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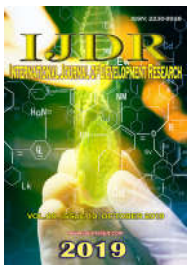

RESEARCH ARTICLE OPEN ACCESS

SENSITIVITIES OF RESIDENT BIRDS TO CLIMATIC WARMING IN ETHIOPIA

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ABSTRACT

The effects of spatially varying temperature on resident birds of Ethiopia was evaluated. The resident bird data was treated at the guild level and the response variable was guild species richness. The guilds considered were granivores, frugivores, insectivores and raptors. The species richness of all the guilds considered declined significantly in response to spatially increased temperature. Because of their significant positive relationship with forest cover the resident bird guilds have significant positive contribution to agriculture and their loss if there is and will be an increase in temperature is a disaster that the country has to deal with. Important mitigation measure is the perpetuation and expansion of carbon sinks which are forests. Since forests have a natural cooling effect on the climate this is a very important measure in any scenario whether it is emissions of green house gases or deforestation which is the cause of climatic warming.

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INTRODUCTION

Until the merging of the studies of climate and biodiversity as result of the threats posed to the latter by the former the two ecological issues were dealt with by scientists separately (Shen & Ma 2014). Studies of the effects of an increasingly warming climate showed that there are worrying signs that biodiversity which with at least its economically key components is disappearing or may disappear after a certain threshold of increase in temperature may be differently in magnitude in a localized manner but with similar endings. As briefly mentioned above at least some components of biodiversity such as plant constituents represented by forest cover (Shimelis 2016, Shimelis 2017) and birds (Shimelis *in press*, Shimelis in prep.) have proven significant positive contributions to a principally agrarian economy such as found in Ethiopia. Inference tells one to generalize from what is known regarding the role of birds in making sure plants survive and flourish in making use of the usefulness arguments at least where the two components of biodiversity are concerned to push forward conservation efforts anywhere in the world. To be able all scientifically sensible conservation efforts work one has to know the natural tolerance limits of populations and communities where they occur in naturally elimited ecological systems. Most importantly if there are proven changes in requirements such as optimum climate that is delimited through natural processes it is important to study the sensitivities of the biodiversity components such as birds and plants to be able to say they are sensitive naturally to factors such as climate and to determine what effects are in waiting in the direction of likely changes or those that happened already. Shimelis (2017) did elucidate on the relationships of key climatic variables such as precipitation and temperature in proving that the extent of forest cover has significant contribution in the regulation of the former two. The math is not mistakable in saying that what Shimelis (2017) reported can also be read as climate also have significant effects on forest cover. As deforestation surely causes warming of the climate loss of forest cover can also be the consequence of a warming climate because of other causes. As depicted in Shimelis (in press), the significant contribution of birds to agricultural output was a result of the positive significant effect of bird diversity on forest cover at least spatially. Similar results were also reported in Shimelis *et al.* 2013. In fact it was reported that logging which is one of the most important drivers of current deforestation affects negatively bird diversity. This indicates the loss of bird species which is the decline in species richness is a proven fact as a

result of forest cover loss. As mentioned earlier through interpretation of interchangeability of effects of forest cover and climatic variables an increasingly warming climate causes the disappearance of forests so too birds. Since it is better to evaluate directly effects whenever it is possible rather than making inferences however useful they are in this paper I evaluated the climate sensitivities of birds spatially across broadly different ecological zones. The hypothesis that is going be tested is there are significant declines in the species richness of birds as the climate got warmer across places within ecologically different zones.

MATERIALS AND METHODS

The study area is the whole Ethiopia. Agro-climatic zones in the lowlands and highlands were used to classify the spatial data both on birds and temperature. With such an approach the effects of spatially varying temperature on bird diversity was evaluated. The bird data in this paper came from my own field notes resulted from extensive field surveys across Ethiopia which was used in the Important Bird Areas publications (Shimelis *et al*. 1996, EWNHS 2001). Birds that occur in 50% or more of the IBAs surveyed (they were 73 sites) were included in the analyses in this paper. The data on temperature normals was gleaned from what was published by Aulachew *et al*. (2007). These two data sets were used in successive simple linear regression modeling.

RESULTS

Figure 1 shows the response of granivorous bird diversity to temperature. The number of species in the guild declined significantly ($P<0.01$) as the temperature warmed. The temperature variable in this simple regression model resulted in a best fit that explained 100 % of the variations observed in the species richness of the granivorous bird guild.

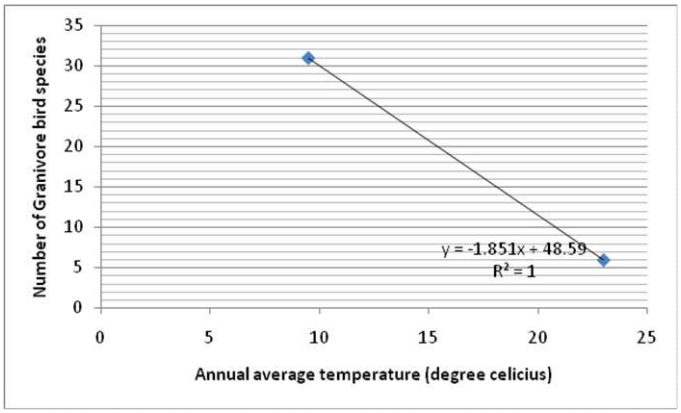

Figure 1. The relationship between temperature and the diversity of granivorous birds in Ethiopia

In Figure 2 the response of species richness of the frugivore bird guild to temperature was significantly ($P<0.01$) negative. Species diversity of the guild declined as there was increase in temperature. The best fit of this model explained 100% of the variations observed in the data set of the response variable.

Figure 3 depicts the significant ($P<0.01$) negative changes in the diversity of insectivore birds in response to temperature. As the temperature warmed the diversity of the birds in the guild declined. The best fit line of this simple regression model explained 100% of the variations in the response variable as a function of temperature variations in Ethiopia. In figure 4 the diversity of resident raptors significantly ($P<0.01$) related to spatial changes in temperature across the country. As temperature increased the raptor diversity declined. The best fit line of this model explained 100% of the variations in the observed data set.

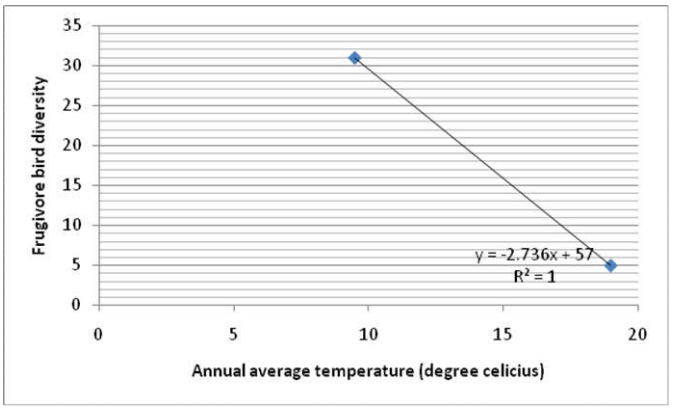

Figure 2. The response of diversity of frugivore birds to climate in Ethiopia

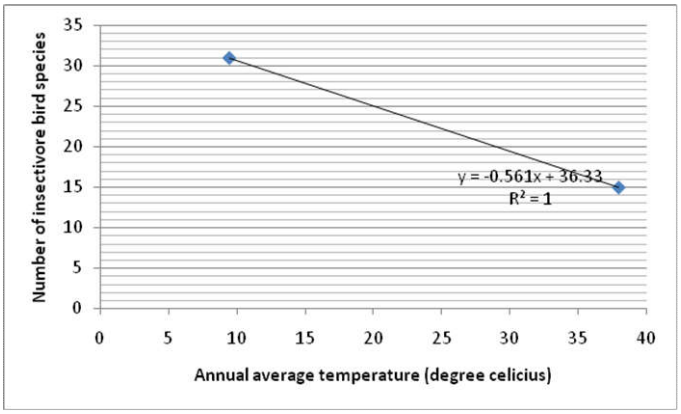

Figure 3. The relationship between temperature and diversity of insectivore birds

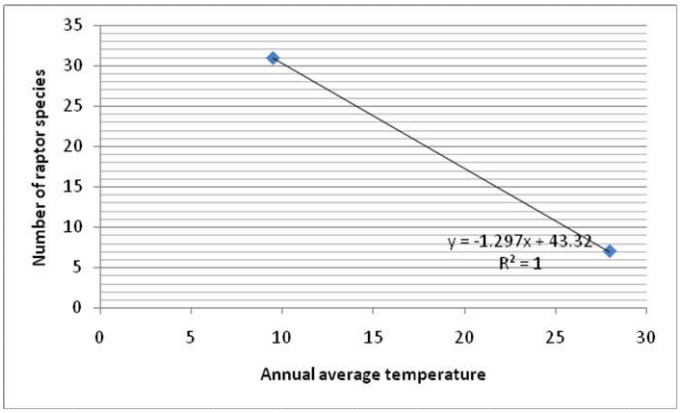

Figure 4. The decline in raptor species richness in response to temperature in Ethiopia

DISCUSSION

It was observed elsewhere that albeit inconsistently in global terms there were documented biodiversity losses as a result of a changing climate (Shen and Ma 2014). Such a loss of

biodiversity beyond what is ethical reasons is a very important trigger for conservation action as it will cause human suffering as result of severe economic shocks. Shimelis (2016) has reported the significant contributions of forest cover to agricultural output and water provisions in Ethiopia. Birds were also shown to be components of biodiversity of great economic importance as result of their positive effects on forests (Shimelis *in press*). This is because birds have significant positive relationship to vegetation cover in a gradient of increasing complexity including composition and also plant species richness both at the community and population levels (Shimelis *et al*. 2013, Shimelis *et al*. $2014_{a,b}$, Gove *et al*. 2008, Shimelis 2008, Shimelis and Assefa 2007).

It was documented that there is a significant threat of forest loss which negatively affects birds too (Shimleis et al. 2013). Such situation of biodiversity loss cannot be at least ignored by Ethiopians as it has dire economic consequences. A loss in forest cover whatever may be the cause warms the climate as forests have significant cooling effect on it. The reported relationship between temperature and forest cover by Shimelis (2017) can also be interpreted as a warming temperature causes significant reductions in forest cover. Thus it can be inferred that the loss in forest cover as result of a warming climate which may be caused by deforestation in addition to emissions does also negatively affect birds. This was investigated in this paper by directly modeling the temperature variable as result of the increase of which there were significant declines in the species richness of guilds of resident birds. Although the modeling involved gleaned data on climatic normals the results are important warning signs of the negative effects of the expected or undocumented but realized warming of the climate in Ethiopia. Unless curbed through climate warming mitigation measures the loss of forests along with birds which have proven significant contributions to the nation's economy is a disaster worth reckoning. Expansion of forest carbon sinks (Shen & Ma) is one obvious important solution to the problem. Apparently this may be an effective combative conservation tool as forests particularly the indigenous ones considered to have significant cooling effect on the climate (Shimelis 2017).

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