International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 4 Issue 6, September-October 2020 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Slope Dynamics and Implications on Livelihoods: A Case study of the Kom Highlands in the North West Region of Cameroon

Tosam Hycinth Ngong

PhD, Department of Land Transport,
Higher Institute of Transport and Logistics, University of Bamenda, Bambili, Cameroon

ABSTRACT

This paper examines the changing nature of slopes and their implications on livelihood activities (faming and settlements), in the Kom highlands. To arrive at this objective, the topographic map of the study area was got from the national institute of cartography and analysed to identify areas of steep, moderate and gentle slopes. Furthermore, the digital elevation model of the study area was realised as well as land use maps. The implications of slope types on livelihoods were determined from field observations, structured questionnaires and interviews. The findings revealed that slope traits are hardly considered when farming or constructing houses. The result of which has been poor farm yields, environmental hazards such as landslides and soil erosion. Based on field findings, a land use suitability map for the study area was realised and it is hoped that if land uses occupy appropriate slope locations, environmental problems such as landslides, soil erosion will be greatly reduced and agricultural productivity will increase.

KEYWORDS: *Slope dynamics, Implications and Livelihoods*

How to cite this paper: Tosam Hycinth Ngong "Slope Dynamics and Implications on Livelihoods: A Case study of the Kom Highlands in the North West Region of Cameroon" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-4 | Issue-6, October 2020, pp.354-365, URL: www.ijtsrd.com/papers/ijtsrd33393.pdf

IJTSRD33393

INTRODUCTION

The earth's surface is never completely flat or uniform because it consists of slopes. In hilly and mountainous environments, livelihood activities must therefore be adapted to the nature of the slopes. Livelihoods refer to the natural and human opportunities and possibilities that man can exploit to make a living. In mountainous environments livelihood activities such as farming and settlements are greatly influenced by the changing nature of slopes. Some authors have defined livelihoods as the totality or set of opportunities capabilities, assets, and activities that are required to make a living (Chambers &Conway, 1992; Ellis et al., 2003). They depend on access to natural, human, physical, financial, social, and cultural capital (assets); the social relations people draw on to combine, transform, and expand their assets; and the ways people deploy and enhance their capabilities to act and make lives meaningful (Scoones,1998; Babington, 1999). Livelihoods are dynamic and people adapt and change their livelihoods with internal and external stressors. Ultimately successful livelihoods transform assets into income, dignity and improve living conditions, a prerequisite for poverty alleviation (Sen,1981). Some slopes are steep and precipitous; others are moderate or gentle. Some are long and gradual; others are short and abrupt. These slope types impact livelihood activities in various ways.

Slope dynamics is the changing nature of the slope over time under the influence of gravity, anthropogenic forces, denudational agents with special emphasis on rain water in the humid tropical environment. The changing nature of slopes has been of great concern since the era of William Morris Davis in the 1800 who proposed that landforms like organisms could be described and analysed in terms of their evolutionary development through time. Davis thus classified landforms according to their stage in a theoretical cycle of development using the term "youth" "maturity" and "old age" where he then inferred the processes by which the landforms of each stage would slowly evolve into those of the next stage. In any region, there is hardly any perfect uniform topographic configuration nor does there exist any environment whose slopes have remained the same over time. Since all human activities and development are carried on the earth surface, slopes with respect to their evolution becomes incumbent to the sustainability of human environment.

According to Hugget (2007), slopes vary from one region to another and are subject to change over time. As noted by Hugget, all landforms consist of one or more slopes of variable inclination, orientation, length and shape. Slope dynamics otherwise known as the evolution of slopes may establish different forms of slopes amongst which are convex, free face, constant, concave amidst a host of others.

Some general classification of slopes have been made by different authors depend on the purpose of the classification. Based mainly on surface processes and based on the practical significance of angle with respect to land use are both approximately logarithmic. Table 1 shows a logarithmic classification. Column A shows an eclectic system based on seventeen classifications (devised mostly for use in soil surveys and land classification). Column B shows the FAO soil system, itself based in part on the most widely used survey scheme, that of the U.S Department of Agriculture. Numerically simple schemes are obtained by making each upper class limit twice the angle value of the lower based (1-2^0-4^0-8^0-16^0-32^0-62^0). Speight carried out the logarithmic principle to its logical extent in a scheme based on equal increments of log. Tan column C which he extended into the under 2^0 or gradient range. The following angle classification designed for slope geomorphology has seven classes with subdivisions of the end numbers which may be employed where either of the latter are especially frequent or significant column Slope classification is incorporated in this study in order to determine the suitability of land used at various slope segments in the study area.

0-20Level to very gentle: This corresponds to what is considered as flat land areas in typical erosional landscapes.

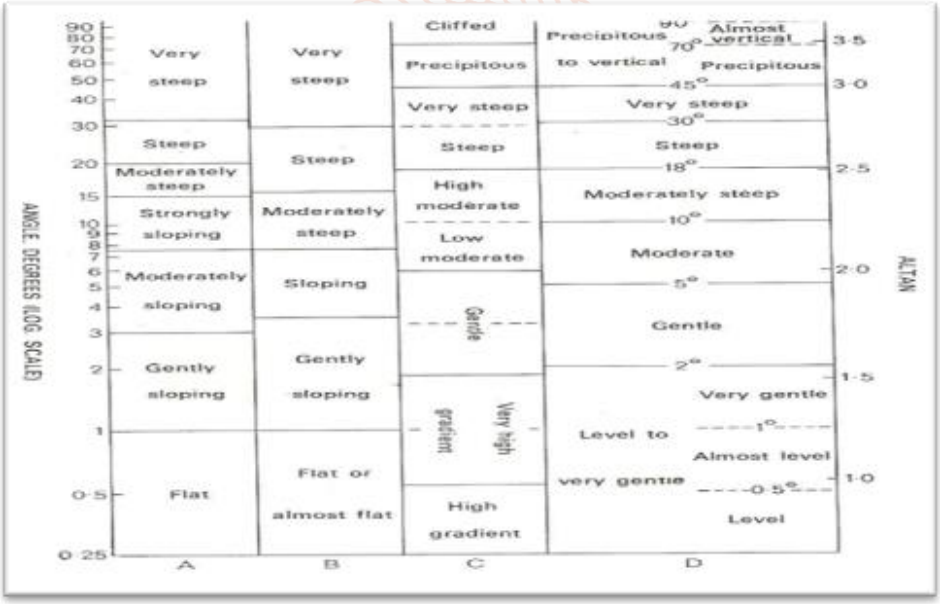
2-50 Gentle: Generally considered to be a peneplain,50 is the steepest acceptable slope. In many areas this class contains the primary characteristic angle.

5-100: Moderate the range in which many regions, angle frequency decline steeply

10-180: Moderately steep landscapes that are neither plains nor steeply dissected, contain substantial areas of this limits and the proceeding class. Practical limitations are substantial but such land can still be of moderate economic value.

18-300: Steep above 180 arable cultivation requires special measures and many forms of land use become uneconomic.

Table 1 Logarithmic classification slopes



Note. Table 1 slope classification
A Ecletic based on 17b previous classification (Curtis et al 1967)
B Classification used in FAO soil manual
C and D classification adopted in this paper

Source: Adapted from Young (1972pp 13 and modified)

Slope gradients greatly influence development activities. According to Berryman et al (2008) Table 2, slope gradients above 25^o are only suitable for only used for open space and certain recreational uses. In the study area the haphazard occupation of steep slopes resulting from increased population pressure has produced varied environmental problems including landslides and soil erosion.

Table 2 Slope Classification and Development Potentials

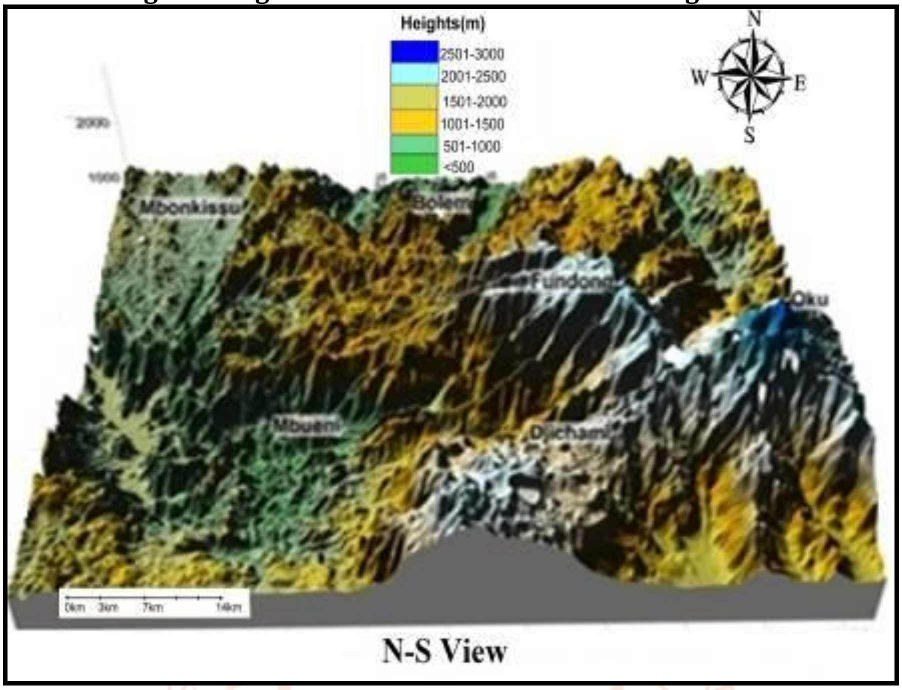
Degree of slope	Development potential
0-3%	Generally suitable for all development and uses.
3-8%	Suitable for medium density residential development, agriculture, industrial and institutional uses.
8-15%	Suitable for moderate to low-density residential development, but great care should be exercised in the location of any commercial, industrial or institutional uses.
15-25%	Only suitable for low-density residential, limited agricultural and recreational uses.
Over 25%	Only used for open space and certain recreational uses.

Source: Berryman et al (2008) Soil Surveys of Lehigh/Northampton Counties, Pennsylvania, Soil Conservation Service, 1963, 1974.

The topography of the study area varies significantly from areas of less than 900metres of altitude to more than 3000metres of altitudes (Fogwe, Z.N. & Tchotsoua, M. 2010). To the western part of the study area relief is generally lowlying. Altitudes vary from less than 900metres, but increase sharply towards the east and culminate in the Ndawara Highlands(2850m) and the Oku mountains (3000m) (Figure1). Geomorphological features constitute major obstacles to agricultural activities and other land uses such as pastoralism, the construction of settlements and road network (Tosam and Fombe 2015). The steep nature of slopes, together with human pressure resulting from rapid increase accelerate the occurrence of landslides, soil erosion varied forms of mass movements. This is visible on the hilly slopes of Anjin, Tumuku Njinikom, and Achain(Figure2)

The elevation determines the distribution of lands uses and this is a typical characteristic of mountainous regions. This means that each zone requires specific sustainable adaptation practices. Livelihood carried out without the respect of these ecological boundaries are bound to confront negative setbacks. the scarcity of land for agriculture and the rapid increase in population have forced the inhabitants to cultivate fragile mountain slopes.

Figure 1 Digital Elevation Model of the Kom-highlands



Source: Derived from the Landsat image of the study area

Some slopes are mantled with soil and covered by vegetation; others consist of barren rocks and rubble (Tassah 2013). Their form and variety are great Figure 2 a and b. Put together, slopes are the most common elements in our physical landscape. Although most slopes appear to be stable and unchanging, they are not static features because the force of gravity causes materials to move down slope. At one extreme, the movement may be gradual and practically imperceptible, at the other extreme; it may consist of a thundering rock fall or avalanche (Edward et al, 1993).

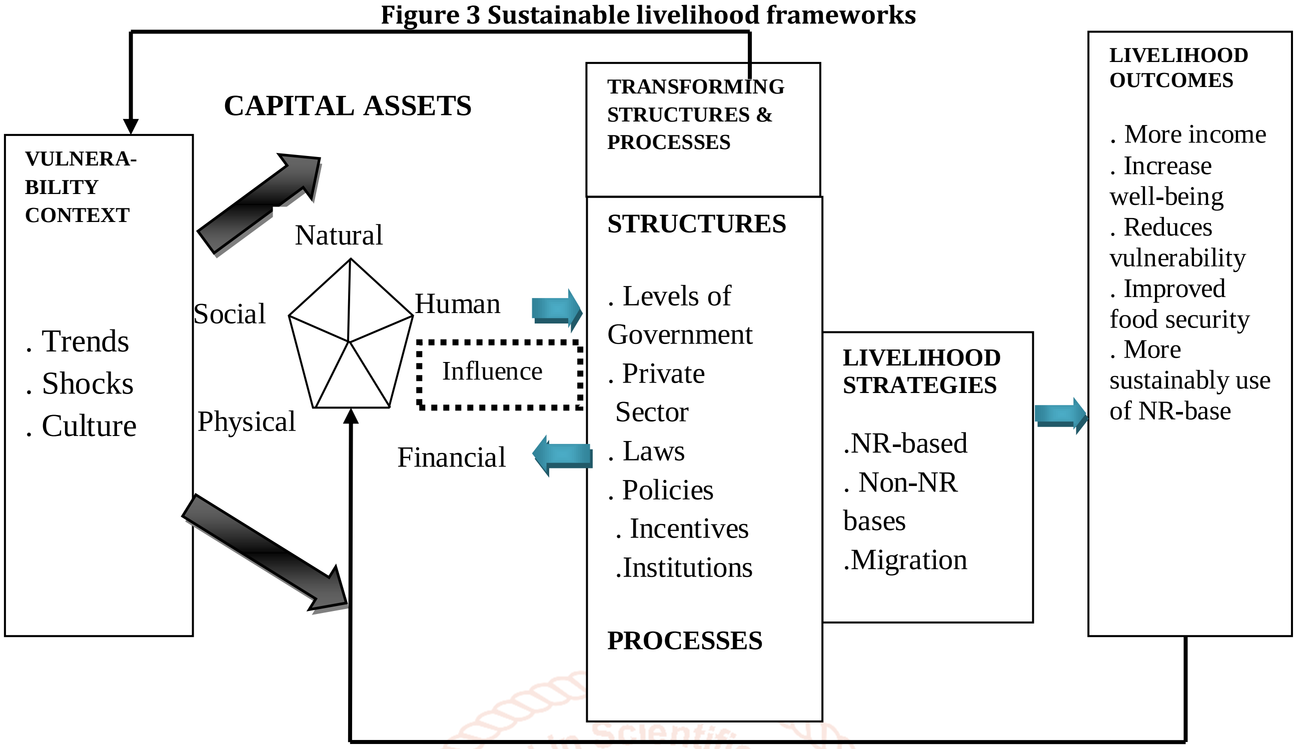
Figure 2a ***Steep sleeps at Achain***

Figure 2b ***Interlocking spurs with steep slopes at Ajung***

Source: Fieldwork (2019)

This study is also rooted in the sustainable livelihood framework proposed by (Ashley and Carney, 1999) (Figure3).

Figure 3 Sustainable livelihood frameworks



Source: Ashley and Carney (1999), pp.7.

Ashley and Carney (1999) considers, sustainable livelihoods as a people-centered view of the development agenda; based on five major assets (natural, financial, human, physical and social) these asset blocs could lead to a range of livelihood outcomes (health, income, reduced vulnerability, food security and a more sustainable use of natural resources). According to the framework there are four types of sustainability, namely economic, institutional, social and environmental sustainability.

Figure 3 illustrates that livelihood asserts can be (physical, financial, human, natural, social and human). These assets are explained as follows:
Natural capital: this asset bloc is comprised of (land, water and other environmental resources the natural resource stocks) from which man can exploit to meet his needs.
Physical capital: the basic infrastructure (transport, shelter, energy) and the production equipment and means which enable people to pursue their livelihoods.

Financial capital: the financial resources available to people (ordinary savings, credit, remittances, pension) which provide them with different livelihood options.

Social asset and political capital: this asset bock is made up of (networks, membership of groups, relationships of trust and reciprocity) on which people depend on to achieve their livelihoods goals.

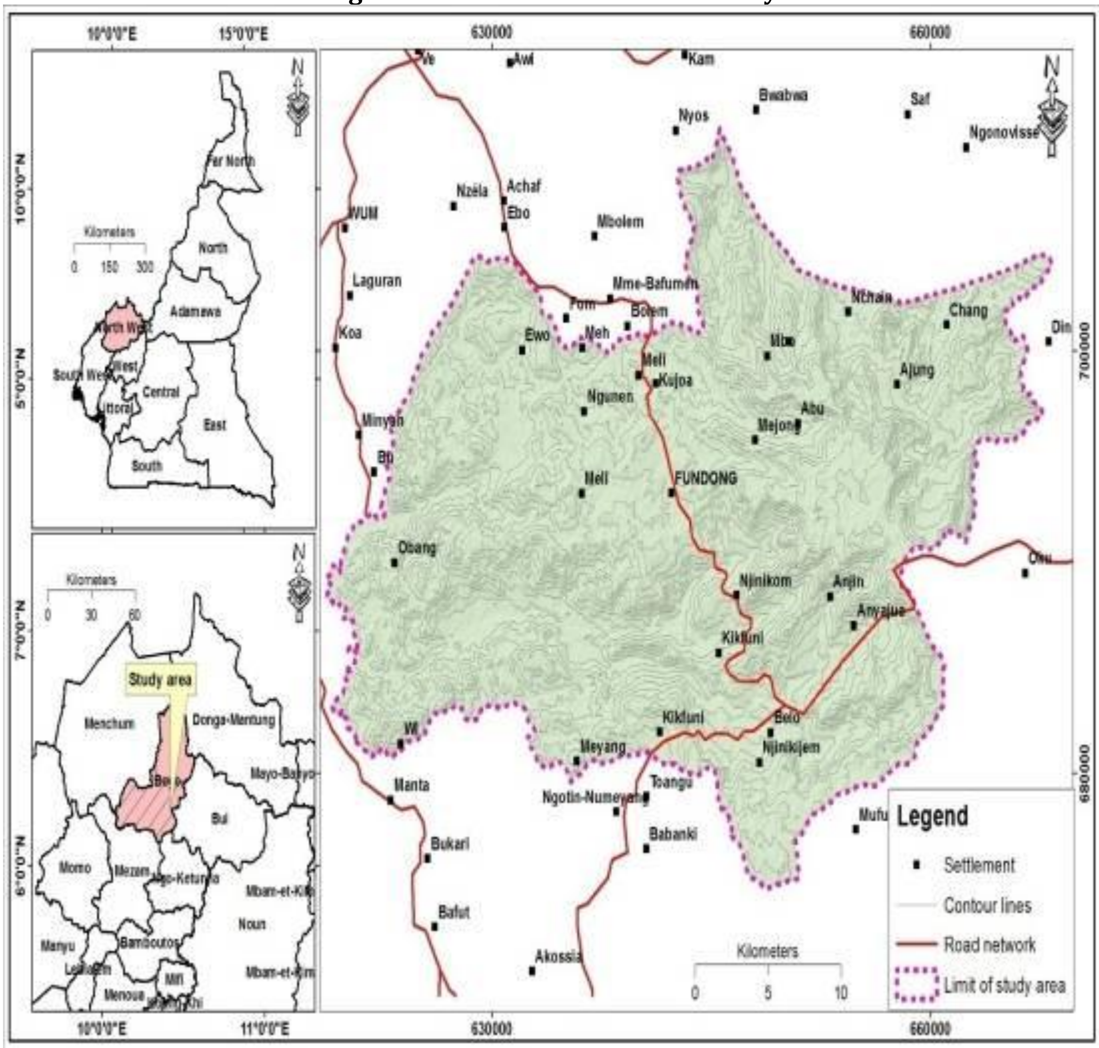
Human capital: Refer to intellectual capacities, competences, skills, professional life and attitudes required for the improvement of living standards, working conditions, social welfare of all the members in a society.it also relates to labour resources available both quantitative and qualitative dimensions. Quantitative refer to the number of household members and time available to engage in income earning activities. Qualitative refer to the levels of educational skills and health status of household members

In consonance with the sustainable livelihood frame work, the livelihood assets in the Kom-highlands include physical asset such as soil types, climates and the topographic landscape. Social capital represents the rich culture such as the works of art, dressing style, traditional dances while human capital represents the indigenous knowledge of the people. The commercialisation of agricultural and non-agriculture products and the funding of projects by the council, NGOs and the state are sources of financial asset. These livelihood assets constitute the basis of a sustainable livelihood in the Kom highlands

STUDY AREA MATERIALS AND METHODS

The study area is found in the North West Region of Cameroon and comprises three subdivisions within the Boyo Division (Fundong, Njinikom, and Belo) Figure 4. The study area lies within Northing 674555N to 710562N and Easting 618651E and 668238E with the total surface area of 94669 hectares. Mean annual rainfall is approximately 2423.4 mm of rain. Altitude ranges from 564 to 2572 m. The slope ranges from flat to very steep slopes.

Figure 4 Location of the area of study



Source: Derived from the political Map of Cameroon

The topo sheets on 1:200,000 scale with 20m contour interval were used for delineating different slope categories. The distance between two adjacent contours represent the horizontal component and the difference in the value of the adjacent contours gives the vertical component. Based on these different slopes categories in gradient and their equivalent horizontal distance (in cm) separating 20m contour were trigonometrically derived (Table 3). By measuring the distance between the contours, the area is delineated into four slope classes. The topographic map of the study was got from the national institute of cartography and analysed to identify areas of steep, moderate and gentle slopes. Furthermore, the digital elevation model of the study area was realised as well as land use maps. The implication of slope types on livelihoods was determined from field observation, structured questionnaires and interviews.

FINDINGS AND DISCUSSIONS

The percentage of each altitudinal zone has been calculated using the topographic map sheets of the study area (Table 3)

Table 3 Percentage of land occupied by the various altitudinal zones of the study area

Locality	Altitude in metres	Percentage of land
Baicham Mbueni mbonkissi	Less than 900	28
Belo njinikom Fundong	901-1500	59
Tumuku Muloin Abuh	Above 1500	13

Source: Calculated from the topographic map the study area

Table 3 shows that 59% of the Kom-highlands are found between 901-1500m of altitude, 13% above 1500m and 28% below 900m. This statistic indicates that the study area is predominately hilly as over 72% of it lies above 901 metres above sea level and only 28% below 900m. The elevation determines the distribution of lands uses and this is a typical characteristic of mountainous regions. This means that each zone requires specific sustainable adaptation practices. Socio-economic activities carried out without the respect of these ecological boundaries are bound to confront negative setbacks.

Slope dynamics and implication on farming

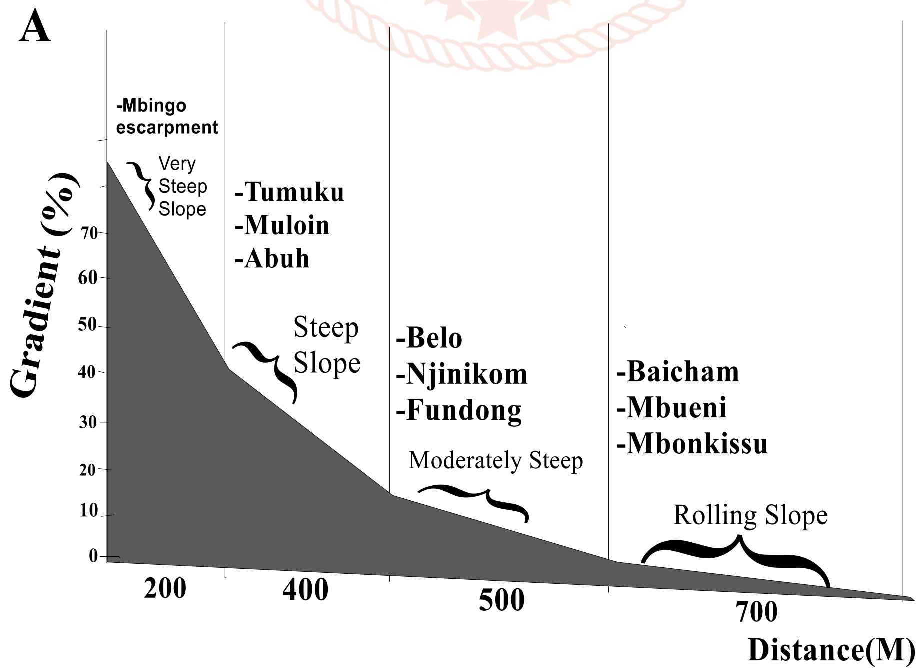
The slopes of the Kom-Highlands vary in their forms from convex, free face, constant and concave slopes. The convex slope refers to the curved over edge of the horizontal surface of the hill top. It occurs at the top of the hill where it curve over to meet the vertical or the free face.The scarp surfaces which are steep and irregular range from 30^0 to 45^0 such slopes are characterised by thin soils due to the influence of gravity. The Mbingo-Baingo escarpment is a typical example of a slope with steep gradient. On such slopes Soil creep and other forms of mass wasting are common The slopes with steep gradients sometimes above 45^0 do not only render the soils poor for any form of agriculture but makes all other forms of agricultural land uses difficult to practice. Faced with accelerated rates of soil erosion, agricultural productivity remains low and human pressure on such steep slopes provoke landslides and other forms of mass wasting. The impacts of slope gradients on farming was investigated in some localities of the study area and summarised in (Table 4 and Figure 6)

Table 4 Slope types and characteristics in the study area.

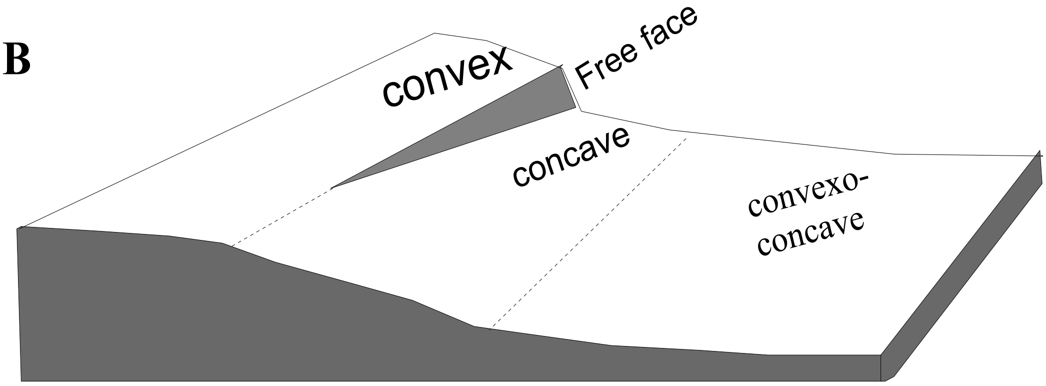
Location	Slope type	description	Slope length (m)	Slope width (m)	Slope gradient (t%)	Remarks
Baicham	convexo-concave	Rolling slope	700	100	8-16	-Slopes mantle with soil and vegetation. Slope merges with valley floor. The main process is the erosion of materials brought from the upper parts of slope. Favorable for the cultivation of crops given that these are basins of material accumulation from the steep and moderate slopes.
Mbueni			700	100	8-16	
Mbonkissu			700	100	8-16	
Belo	concave	Moderately steep	500	100	16-30	Straight and gentle slope mostly found below the free face slopes. Main process is the accumulation of debris form the free face slope. Such slopes are generally not suitable for any form of land used but due to land scarcity and population pressure they are occupied by settlements, subsistence farming and animal grazing.it is due to such antropogenic activities that slope failures are common in the study area.
Njinikom			500	100	16-30	
Fundong			500	100	16-30	
Tumuku	convex		400	100	30-50	
Muloin		steep	400	100	30-50	Vertical slope made of bare rocks. The slope is too steep to allow the accumulation of debris. The main processes are erosion landslide and pressure release. Such slopes are occupied by patches of secondary forest given that the original climax vegetation has been reduced to a subclimax
Abuh			400	100	30-50	
Mbingo escarpment	Free face	Very steep	200	100	≥50	

Source: Field work (2019)

Figure 5 Slope types in the Kom-Highlands



B

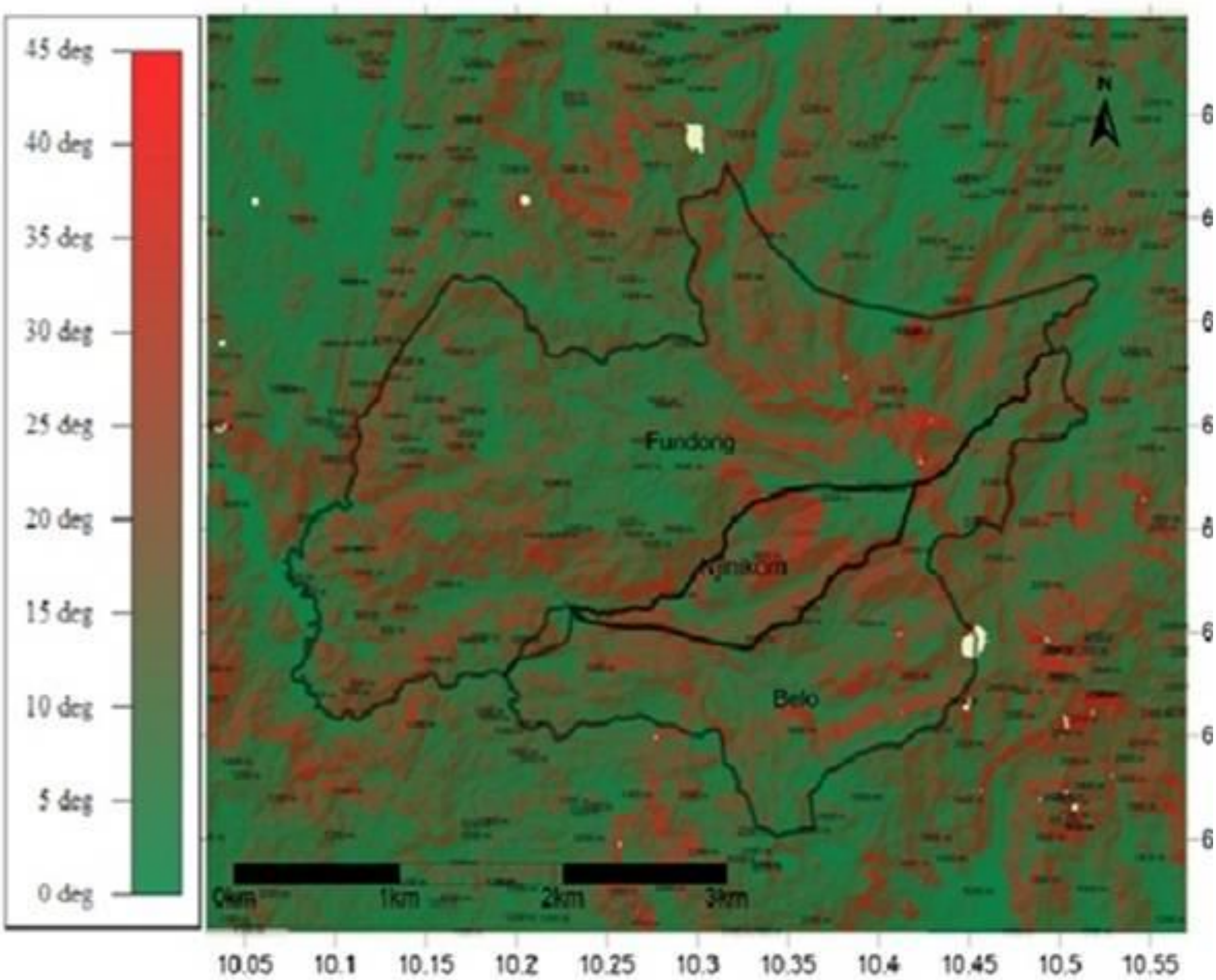


Source: Field work (2019)

The Baicham, Mbueni and Mbonkissu area are characterized by convexo concave slopes which are less steep and more favourable for agricultural development as well as settlement and road construction but surprisingly these areas are sparsely populated. Agricultural development in this area is still very subsistent; settlement and transport network are still very poorly developed. The most densely settled parts of the study are Belo,Njinikom and Fundong which are characterized by concave slopes while the Tumuku,Muloin and Abuh areas are dominated by convex slopes which are very steep and greatly accelerate soil erosion, landslides and other forms of mass movement, all of which negatively influence agriculture, settlement and transport network development.

The hilly and mountainous topography of Kom consists of slopes with varying degrees of steepness (Figure 6).

Figure 6 Slope gradients in the study area



Source: Fieldwork (2019)

The nature of slopes greatly impacts on agricultural prodctivity. This however depends on the type of crops cultivated. In a study carried out by Tosam and Fombe(2015)Table 5, it was revealed that, the productivity of maize, declines with increase in altitudes and gradient, This is explained by the fact that natural productivity conditions for maize like the thickness of the soil layer, and climatic conditions become less favorable at high altitudes. Conversely the productivity of beans, Irish potatoes and coffee increase with altitude and the nature of slope. This because the root nature of such crops can better withstand the effects of soil erosion and leached soils. Thus as the slope morphology changes from gentle, moderate and very steep, so too, do the soil characteristics, such that at high altitudes the soils are very thin. Consequently, the rate of humus decomposition becomes very slow and the growing season is lengthened as compared to the gentler slopes. Farming in such mountainous environments therefore must take into consideration the nature of slope, and the type of crop.

Table 5 Variation in average crop yields per respondent as a function of slope angle in the Kom highlands

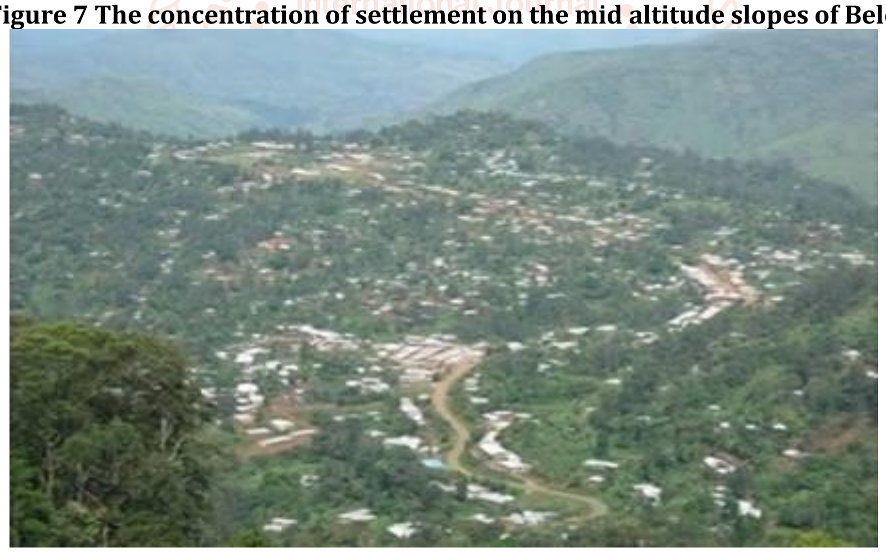
Village location	Altitude	Slope angle	Crop type	Estimated farm size(ha)	Annual yield (tons)
	Low altitude				
Mbueni	<900m	5^{o}	maize	3	10
Baicham			beans	3	3
Mbonkisu			coffee	3	2
	Mid altitude				
Belo	901-1500m	10^{0}	maize	3	6
Njinikom			beans	3	4
Fundong			coffee	3	5
	High altitude				
Tumuku	>1500m	15^{0}	maize	3	2
Muloin			beans	3	4
Abuh			coffee	3	7

Source: adopted from Tosam and Fombe (2015)

Implications on Settlement and Transport infrastructure

Development infrastructure such as road and settlement construction depend directly on environmental factors particularly the relief and geology. Even though it is difficult to determine the maximum altitude on which man can live, population concentration generally declines with an increase in altitudes. This is so because mountainous areas are characterised by negative environmental conditions such as cold weather, poor soils, steep and rugged slopes all of which make the construction of roads and houses not only difficult but very expensive. In the Kom-Highlands, settlements and road infrastructure are concentrated in the mid altitude areas of (901m -1500m) while high altitude areas of more than1500m are considered as marginal lands (Figure 7). The steep slopes of these areas are used for shifting cultivation and annual cropping as well as livestock grazing.

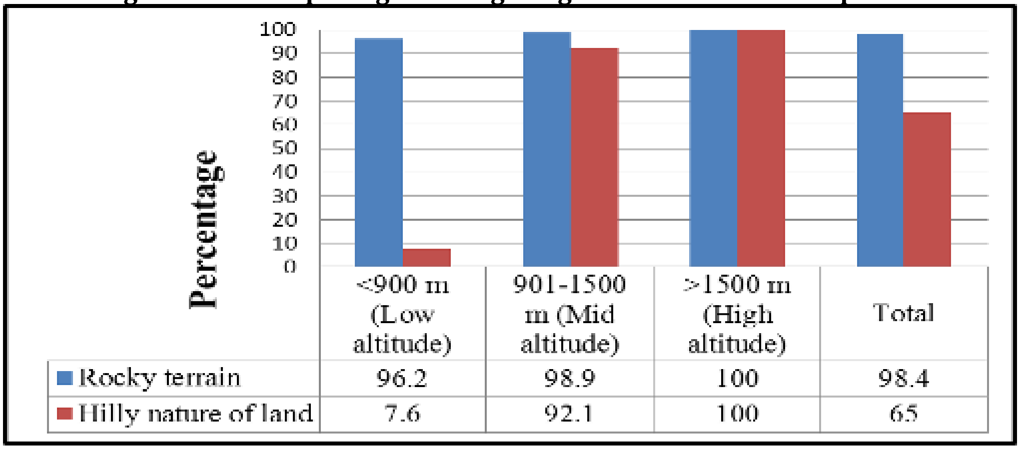
Figure 7 The concentration of settlement on the mid altitude slopes of Belo



Source: Field work, 2019

Geomorphomorphical and geological factors were considered as factors that hinder development in the study area. In the anthropological survey that was conducted for the purpose of this study, 98.4%and 65.0% of the respondents indicated that the hilly and rocky terrain were the most serious controls to development in the study area. The rocky nature of terrain was perceived at all the altitudes as a development problem by 96.2% of the respondents at low altitude, 98.9% at mid altitude area and 100% at high altitude areas (Figure 8). At the mid and high altitude, almost all respondents expressed the view that the topography is a hindrance to development with a weighting 92.1% for the mid altitude areas and 100% for the high altitude. The present state of technology characterized by the hoe and the cutlass, makes it difficult for the inhabitants to transform the steep slopes into vast agricultural land that could produce food sufficient to feed

Figure 8 Geomorphological and geological controls to development



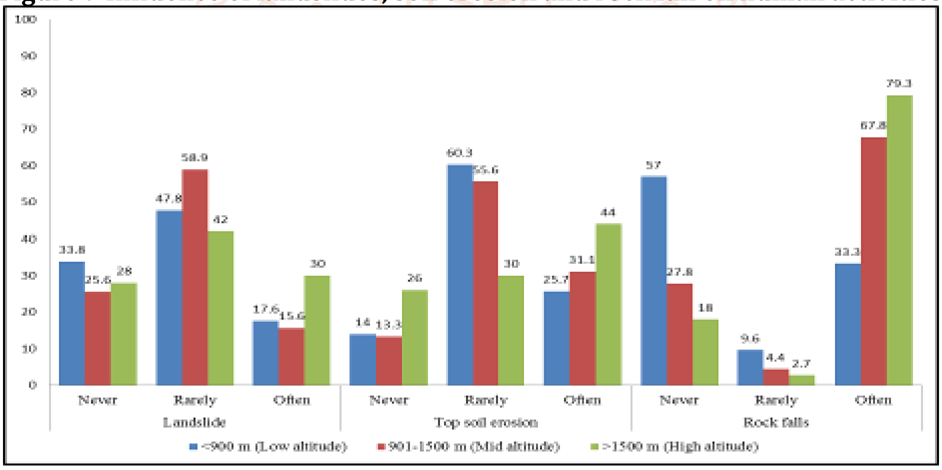
Source: Field work (2019)

Environmental implications of slope dynamics

Landslide was considered by 30.0% of the respondents in the high altitude as a major constraint to development (Figure 9, Table 6). It was however paradoxical, that at low altitude17.6%considered landslides to be a constraint to development than in mid altitude where only 15.6% of the respondent associated the slow rate of development to landslide hazards. This association was significant ($\chi 2$=13.761; df=6; P=0.032).

With regards to soil erosion, the trend was more consistent at all altitudes the perceived severity increased with altitude. At high altitude 44.0%indicated that soil erosion was a serious problem to agricultural productivity, at mid-altitude 31.1% also admitted that low agricultural yield could be associated with soil erosion while at low altitude 25.7% of the respondents also associated agricultural problems to soil erosion. This association was very significant ($\chi 2$=30.321; df=6; P<0.001).

Figure 9 Influence of landslides, soil erosion and rock fall on human activities



Rock falls is also a development obstacle although it is not widespread. At high altitude 79.3%, confirmed that rock fall hindered farming, construction of settlements and road network. At the mid altitude 67.8% of the respondent indicted that though rock fall rarely occurs in area where this geomorphological process is common it has greatly reduced the rate of development. At low altitudes only 33.3% of the respondents admitted that rock fall was a development problem. This association was very significant ($\chi 2$=65.671; df=6; P<0.001.

Table 6 Landslides and other forms of mass movements as obstacles to development in the Kom-Highlands

Type of disaster and hazard	Sub-Division	Locality	Geographic coordinates	Real or probable causes	Consequences/ repercussions	Measures taken or envisaged	Date of disaster or hazards
Mudslide/landslide and mass movement	Njinikom	Koini Hill	N6,2602º E10,2963º	Steep slopes and saturated soil	Traffic was disturbed	None	2012
	Njinikom	Muloin	N6,2407º E10,3270º	Steep slopes and saturated soil	Loss of human lives	None	1998
	Belo	Sho	N6,2129º E10,3342º	Steep slopes and saturated soil	Two people died and property destroyed	People were evacuated	September 1997

		Anjang	N6,2131° E10,4054°	Steep slopes and saturated soil	One person died and a compound destroyed	None	1999
		Baingo-Mbingo	N6,1662° E10,3287°	Steep slopes and saturated soil	Five people died and property destroyed	None	July 1998
	Fundong	Koini Hill	N6,2651° E10,2934°	Steep and meandering road		None	
		Abuh	N6,2860° E10,2903°	Steep slopes and saturated soil	Houses and vegetation destroyed	None	1992
		Ameng	N6,2762° E10,2906°	Steep slopes and saturated soil	Bridges destroyed	None	September 2013
		Aduk	N6,2951° E10,2883°	Steep slopes and saturated soil	Destroyed a church and property	None	2009
		Ilung	N6,3050° E10,2689°	Steep slopes and saturated soil			
Rock fall	**Fundong**	**Koini Hill**	**N6,2604° E10,2986°**	**Steep and meandering road**	**High risk of rock fall**	**None**	

Source: Divisional Delegation of Mines, Industry and Technological Development for Boyo

The direct and primary effect of soil erosion is soil loss and nutrient leaching which results in the reduction of land productivity. The soil loss in the study area was calculated with the aid the Universal Soil Loss Equation developed by Wischmeier and Smith (1978) On steep slopes, soils are washed away or blown away more easily. In a study sample carried out in three localities of the study area (Baicham,Njinikom and Abuh), it was observed that the tonnage of soil loss varies with the slope gradients. The steep nature of slopes in the study area shows that soil erosion and the downward translocation of soil mineral under the influence of gravity is accelerated (Figure10).

Figure 10 Soil loss in tons/year estimated with the aid of USLE developed by Wischmeier and Smith (1978)

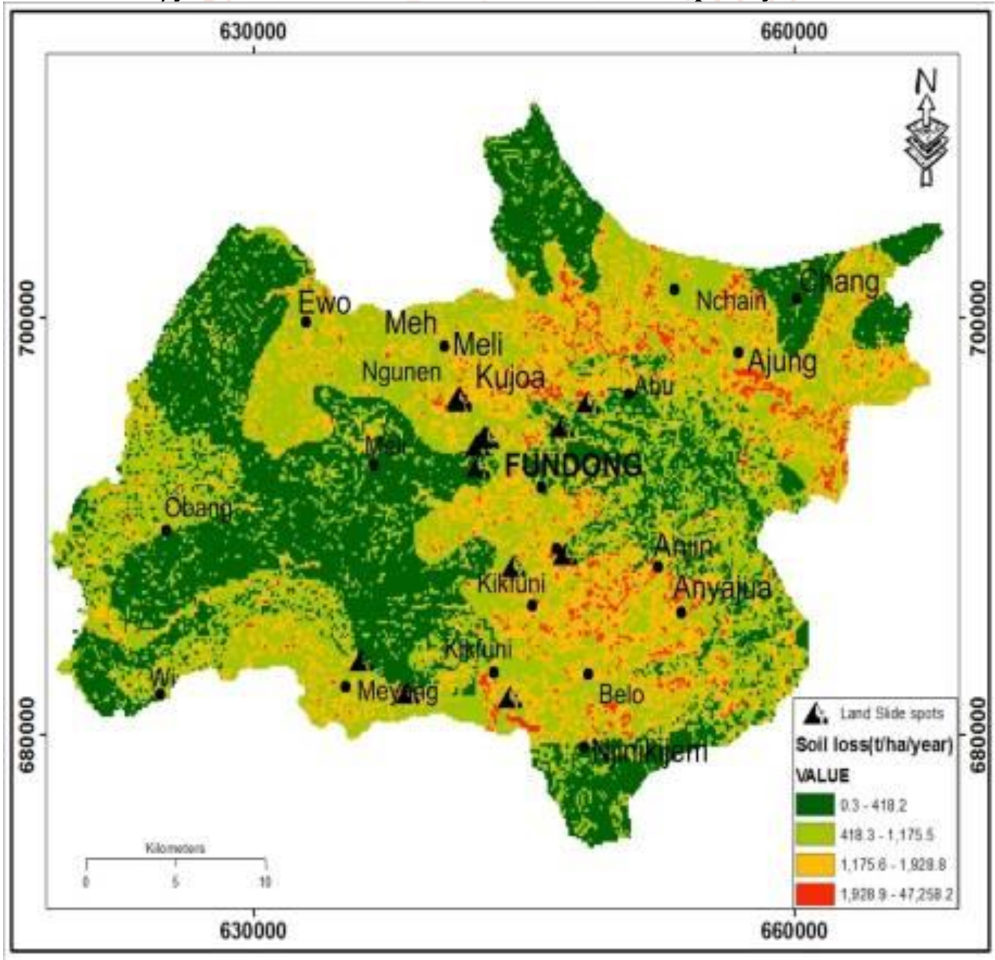
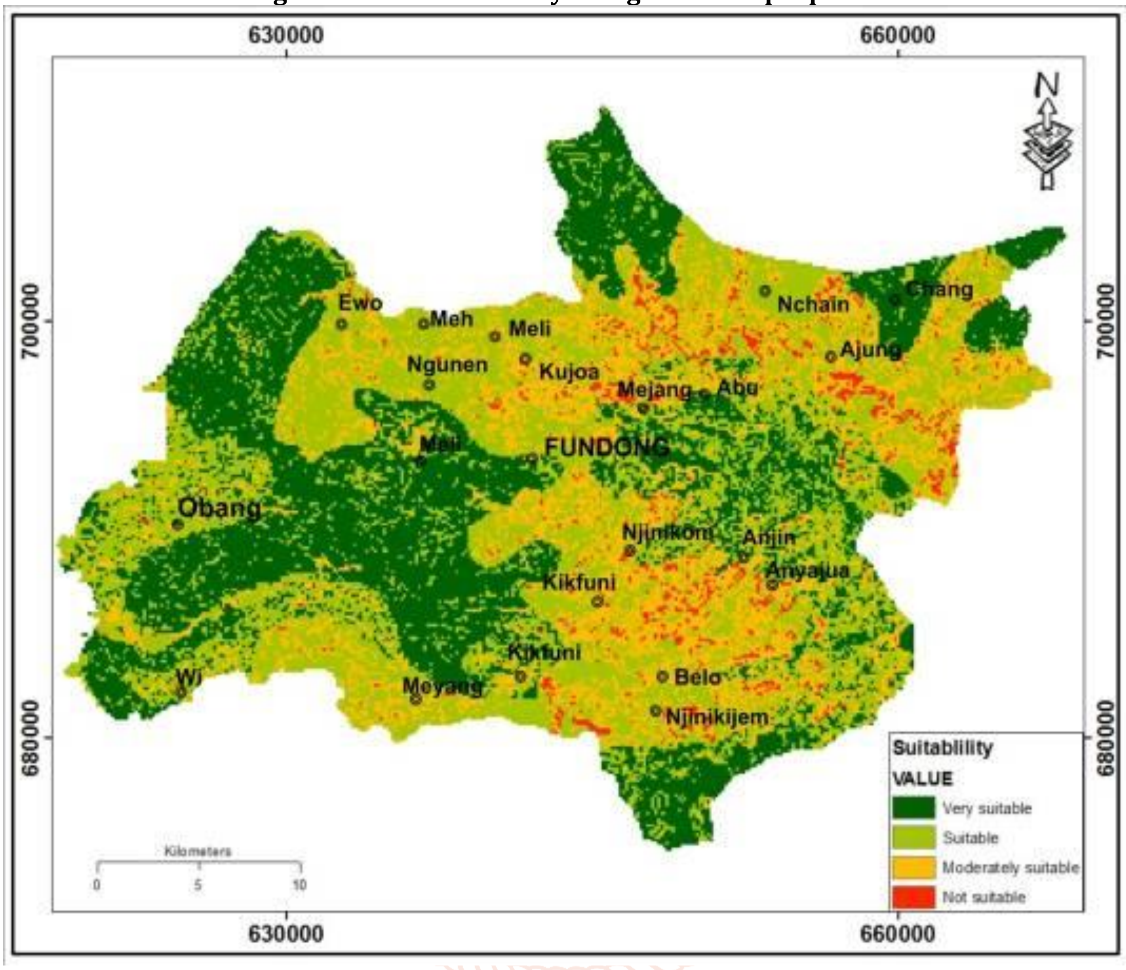


Figure 10 shows that in area with steep gradients, over 1.928 to 47.258 tons of soils are lost per hectare in year compared to 0.3-418.2tons in areas with low gradients. The soils of the Kom Highlands are developed on basaltic rocks (recent basalts, trachy-rhyolites, and andesitic basalts). These volcanic soils and rock types are also developed on pyroclastic deposits (ash and cinder) around the crater lake of Mount Oku

Agricultural performance in the study area depends significantly on the nature and quality of soils on which it is practised. Looking at soils in terms of altitudinal zoning, one witnesses a marked variation in characteristics and composition. Taking the flat and low-lying areasof Baicham, Mbonkissu and Mbueni one realizes that in some areas the soils are alluvial particularly along river valleys (figure 10)

Figure 11 Land suitability for agricultural purposes



Source: field work (2019)

Figure 11 shows that in the Baiso plains, the soils are loamy, friable, and porous and are very fertile and therefore suitable for the cultivation of corn, groundnuts, cocoyams and other cereals. The colluvial soils found mainly at the edges of the plain are derived from granites while the alluvial soils are of a mixture of lava and granite. These, in effect, are late Quaternary sediments of alluvium and colluviums resulting, respectively, from streams and weathering of the surrounding granites.

Progressing northwards to high altitude areas like Muloin, Abuh, Tumuku, Ndawara plateau and Ijim mountain regions, the soils become come acidic but nevertheless favours the cultivations of crops such as coffee, beans, maize, Irish potatoes and a wide variety of vegetables (onions, tomatoes, cabbages and carrots)

The soils within this area vary greatly owing to factors such as parent materials, climate, vegetation and the topography. The soil types found to the western part of the study areas are dominated by old granitic soils while humid and undifferentiated basalts are found to the west of the study area. Granite and recently formed basalts occur sporadically in some specific locations of the study area. The main parent rock is granite which is constantly being weathered and decomposed due to heavy rains and the topography of the area. The soils within this area vary greatly owing to factors such as parent materials, climate, vegetation and the topography. The main parent rock is granite which is constantly being weathered and decomposed due to heavy rains and the topography of the area.

This study recommends that for greater productivity, agricultural practices should be adapted to the soil types of the study area. This means that the delegation of agriculture should carry out soil analysis and disseminate the results to the local population and also reoriented their farming activities and other land uses to match with the soil types.

REFERENCES

[1] Ashley, C. & Carney, D. (1999). *Sustainable livelihoods: Lessons from early experience.* DFID, London,

[2] Bebbington, A., (1999). Capitals and capabilities: a framework for analyzing peasant viability, rural livelihoods and poverty. *World Development, 27(12)*, pp 2021-2044.

[3] Berryman, D. P., Lipe, A. J., Lynette, E. R., & Rockwell, S. L. (2008). *Steep lopes Guide I Model Regulations Lehigh Valley Planning Commission*.

[4] Ellis, F., M. Kutengule, and A. Nyasulu, 2003: Livelihoods and rural poverty reduction in Malawi. World Development, 31(9), 1495-1510

[5] Curtis, L. F., Doornkamp, J. C. and Gregory, K. J. 1965. The description of relief in field studies of soils. J. Soil Sci. 16: 16-30

[6] Chambers, R. & Conway, G. (1992). *Sustainable Rural Livelihoods: Practical concepts for the 21st Century.* IDS Discussion Paper 296, IDS, Brighton, UK.

[7] Edward, J., Tarbuck, F., Lutgen, K., D. & Tasa, G. (1993). *An Introduction to Physical Geology.* Fifth Edition. Prentice Hall, Upper Saddle River, New Jersey

[8] Fogwe, Z. N. & Tchotsoua, M. (2010). Ecological Adaptability and Slope-Trait Considerations for Water and Soil Conservation on the Vulnerable Oku-Kom Plateau in the Western Highland of Cameroon. *Journal of Human Ecology*

[9] Huggett R. J. (2007). *Fundamentals of Geomorphology.* Rout ledge Tylor and Francis Group, London and New York

[10] Scoones, I., (1998). Sustainable Rural Livelihoods: A Framework for Analysis. *IDS Working Paper No. 72,* Institute of Development Studies (IDS), University of Sussex, Brighton, UK, pp 22

[11] Sen, A. K., (1981). Ingredients of famine analysis: availability and entitlements. *The Quarterly Journal of Economics, 96(3),* pp 433-464.

[12] Tassah, I. T. (2013). *Slope dynamics and implications on agricultural development in the Widikum-Menka Sub-Division North West Region of Cameroon*. (M.Sc. thesis) university of Buea

[13] Tosam, H. N. & Fombe, L. F. (2015). Slope morphology and impacts on agricultural productivity in the Kom-highlands of Cameroon in Advances, *Social Sciences Research Journal Vol.2, No.9*

[14] Wischmeier, W. H. & Smith, D. D. (1978). *Predicting Rainfall Erosion Losses. A guide to conservation Planning* USDA *Agriculture Handbook.* Washington, DC

[15] Young, A. (1972). *Slopes Longman Group* LTD third Edition. Department of Earth Sciences, University of Waikato