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Vulnerability of Zimbabwe forests to global climate change

C. H. Matarira, F. C. Mwamuka

Scientific and Industrial Research and Development Centre (SIRDC), Environment and Remote Sensing Institute (ERSI), PO Box 6640, Harare, Zimbabwe

ABSTRACT: The impacts of global climate change on forest distribution was evaluated using the Holdridge life zone and GISS general circulation model scenarios. Across Zimbabwe, 17 to 18% of the total land area is projected to shift from subtropical thorn woodland and subtropical dry forest to tropical very dry forest under the GISS scenario. The projected shift in forest distribution is attributable to a future decline in precipitation patterns and an increase in ambient temperature.

KEY WORDS: Climate models · Ecological zone · Forestry

INTRODUCTION

Anthropogenic emissions of greenhouse gases (e.g. CO_2, CH_4) to the atmosphere are projected to stimulate global climate change (Houghton et al. 1992). Shifts in the distribution of global vegetation, especially forest systems, may result from changes in ambient temperature and precipitation patterns (Smith et al. 1993). Extratropical forest biomes are expected to shift poleward, while low latitude forests could expand or contract regionally (Prentice et al. 1992).

The forest systems of Zimbabwe vary in distribution and productivity (Singh 1993). Forests offer both timber and non-timber goods and services in spite of recent degradation and loss of indigenous species. Plantations composed of exotic species are widespread, providing an adequate supply of wood and fiber products. Both indigenous and exotic forest species are highly susceptible to short-term shifts in climate (Smith et al. 1991). The objective of this study is to compare the current and future distribution of forest resources in Zimbabwe using Holdridge life zone classification and a General Circulation Model (GCM) scenario.

MATERIALS AND METHODS

The scenario of double CO_2 climate change used to drive the GCM was the Goddard Institute of Space Studies (GISS) model (Hansen et al. 1983). The output from the model was precipitation and surface air temperature data. One of the limitations of the GCM is spatial resolution. Zimbabwe in this case study is represented by 4 grid points which cannot fully represent the high spatial precipiation variability across the country due to the influence of topographic differences and other factors. A north-south and east-west gradient exists in precipitation and ambient temperature patterns which is not fully represented by the 4 grid points over Zimbabwe (Unganai 1996).

The potential effects of global climate change on the forests of Zimbabwe were estimated using the GISS scenario and the Holdridge Life Zone classification (Holdridge 1967, Smith et al. 1993). The Holdridge classification relates the major plant formations in the world to 2 climate variables, biotemperature (growing season index) and total annual precipitation. The Holdridge life zones considered in this study of Zimbabwe include 5 classifications (Table 1). The future vegetation scenario should be considered as a sensitivity analysis given the limitations of both GCMs and the Holdridge system (Smith et al. 1991).

RESULTS

Under current climate conditions Zimbabwe contains 5 Holdridge life zones: subtropical dry forest,

Table 1. Holdridge forest life zone classes for Zimbabwe under current climate conditions

Life zone classes	Forest area (km^2)	% of Zimbabwe
Subtropical dry forest	264056	68.7
Subtropical thorn woodland	83725	21.8
Tropical very dry forest	21253	5.5
Subtropical moist forest	10304	2.8
Warm temperate moist forest	5152	1.2

Table 2. Holdridge forest life zone classes for Zimbabwe under GISS climate change scenario

Life zone classes	Forest area (km^2)	% of Zimbabwe
Subtropical thorn woodland	9016	2.3
Subtropical dry forest	175179	45.6
Subtropical moist forest	1223	3.2
Tropical thorn woodland	3220	0.8
Tropical very dry forest	157790	1.0
Tropical dry forest	27050	7.1

subtropical thorn woodland, tropical very dry forest, subtropical moist forest, and warm temperate moist forest (Table 1). The Holdridge life zone subtropical dry forest covers the largest area in Zimbabwe (68.7% by area) and extends across the largest latitudinal range, 15.5°S and 22°S. This zone corresponds to miombo woodland and savanna, mopane woodland and savanna, *Terminalia-Combretum* woodland, Zambezi teak (*Tectona grandis*) woodland and *Acacia* woodland according to historic classification systems.

Under the GISS scenario there is a climate shift towards reduced annual precipitation and high ambient temperatures. Northeastern Zimbabwe, for example, becomes more suitable for vegetation found under the subtropical moist forest conditions in the GISS climate change scenario as opposed to the warm temperate moist forest which exists under current climate conditions (Table 2). Similarly, the southeastern region of Zimbabwe is projected to become unsuitable as a subtropical moist forest area and to shift to the subtropical dry forest life zone. The greatest life zone changes are those shifts from subtropical dry forest to tropical very dry forest and from subtropical thorn woodland to tropical very dry forest.

DISCUSSION AND CONCLUSION

Shifts in the areal distribution of Zimbabwe forests are predicted by the GISS climate change scenario and the Holdridge model (Smith et al. 1991). During this century, southern Africa has experienced dramatic fluctuations in precipitation, with significant impacts on agronomic and forest vegetation (Unganai 1996). Recent climate shifts in southern Africa have been sporadic, but future changes may be more distinctive in direction and magnitude (Houghton et al. 1992). The widely cultivated exotic forest species of Zimbabwe may be especially susceptible to shifts in precipitation and ambient temperature (Dixon et al. 1996).

The climate scenario comparisons in this study should be viewed as a sensitivity analysis due to limitations of the models and their high spatial variability (Smith et al. 1993). The Holdridge model is steady-state, not dynamic, and does not consider the ecologic and physiologic response of plants (Prentice et al. 1992). Although this analysis has limitations, it is a preliminary estimate of future forest system response to climate change in Zimbabwe.

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