

An Evaluation of Water Resources on the Eastern Slopes of Mount Cameroon

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ABSTRACT The paper on evaluation of water resources on the eastern slope of Mount Cameroon was carried out with the aim of investigating the problems associated with water resources and their implication on rural development. The data were obtained from the field with the assistance of a structured questionnaire. The paper reveals that water availability and its exploitation has a direct relationship with rural development. The villages of the upper eastern slope with acute water crisis tend to lag behind in rural development unlike those of the lower slopes where the abundance of water resources has accelerated socio-economic development. To minimize the effect of physiological drought that is threatening human survival in the upland villages, we suggested the implementation of proper land use strategies such as planting of environment friendly trees that bring water to the upper part of the water table and the avoidance of unsustainable farming practices and deforestation. Such practices may give better prospects for available water resources and proper rural development along this sector of Mount Cameroon. Afforestation in the source region of streams and other underground water resources is a useful exercise for the water engineer, the hydrologist, forest conservator and land use planner. Studies from other parts of the world suggest that forest remains the most acceptable land use for reservoir grounds.

INTRODUCTION

The most important natural resource which sustains life and enhances development especially in rural areas is water. The siting and evolution of most forms and patterns of settlements is mostly linked to the availability of water resources. The Mount Cameroon region with her rich and diversified natural resources has offered opportunities for its exploitation by the local population resident along its eastern slopes. Besides the rich andosols, water remains one of the vital natural resources appealing to the local inhabitants of the eastern slope. In recent years, there has been an increasing demand for it fueled by a wide range of factors including plantation and subsistence farming along water courses, urbanization and domestic demand just to cite a few. This can be judged from the increasing number of persons at water points (taps) at peak hours of water demand, the encroachment of the local population into swampy areas during the dry season for crop cultivation, the exploitation of local streams at car-wash points, the commercialization of water at bus stops/parks and long distance travel to obtain water. These are all indicators that there is an increasing demand for water on the eastern slope of Mount Cameroon (Fig. 1).

Although this is part of a watershed, the availability and management of water in the region still remains a major preoccupation. The question is whether the problem of water resources in the region is linked to availability, or management. To answer this question, it was hoped that a study of water resource evaluation on the eastern slope of Mount Cameroon will bring to light some of the major problems associated with the resource. Since the Mount Cameroon region remains an attractive zone for the influx of both migrants and indigenous population for development activities requiring water, this study highlights some of the management problems associated with it and suggest possible recommendations.

This micro pilot study was designed to encourage similar investigations to be undertaken in the water-stressed areas where the overlying and underlying volcanics behave in much the same way as regions which are underlain by limestones thus giving us volcano-karst (Ollier, 1976) characteristics in terms of some surface and underground water supplies.

METHODOLOGY

The data for this study were obtained from the primary sources. This was achieved through field observation and the administering of a

structured questionnaire. Field observations were made to assess the various methods used by the local people to exploit the water resources available in the study area. Water sites visited include streams, swamps, taps and hand-dug wells.

A structured questionnaire was designed and administered to the inhabitants of five villages situated on the eastern slope of Mount Cameroon. The villages sampled include Muea, Bomaka, Bova, Bokova, Mamu and Ekona (Fig. 1). A total of 120 questionnaires were administered with 20 each per village. The questionnaires were analyzed using simple descriptive statistical techniques. The eastern slopes of Mount Cameroon supplies the water needs of its more than 257000 inhabitants.

RESULTS

Fresh water sources predominate only in localized places the study area; these consist of streams, ponds, marsh and rainfall. Rain water is omnipresent especially in the rainy season, but it is highly utilized in cleaning domestic utensils. Other sources of water and their availability vary as a function of the steepness of slope. Streams, ponds, and marshes predominate in the lowland villages where the slope varies between 0° - 2° . On the other hand, surface water in areas like Bova, Bokova, Bonakanda and Ekona Lelu is scarce as opposed to Muea, Ekona, Bomaka which have low gradients. The physical factors account for the distribution of surface water resources in the area.

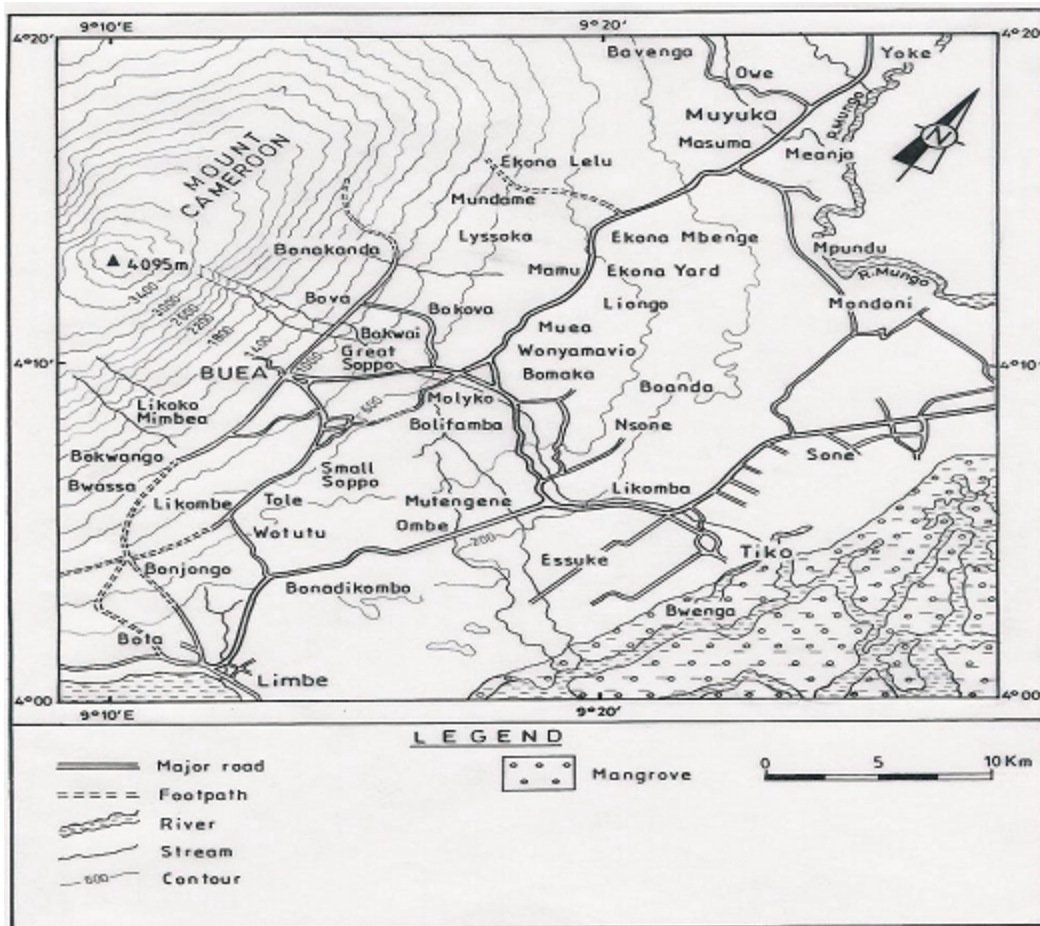


Fig. 1. Location of the study area

Beside the physical factors, man has influenced the distribution of water resources in the area. Though all the villages surveyed are rural settlements, water has been made available to most of them through pipe-borne schemes by the local communities themselves. This is the case of Bomaka, Bova, Bokova while those in Ekona, Muea have benefited from the assistance of the local council, Cameroon Development Corporation (CDC) and private initiatives.

Because of the scarcity of surface water in the upland villages, water supply is possible only through scan water schemes where machines are used to drag water from the ground against the force of gravity. This shows the difficulties encountered by man to obtain water at the sector of the mountain. This is a general problem in

Bonakanda, Bova and Bokova where available tap water is from scan sources. In lowland villages, tap water is obtained from streams oozing from the upper slopes where the water table is found close to the surface or cuts through a slope.

Because of the difficulties encountered by man in obtaining water, its exploitation is a function of its availability rather than quality. This is why the local population along this sector of Mount Cameroon exploit and use streams both for domestic and agricultural purposes. Marshes are very common at the lower outskirts of the lowland villages around Bolifamba (Mile 16), Muea, Mile 18 and Mamu. These are potential avenues for dry season agriculture. These wetland areas are commonly referred to as 'lambas' by the local population.

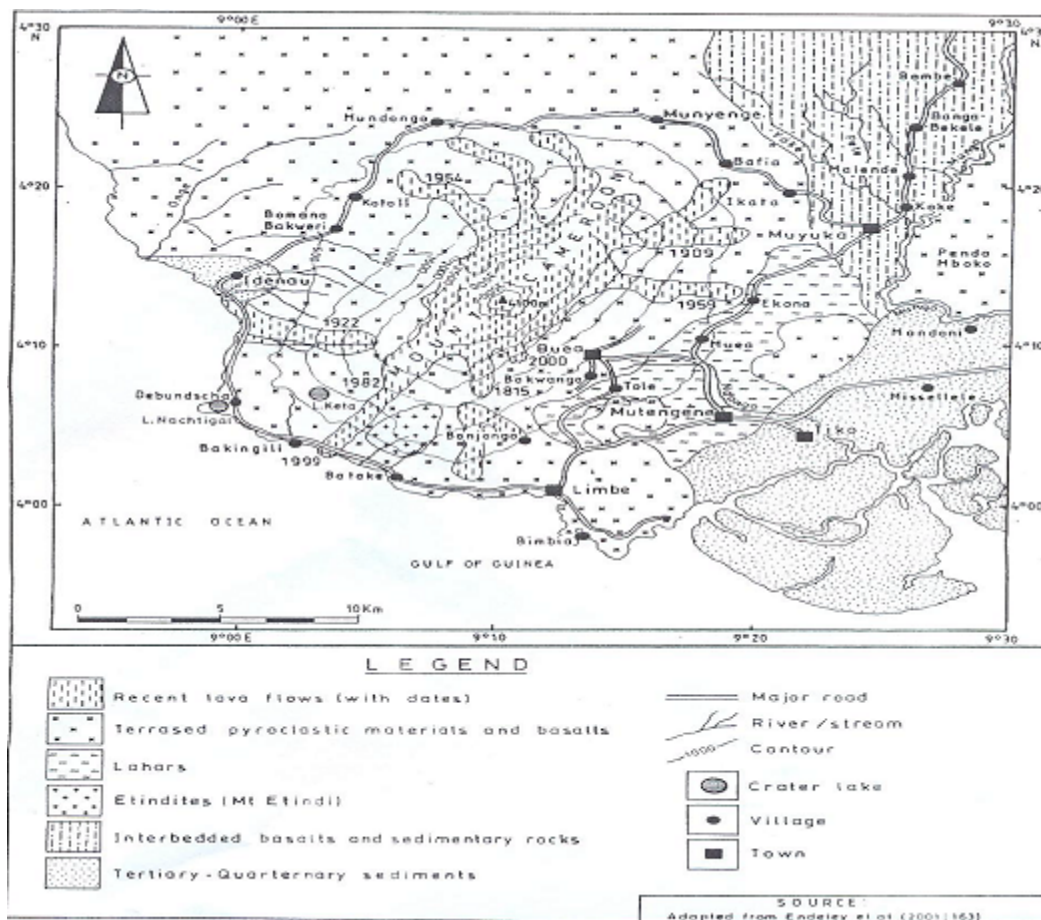


Fig. 2. The lithological setting of the Mount Cameroon region

The exploitation and management of water resources depend on the position of the respondent on the slope of the mountain. This survey shows that about 90% of the local people within the steeper sector of the slope (upland villages) use mainly rain water and tap water from scan sources. This is an indication that surface water availability remains a major problem in the area. This is the case of Bova and Bonakanda. The trend gradually changes as the steepness of slope decreases. To this effect, about 90% of the population in the lowland villages depends on the use of tap water, while 20% indicated the use of streams or '*lambas*'. The 20% is probably those who cultivate crops along water courses in the dry season.

In all the villages surveyed, water from pipe-borne sources is supplied and managed by the local people under the supervision of the village councils (Table 1). In the upland villages of Bonakanda and Bova, pipe-borne water is obtained from scan water sources in which water is dragged by the use of special machines from the water table far below. In Muea, Bomaka, Ekona, Mamu, pipe-borne water is obtained from surface water sources like streams found in the neighbourhood or some catchment.

The creation of vast banana and palm plantations in some of these foothill villages around Bomaka-Muea area, Mamu and Ekona has not been a result of chance. Water which infiltrates through scoriaceous or pyroclastic deposits and becomes imprisoned in the underlying volcanics from the upper slope villages generally gush out around the plantation sites in much the same way as the boiling springs of Carlisle, Pennsylvania. As bananas in particular are heavy water consumers, the emergence of copious amounts of water at the surface has been the prime factor encouraging the opening of the CDC agro-industrial plantations.

Surface water is evenly distributed and available in the Mount Cameroon region in general

and the eastern slope in particular. Surface water sources like streams are scarce on the upper slopes and more abundant on the lower slopes. This areal distribution is accounted for by two physical parameters; namely, the steepness of slopes and nature of rocks. Steeper slopes enhance rapid surface flow since they take a shorter time to be saturated. This water can easily drain away from it. In addition, the nature of volcanic rocks here improves the surface drainage by encouraging a high degree of deep percolation. Though the landscape is a major watershed, most of the incoming precipitation is lost into the underground portion of the crust limiting available water supply in the upland villages. This is why scan water machines have been installed to replenish surface loss. Most of the water even oozes out at the surface in the lowland villages where the gradient is very gentle. This is why at relatively low gradients of about 2°, surface water sources like streams and swamps are abundant in Ekona, Mamu, Mile 16, while steep slope villages like Bonakanda, Ekona Lelu, tend to suffer from physiological drought as most of the water is available only in the subsoil.

The streams found in this region have local names derived from some of the most important indigenes of the area considered to be owners of the streams. In the lowland villages, the major streams frequently exploited by the local people for domestic purposes and agriculture have the following appellations as shown in Table 2.

Bomaka has, besides 'Mr. Peter' two other sources of water, namely, 'Big Water' (spring) at the Mile 18 camp, and Boma (spring) located downtown Bomaka. It also has two wells which were sunk in order to facilitate building construction as tap water is unreliable and congested and 'Mr. Peter' is rather distally located. The Bomaka water supply is of poor quality for reasons invoked later.

Apart from the 10 stand pipes at Muea, it has been the 'Njonjie' and 'Three Pumps' (spring)..

Table 1: Pipe-borne water sources on the eastern slope villages

Sources Pipe-borne	Muea No. of respondents	Bomaka No. of respondents	Ekona No. of respondents	Mamu No. of respondents	Bova/Bokova No. of respondents
SNEC	0	0	0	0	0
Community	20	20	20	20	20/20
Private	0	0	0	0	0
Other (s)	0	0	0	0	0

Source: Authors Fieldwork (February 2006)

Table 2: Main streams exploited by the local population

<i>Settlement</i>	<i>Muea</i>	<i>Bomaka</i>	<i>Ekona</i>	<i>Mamu</i>	<i>Bova/Bokova/ Bonakanda</i>
Stream (S)	‘Njonjie’ ‘Three pumps’	‘Mr Peter’ “Big Water” Boma	‘Mr Findy’ “Ekona Water” “Last Town Stream”	‘Ma Mbiango’	No stream No spring Scan water scheme only

Source: Authors Fieldwork (February 2006)

Fresh water gushes out from the “Three Pumps” opposite the Mount Cameroon Sports Academy in much the same way like the reputed “Boiling Springs Fields” of Carlisle, Pennsylvania. This strong pressure flow is probably linked to the strongly dipping nature of the water table from the Moli volcanic cones around Lyongo. This inference is based on the fact that the water table tends to follow the topographic setting of the landscape. The ‘Three Pumps’ and the spring of the former Moli Banana Boxing Station are two of three foothill springs which emerge within a vicinity of 50-60m from the Moli scoriaceous cones. These two springs are all characterised by strong hydraulic pressure even in the heart of the dry season. The River Koke which flows through the town comes from the waste pipes of the Bwitingi catchment.

This source is highly polluted and it is used only for laundry and bathing. The upland villages, namely, Bova, Bokova and Bonakanda thus depend on the scan water schemes. If the scan water machine does not function to pump water from the Bwitingi source region, these settlements would have no water at all. But the following three sources, “Big Water”, ‘Three Pumps’ and Boma are springs which are exploited only in times of great water stress because of their distal locations.

Generally, water quality varies from one settlement to another and it is affected by factors like agricultural practices and geology. In Ekona and Mamu villages, more than 90% of the people indicated that they enjoyed excellent and good quality water availability, 80% indicated the availability of good quality water in Muea while almost all the respondents in Bomaka and Bova complained of poor water quality. In the Bomaka area, inhabitants complained of the presence of green algae (green grass) and other unknown sediments in their pipe-borne water. They blamed this on the inability of the council to manage the water and the nature of the water source. The good quality in the Ekona and Mamu area is linked to the nature of the surface rocks. These two

settlements have very rocky/stony and undulating landscape characterized by many valleys, factors that improve drainage and water quality. The poor water quality in the Bomaka area is linked to high degree of plantation farming around the watershed or source by the Cameroon Development Corporation (CDC) which pollutes the water through the enormous application of agricultural pesticides. These contaminate both surface and underground water. The Bomaka water comes from the Mile 18 Banana project. The rural water supply for this settlement was simply tapped from the water resources designed to run the banana plantation both for irrigation and processing of bananas for export. So the water quality does not meet the potable standards that will be required of well designed systems. The stream christened “Ekona Water” is highly polluted and of poor quality because it comes from Mamu where upstream utilization degrades water quality.

The local population residing along the eastern slope use water in a variety of ways; such manipulations have altered the quality and quantity of water. In the first place, 70% of the population here depends on agriculture as a principal economic activity which is practised almost all year round. Consequently, since rain, which is the principal determinant of agriculture is not all year round, the local people tend to resort to crop cultivation along water courses especially during the dry season. This type of farming here is locally called ‘*lamba farming*’. This type of farming involves some sort of seasonal migration to and from the river/stream valleys in the dry and rainy seasons respectively, a concept that could be locally called ‘agro-transhumance’. In the dry season, the valleys of Njonjie, Mr. Peter and Koke streams are invaded by the local women due to lack of soil moisture on the land. Vegetal cover is cleared, and burnt while some is sprayed using gamazone. The soil is tilled and crops like vegetables and Ibo cocoyams are planted. Harvesting is done between 2-3 months and the women can now

migrate back to land especially at the onset of the rainy season. This cycle continues year in, year out and these activities greatly modify the stream ecosystem and affect water quality. This cycle involves the use of chemicals that affect water quality, such as fertilizers, gamazone and burning. The use of these chemicals or farming techniques along the streams implies pollution of the water ecosystem.

Other sources of water pollution around the eastern slope include activities like car wash points, stray animals (pigs), laundry and plantation farming. Many car washing points have been established by young men between the 17 – 28 years age range from Mile 17 area to Ekona. These activities involve the use of disinfectants or disintegrated whose effect on the local aquatic ecosystem may be disastrous. These points are fast becoming commercial points especially the sale of food, cigarette and sugar cane. The plantation farming activities of the CDC have been consistently blamed by the local population to be the main source of pollution for their portable water supply especially in the Mile 18 and Bomaka area. This is probably because the main water source for these settlements is where there is intensive banana cultivation by the CDC. Generally, the major source of water pollution in the eastern slope of Mount Cameroon are agricultural (subsistence and plantation), car wash points and stray animals like pigs.

Though water is a free gift from nature, it is increasingly becoming a commercial commodity fueled by the rapid population growth, and the diverse purposes for reading socio-economic implications. To this effect, local income is generated from it especially from those involved in the sale of water at the major bus stop of Mile 17 and Muea. In addition, water courses provide self-employment to the local population. This is reflected in the increasing number of people cultivating crops and vegetables along water courses in the dry season both for subsistence and commercial purposes. Another important activity from which young people earn money is car wash along local streams. These car wash points are also becoming mini-markets as the sale of cooked food, cigarettes, ripe bananas and sugar cane. This high interaction of commercial activities at water courses tends to reveal the importance of water as a universal resource.

It has been observed that there is little impact of water exploitation on the resources of the

eastern slope. The exploitation of water courses for agriculture has little or no effect on soil fertility. The soils along the local streams though under constant cultivation by subsistent peasant farmers still remain very fertile. One possible explanation for the fertility could be the high andosol content of the young volcanic soils and their Allophane content.

The only significant impact of water resource exploitation could be that observed on the quality available. There is a gradual reduction in stream volume from the lowland to upland villages. There is a strong relationship between fall in stream volume and altitude or gradient. As slope steepness increases, the volume of streams decreases. There is a sharp fall in stream volume of gradient of about 4° – 8° , which corresponds to villages like Bova, Bonakanda, and Ekona Lelu. Here, surface water is scarce because much of it either goes away as runoff or sinks in the underlying substratum given the highly jointed and scoriaceous nature of the overlying volcanics. This brings about the physiological drought phenomena. Here, water is available but the water table below is very deep. This makes surface water scarce. It is important to note that at a gradient of about 2° which corresponds to the lowland villages, the water table is permanently close to the surface. This makes available surface water supply occur abundantly in the lowland villages in the form of streams and swamps. The lower slopes here have fine textured soils with low degree of compaction.

Generally water affects the rate of development of any rural community. The problems of water and exploitation have a direct implication on rural development as observed in villages of the eastern slopes of Mount Cameroon. The principal problem faced by these communities especially the upland villages is that surface water availability and the long distances effected to obtain water. This is related to the effect impinged by the physiological drought phenomena. This situation necessitates the application of some technological strategy to obtain water. In this respect, scan water schemes are used to pump water against the force of gravity to the upland settlements. This further complicates the issue of enough water supply. In addition, local village authorities complain that three scan water machines were stolen in the neighbourhood just at the eve of this research. Apart from these problems, the cost of obtaining water is high especially in the upland villages as per Table 3.

Table 3: Monthly cost of water, distance to and time spent at water collection points

<i>Settlement</i>	<i>Average Monthly Cost</i>	<i>Distance to Water Point</i>	<i>Average Time Spent at Collecting point</i>
Ekona	0	50m	20 min
Muea	0	50m	20 min
Bomaka	0	200m	30 min
Mamu	0	50m	15 min
Bova	1500FrS	500m	35 min
"Bonakanda"			

Source: Author's Fieldwork (January 2006)

The upland villages spend a lot in terms of money and distance to get water for domestic use. The monthly average expenditure is 1500 FRs and most people travel up to about half a kilometre to obtain water. According to the local population, the 1500FCFA represents the cost of transport fare to Muea, Ekona or Buea where they have to travel to get water. This can be explained by the effect of physiological drought where most of the water is available only in the subsoil deeper water table. The case of Ekona Lelu is even more precarious as the inhabitants must travel down to Mundame Camp to obtain water. For this upland settlement in particular, the coming of the rainy season is seen as a great blessing which is greeted with enthusiasm and hope.

Though people in the lowland villages pay no monthly rate to obtain water, it was also established that most of them had to pay 50.000FCFA each when most of the community water projects were initiated. The long distance covered to obtain water in the Bomaka area could probably be explained by the fact that it is a well planned settlement evolving under the effect of suburbanisation from Buea with houses following a checker-board pattern.

The short distance and time spent at collection points in Muea, Mamu and Ekona is linked to the dense network of pipe borne taps. They have been implanted at irregular intervals to serve the clustered settlements.

There is no doubt that in terms of rural development, the distribution and availability of water resources influence the rate of development in the villages and communities surveyed. The lowland villages with enough water and uninterrupted supplies have been experiencing a relative faster rate of rural development, all other factors being constant. This is the case of Ekona and Muea where most of the CDC plantations have been created due to enough surface flows

to supply crops with enough moisture. Subsistence crops by the local population are also omnipresent as the main source of revenue to them.

These factors are partially responsible for the high influx of people into this region from other parts of Cameroon especially the agricultural population. The rate of rural development has been seriously slowed down by crisis in the upland villages of Bonakanda, Ekona Lelu and Bova especially during the dry season. This is because these are predominantly agricultural based communities which depend principally on rain-fed agriculture. Irrigation and swamp cultivation is common place in the lowland villages. The dry season renders agriculture dormant in the upland villages. This has slowed down migration into the upland villages, slowing agricultural productivity and rural innovations. Water related self-employment activities practised along water courses are completely absent in the upland villages. This further aggravates rural poverty.

Most of the buildings or houses in the lowland villages are modern cement houses which have been put in place, thanks to enough water for the moulding of cement bricks. On the other hand, because of water crisis, houses in the upland villages are wooden houses. Being a mobile zone, most of these houses constructed of wood are not easily damaged during seismic activities that is recurrent here. For these reasons, there is no doubt that rural development still lags behind in the upland villages as compared to the situation in the lowland villages.

DISCUSSION

Generally, the local people around the eastern slopes of Mount Cameroon recognize water as an important natural resource. From all indications, their responses seem to correlate with the purpose for which water is exploited. More than 70% of the respondents indicated that water is life. This means that they are already aware that without water, their existence and survival is threatened. Some respondents indicated that water is important for agriculture. This is perhaps because most of them are farmers who practise crop cultivation along water courses especially during the dry season period and are therefore obliged to do some minor irrigation when surface water from springs and streams is not readily available.

The eastern slope of Mt Cameroon is a well watered region which is frequently recharged by the heavy precipitation that characterizes the eastern slope. Some of the pyroclastic cones are underlain by impermeable layers of basalts. The heavy precipitation which recharges the underground supplies percolates through the scoriaceous materials until it gets to the perched water table. The jointed nature of some of the basaltic lava flows and the porous nature of the scoriaceous deposits make this area a rich hydrological reservoir. The jointed and fractured nature of the basalts together with the unwelded nature of the pyroclastic deposits gives the underlying substratum a high porosity and permeability. So the underlying lithology acts as a 'sponge' giving rise to a volcano-pseudo karst or volcano-karst drainage system (Ollier, 1976). The appearance of vauculian springs in which surface water disappears underground and reappears as resurgences has also been noted in parts of this volcano-karst landscape.

Since this region is underlain by basaltic lavas which are, in turn, overlain by volcanic scoriaceous deposits from the strombolian eruptions of Mount Cameroon (Fig. 2), the most impressive characteristics of these volcanic extrusions therefore are their high degree of porosity and permeability. This is so because the loose scoriaceous deposits possess interstitial spaces, cavities and gas vesicles. Apart from these weaknesses which make up passage venues for infiltration of meteoric water into the substratum to give underground water, the strongly jointed nature of some of the underlying basaltic lava flows accounts for the frequent occurrences of dry valleys. These characteristics have all gone to enhance the degree of porosity and permeability of the volcanics.

The lahars which occur on the north eastern slopes of Mount Cameroon dominate the areas around Muyuka-Ekona-Muea-Tole and Mutengene. So the springs either originate from the lahars or from the plane of contact of pyroclastic materials and basalts. Since some lahars may possess a high clayey content which constitute the impermeable layer, springs emerge along the slope.

Furthermore, the topographic lay out of these eastern slopes shows many pyroclastic cones on the upper and middle slopes. Made up of unwelded scoria or pyroclastic materials, they are porous and therefore, make up good aquifers with

an enormous water-holding capacity. But on the lower slopes where impermeable massive basaltic lava flows or strata outcrop on the surface, springs emerge at the top of the impervious or impermeable strata. Thus, Foster (1971) remarks that perched aquifers occur when the downward percolation of infiltrating water is stopped by a relatively impermeable rock as may be the case with massive basalts or clays. Consequently; the influence of the underlying lithology and geological structure on the surface and ground water resources is profound following the occurrence of alternate bands of lava flows and unwelded pyroclastic deposits. Ashu, (2002) noted that underground water emerges as streams generally where the lava-scoria interface intersects the slope. He also remarks that most streams arise as springs at altitudes somewhere around 1,800m and below.

CONCLUSION

Water is the most important natural resource whose availability and management influences the rate of socio-economic development. This paper reveals that the problem of water resources in the Mount Cameroon region is very much related to its availability rather than its management. It is more available in the lower villages where its exploitation especially for agriculture and commercial activities has accelerated the rate of rural development. On the other hand, the natural phenomena or physiological drought tends to hinder rural development in the upland villages. This situation is made worst because of the irresponsible behaviour of bandits who always do away with some of the scanned water machines, sooner or later as they are installed. To reduce the impact of surface water supply on the upper slopes of Mount Cameroon, sound water management policies are required to be put in place since Mount Cameroon is a major watershed. Local development organisations like South West Development Authority (SOWEDA) and The Mount Cameroon Project should sensitise and educate the local population on proper land use methods like planting of trees through reafforestation schemes in order to protect the degradation of the watersheds. Furthermore, the planting of environmentally friendly trees that bring water closer to the surface is highly recommended especially in the upland villages

that suffer from physiological droughts. With these and other strategies, the future of both subsistence and plantation agriculture and rural development could be brighter.

All the community-based water schemes of the selected settlements on the eastern slope of Mount Cameroon have been established because of the impetus or contributions of the Cameroon Development Corporation agro-industrial plantations which have emerged as true catalysts for rural and socio-economic development. The Cameroon National Water Corporation (SNEC) on the other hand, unfortunately only targeted the urban populations.

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