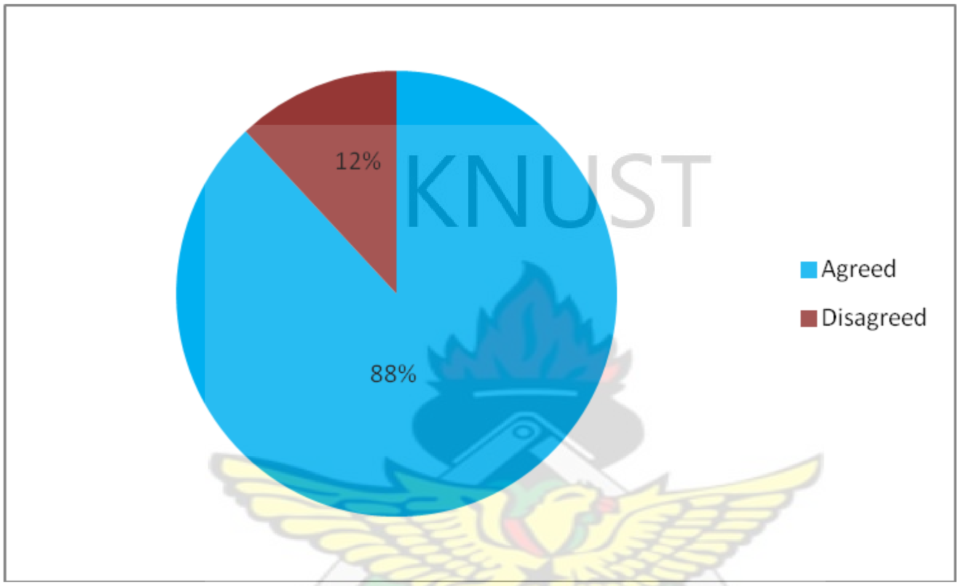


Fig. 8: Resource Availability outside the Afram Headwaters Forest Reserve.

In order to make these resources available to community members, 71% of the respondents suggested that some form of financial support should be given for their provision, while 25% preferred some technical support. As few as 4% of the respondents said they needed no support (Fig. 9).

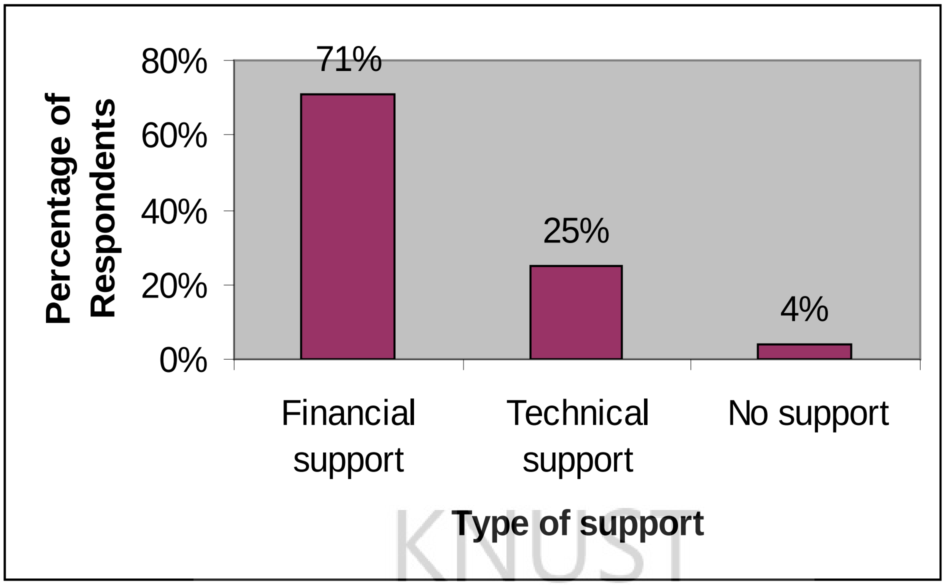


Fig. 9: Making scarce Resources outside of the Afram Headwaters Reserve available.

4.4.1.3 Farming Practices employed by community Members

With regards the type of farming practice used by the fringe communities, as many as 82% of the respondents said they engage in subsistence farming, whereas 18% said they relied on commercial farming (Fig.10).

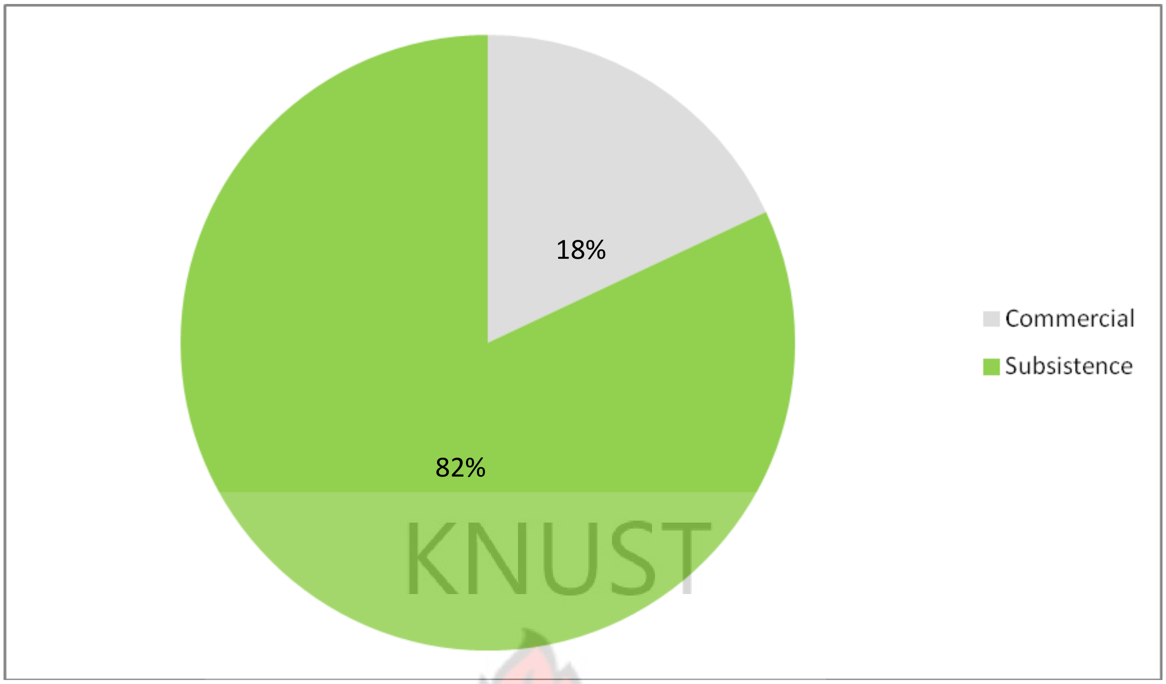


Fig. 10: Type of Farming Practice used by fringe communities

On the issue of the method employed in farming, the following responses were generated and are illustrated in Fig. 11; Slash and burn 55%, Taungya farming 31%, Shifting cultivation 8% and Bush fallow 6%.

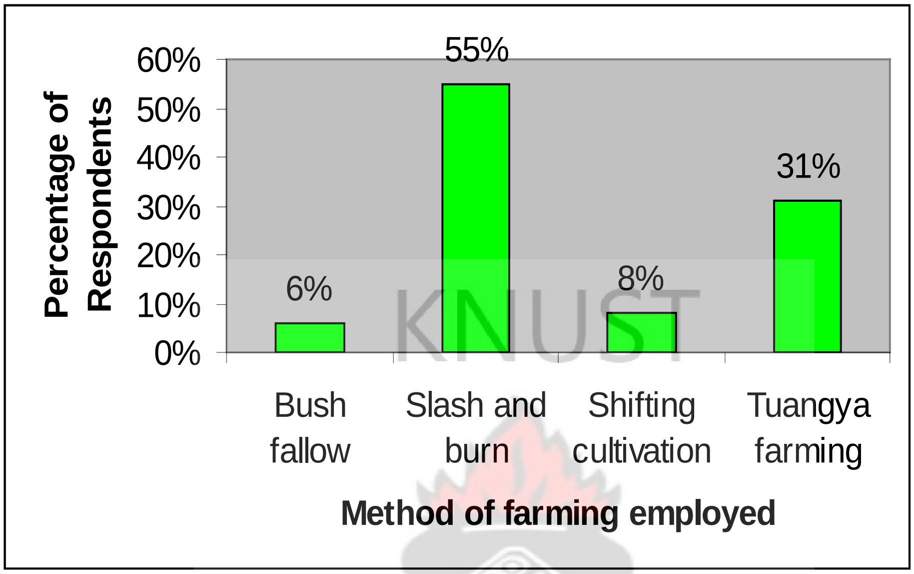


Fig. 11: Method of farming employed by community members.

4.4.1.4 Activities of fringe communities that posed as an encroachment threat to Afram Headwaters Forest Reserve.

On encroachment on the Afram Forest Reserve, 72% of the all respondents agreed that some of their activities posed a threat to the Reserve, while 28% did not agree that their activities posed an encroachment threat to the Afram headwaters Forest Reserve (Fig.12).

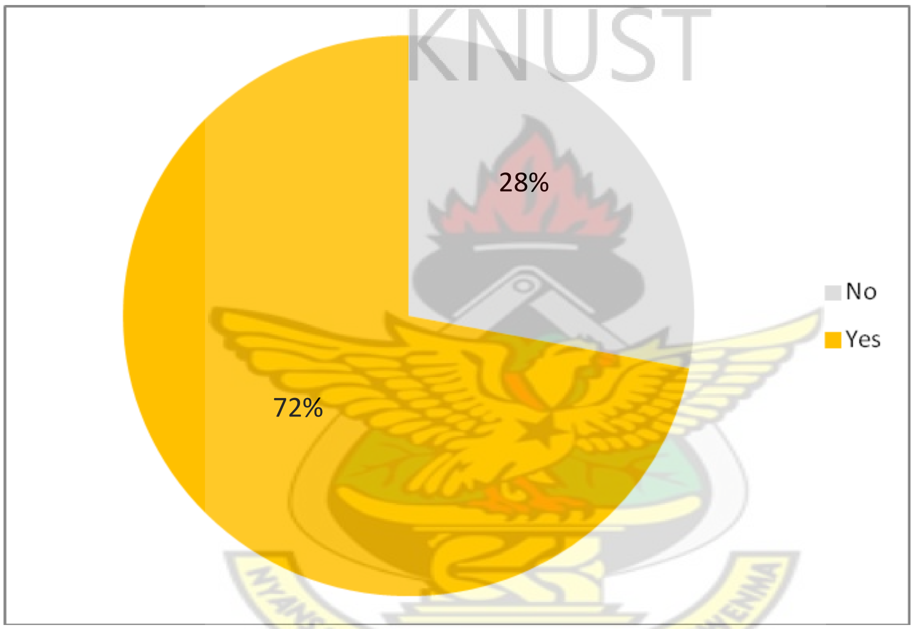


Fig. 12: Threat to encroachment on the Reserve.

As regards the specific activities of the fringe communities that posed as an encroachment threat to the Forest Reserve, the following responses were recorded; 58% agreed that slash and burn farming was a major threat, 32% said it was logging, 6% said it was hunting and just 4% of the respondents mentioned other activities including gathering of fuelwood for domestic use (Fig. 13).

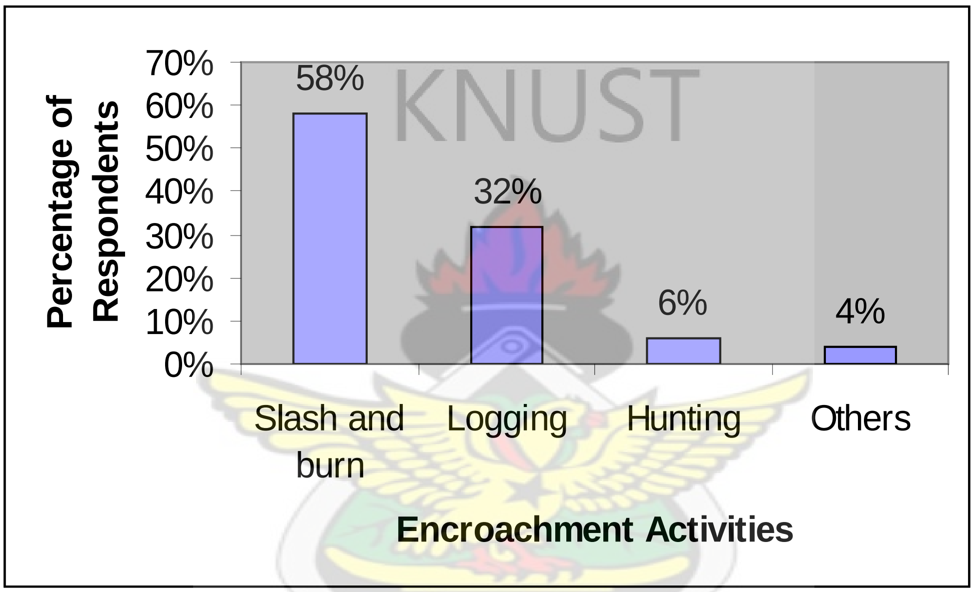


Fig. 13: Specific Activities of community Members that posed a threat to Encroachment on the Afram Headwaters Forest Reserve

CHAPTER FIVE

5.0 DISCUSSION

5.1 Floristic Composition and Life Form Distribution.

The general floristic compositions of both the Forest Reserve and Farmland were quite different. The Forest Reserve comparatively, had more tree species (Fig.3) with closer spatial distribution and extremely sparse undergrowth that made movement through the forest very easy. A total of seventy (70) plant species were indentified in the Forest Reserve with thirty-one (31) of these species also occurring in the Farmland. Thus the remaining thirty-nine (39) plant species were unique to the Forest Reserve (Table 7). The vegetation of the Forest Reserve is an example of a secondary forest type, consisting of a complex mosaic of woodland thicket with few trees dominated by *Broussonettia papaverifera, Chromolaena odorata* (L), *Antiaris toxicaria* (Lesch) *and Bidens pilosa* (Linn). This observation was also made by Howthorne and Musah (1993).

The Farmland on the other hand, had a good cover of herbs, however, with seedlings and saplings of tree species dominating (plates 2a & 2b). *Carica* papaya (DA), *Triplochiton scleroxylon* (K Schum), *Parkia filicoidea* (Keay). and *Tectona grandis* were the matured tree species encountered on the farmland. A total of sixty-six (66) species were indentified on the Farmland with thirty-five (35) occurring on the Farmlands only (Table 7). There has been much loss of tree species due to the gradual elimination of tall tree cover and the very few left were widely spaced. This observation was also made by Attua (1996) and cited by Wodah (2009). The abundance of some herb species such as *Chomolaena odorata* (L) *(2520), Motandra guineense* (DC) *(230) and Sida acuta* (Hasok) *(130)* on the farmlands could be attributed to the slash and burn approach adopted by most of the farmers (Fig 13). Land is clear- cut of its vegetative cover including trees, slash burnt and coppices destumped, depleting the soil's seed stock and killing root of felled trees and shrubs (Hopkins, 1974). This therefore made it floristically poor in terms of the larger tree species though it had a good number of smaller tree species especially *Tectona grandis* that were used in taungya farming practice.

The general preponderance of herbaceous species over tree species was suggestive of vegetative destruction resulting primarily from non-prudent land use activities, particularly arable farming (Attua, 1996).

From Lawson (1985), in many vegetation areas of the country today, indiscriminate bushfire, intensive cultivation and overgrazing by cattle are the most important factors of current vegetation change

5.2 Species Diversity

Species diversity is defined on the basis of two factors; the number of species in a community (i.e. species richness), and the relative abundance of each species within a given area (i.e. species evenness). The influence of these two components on the two study sites sampled was clear as the Forest Reserve recorded a higher species richness of 70 than the Farmland which recorded a lower species richness 66 and evenness (Tables 7:). Also the Forest Reserve has more species evenness than the Farmland. This is because the total numbers of individuals were quite evenly distributed among most of the species in the Forest reserve, whereas the Farmland has been dominated by a few species such as *Broussonettia papaverifera* and *Chromolaena ordorata.*

The difference in species diversity recorded between the Forest Reserve and the Farmland could be attributed to the differences in microclimate as this influences germination and establishment. The minimal human interference within the Forest Reserve compared to the farmland where human activity had altered the microclimate also accounts for the difference. This might have also influenced the growth and distribution of natural forest species.

5.3 Species Distribution Patterns

The distribution of individuals of a population may be one of three patterns, namely; random, uniform and aggregated (Ewusie, 1980). According to Kershaw (1973) individuals are randomly distributed when the variance mean ratio is 1 but aggregated when the ratio is greater than 1. On the other hand, when the ratio is less than 1, individuals are evenly distributed. Most studies have shown that regular distribution of species is associated with very few species while the distribution of a very good number of species is either random or aggregated.

Studies conducted in the Forest Reserve and Farmland did not produce any uniform or regular distribution on the part of any species. However, the following distribution were registered: Farmland thirty-nine (39) aggregated, twenty seven (27) random (Table 5) ; and in the Forest Reserve, twenty-one (21) showed aggregation and forty nine (49) randomly distributed (Table 4). It is clear from the above that most of the species encountered during the sampling were randomly distributed and this implies that the environment in which these plant species grow is homogeneous and has many factors acting on the population (Ewusie, 1980).

The aggregated patterns of the species encountered was due to regeneration close to seed sources, vegetative regeneration or the occurrence of 'safe site' (Augspurger, 1984). The random distribution came about from processes such as seed dispersal and anthropogenic factors that directly produced such a distribution, or from the combined effects of agents, that were capable of turning aggregated patterns into random patterns or vice versa (Prentice and Werger, 1985). The analyses of distribution pattern of species sampled were determined for the Forest Reserve and Farmland (see appendices 2 and 4).

5.4 Assessment of the Effect of Human Activities on the Forest Reserve.

The study revealed that the forest reserve provided the fringe communities with fuelwood, constructional materials, medicines and food.

Fuelwood is the main source of energy for almost all the households and small industrial activities of the local people. The use of fuelwood as a source of energy provided by the Afram Forest reserve has been extended to many settlements within the Offinso municipality and even beyond. The drawing of this resource from the forest reserve, have resulted in the loss of some plant species thus affecting the floristic composition, diversity and distribution of the reserve.

The survey revealed that wood and thatch are the main building materials for most households within the two communities visited (Fig. 7). The main roofing materials were wood from various timber species and raphia. The harvesting of these plant species from the forest reserve for building purposes also affected the population of these plant species especially the timber species such as *Triplochiton scleroxylon, milicia zechiana* and *Funtumia elastica* which recorded 1, 5 and 3 in the four quadrats sampled within the Forest Reserve.

The study also revealed that some plants were used for medicinal purposes (Fig.7). Various parts of these medicinal plants, such as the bark of *Khaya ivorensis*, the roots of *Carpolobia lutea* and the fruits of *Tetrapleura tetraptera;* could be used for the treatment of various ailments. Other forest resources that the study found out to be exploited by the people include *Elaeis guineense* (oil palm) which branches and leaves were used for basketry and broom production. Reddish clay from the reserve is dug for pottery and wall paintings.

Again it was revealed that the fringe communities whose occupation was predominantly farming were largely into subsistence farming. These farmers still relied on the cutlass and hoe; and the method of farming practiced in the area was largely the traditional slash and burn farming which has caused a change in the vegetation of the forest reserve (Fig.11).

As a measure to reverse this effect (impact) on the area, it was revealed that some farmers were being organized into groups by some plantation development companies, such as the Polar Company and the Ohyia Plantation Company, where these farmers were being introduced to the taungya system of farming. This system was to help the farmers satisfy their food needs by growing food crops on the pieces of land allocated to them while at the same time helping to re-grow the area with seedlings of some forest plant species notably *Tectona grandis.*

Another human activity observed from the study to be contributing to the loss of vegetation of the study area was the action of illegal loggers or chain-saw operators. The Ghana logging manual prescribes measures that loggers are to follow when felling timber species in our forests. However, it was revealed that these chain-saw operators bluntly failed to comply with these prescriptions which constitute an offence, but there was no evidence of prosecution of offending companies or individuals, as observed by Hall and Swaine (1981)

The activities of these loggers did not only destroy water courses, but also caused damage to cash and food crops and the soil as was indicated by some respondents to the questionnaire. This action has a long term effect on the productivity of the land with serious socio-economic consequences on the fringe communities of Afram Headwaters Forest Reserve, who are predominantly farmers. Again it was made clear that settlement packages or arrangements in the form of compensations have often been worked out (by the Valuation Board) for such farmer victims. However, most of the times the loggers refuse to fulfill these obligations. This situation even becomes worse when the logger cannot be traced.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

Generally, species richness was found to be greater in the forest reserve than in the farmlands. In terms of tree species, the farm land recorded the highest prevalence through these tree species were in the seedlings and sapling stages, species diversity values were quite higher in the two study sites. However, species diversity values were found to be higher in the forest reserve than on the farmland.

Also, the seedlings and saplings of natural forest species were discovered in both sites studied. (i.e., the forest reserve and farm land). This means that if the farmland is protected, it could return to its natural forest status.

Again, it was observed that the forest type of the study area is in transition between the moist-semi deciduous forest and the dry forest due to the presence of plant species such as *Parkia sp., Markhamia lutea, Khaya grandifoliola* and *Pachystela brevipes.* Which are plant species typical of the transitional zone of Ghana's vegetation type (Yeboah - Gyan and Anning, 2009). With regards to spatial distribution of species, most of the herbs and seedlings of tree species showed an aggregated pattern. However at the individual sites, more of the species were randomly distributed and this support the fact that random distribution is characteristic of uniform environments.

Erosion of flora diversity both within and outside the reserve has been on the ascendancy. This situation has resulted in the loss of forest vegetation. The implication here is that there is an increasing rate of de-vegetation and there is therefore the need for this situation to be arrested in order not to turn this area into a complete dry land.

The fringe communities depend on the Afram Headwaters Forest Reserve for fuelwood, medicine and constructional materials. Other forest trees were exploited for basketry and broom production. The communities rely largely on the forest for their livelihood, but they are restricted by the reserve from expanding their farms, even though farming is the primary occupation of these people. This has resulted in short fallow periods leading to poor crop yields and low incomes of the people. Human activities in the study area have resulted in four main environmental issues;

The first issue is that, the area has lost its forest cover over the last four to six decades due mainly to farming and logging. Farming and logging have also taken place along rivers in the agricultural lands and within the Forest Reserve in contravention of environmental standards.

The second environmental issue is that reduction in the forest cover and bad land use practices. These have adversely affected water quality and its flow in the catchment area. The third issue relates to the negative impact of forest degradation on economic activities in the study area. There is rural – urban drift of the youth from the study area and farming activities are left in the hands of the aged who mostly engage in subsistence farming. The fourth issue is about the rate of forest degradation in terms of stem reduction per annum in the Afram East headwaters forest reserve. This is attributable to the intense logging, occurring within the area, both legal and illegal.

6.2 RECOMMENDATIONS

For this study, to help address the aforementioned environmental issues, it is important for the following actions to be taken; there is the need for the provision of alternative livelihood schemes such as the practice of taungya farming to reduce the current pressure on the Afram Headwaters Forest resource and prevent resource depletion.

Another action that should be taken should include provision of mechanisms for information sharing that would enable policy - makers and reserve managers to develop appropriate strategies for managing the reserve. In this light, the public and other professional (Planners, foresters, health workers, researcher etc) need to understand the implication of environmental and population trends and to develop consensus on appropriate actions to be taken.

The success of the environmental strategies will depend to a greater extent on the communities. These communities must therefore be involved in the planning and implementation of these strategies. Obviously, the solutions to these environmental and population problems depends on a network of individual actions, therefore, at the local level, small groups can do much to preserve the environment and improve living standards.

Again, there would be the need to ensure effective enforcement of environmental laws and regulations. This will call for the concerted efforts of the chiefs (The custodians of the land) and the law enforcement agencies.

Finally, further research should be carried out to consider the effect of non-anthropogenic factors on the study area.

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