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Adaptation of Women to Climate Variability in the Southern Slopes of the Rumpi Hills of Cameroon

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Abstract: In this paper, we examine the vulnerability and adaptability of women along the southern slopes of the Rumpi Hills forest, Ndian Division of Cameroon. We used primary weather data and household livelihood surveys, to identify a broad range of climate variability that combine to create different adaptation and household livelihood outcomes. We used this information to explore the ways in which livelihoods have changed and adapted over a 38 year period (1976-2014), as well as considered the factors that have contributed to these outcomes. Using this approach, we assessed 858 women across six villages, our results showed decreasing amounts of rainfall, receding forests, increasing temperatures and water scarcity, and increasing costs of living. We also found that, despite adjusting sowing dates, adopting petty trading and changing cropping patterns, climate variability affects their livelihood strategies.

Keywords: Cameroon Forests, Climate Variability, Vulnerability, Adaptation, Rumpi Hills, Rural Women Livelihood

1. Introduction

At local scales, climate variability exerts a significant control on livelihood activities across Africa (IPCC, 2007). This is linked to complex maritime-land interactions with varying effects on people's lives and livelihoods (IPCC, 2007; Mukete and Sun, 2014; Dokken and Angelsen, 2015). This variability exacerbates environmental threats such as deforestation, water scarcity and land degradation, which adversely affect long and short term livelihood prospects (IPCC, 2007; UNDP, 2012; World Bank, 2012). The type, magnitude and rate of climate variability to which a natural system is exposed, is usually referred to as vulnerability (IPCC, 2007; Demetriades and Esplen, 2008).

Given their different roles and responsibilities at the household and community levels, climate variability is known to have different impacts on men and women (Seema, 2011; UNDP, 2012). Women are involved in and depend on livelihood activities directly linked to the natural environment, are often poorer and receive little or no education (Denton, 2002; Terry, 2009; Brown, 2011). Additionally, due to cultural norms related to gender and social inequality, women are less involved in political and household decision-making processes which affect their lives (Demetriades and Esplen, 2008; MacGregor, 2010; Seema, 2011; Coleman and Mwangi, 2012).

According to a World Bank study, 25 of 35 economies in sub-Saharan Africa have legal distinctions between men and women (World Bank, 2012). Similar studies across Africa (Neumayer and Plümper, 2007; UNDP, 2007; Etongo and

Glover, 2012; Mukete, 2014; Dokken and Angelsen, 2015), assert that, women carry the disproportionate water harvesting and fuel burden for everyday survival even where access to these natural resources are scarce. For instance, in Ndian division of south west Cameroon, women have limited access to land, are economically poorer (possess fewer assets), do most of the agricultural work and bear unequal responsibility for household food security (Etongo and Glover, 2012; Mukete, 2014).

With an estimated population of 7000 people distributed over a surface area of 5602 km² in 1966 and projected at 130000 by 2015 (MINHUD, 2005), aggregate population pressure on the forest has become considerable. According to Quan and Foy (1994), an average family of shifting cultivators in Cameroon (consisting of five persons) needs about 6.2 hectares of forest land in a ten year fallow regime. This means that, five persons need about 25 hectares in a forty year fallow cycle or over 2000000 hectares for the projected population of 130000 people by 2015. Also, along these southern slopes, oil palm (*Elaeis guineensis*) resulting from agricultural activities of the agro-industrial company, Pamol Plantations PLC and emerging smallholder feeder plantations, coupled with pressures arising from artisanal logging and subsistence agriculture, the forests of this area which provided local communities with countless resources have been converted into crop lands (Etongo and Glover, 2012; Greenpeace Africa, 2012; Birdlife International, 2014; Mukete, 2014). This has resulted in the deterioration of the environment and loss of livelihoods for local people (Etongo and Glover, 2012; Mukete, 2014). Further to these impacts are poor seed germination and fruiting, blowing down of crops due to heavy rains and winds as well as reduction in water resources availability especially during the dry season (Mukete, 2014). Therefore, these impacts over time, increase women workloads in agriculture, domestic fuel and water collection. This is because, women, have to travel further and work longer to access natural resources inorder to meet-up with household and local market needs.

In this study, we examine local scale climate variability along a 38 year period, and its impacts on the livelihood strategies of local women (because women are involved in and depend on livelihood activities directly linked to the natural environment). We also assess the various adaptation strategies employed in coping with these impacts. These adaptation strategies refer to adjustments aimed at decreasing the vulnerability of local communities to the ensuing climate variability (IPCC, 2007; Adger et al., 2009).

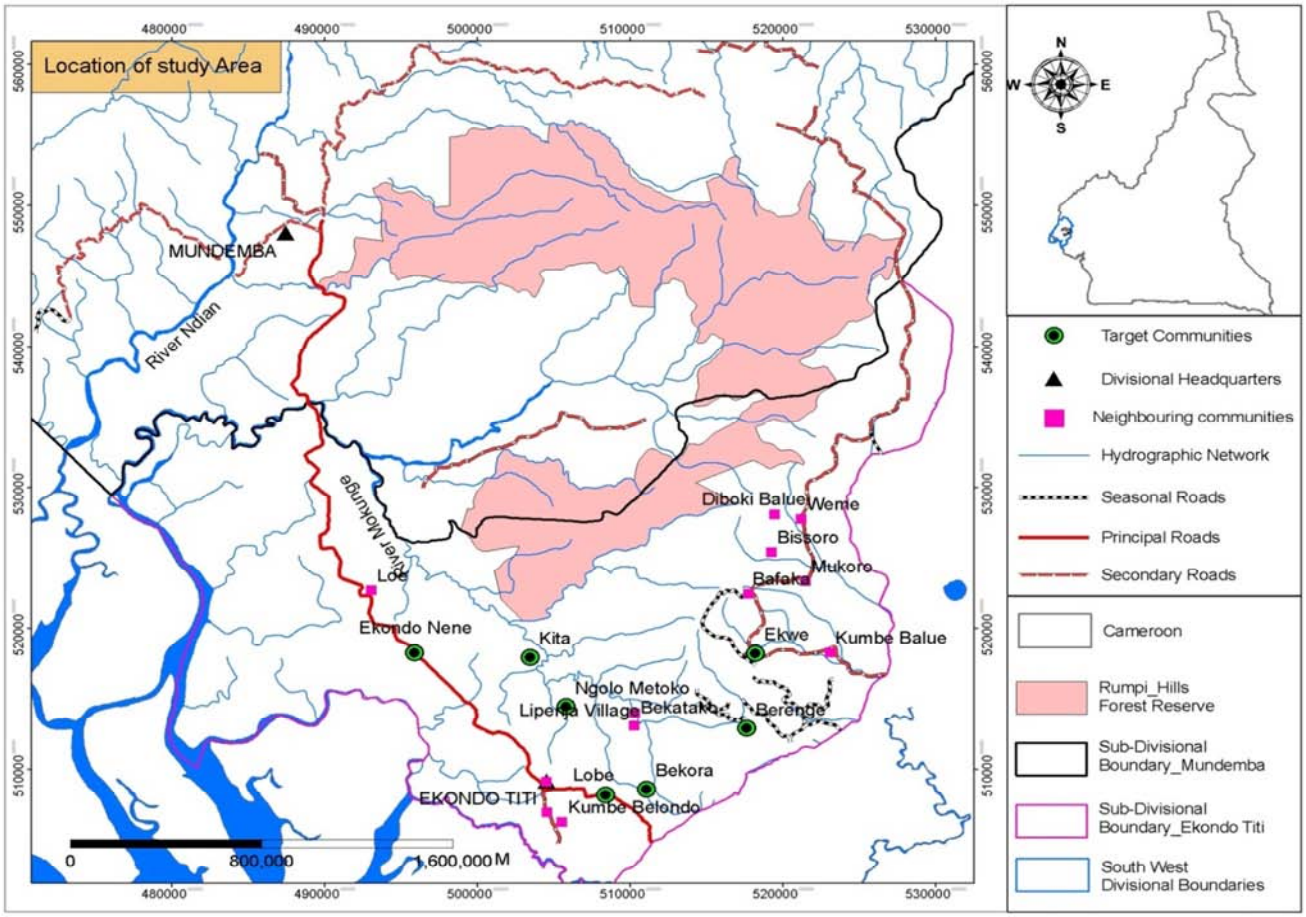

Figure 1. *Map of study area.*

2. Methodology

2.1. Study Area

The study was carried-out along the southern slopes of the Rumpi Hills Forests located between 4° N 9° E, in Ekondo Titi Municipality, Ndian Division of South West Cameroon (see figure 1). These southern slopes, are characterized by vast lowlands with fairly undulating hills rising up to its highest peak, Mount Rata about 1768m (White, 1983; Etongo and Glover, 2012; Mukete, 2014). The soils are composed of Precambrian clays and sandstones which may have emanated from various volcanic eruptions (White, 1983; Yerima and van Ranst, 2005; Etongo and Glover, 2012; Birdlife International, 2014). The area has two seasons, a dry season from December to February and a rainy season from May to October where annual rainfall ranges from 4027mm to 6368 mm. Temperature varies little throughout the year with mean monthly maximum temperatures in the dry season being 31.8°C and in the rainy season 18.2°C (Fund, 2014). The relative humidity is high during most of the year with minimum monthly values ranging between 84% in these southern areas.

2.2. Data Collection and Analysis

Using a simple random sampling method, we identified individuals for the focus group discussions and individual questionnaires as described by (Ellis, 2000; Sallu et al., 2010). Data were collected from identified women about their livelihood activities, changes that have taken place within the past 38 years and how they have been coping with these changes. About 858 women in six villages were surveyed and site selection was based on geographical location (southern slopes).

In villages with a female population of more than one hundred, each village was divided into quarters for the focus group discussions which consisted of about ten women of at least 18years old (as required by Cameroon Law). We verified their National Identity Cards and in cases where this was unavailable, recommendation was sought from the local community leader. In villages with a female population of less than one hundred, we used only semi-structured and open ended questionnaires through a door to door survey. In instances were potential participants were unable to read and understand the English or French languages, the local Pidgin English or Oroko dialect were used to ensure proper understanding.

In addition, we examined local scale changes in weather conditions including mean monthly rainfall, minimum and maximum temperatures from 1976-2014 obtained from the Pamol Plantations Plc Lobe Estate located in the southern slopes of the Rumpi Hills. The station is owned and maintained by the Pamol Plantations Plc established in 1964, which is an agro-industrial giant specialized in oil palm and rubber cultivation. The meteorological station is located in an open air environment devoid of tree cover; hence there exist no influence of landcover on the obtained data. Oil palm trees which are the main surrounding vegetation type are located above 50 meters from the station.

We used Microsoft Excel Software for Windows 10, to deduce the mean annual weather data per parameter. Using cumulative responses obtained via questionnaires, we obtained variation in perceptions with regards to local scale climate variability and their impacts as well as various adaptation approaches used to mitigate climate variability.

It should also be mentioned here that, all procedures performed in this study involving human participants were in accordance with the ethical standards of the Beijing Forestry University and University of Buea Institutional research committees and with the 1964 Helsinki declaration and its later amendments.

3. Results

3.1. Variation in Mean Annual Rainfall

Average annual rainfall varied considerably from 1976 to 2014 with 1984, recording the least while 2005 recorded the highest amount of rainfall, see figure 2.

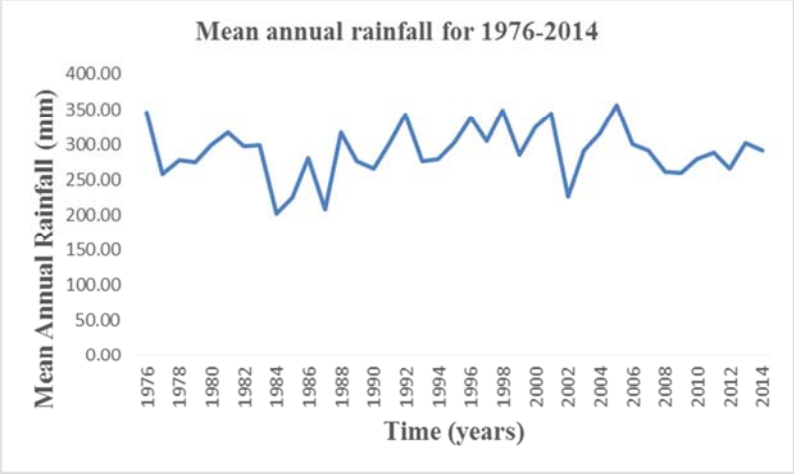

Figure 2. *Mean annual rainfall from 1976-2014.*

3.2. Variation in Mean Annual Number of Rainy Days

Similarly, the highest mean annual number of rainy days for the entire period of 38years was observed in 2001 and the least in 1989, see figure 3.

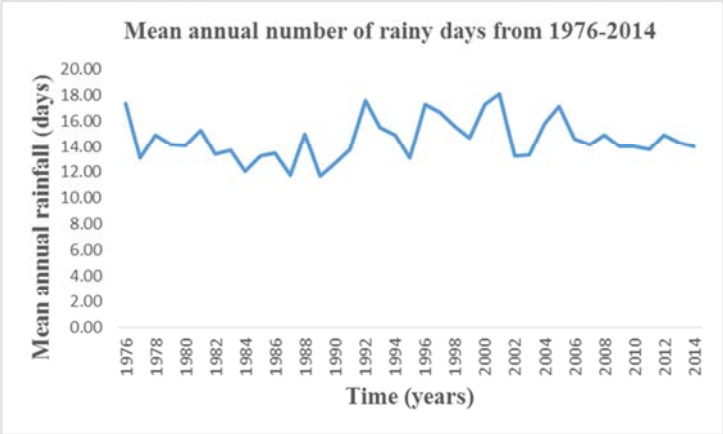

Figure 3. *Mean annual number of rainy days from 1976-2014.*

3.3. Variation in Mean Minimum Temperatures

The lowest annual mean minimum temperature was recorded in 1998 while the highest maximum annual temperature was recorded in 2014, figures 4 and 5.

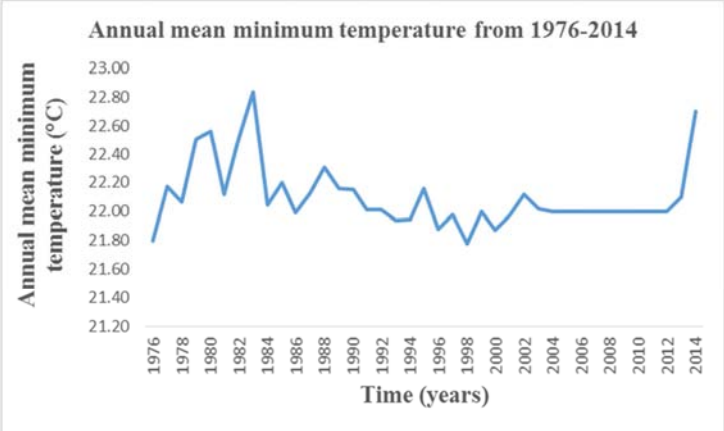

Figure 4. *Annual mean minimum temperatures from 1976-2014.*

3.4. Variation in Mean Maximum Temperatures

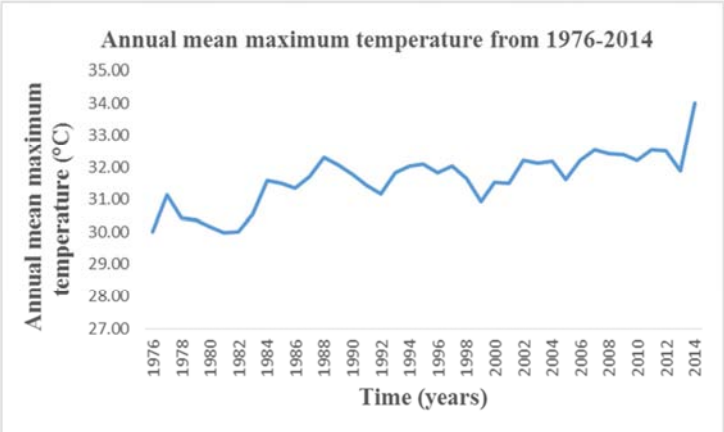

Figure 5. *Annual mean maximum temperatures from 1976-2014.*

3.5. Local Perceptions to Climate Variability

Data obtained from questionnaires showed 89% of the respondents believed average temperatures had increased, 58% thought rainfall had decreased while 82% believed winds had increased in intensity, occurrence and prevalence, see figure 6.

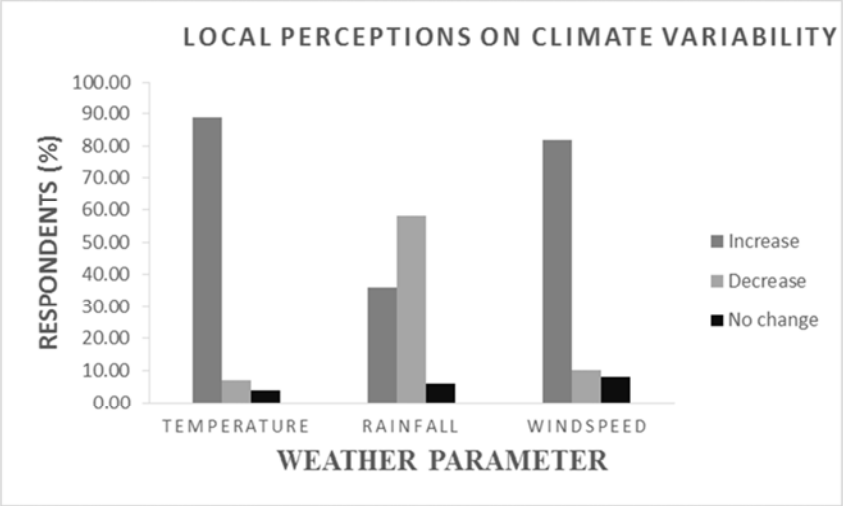

Figure 6. *Local perceptions on changes in temperature, rainfall and wind.*

Table 1. *Local scale observable impacts of climate variability along an intensity gradient (increase, decrease and no change).*

Affected parameter	Increase (%)	Decrease (%)	No change (%)
Poor seed fruiting and germination	93.47	3.96	2.56
Stunted growth in crops	93.12	3.37	3.49
Drying of crops	66.55	17.48	15.96
Reddishness of crops	55.36	23.31	21.32
Blowing down of crops	81.81	10.25	7.92
Extinction of species	99.18	0.82	0.00
Alteration of farming calendar	100	0.00	0.00
Reduced forest resources availability	88.11	10.8	1.09
Reduced water resources availability	53.84	36.36	9.79
Poor harvests	100	0.00	0.00
Higher incidence of pests and diseases	71.21	14.33	14.46
Higher costs of living	100	0.00	0.00
Lower standards of living	81.93	8.74	9.32

Table 2. *Local adaptation approaches against climate variability along an intensity gradient (very important, important and not important).*

Adaptation approach	Very important (%)	Important (%)	Not important (%)
Replanting and re-ploughing	89.88	8.76	1.89
Mixed-cropping	100	0.00	0.00
Modification of farming methods	78.32	5.71	15.98
Replace vulnerable crop species	11.86	33.11	55.03
Reliance on wells and distant water sources	47.94	20.51	31.55
Manage what is available	71.09	11.18	17.74
Shifting cultivation and bush fallowing	100	0.00	0.00
Farming on distant lands	59.76	31.11	9.15
Renting extra piece of land	53.84	9.32	36.88
Practice two-party	5.94	44.52	49.55
Reuse household organic matter	84.26	6.41	9.33
Diversion to processed products	28.91	11.34	59.74
Use of pesticides	36.36	39.41	24.24

4. Discussion

4.1. Climate Variability

Analysing temperature and rainfall trends from 1976-2014 showed that, both climatic parameters have been changing over time. Significant fluctuations in the amount of rainfall the area received were observed with the lowest in 1984. This variation in precipitation is also exhibited in the number of rainy days within the 38 year period where, rainfall exhibits notable spatial and temporal variability with inter-annual rainfall variability being significant. According to Christensen et al., (2007) and UNFCCC, (2007), Africa's climate is controlled by complex maritime and terrestrial interactions that produce a variety of climates across a range of regions. These complex mechanisms are linked to a positive trend in equatorial Indian Ocean sea-surface temperature (SST) and in El Niño-Southern Oscillation (ENSO) events. This climate variability, is further influenced by the intensities and localizations of the African Easterly Jet (AEJ), the Tropical Easterly Jet (TEJ) and sea-surface temperature (SST), in the Gulf of Guinea (Vizy and Cook, 2001; Nicholson and Grist, 2003; UNFCCC, 2007).

Due to these complex maritime and terrestrial interactions, a study by UNFCCC observed declining annual rainfall in West Africa since the end of the 1960s. The study noted a decrease of 20 to 40% between the periods 1931-1960 and 1968-1990 (UNFCCC, 2007). Additionally, Malhi and Wright (2004), noted declines in mean annual precipitation of around 4% in the tropical rain-forest zone of West Africa, 3% in North Congo and 2% in South Congo for the period 1960 to 1998. Similarly, Nicholson (2000), observed a 10% increase in annual rainfall along the Guinean coast during the last 30 years. Other studies (Nicholson, 2001; New et al., 2003; UNFCCC, 2007), have also recorded increased inter-annual variability in the post-1970 period, with higher rainfall anomalies and more intense and widespread droughts.

Mean minimum and maximum temperatures; have consistently varied from 1976 to 2014 with the lowest mean minimum temperature recorded in 1998 and highest maximum annual temperature recorded in 2014. Studies by UNFCCC, (2006) and Christensen et al., (2007) observed that, since the 1960s, minimum temperatures have increased slightly faster than maximum or mean temperatures mostly in Southern Africa and Ethiopia. Additionally, New et al., (2003) affirmed that between 1961 and 2000, there was an increase in the number of warm spells over southern and western Africa, followed by a considerable decrease in the number of extremely cold days.

The importance of terrestrial vegetation cover and the associated dynamic feedbacks on the physical climate are thought to influence climate variability (Christensen et al., 2007; UNFCCC, 2007). An increase in vegetation density, for example, has been suggested to result in a year-round cooling of 0.8°C in the tropics, including tropical areas of Africa (Bounoua et al., 2000).

4.2. Livelihood Activities and Climate Variability

Farming, harvesting of non-timber forest products (NTFPs) and animal rearing were the major activities carried-out by most women. Alongside these major activities, some women were involved in fishing and petty trading of food crops. Local scale perception towards climate variability exposes an increase in average temperature, a decrease in rainfall and increase in winds intensity, occurrence and prevalence. In separate studies, Maddison (2006) and Mary and Majule (2009), found a significant number of farmers in eleven African countries to have observed an increase in local temperatures and decrease in precipitations. This shift in the onset of rainfall and a consequent shorter rainy season, automatically changes the farming calendar. Hence, from planting of crops in March/April as in the past, planting is performed in January/February. This farming calendar change results in poor harvests as a consequence of poor seed germination, stunted growth and drying or reddishness of crops. These are the direct effects of increased temperatures and drop in water resources availability (especially in the dry season). This poor harvest, is further worsen by washing away of seeds or crops, blowing down of crops and extinction of some cocoyam species (*Colocassia esculenta* or Ibo Coco), due to flooding from heavy rains, winds as well as high incidents of pests and diseases.

Similar studies (Molua and Lambi, 2007; Mongi et al., 2010; Shackleton et al., 2011; FAO, 2012) affirm that, intra-seasonal factors such as timing of the onset of first rains, duration of the rains during the growing season and the effectiveness of the rains in each precipitation event, all affect crop-planting regimes. Furthermore, changes in rainfall amount and patterns also affect soil erosion rates and soil moisture, both of which are important for crop yields (IPCC, 2007). Changes in rainfall amount and patterns, in addition to shifts in thermal regimes tend to influence local seasonal and annual water balances. These in turn, affect the distribution of periods during which temperature and moisture conditions permit agricultural crop production (IPCC, 2007; Molua and Lambi, 2007; Mongi et al., 2010).

4.3. Adaptation to Climate Variability

To curb the washing away of seeds/crops, poor seed germination and stunted growth, women practice re-ploughing, replanting and changing planting dates with respect to the onset of the first rains. Moreso, instead of the traditional tilling and planting, most women tend to making mounds which provide better resistance to crops during stormy weather. In many instances, mixed-cropping which involves the planting of different types of crops (ranging from vegetables to fruit trees) on the same piece of land is carried-out. This ensures recycling of dead organic matter and it serves as natural manure for other crops that mature later during the same farming season. The fruit trees (e.g. bush mango, *Irvingia gabonensis*; plum, *Dacryodes edulis*;

avocado, *Persea americana*; Mango, *Mangifera indica*) planted on the same piece of land, also serve as wind breaks, support to the climbing crops and as shades to crops that are more vulnerable to increase precipitations and temperatures (FAO, 2007; Awono et al., 2010).

To prevent the spread of pests and diseases on farms, crop species that are more vulnerable to attack are replaced by more resistant (hybrids) usually obtained from suppliers at a given price. For instance, cassava (*Manihot esculenta*), is mostly substituted for plantains (*Musa paradisiaca*) because it has a shorter growth period and the effect of high winds on them is not as damaging as on plantains. Additionally, donated or purchased pesticides, insecticides and fungicides are used inorder to eliminate the effect of on farm disease-causing vectors.

Shifting cultivation as a suitable farming method has been adopted since the fertility of a particular piece of land cannot support long periods of cultivation. This is usually done by those with access to available land where the previously cultivated land is left to fallow. Individuals with a single piece of land, practice what is commonly known as 'two party'. This is a practice whereby at harvest time, the crops are shared with the land owner on the basis of usually a verbal agreement (Molua and Lambi, 2007).

Another common adaptation method is the re-use of household organic matter especially crop residues as manure for the cultivated crops. During decomposition, this increases soil nutrients, as mulch to shield from radiant heat, heavy rains and high winds. In a bid to remedy water stresses due to a reduction in available water resources, watering cans and hand buckets are used to manually water near-by farms. Water for individual consumption and household use, is usually obtained from wells (bore-holes) of neighbors or distant sources in search of water especially during the dry season when near-by streams run dry.

5. Conclusion

The women dwelling along the southern slopes of the Rumpi Hills forests are vulnerable to global environmental changes. Climate variability (precipitation, wind and surface temperature), hydrology and agricultural activities at this local scale, significantly explain the vulnerability to climate variability and the consequent adaptation strategies that have been developed. With decreasing amounts of rainfall and increasing temperatures, farming, NTFPs harvesting and fishing still remain major activities for the women folk. By adjusting sowing dates, adopting higher-yielding and changing cropping patterns, these women are adapting and mitigating these impacts.

Competing Interests

The authors hereby declare that, they have no existing financial and non-financial competing interests to declare with respect to this manuscript.

Authors' Contributions

MB designed the research, OL and TR collected the data and wrote the preliminary manuscript. SA and SY coordinated the research and edited the preliminary manuscript while MB and IC, performed the data analysis and wrote the final manuscript. It should also be stated here that, all authors read and approved the final manuscript before its submission.

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