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Introduction

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The past, present and future of Africa's rainforests

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The African wet tropics contain the second largest area of tropical rainforest in the world (second only to Amazonia), accounting for roughly 30% of global rainforest cover, the lush green heart of an otherwise generally dry continent. These rainforests have global significance and value as reservoirs of biodiversity, as stores and sinks of atmospheric carbon, as regulators of flow of mighty rivers, as sources of moisture to the atmosphere and engines of the global atmospheric circulation, as a key component of the Earth system and its biogeochemical cycles, and as providers of resources and ecosystem services to local communities and the region's nations. They also have a unique and particular history of changes in climate and human pressure, and face a range of contemporary pressures. Over the twenty-first century, the African rainforest realm has the potential to witness massive change, both through an expansion of deforestation, hunting and logging, and through the effects of global climate change.

This Theme Issue presents a multidisciplinary perspective on the nature and ecology of the African rainforest biome, and examines the current pressures and future threats to this biome. Compared with the other major rainforest regions, Amazonia and Southeast Asia, the African rainforest realm remains understudied, and in particular there have been very few attempts at interdisciplinary synthesis. This Theme Issue is an attempt to address this deficit, and explores what we know about the African rainforests and the threats they face, and what we need to know in this century of rapid change. In some ways, this can be viewed as a complement to similar Theme Issues of this journal focused on the rainforests of Amazonia [1,2] and Southeast Asia [3].

First, it is necessary to acknowledge the limits of this thematic issue. It focuses on the humid tropical forest biome (the 'rainforests'). There are many other valuable biomes in Africa, most notably the extensive dry open forest, savanna and grassland biomes, and also mangroves, afro-montane ecosystems and others. All of these are valuable and fascinating ecosystems, which for reasons of brevity are not covered in this volume. Second, many of the analyses presented dwell on the largest biogeographic unit that accounts for 95% of African rainforests, the Guineo-Congolian forests of West and Central Africa. We particularly focus on Central Africa (technically the Congo–Ogooué Basin and contiguous forests, hereafter termed the Congo Basin for brevity), which accounts for 89% of African rainforests. The submontane forest patches of East Africa and the unique forests of Madagascar receive less detailed attention here. However, a number of studies, including those on deforestation, woody encroachment, climate change, and forest structure and biomass, do extend beyond the Guineo-Congolian forest zone (see below for details).

The issue starts with several papers exploring the current extent of the African rainforest biome, and patterns and agents of contemporary change. Mayaux *et al.* [4] present a new state-of-the-art map of the current extent of the rainforest biome, and the patterns and drivers of change between 1990 and 2010. Rudel [5] explores the social and economic factors that are driving

these patterns of change across African rainforest nations, highlighting, in particular, the importance of oil and mineral extraction in shaping economies and lowering deforestation pressure in rainforests. Mitchard & Flintrop [6] turn attention away from forest loss, and instead review and map the phenomenon of woody encroachment, where rainforests appear to be expanding and tree cover seems to be increasing in some mixed tree–grassland systems.

The issue next shifts attention to a cryptic but pervasive agent of change in African rainforests. Abernethy *et al.* [7] summarize the patterns and massive rates of hunting that are underway in the rainforests, and explore what knock-on effects these changes may have on forest ecosystem structure, biodiversity and function.

Oslisly *et al.* [8] present a valuable historical perspective on change in the African forest biome, synthesizing a wealth of archaeological data from western Central Africa to illustrate the waves of human settlement and occasional population collapse within the rainforest realm. Willis *et al.* [9] describe the history of climate variation in Africa since the last Ice Age, again narrating a story of change and periods of retreat and advance of forests. The story emerging is of a rainforest biome that has undergone varying levels of human and climatic pressure over time, and that these changes may be reflected in the current structure and composition of the African forests, and their potential for resilience to present and future change.

Global and regional climate change is a major issue for this century. In the context of African rainforests, there is much still to understand both about the patterns of present and future climate, and in the potential responses of rainforests to this change. A number of papers explore our understanding of climate change for this region. James *et al.* [10] examine the outputs from a large number of climate models, to understand likely patterns of rainfall change and their links to changes in ocean surface temperatures. Washington *et al.* [11] highlight how little we know about the present-day climate of the region, and how the ground-based climate observation system for the region has deteriorated over time. Otto *et al.* [12] present the first attempt at a climate change attribution study for a tropical region, to see whether patterns of drought in Central Africa can be explained by global climate change. Asefi-Najafabady & Saatchi [13] present a satellite-based analysis to document the patterns of drought in the region and explore what impacts these droughts had on rainforest vegetation. Fisher *et al.* [14] explore the impacts of

atmospheric change (both climate change and the rise of atmospheric CO₂ concentrations) on the carbon balance of African rainforests, presenting a synthesis of outputs from a number of ecophysiology-based ecosystem models.

We next focus attention on new understanding the forest ecology of the region. Lewis *et al.* [15] present a new synthesis and analysis of how intact forest structure and biomass vary across the region, and how it compares with the forests of Amazonia and Asia. Gourlet-Fleury *et al.* [16] present new long-term data on the impacts and sustainability and sustainable logging. Gond *et al.* [17] explore the potential of satellite data to map the various types of lowland forest in Central Africa.

Finally, we explore that opportunities and challenges that climate change mitigation funds provide for African rainforest nations and communities, through mechanisms such as the REDD+ process (reducing emissions from deforestation and forest degradation and conservation of forest carbon stocks, sustainable management of forests and enhancement of forest carbon stocks). This represents a potentially transformative opportunity for a more sustainable future for Africa's forests but faces a number of challenges. Maniatis *et al.* [18] present a national-level analysis of the state of REDD+ funding and preparedness amongst the Congo Basin Nations. Asare [19] focuses at the challenges faced at the community scale and highlights experiences gained from the community resource management area model in Ghana.

The issue concludes with a synthesis paper [20] that draws together the various strands addresses in each paper, to weave a picture of what key findings and insights have emerged, and what the research and policy priorities should be to ensure a sustainable future for Africa's unique and precious rainforests.

This theme paper is based on a conference, *Climate Change, Deforestation and the Future of African Rainforests*, held at Oriel College, Oxford, on 4–6 January 2012. We thank Oriel College for hosting this conference, and the Waterloo Foundation and the Oxford Martin School for providing the funds to make this meeting possible. We also thank the Waterloo Foundation for providing the funds to make a number of the papers in this issue Open Access, ensuring greater availability to an African readership. Finally, we thank Helen Eaton at the Royal Society for patiently helping us navigate this thematic issue to the shore. It is our hope that it will provide new insights, and stimulate greater interest and research attention on the beautiful and fascinating rainforests of Africa and the challenges they face.

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