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IMPACTS OF CLIMATE CHANGE ON KAKAMEGA TROPICAL RAINFOREST ECOSYSTEM OF KAKAMEGA COUNTY, KENYA

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Abstract: Africa is threatened by climate change, yet adaptive capacity of local communities continues to be weakened by ineffective and inefficient livelihood strategies and inappropriate development interventions. One of the greatest challenges for climate change adaptation in Kenya is related to the Tropical Rainforest Ecosystem resources used by vulnerable poor groups as assets for adaptation. The objective of this study was to assess the impacts of climate change on Forest Ecosystems in Kenya with special emphasis to Kakamega Tropical Rainforest Ecosystem. This study was descriptive and cross-sectional in design and relied on a mixed methods methodology. Anthropogenic Global Warming Theory and Adaptive Management Theory were used to guide the study. A conceptual framework showing the interrelationship between the dependent and independent variables was outlined. The study utilized both secondary and primary data. The target population was 200 households living up to 10 km from the forest edge in the selected communities neighbouring Kakamega Tropical Rainforest and 20 government officials within Kakamega County. A total of 119 members of the households and 20 forest officers were sampled as respondents in the study. The study findings revealed that the impacts of climate on Kakamega Tropical Rainforest included; changes in productivity, functional trait composition, species extinction and range redistribution, increased fire frequency and changes in precipitation and warming patterns. The study recommended that there is need to conserve the forest to get rid of extreme temperatures and precipitation since it was a source of many services to the surrounding communities and that the forest ecosystem also helped to adapt or mitigate climate change among others.

Keywords: Climate Change, Impacts

Introduction

Climate change has increased the risk of catastrophic natural disasters all over the globe (Kabubo-Mariara and Kabara, 2015). Despite the fact that the impacts of the changes are worldwide , developing countries are more in danger, basically on account of their high reliance on natural resources, poverty, low capacity to adapt (Bryan et al., 2013; Kabubo-Mariara and Kabara, 2015), lack of technological capability (Mwendwa and Giliba, 2012) and the presence of environmental stress (Norrington-Davies and Thornton, 2011). Also, almost no data about the change and applicable mitigation and adaptation measures fuel the circumstance in developing countries. Despite the fact that agriculture remains the backbone of Kenya's economy directly and indirectly supporting more than 75 percent of the Kenyan populace (FEWS NET, 2013), the sector's reliance on natural resources makes it very vulnerable to the impacts of climate change and variability.

The impacts of climate change may have direct impacts on vegetation, like, changes in productivity, functional trait composition and species extinction or range redistribution. These changes might be associated with increased drought stress (Malhi et al., 2009), drying or dieback. Climate change can also have indirect impacts on vegetation, for example, increased fire frequency. Worldwide and regional climate simulations for the next few decades project changes in precipitation and warming that may seriously impact major biomes all over the world (IPCC, 2013).

Shaw et al., (2011) have evaluated the climate change impact on California's Ecosystem Service under IPCC (2007) high and low greenhouse gas emission scenarios using Dynamic Global Vegetation Model (DGVM). They have discovered that the provision and value of Ecosystem Service will decrease under most of the future greenhouse gas trajectory. Ding and Nunes (2014) have as of late modelled the impact of climate change on Ecosystem Service across European forests. They have discovered that climate change impacts on Ecosystem Services are regionally specific. They have additionally discovered a solid relationship between temperature and the value of Ecosystem Services; however the direction of the relationship may be either positive or negative depending on the type of Ecosystem Service under consideration.

Other than the climate change alleviation capability of tropical forests, tropical forests are also significantly influenced by worldwide climate. Increasing atmospheric Carbon dioxide concentrations, increasing temperature, and changing rainfall patterns will pose a challenge to the functioning of forests (Brienen et al., 2015). Whether ecosystem functioning will be maintained depends on whether species can adapt or acclimate to new a biotic conditions, and/or whether species composition can change so that better adapted species become more dominant. The questions are, therefore, how tropical forests respond to changes in abiotic condition, and how biotic conditions (for example the type and assorted diversity of species) contribute to this response capacity.

Evidence is increasing that old-growth tropical forests are not in a stable state but are accumulating biomass (Brienen et al. 2015) and are changing in species composition (for example Enquist and Enquist 2011, Feeley et al., 2011). In accordance with the insurance theory (Yachi and Loreau 1999), several studies in grasslands and temperate forests find that biotic conditions, particularly species and trait diversity, are important for increasing the long-term stability of ecosystem processes (Hector et al. 2010, Morin et al. 2014).

This phenomenon, however, has yet not been demonstrated for tropical forests because, due to their high diversity, high structural complexity, and the long turnover time of most tropical tree species, it is difficult to assess this relationship empirically. Global dynamic vegetation models that include realistic levels of diversity (Sakschewski et al., 2015) may provide an opportunity to evaluate effects of diversity on the long-term stability of tropical forests. This knowledge is crucial because tropical forests are important for global climate now, and should be so too in the future.

Discussion of Research Findings

The third objective of this study was to assess the impact of climate change on Kakamega Tropical Rainforest ecosystem. In order to answer this question several responses were sought from the members of the households and the forest officers. The results are summarized in Table1 below.

Table 1: Impacts of Climate Change on Kakamega Tropical Rainforest Ecosystem

ITEM	CATEGORY	Agreed		Undecided		Disagreed		Total	
		F	%	F	%	F	%	F	%
Changes in productivity	HM	97	81.5	6	5.0	16	13.5	119	100
	FO	20	100	-	-	-	-	20	100
Functional Trait Composition	HM	90	75.6	10	8.4	19	16	119	100
	FO	20	100	-	-	-	-	20	100
Species extinction or range redistribution	HM	106	89.1	3	2.5	10	8.4	119	100
	FO	20	100	-	-	-	-	20	100
Increased fire frequency	HM	34	28.6	24	20.2	61	51.2	119	100
	FO	19	95	1	5	-	-	20	100
Changes in precipitation and warming	HM	92	77.3	-	-	27	22.7	119	100
	FO	20	100	-	-	-	-	20	100

KEY: HM-Household members. FO-Forest Officers

The researcher sought to know if one of the impacts was changes in productivity. On this question a majority at 97 (81.5%) of the members of the households agreed that, indeed it caused a change in productivity, a few 16 (13.5%) disagreed while only 6 (5%) were undecided. On the other hand all the 20 (100%) of the forest officers agreed that one of the impacts of the forest ecosystem was the changes in productivity.

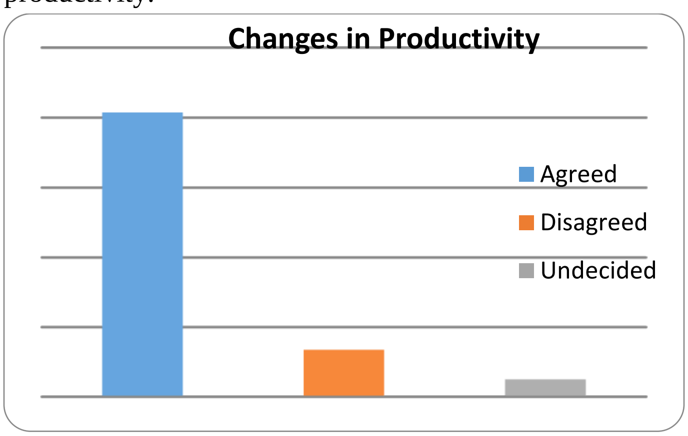

Figure 1: Changes in Productivity

When the members of the households were asked if one of the impacts on the forest ecosystem was functional traits composition, a majority at 90 (75.7%) agreed, a few at 19 (15.9%) disagreed, while only 10 (8.4%) were undecided. On the other hand all the 20 (100%) of the forest officers agreed.

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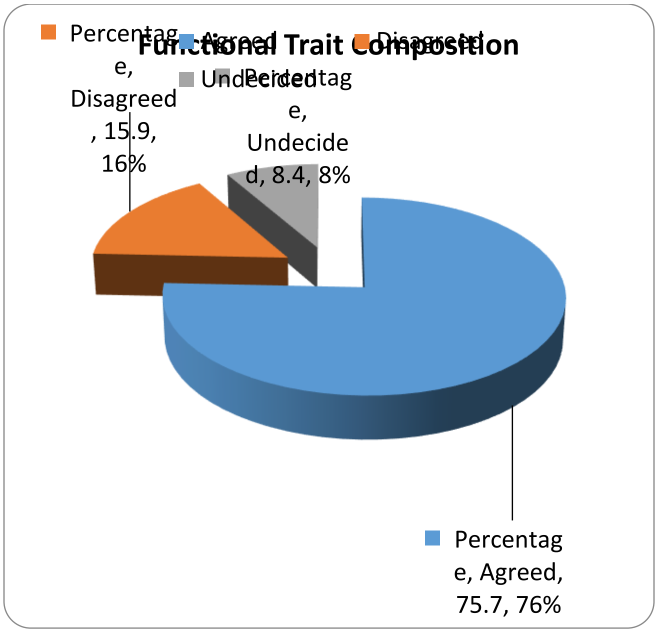

Figure 2: Functional Trait Composition

When asked if the forest ecosystem impact was that it led to species extinction or range redistribution, a majority at 106 (89.1%) agreed, a few at 10 (8.4%) disagreed while only 3 (2.5%) were undecided. On the same question, all the 20 (100%) forest officers agreed. This shows that extinction of species or range distribution of species was one of the impacts of forest ecosystem destruction as agreed by Malhi *et al*. (2009) and IPCC (2013) that the effects of climate change may have direct impacts on vegetation such as changes in productivity, functional trait composition, species extinction or range redistribution. These changes may be associated with increased drought stress, drying or dieback. Climate change can also have indirect impacts on vegetation such as increased fire frequency. Global and regional climate simulations for the next few decades project changes in precipitation and warming that may severely impact major biomes all over the world.

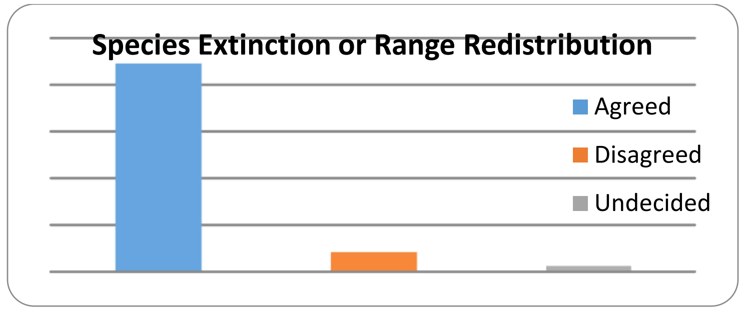

Figure 3: Species Extinction or Range Redistribution

When the members of the households were asked if one of the impacts was increased fire frequency, a majority at 61 (51.2%) disagreed, 34 (28.6%) agreed, while 24 (20.2%) were undecided. On the other hand, a majority at 19 (95%) of the forest officers agreed, while only 1 (5%) was undecided. This shows that there was disagreement between the forest officers' views and the members of the households' views but nonetheless, increased fire frequency was an impact of climate change as observed by Malhi *et al*. (2009) and IPCC (2013).

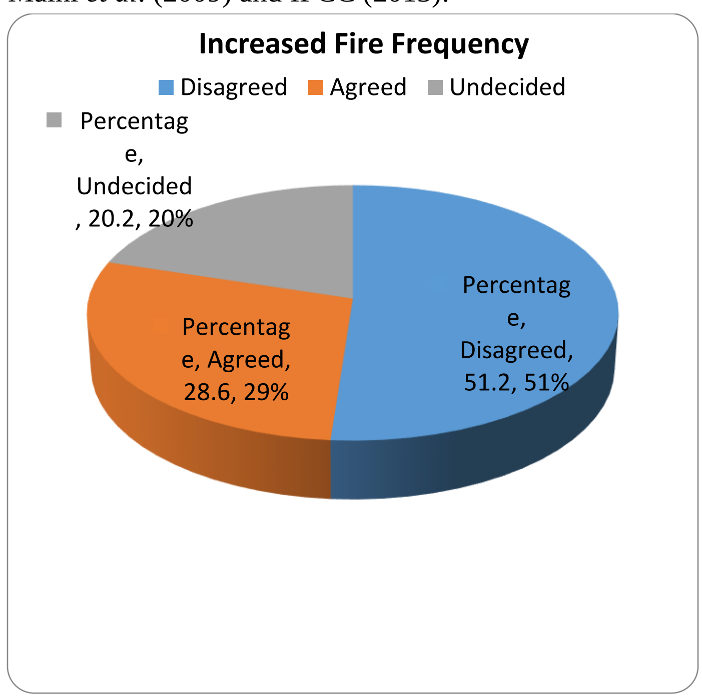

Figure 4: Increased Fire Frequency

When the members of the households were asked if one of the impacts of the forest ecosystem was changes in precipitation and warming. The majority at 92 (77.3%) agreed, 27 (22.7%) disagreed and none was undecided. On the other hand all the 20 (100%) of the forest officers agreed. This agrees with the views of Chen and Chu, (2014) that changes in precipitation and warming was one of the impacts of climate change in the Kakamega Tropical Rainforest ecosystem.

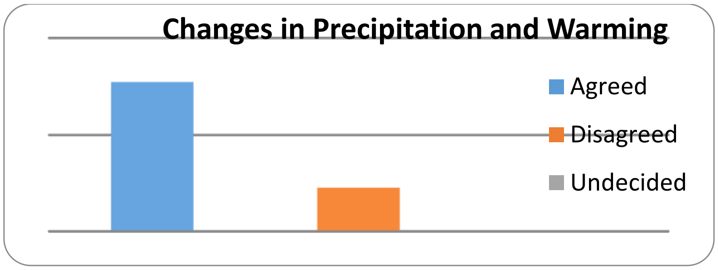

Figure 5: Changes in Precipitation and Warming

Summary of the Findings

The researcher sought to know if one of the impacts was changes in productivity, and on this question a majority of the members of the households were in agreement, while all the forest officers agreed that one of the impacts of the forest ecosystem was the changes in productivity.

When the members of the households were asked if one of the impacts of climate change on the forest ecosystem was functional traits composition, a majority of the members of the households agreed, while all the twenty forest officers interviewed also agreed.

A majority of the members of the households and forest officers agreed that one of the impacts of the forest ecosystem was that it led to species extinction or range redistribution. This shows that extinction of species or range distribution of species was one of the impacts of forest ecosystem destruction as pointed out by Malhi *et al*. (2009) and IPCC (2013).

When the members of the households were asked if one of the impacts was increased fire frequency, a majority of them disagreed while a majority of forest officers agreed. This shows that there was disagreement between the forest officers' views and those of the members of the households.

When the members of the households and forest officers were asked if one of the impacts of the forest ecosystem was changes in precipitation and warming, both the members of the households and forest officers were in agreement. This agrees with the views of Malhi *et al*. (2009) and IPCC (2013) that changes in precipitation and warming was one of the impacts of climate change in the Kakamega forest ecosystem.

Conclusion

The impacts of climate change on Kakamega Tropical Rainforest Ecosystem were changes in productivity, functional traits composition, changes in precipitation and warming, species extinction or range redistribution. However, there was disagreement to some extent on whether the increased fire frequency was indeed an impact on the forest ecosystem.

Recommendation

There is need to conserve Kakamega Tropical Rainforest Ecosystem to get rid of changes in productivity, functional traits composition, changes in precipitation and warming, species extinction or range redistribution.

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