IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402,p- ISSN: 2319-2399.Volume 14, Issue 3 Ser. 1 (March. 2020), PP 19-25
www.iosrjournals.org

Assessment of the Impacts of Climate Change on Biodiversity and Conservation at Nimbia Forest in Southern Part of Kaduna State, Nigeria

Ochiche, C. Abua; Bonoh, Fridayand Bege, I. Adon
Dept of Geography and Environmental Science, University of Calabar, Nigeria
Dept of Geography, Kaduna State College of Education Gidan Waya, Nigeria
Corresponding author: Ochiche C. Abua

Abstract: *Nigerian ecosystems comprise a variety of flora and fauna, which constitute about 15 percent of all known species in the world. Several of these species are under threat from a changing climate. Climate change is likely to affect most of Nigerian natural resources with a range of potential impacts on both terrestrial and aquatic life. This paper is on the assessment of the impact of climate change on biodiversity and conservation at Nimbia forest in southern part of Kaduna state. Purposive sampling of the representative villages was use taking into consideration location of the village with reference to Nimbia forest. A random sampling technique was employed to select sample household through the use of questionnaires to collect primary data. Secondary data (rainfall and temperature) were collected from the Nigerian meteorological unit of the Nimbia forest. The data collected were analysed using descriptive statistics of mean and percentages. Statistical tool of SPSS and Excel Spreadsheet were used. The results revealed a significant inter annual variability with a continues decrease in rainfall and a continues increase in temperature thereby having a significant negative impacts on biodiversity and their conservation in Nimbia forest. The paper recommended the need for collaborative effort between the communities and the forest management to address or minimize potential negative impact of climate change on biodiversity and the need to discourage cultivation near the forest to minimize its potential impacts on the community and biodiversity.*

Key Words*: Climate Change, Biodiversity, Conservation, Nimbia forest and collaborative efforts*

Date of Submission: 26-02-2020 Date of Acceptance: 12-03-2020

I. Introduction

Climate change refers to the change in weather patterns such as temperature, precipitation and wind over a period of time, ranging from months to millions of years. Climate change is largely attributed to both natural and anthropogenic factors (IPCC, 1996, 2007b). Natural factors such as solar variations and volcanic activities occur beyond human involvement. Anthropogenic factors are human based activities causing changes in earth's atmosphere.

Climate change can have significant negative impacts on the natural environment including the loss of biodiversity and changes in ecosystems. According to the Intergovernmental Panel on Climate Change (2007a), any increase in global average temperature above the range of 1.5- 2.5°C is likely to result in significant alterations in the structure, function and geographical ranges of ecosystems, thus negatively influencing species distribution and survival. In developing countries with a greater dependence on natural resource based livelihoods, this can impact the socio-economic status of communities, hamper progress towards development goals and present an overall threat to sustainable development (IPCC, 2007a). Several species around the world are now affected by the combined impacts of climate factors and their interactions with other anthropogenic stressors such as encroachment, land fragmentation and destruction of natural habitats. Together, climate and non-climatic stressors may have considerable impacts on the ecosystems functions and on ecosystem services (Lovejoy at al., 2005).

Nigerian ecosystems comprise a variety of flora and fauna, which constitute about 15 percent of all known species in the world (Biggs et al., 2004). Several of these species are under threat from a changing climate. Climate change is likely to affect most of Nigerian natural resources with a range of potential impacts on both terrestrial and aquatic life (Leemans and Eickhout, 2004; Boko et al., 2007). Climate change impacts such as rising temperatures and declining rainfall in combination with other stresses could result in loss of flora and fauna and an overall reduction in ecological productivity in Nigeria (Boko et al., 2007).

The impacts of climate change can also create increasing friction between protected area managers and local communities bordering protected areas as wild animals and community increasingly compete for the scarce resources (Lovejoy at al., 2005).

The Nimbia forest in southern part of Kaduna state is one of the most pristine forest in Kaduna state endowed with rich biodiversity. Nimbia forest has the second highest number of plant species than any other protected area in north central Nigeria (Caro, 1999). The vegetation is a colourful mosaic including woodlands of varying canopy cover, bush lands, vast grasslands, swamps, seasonal rivers and woodlands with tall trees. The biodiversity of Nimbia forest is being threatened by the effects of climate change whose signs are already evident.

This study is aimed at assessing the impacts of climate change and on large biodiversity in the northern, central and southern parts of the Nimbia forest. The study also elucidates the role played by the community in terms of coping and adapting to the impacts of these changes.

Climate Change Impacts on Biodiversity

Many species around the world are now affected by the combined impacts of natural climate variability and anthropogenic climate change and their interactions with other human stressors such as the encroachment, fragmentation and destruction of natural habitats (Hananh 2005). Often various wild animal species respond to climatic stressors by migrating and shifting their ranges to areas with more favorable conditions. This has already been noted in the case of birds, marine life forms, butterflies and insects in response to the changes in climate that have already taken place, particularly the increase in temperature (Hananh et al., 2005). Besides, many range-restricted species, chiefly polar and mountaintop species, show severe range contractions and have been the first groups among which entire species extinctions have been noted due to the recent changes in climate (Parmesan, 2006). It has also been observed that, tropical coral reefs and amphibians have been the most negatively affected. The differential responses of species to warming have also been reported to have disrupted predator-prey and plant-insect relationships (Parmesan, 2006).

According to the IPCC (2007a), any increase in global average temperature above the range of 1.5-2.5°C is likely to result in significant alterations in the structure, function and geographical ranges of ecosystems thus negatively influencing species distribution and survival. In most cases ecosystem responses to climate change and increased atmospheric CO2 concentrations are expected to be non-linear in nature and the surpassing some of critical threshold values are likely to induce sudden transitions in state. Terrestrial ecosystems are also likely to initially experience increased growth from CO2 fertilization effects but these benefits are projected to be soon overshadowed by the negative impacts of increased temperature by the end of the 21st century.

Overall a very high possibility of irreversible losses of biodiversity as a result of such changes in climate are projected with many terrestrial, freshwater and marine species being placed at a much greater risk of extinction than before (Fischlin et al., 2007). . Findings from this study will thus be useful for policy and decision making processes relevant to biodiversity conservation in a changing climate and sustaining ecosystem services to support for human well-being.

Statement of the Problem

In Nimbia forest, the large biodiversity and the associated environment are one of the major tourist attractions that contribute to income generation for the Kaduna state government in the area.. According to the IPCC (2001a, b), a large number of biodiversity are subject to a wide range of environmental stresses during their lifetime including changes in climate. There is limited information available on the impact of climate change on biodiversity's population in Nimbia forest; understanding the likely influence of climate change on the individual plant species will requires an in-depth understanding of species ecology and life history parameters as well as how they may respond to changes in local climate.

The impact of climate change on the livelihoods of communities' living adjacent to Nimbia is also not well documented. There is therefore the need for this study to analyze the current and potential impacts of climatic change on biodiversity in Nimbia forest. It also to examine adaptive and conservation strategies used by the local communities. It therefore contributes towards an understanding of the influence of climate change on ecosystem functions and ecosystem services.

The baseline field information from this study together with existing meteorological data can guide the development of future adaptation and conservation strategies for the forest's biodiversity, ecosystems and local communities.

Research Aim and objectives

The aim of this study was to assess the impacts of climate change on biodiversity and conservation at Nimbia forest area in southern part of Kaduna state.

The specific objectives are:

1. To assess the impact of climate change on biodiversity and conservation at Nimbia forest.
2. To examine the evidence of climate change in the study area

3. To examine non-climatic factors that influence biodiversity conservation in the study area.
4. To assess the adaptive and coping strategies of biodiversity on climate change.
5. To assess the adaptive and/or coping strategies of community and forest management to climate change impacts.

Research Questions

1. What are the plant species most affected by the impacts of climate change and how has distribution pattern changed Nimbia forest?
2. What are the non-climatic factors that influence biodiversity conservation in the study area?
3. What are the coping and adaptive measures used by plant species in response to the climate change impacts in the study area?
4. What are the impacts of climate change on community livelihood in areas adjacent to Nimbia forest?
5. What are the coping and adaptive strategies used by forest management to address climate change issues?

II. Material and Methods

Study Design and Sampling Design

A cross sectional design was used during data collection. According to Barley (1994) such research design allows data to be collected at a single point in time without repetitions. The design uses minimum time and resources.

Two stage sampling procedure was adopted. In the first stage purposive sampling of the representative villages was carried out taking into consideration location of the village with reference (close) to Nimbia forest. In this stage 8 villages out of 20 were selected. The villages selected are Tajak, Sakio, Katsak and Janta (Nimbia) at the northern part of the forest while Kurmin goro, Bom, Gimi and Gaida at the southern part of the forest. A simple random technique was employed to select sample households within the village. The sampling unit in this study was the household. A household here is taken as the unit of analysis because it is where all decisions are primarily taken. The sample size was 5% of the total number of households in each village, forming a total sample of 233 households (Table 1). Key informant interviews were undertaken with various experts in the area, local institutions, and conservation agencies. These are individuals who were approached for their views on the climate change issues using a semi-structured list of questions. The type of information was obtained from the villages. Some of them included extension officers, wildlife officers, forest officers, Community Development officers, elders and influential people in the village. Questions asked were on the impacts of climate change on biodiversity especially plant species and community livelihoods in the study area and the adaptation measures to these impacts. The techniques used to acquire primary data included questionnaire survey, focus group discussion, key informant interviews and participant observation. Data collection was preceded by a preliminary survey in order to be acquainted with the study area.

Table 1: Villages and households interviewed

S/N	Name of Village	No of Household	No of Household interviewed
1	**Tajak**	**624**	**31**
2	**Sakio**	**618**	**31**
3	**Katsak**	**1190**	**60**
4	**Janta Nimbia**	**400**	**20**
5	**Kurmin goro**	**534**	**27**
6	**Bom**	**310**	**16**
7	**Gimi**	**402**	**20**
8	**Gaida**	**550**	**28**
Total		**4628**	**233**

Source: Author's Fieldwork, 2017

Data Collection

The techniques used to acquire primary data included questionnaire survey, focus group discussion, key informant interviews, Secondary data (on rainfall and temperature) was collected from the Nigerian Meteorological unit of the Nimbia forest and Participant observation was also used, in this method, the researchers physically looked at what was real on the ground and made comparisons with what had been told by respondents in focus group discussion, household and key informant interviews.

Data Analysis

Data collected through questionnaire were coded to facilitate data entry in the computer. Coding involved organization of data into categories and where each response category was assigned a numerical code

as described by Babbie (1995). The statistical analysis of data was undertaken using the Statistical Package for Social Science (SPSS) and excel spreadsheet computer packages.
Descriptive statistics such us percentages of responses, frequencies and means were obtained, and where relevant cross-tabulations were made. Results are presented in various formats such as tables and charts, as well as narratives.

III. Presentation and Discussion of Results

Table 2: Mean Annual Data of Rainfall and Temperature from Nimbia forest

Year	Rainfall	Temperature
2003	1042	27.4
2004	940.5	27.9
2005	1031	33.9
2006	934	27.9
2007	1020.9	31.9
2008	948.5	32.7
2009	824.7	33.4
2010	854.1	33.2
2011	1009.6	33.4
2012	1011.5	35.9
2013	944.2	35.7
2014	945.6	33.5
2015	832.7	34.2
2016	831.9	34.8

Source: Meteorological Unit Nimbia Forest.

The table revealed seasonal changes in rainfall in the area with a wet season in April - October and a dry season during the rest of the year. It also revealed a continues increase in temperature from 27.4^{o}C in 2003 to 34.8^{0}C in 2016.Climatic data collected at the meteorological unit of the Nimbia forest for the years 2003-2016 indicates that during that period mean annual rainfall fluctuates and continue to decreases. Mean annual rainfall is 951.5mm per year and mean annual temperature is 33.9^{0}C.

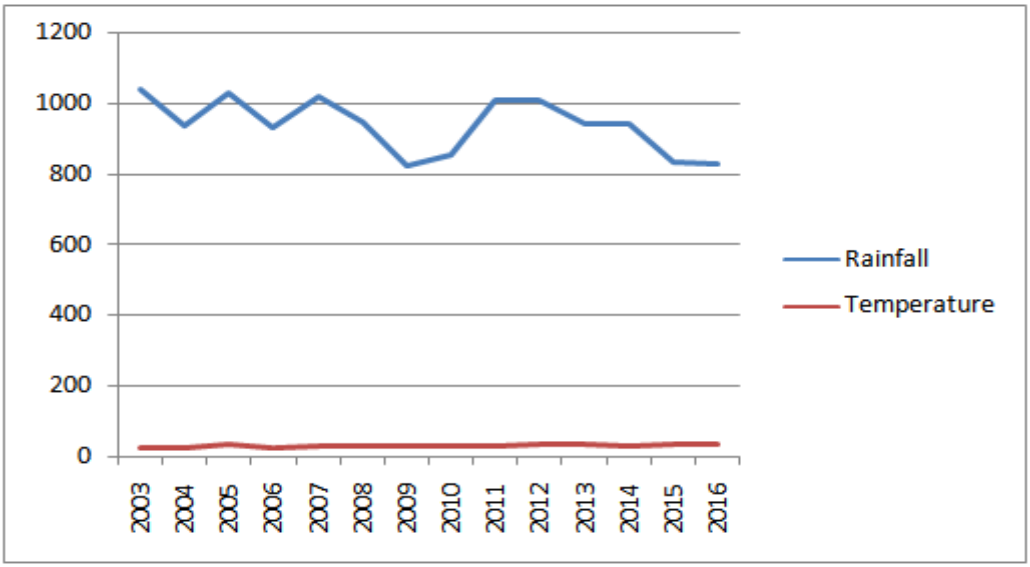

Fig1: Annual Rainfall and Temperature at Nimbia Forest between 2003-2016
Source: Author's Field Work, 2017.

The rainfall records presented in fig 1 indicate further that there was a significant inters annual variability. For instance there was a considerable decrease in amounts of annual rainfall from about 1042 mm in 2003 to 854.1mm by the year of 2010. This was followed by fluctuations in the amounts of rainfall as expressed by the period between 2011 and 2013. In the year 2014 the area experienced heavy rainfall of 945.6 mm but relatively low in 2015 and increased at small amount in 2016 (Fig 1). Apart from the inter-annual variability, about eight out of the ten seasons covered by the available data had below average rainfall and temperatures. The effect of low rainfall is somehow counterbalanced by the low temperatures. The similarity in the rainfall amounts between 2003 and 2012 seem to suggest a ten-year cycle of heavy rainfall for the area, however this is not a complete confirmation as the time period of fifteen years is too short to describe a cycle of rainfall for climate change

Table 3: Non-Climatic Factors Activities that Affect Biodiversity in Nimbia Forest

Option	**Frequency**	**Percentage**
Crop cultivation	**151**	**65%**
Animal Rearing	**42**	**18%**
Hunting	**26**	**11%**
Trading	**14**	**6%**
Total	**233**	**100%**

Source: Author's field work, 2017.

Table 3 above revealed that 151 (65%) respondents are with the opinion that crop cultivation is a non-climatic activities that affect biodiversity, 42 (18%) said it is farming, 26 (11%), said it is hunting and 14 (6%) agreed that it is trading activities that affect biodiversity in Nimbia forest. Involvement in all this activities with the exception of trading has negatively affected the rich biodiversity of the agro-ecosystem of the Nimbia forest.

Table 4: Changes in Agricultural Activities

Option	**Frequency**	**Percentage**
Yes	**226**	**97%**
No	**7**	**3%**

Source: Author's Field work, 2017

Regarding changes of agricultural activities overtime, 97% of the respondents expressed that there have been changes in the types and magnitude at which these activities are implemented Out of interviewed correspondents, 97%% (Table 4), stated that the productivity and performance have reduces for most agriculture activities, and most of these communities are those who are now dependent on government for fertilizers, improved seeds and good tools for agriculture.

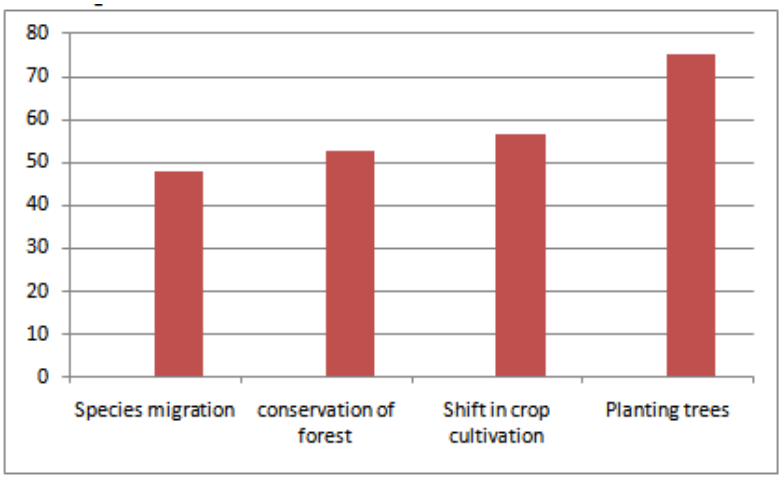

Fig 2: Strategies for biodiversity conservation under climate change

Figure 2 revealed traditional strategies of biodiversity conservation in Nimbia forest. It shows that 48 (21%) of the respondents are with the opinion that species be migrated from such areas, 53 (23%) said forest should be conserved, 57 (24%) said shift in the type of crop cultivated in the forest and 75 (32%) of the respondents are with the opinion that trees be planted as a strategy biodiversity conservation.

IV. Discussion of Results

Traditional biodiversity conservation strategies have been designed under the assumption of a relatively static environment; an idea that is now challenged by the influence of the rapid rate of climate change on ecosystem boundaries and species distribution, already threatened by the impacts of human stressors. As a result existing conservation strategies now need to be revised in order to respond to the new challenges posed by a changing climate and its synergistic interactions with a multitude of other human stressors. The management of natural areas must therefore account for such natural transitions (Hannah et al., 2005).

Therefore, the research revealed that though the traditional methods and tools of conservation is relevant, they would nonetheless need to the modified where necessary to provide for the flexibility that migratory species will need in tracking changing climates. Importantly, such strategies will need to include the addition of new protected areas to allow for range shifts and the maintenance of connectivity between habitats to enable successful species migrations it agreed with Lovejoy, 2005; Hannah etal., 2005 that opined that in addition, from the human perspective, such strategies will also need to ensure sustainability in the provision of ecosystem goods and services and the maintenance of subsistence livelihoods for indigenous populations. With help from agricultural officers, some have shifted to crops like cassava that can withstand drought and some have extended the size of cultivated farms. These are among the strategies that local communities are using to adapt to the impacts of climate change. Although they are also facing the same problems of climatic variability (shift of rain patterns and droughts) as other villages.

Table 4 shows further that 97% of respondent have noticed negative changes in agricultural productivity due to climate variability and change for more than one year. The variations in the responses to since when changes were observed may indicate the levels of knowledge of changing conditions and adaptive capacities of respective respondent households. Since agriculture is the main economic engine for the community to meet their livelihoods needs, then once it is negatively affected other activities are also likely going to be affected.

The reseaarch revealed that interviewed households expressed that all of the livelihoods activities especially agriculture which most of the community member depend on, are heavily dependent on climate. For instance, the amount and temporal distribution of rainfall and other climatic factors such as temperature dominant during the growing seasons have important influence on crop yields and pastures for livestock hence affecting the local welfare. It was reported by the respondents in this study that rainfall variability, such as very heavy rainfall storms at once, delay of rainy season, prolonged dry seasons within the rainy season and early ending of rainy season were the major causes of decreased agricultural productivity. This is in line with the work of Lovejoy and Hannah, 2005, that such conditions are all linked to climatic factors as a result of climate change Lovejoy and Hannah, 2005.

V. Conclusion

This study on impacts of climate change on biodiversity and conservation in Nimbia forest has shown that climate change and variability are both affecting the animals and plants species and community livelihood

in the ecosystem. In recent years the amount and distribution of rainfall have become more unpredictable, causing significant impacts on all production sectors, including biodiversity conservation. Signs such as late rains, little rains, floods and unpredictable rainfall distribution, and high temperature seem to have been common in the target community.

The agricultural sector (crops and livestock), which is the main source of food and income for the majority of local people in the area appears to have decreased considerably in the recent years, but mainly through decrease in the area under cultivation and migration of livestock. This may probably lead to a tendency to overlook the real impacts of climate change on productivity. While the total production per household may be increasing due to farm expansion, agricultural productivity is highly affected by climate change and variability.

The impacts of changing climate on animals and plants species in Nimbia forest are almost certain, and there are already reported deaths of animals resulting from lack of water and waterborne diseases within the forest area. The animals in Nimbia forest show different adaptation strategies to climate change and variability, including seasonal migration to locations with better opportunities. Community members use various ways to adapt to the impacts of changing climate in their daily activities. Extension of farmed area, planting drought tolerant crops and digging wells, are among the adaptive strategies employed. While these adaptation strategies seem helpful, no one is sure whether they may be able to persist in the long-term. Thus deliberate and concerted efforts are needed to ensure that sustainability concerns are addressed in biodiversity conservation in a changing climate.

Findings from this study have also demonstrated that climate change impacts are significantly exacerbated by non-climatic factors as has been the case of Nimbia forest. Thus to effectively reduce climate change impacts, firm and joint efforts should be taken to also address non-climatic stressors which exacerbate the actual impacts of climate changes.

Recommendations

Based on the findings of this research it recommended that

1. There should be collaborative efforts between villagers and the forest management in addressing or to minimize potential negative impacts of climate change on local biodiversity.
2. There is the need to facilitate sustainable irrigation farming so that water abstraction from rivers flowing through Nimbia forest allows for environmental flows and other downstream water users.
3. Stopping or discouraging cultivation near the forest and to minimize its potential impacts on the community and biodiversity.
4. Finally more detailed studies would be needed to establish impacts of climate change on all plant species, wild animals and streamline adaptation measures that address the entire forest.

References

[1]. Biggs, R., Bohensky, E., Desanker, P.V., Fabricius, C., Lynam, T., Misselhorn, A.A., Musvoto, C., Mutale, M. and Co-authors, (2004). Nature Supporting People: The Southern AfricanMillennium Ecosystem Assessment Integrated Report. Millennium Ecosystem Assessment, Council for Scientific and Industrial Research, Pretoria, 68 pp

[2]. Boko, M., Niang, I., Nyong, A., Vogel, C., Githeko, A., Medany, M., Osman-Elasha, B., Tabo, R., Yanda, P. (2007). Africa: Climate Change 2007: Impacts, adaptation and vulnerability, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Parry, M.L., Canzian, O.F., Palutikof, J.P., van der Linden P.J., and Hanson, C.E. (Eds.). Cambridge University Press, Cambridge UK,pp 433-467.

[3]. Caro, T.M. (2008). Decline of large mammals in the Katavi-Rukwa ecosystem of westernTanzania. African Zoology, 43: 99-116.

[4]. Hannah, L., Lovejoy, T.E., and Schneider, S.H. (2005). Biodiversity and Climate Change inContext, In, Lovejoy, T. E., Hannah, L. (Eds.) Climate Change and Biodiversity, Yale : University Press, New Haven, CT, USA and London, UK.

[5]. IPCC (1996) Summary for policy makers, In Watson, R.T., Zinyowera, M.C. Moss, R.H. (Eds.) Climate Change 1995: Impacts, Adaptations and Mitigation of Climate Change: Scientific-Technical Analyses. Contribution of Working Group II to the Second Assessment, Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK and New York, NY, USA

[6]. IPCC (2001), Climate Change 2001: Impacts, adaptation, and vulnerability. Contribution ofWorking Group II to the Third Assessment Report of the Intergovernmental Panel onClimate Change. McCarthy, J.J., Canziani, O.F., Leary, N.A., Dokken D.J., and White,K.S. (Eds.), Cambridge University Press, Cambridge, 1032 pp.

[7]. IPCC (2007a) Summary for Policymakers In Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden P.J., and Hanson, C.E. (Eds.). Climate Change 2007: Impacts, Adaptation andVulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK and New York, NY, USA.

[8]. IPCC (2007b) Summary for Policymakers, In, S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B Averyt, M. Tignor and H.L. Miller (Eds.). Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK and New York, NY, USA

[9]. Leemans, R., and Eickhout, B. (2004). Another reason for concern: regional and global impacts on ecosystems for different levels of climate change. Global Environmental Change 14: 219-228

[10]. Lovejoy, T.E. (2005). Conservation with a changing climate, In Love joy, T. E., Hannah, L (eds.), Climate Change and Biodiversity, Yale University Press, New Haven & London, UK

[11]. Parmesan, C. (2006) Ecological and evolutionary Responses to Recent Climate Change Annual Review of Ecology Evolution and Systematics, 37: 637-669