Loss of natural habitats under future climates?

Summary

Eastern Africa has a wide range of rich natural habitats that accommodate a large number of native species and offer invaluable services and products. The habitats and their species are however, under pressure due to land use changes, increasing human population pressure, and expected climate changes. An improved understanding of the presence and dynamics of the unique habitats are required in order to develop effective strategies for their sustainable use and conservation. 'Where are the various habitats located and native species distributed?', 'how well are species and ecosystems currently protected?' and 'how will this change under future climate scenarios?'. In order to address these questions we have combined high resolution maps of the natural vegetation of eastern Africa with data on g key environmental and anthropogenic factors. With this input we have succeeded in developing statistical modeling that can help to assess the current conservation status of the natural vegetation in eastern Africa. Also, by application of future climate models, we have predicted the potential impact of climate changes on the future natural habitats. We find that present conservation efforts, human influences and likely effects of future climate changes differ substantially among different vegetation types and habitats. This implies that effective conservation planning and actions require detailed spatial analyses to identify both problems and opportunities in a complex regional and local socio-ecological context. The present study has provided new tools to predict future pressure on specific habitat and species in eastern Africa and thereby support identification of priority areas for future research, conservation actions and support to sustainable land use developments.

Introduction

This policy brief examines the conservation status of the natural vegetation in eastern Africa and how this may change under future climates. The work presented is based on a series of studies that have been carried out as part of the Ph.D. project 'Changing natural habitats under future climates', which was funded by a grant from the Danish Consultative Research Committee for Development Research (FFU - Danida) under project 10-095-LIFE.

The main objective of the study was to develop information supporting the planning and targeting of habitat and tree species conservation and sustainable use, thus enabling relevant organizations to make better informed decision on the use of these habitats and species in e.g., reforestation, restoration or in agricultural landscapes.

Conservation status

The countries of eastern Africa (Ethiopia, Kenya, Uganda, Tanzania, Rwanda, Malawi and Zambia) have a wide range of rich natural habitats, which offer invaluable services and products. These habitats or vegetation types are, however, increasingly under threat from land use changes and degradation. Significant

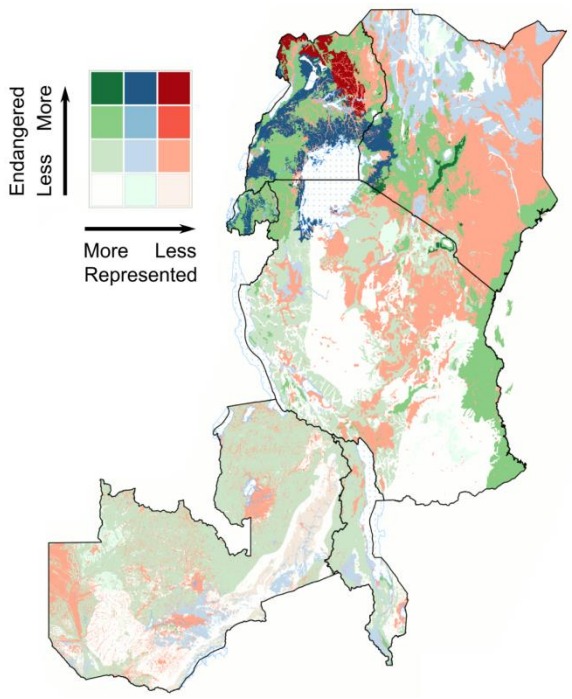

Figure 1 Crisis potential natural vegetations. The potential natural vegetations were classified based on how critically endangered they are to what extent their range of environmental conditions are well represented within the protected areas. The darker colors thus represent a higher risk.

areas have been designated as protected areas to protect the unique biodiversity. However, this process started several decades ago and was therefore based on principles and objectives that do not necessarily agree with the wider view of biodiversity conservation prevalent today. To identify options for improvement, a key question is therefore whether the current areas are representative of the diverse range of species and habitats found in the region. Important is also if the conservation efforts protect areas where the state of biodiversity is likely to deteriorate without further interventions in a near future.

Climate change

The fifth assessment report of the Intergovernmental Panel on Climate Change (IPCC) shows that eastern Africa is likely to experience increased temperatures and, on average, an increase in rainfall in large parts of eastern Africa. Not much is known yet about the response of the African flora to projected future climate changes, but studies in other parts of the world show that we may expect significant shifts in the geographical range of species and/or habitats, which may lead to a decline in populations and local species diversity. This is likely to result in a higher vulnerability of ecosystems to natural and anthropogenic disturbances. To identify species and their habitats that are most vulnerable for future climate changes, we therefore need to address the question 'how will climate change affect current distribution patterns of species and their natural habitats, and which species or habitats are most vulnerable for future climate changes?'

Background

Various studies have addressed potential shift in distribution of species and ecosystems at global and continental scales. However, conservation decisions are taken at the national and regional level, requiring finer scale baseline data than is often available through these global studies. A major challenge is that for many species occurrence data is limited and potentially biased, while alternative sources of information, such as vegetation maps, often come at a low resolution and provide information at a highly aggregated level, making it less suitable for use at the national or sub-national level.

For the present study we utilized recently developed high-resolution potential natural vegetation (PNV) map for eastern Africa as a baseline to assess the distribution of the vegetation under natural conditions. The map provides the most detailed map of the natural vegetation in the seven countries of eastern Africa to date allowing detailed inference at the national and regional level.

Environmental gap analysis

We examined how well different potential natural vegetation types (PNVs) are represented in the present network of protected area (PA) in eastern Africa and combined this with a number of existing and newly

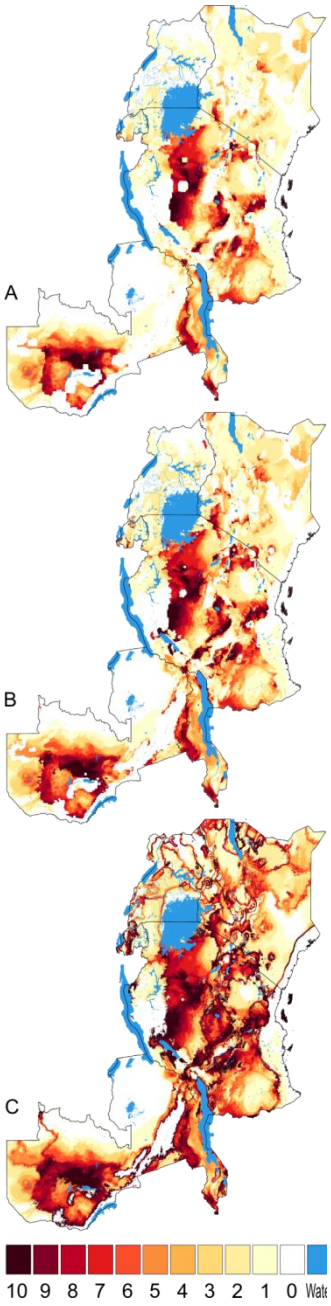

Figure 2. Areas of PNV change. We used 10 different GCM/scenarios to project the future vegetation distribution for 2080. The maps give the number of models that predict areas to become A) unsuitable for the current PNV and unreachable for others, assuming a maximum dispersal rate of 2 km / decade B) As A, but assuming a maximum dispersal rate of 0.7 km / decade C) As A, but including areas that become suitability and reachable for other PNVs.

developed maps of potential human influence on the natural vegetation. Hereby, we could assess the level of threat to different PNVs. Based on the combination of protection status and human pressure, we classified the PNVs as critically endangered, endangered, vulnerable and not vulnerable. In addition, we examined to what extent the environmental conditions were unique for the protected areas or provided a fair representation of areas outside the protected areas.

Climate change

For each of the vegetation types occurring in the region, we created environmental distribution projections using various predictive environmental models. We used these models to project future PNV distributions; using projected climate change data based on 10 different emission scenarios and coupled ocean-atmosphere general circulation models (GCM) from the 4th IPCC assessment. We used multiple models in order to provide a robust assessment of the climate change consequences on the vegetation distribution, and identify the level of uncertainty in predicted changes.

Dispersal limitations

There is a maximum distance a species can move each year. This varies between species and estimates range from than 1 to 17 kilometers per decade. An important question is whether this is enough to keep up with future climate change velocities, which in some predictions are estimated to be as high as 30 to 50 kilometers per decade. To narrow-down the large uncertainty obtained from unlimited versus no-dispersal scenarios, we constrained projected changes in vegetation distribution to a maximum of 10, 2 and 0.7 km per decade.

Results

Vegetation types at risk

Over 26% of the land is currently protected in eastern African, which is well above the global CBD Aichi target for 2020 of 17%. However, our results show that there are substantial differences in how well PNVs are protected; percentages vary from less than 2% to 100%. Differences are also large in terms of how well the protected areas reflect the environmental variation within vegetation types, and the degree to which biodiversity protection and ecological functions of the PNVs are at risk. Combining these factors, we identify the crisis PNVs as those with the highest risk and poorest environmental representation in the protected areas (Figure 1).

Changing habitats under future climates

Future climate changes are likely to have an impact on the future vegetation distribution patterns in considerable areas in eastern Africa (Figure 2). Differences in model predictions are large, but overall results suggest that in large parts of the region (50% if we use results agreed under at least 6

GCMs/scenarios) changing conditions may cause significant shifts in current vegetation boundaries, with considerable differences between PNVs (Figure 3).

How these changes will transform into changes in distribution of species will depend on how well the different species in the vegetation type are able to keep up with changes in the climate. Our results show that dispersal limitations is likely to keeps large areas out of reach of species, which would otherwise be able to establish there under future conditions. Also, it may prevent species from 'filling the gap' that is created by retreating boundaries of present PNVs.

Climate change in protected areas

We predict that climate-change will lead to significant shifts in vegetation boundaries in 40% of the PAs in the region. Such changes will affect the protection of target species or habitats and l thus have important implications for the ability of the PA to protect indigenous species in the future.

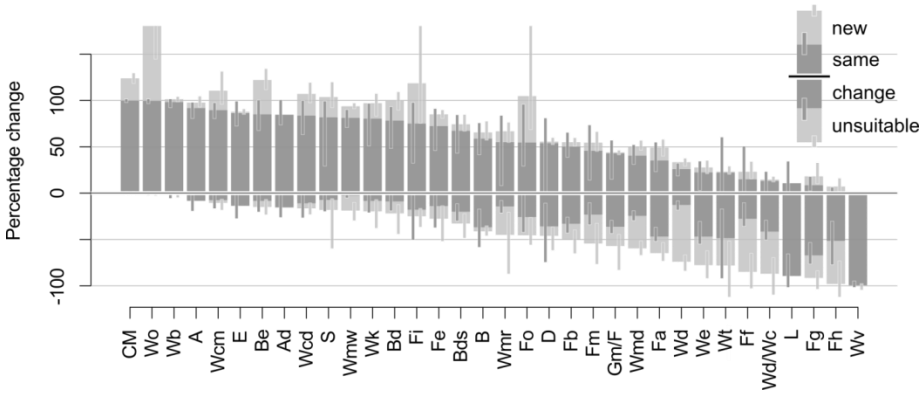

Figure 3. Barplot showing the area of vegetation types that remains suitable (same), becomes suitable and reachable (new), changes to another PNV (change), or unsuitable and unreachable for any PNV (unsuitable) under a scenario of maximum energy requirements. The bar plots give the average, and the bars the range over the different GCMs.

Conclusions and recommendations

Conservation efforts and human influences differ substantially across the different vegetation types and habitats. Effects of future climate are likely to exacerbate the pressure on East Africa's habitats, with shifting vegetation boundaries resulting in a rearrangement of existing vegetation patterns and possibly the creation of novel communities.

To protect the natural resources now and in the future, there is a need for conservation and sustainable use strategies that address both the various current and future threats. The newly developed spatial data sets provide an overview of the region's most vulnerable habitats and vegetation types and can be used to support future planning and targeting of habitat and their tree species for conservation and sustainable use actions. In addition, the spatial dataset provides the first comprehensive hypothesis for the distributions of the woody species of East Africa and the analyses presented by this study is a major step towards the development of species-specific national and regional planting zones for the hundreds of ecologically and economically important woody species utilized in agroforestry and in the restoration of ecosystems in eastern Africa. The developed information contributes towards transparent and better informed translation from global priorities to regional or national implementation in eastern Africa, complementing other important criteria commonly used, such as levels of biodiversity and endemism.

For more information about the project and its products, please visit http://vegetationmap4africa.org