Climate Change and Natural Resources Conflicts in Africa

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Donald Anthony Mwiturubani and Jo-Ansie van Wyk

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Introduction

Donald Anthony Mwiturubani and Jo-Ansie van Wyk

This monograph contains papers that were presented at the International Conference on Climate Change and Natural Resources Conflicts in Africa, 14–15 May 2009, Entebbe, Uganda, organised by the Environment Security Programme (ESP) of the Institute for Security Studies (ISS), Nairobi Office.

The climate change phenomenon is a global concern, which typically threatens the sustainability of the livelihoods of the majority of the population living in the developing countries. Africa, particularly the sub-Saharan region, is likely to be negatively impacted by climate variability and change. According to the Intergovernmental Panel on Climate Change (IPCC), Africa's vulnerability arises from a combination of many factors, including extreme poverty, a high rate of population increase, frequent natural disasters such as droughts and floods, and agricultural systems (both crop and livestock production) that depend heavily on rainfall. Extreme natural occurrences such as floods and droughts are becoming increasingly frequent and severe. Africa's high vulnerability to the negative impacts of climate variability and change is also attributed to its low adaptive capacity.

Climate variability and change have further exacerbated the scarcity of natural resources on the African continent, leading to conflicts with regard to access to, and ownership and use of these resources. The scarcity of natural resources is known to trigger competition for the meagre resources available among both individuals and communities, and even institutions, thus affecting human security on the continent.

In recognition of the fact that climate change and its impact are complex phenomena that require a multidisciplinary approach to address them, the ISS through ESP organised an international conference to bring together experts, practitioners, policy decision makers and researchers to share experiences and information on the best ways to deal with this unavoidable environmental insecurity.

The conference aims to address a number of questions such as: How vulnerable are the economies of Africa to the impact of climate variability and change? How are national and regional institutions preparing to adapt to the impact of climate variability and change? How are climate variability and change likely to affect existing traditional norms governing access to, and use and management of natural resources on the continent? Are the environment-related policies in African countries effectively addressing issues pertaining to climate variability and change?

The monograph is divided into five sections that correspond to the main themes of the conference. The first part contains a chapter that discusses the link between climate change and human security in Africa by focusing on the role of the African Union in addressing the impact of climate change in general. Other chapters in this section address the effects of climate change on the human population in Africa, more specifically around Lake Chad and in Lesotho.

The impact of climate change on access to, and utilisation and management of natural resources and food security are dealt with in part two of the monograph. Chapters in this part address the effect of climate change on access to water resources and escalating food insecurity owing to water shortages.

The third part addresses issues on climate change and natural resource-use conflicts in Africa. The chapters in this part focus mainly on case studies including natural resource-use conflicts in Nigeria and more specifically in the Niger Delta, the use of indigenous knowledge in conflict resolution among the Nyakyusa people of southern Tanzania and land-use conflicts arising from anthropogenic-induced climate change in the Soutpansberg region of South Africa.

In part four, chapters explore the vulnerabilities and adaptation to climate change at a local level in East Africa. These chapters focus on soil carbon sequestration potential at the smallholding farm level in north-west Tanzania, the pastoralists' vulnerability to climate change and the adaptation options available in northern Kenya, as well as the land-use dynamics related to climate change in Botswana.

The final part of the monograph discusses the role of legislation and policies in addressing climate change issues in Africa. The chapters in this section cover policy and legal challenges in the implementation of reducing emissions from deforestation and forest degradation (REDD) for the United Republic of Tanzania, and the nexus between climate change, law and sustainable development in Uganda.

It is expected that the information presented in this monograph will contribute to the existing knowledge on the impact of climate on natural resources management in Africa and hence assist policymakers and planners to formulate and implement appropriate policies to curb the effects of climate change. The monograph will also provide secondary materials for researchers and academics working on issues related to climate change in Africa and globally.

Part 1

Climate Change and Human Security in Africa

1 The African Union's response to climate change and climate security

Jo-Ansie van Wyk

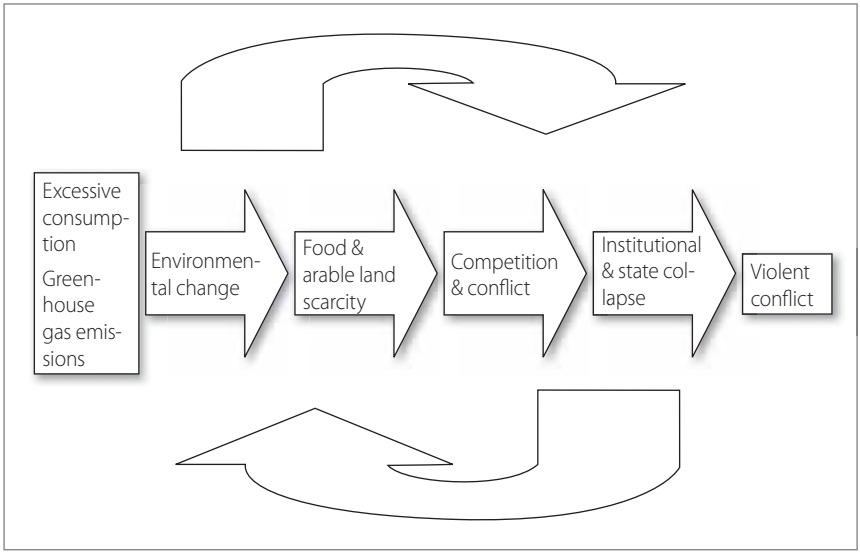
INTRODUCTION

In its Declaration on Climate Change and Development in Africa adopted in January 2007, member states of the AU acknowledged African's vulnerability to climate change and that 'climate change could endanger the future well being of the population, ecosystems and socio-economic progress of Africa'.[1] A few months later, in April 2007, the Intergovernmental Panel on Climate Change (IPCC) concluded that Africa is one of the continents most vulnerable to climate variability and change owing to 'multiple stresses and low adaptive capacity', and despite the fact that some adaptation is taking place 'this may be insufficient for future changes in climate'.[2]

There is scientific consensus on climate change, its causes and effects.[3] The scope and projected impact of climate change on Africa generally and on specific regions such as, among others, the Sahel and southern Africa, the Okavango Delta, eastern Africa and Sudan has been analysed, and is not the focus of this chapter.[4]

Figure 1 contains a simplified conceptualisation of the link between climate change, resource scarcity and resource conflicts. These three factors form the basis of the chapter's analytical framework, which recognises climate

Figure 1 Simplified conceptualisation of the link between climate change, resource scarcity and resource conflict



Source Adapted from O Brown, A Hammill and R McLeman, Climate change as the 'new' security threat: implications for Africa, ***International Affairs*** 83(6) (2007), 1148

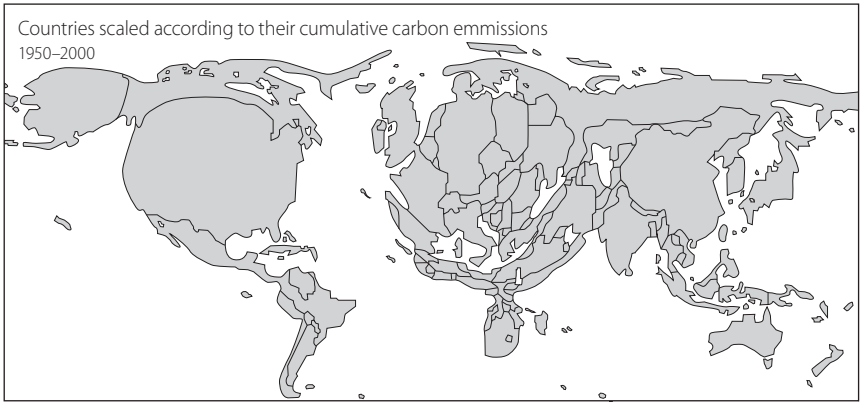
change as a driver of resource conflicts – a position supported by, for example, the IPCC. The chapter also follows the notion that excessive resource use such as the logging of hectares of forests can contribute to climate variations and long-term change.

The purpose of this chapter is twofold: to assess the AU's response to climate change by providing an overview of the AU's environmental and climate change regimes, and to formulate policy recommendations to improve the AU's response to climate change. Here, climate change is considered as a specific environmental regime. The chapter concludes with a proposed framework for achieving climate security on the continent.

THE GEOPOLITICS AND GEO-ECONOMICS OF CLIMATE CHANGE

The global political economy of climate change is already evident. Greenhouse gas (GHG) emission-driven climate change knows no boundaries and does not

Figure 2 Africa's share of carbon emissions



Source Climate change and the poor. Adapt or die, *The Economist*, 13 September 2008, 66

respect states' territorial sovereignty. In contrast to Africa's major vulnerability to climate change is its scant contribution to the causes of climate change. As Figure 2 illustrates, Africa emits far less carbon than any other continent. The continent is home to 14 per cent of the world's population, but accounts for only three per cent of the world's energy consumption, and contributes approximately 3,8 per cent of total greenhouse gas emissions.[5]

African countries are excluded from all commitments to emission reduction in terms of the UN's Climate Change Conference in Bali in 2007.

Table 1 African trade, 2005

Region	Destination of African exports (%)	Origins of African imports (%)
North America	22,0	7,5
Latin America	3,0	4,0
Europe	45,0	46,5
Intra Africa	9,5	11,0
Middle East	2,0	6,5
Commonwealth of Independent States	0,5	2,0
Asia	18,0	22,5

Source D Coetzee, D Large and P Smith, Africa in the world. The new great game, *Africa Report* 9 (2008), 62

Table 2 Status of major environmental treaties in Africa

Major environmental treaties	Number of African states to have ratified, acceded to, approved or succeeded to
Cartagena Protocol on Bio-safety (2000)	40
Framework Convention on Climate Change (1992)	52
Kyoto Protocol to the Framework Convention on Climate Change (1997)	47
Convention on Biological Diversity (1992)	52
Vienna Convention for the Protection of the Ozone Layer (1988)	51
Montreal Protocol on Substances that Deplete the Ozone Layer (1989)	53
Stockholm Convention on Persistent Organic Pollutants (2001)	44
Convention on the Law of the Sea (1982)	40
Convention to Combat Desertification (1994)	53

Source United Nations Development Programme (UNDP), Human Development Report 2007/2008. *Fighting climate change: human solidarity in a divided world,* New York: Palgrave Macmillan, 2007, 314–317

Adapting to, or mitigating the impact of climate change is costly. By 2020, it is projected that between 75 and 250 million Africans will be exposed to water stress caused by climate change. For Africa, the cost of adaptation has been estimated at least five to ten per cent of GDP.[6]

Europe, for example, is increasingly strategically improving its global competitiveness vis-a-vis climate change, which could lead to it setting global climate change standards.[7] This may bode ill for Africa, as Europe remains its major trading partner, as Table 1 indicates.

Few African leaders have grasped the scale of the impact of climate change. A notable exception is Yoweri Museveni, the president of Uganda, who, in 2007, called climate change an 'act of aggression' by developed countries against developing countries. Museveni is also on record for demanding compensation for the damage caused to Africa by climate change. Another exception is the Namibian representative at the UN, Kaire Mbuende, who, also in 2007, said the GHG emissions of developing countries were equivalent to 'low biological or chemical warfare'.[8] The AU 'has done little to sound the climate-change alarm' and there is 'a need for the integration of the environmental protection

concerns into the manifold policies of African states in general and the AU in particular'.[9] Other views maintain that 'many African countries cannot cope with the current impacts of climate change' and that Africa 'has little capacity to mitigate the effects [of climate change] or adapt to them'.[10] Moreover, the AU and African regional organisations are often absent from the proceedings of climate change-related multilateral organisations such as the UN Commission on Sustainable Development (CSD).[11]

Notwithstanding these critical views, the AU has responded in various ways to climate change.

STATUS OF MAJOR ENVIRONMENTAL TREATIES IN AFRICA

Almost all African states have, as Table 2 indicates, ratified, acceded for approval or succeeded to the major international environmental treaties. In particular, all African states have ratified the 1992 Climate Change Convention.

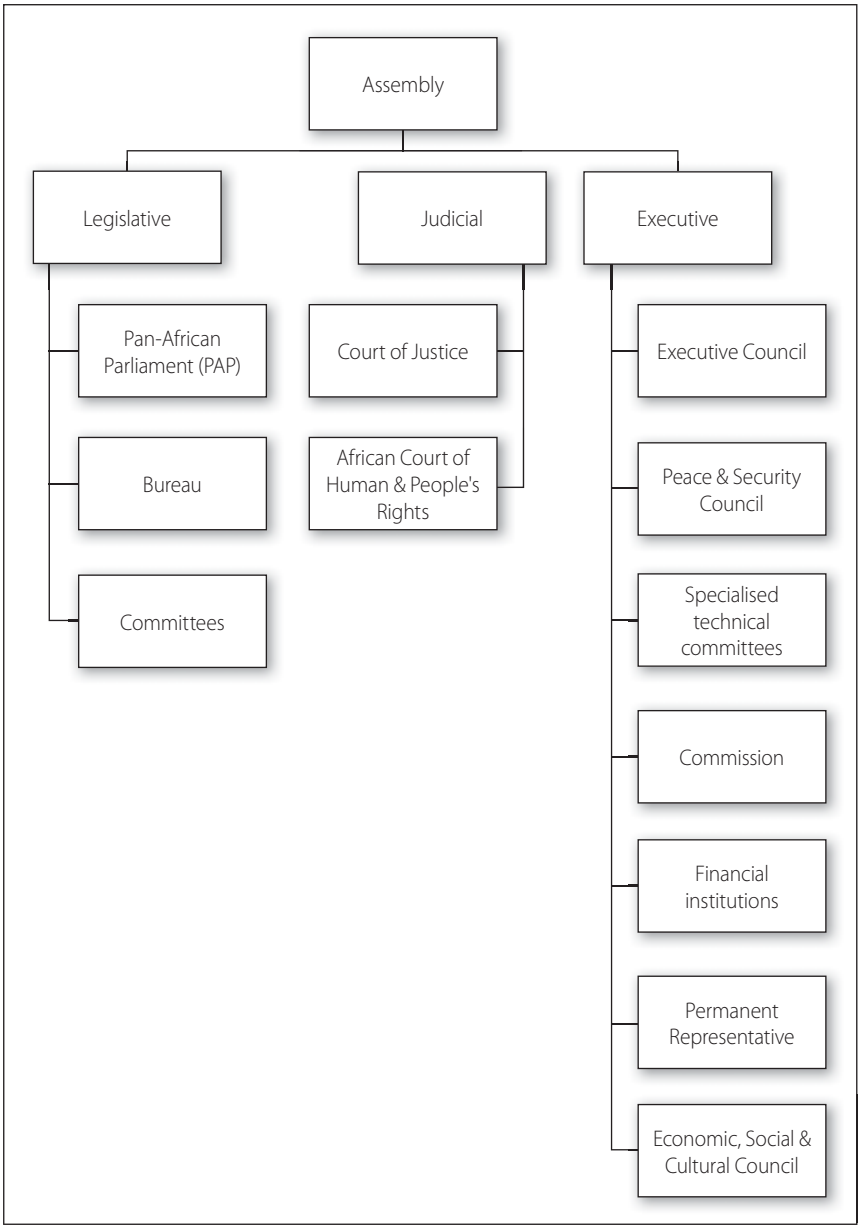
It is evident from Table 2 that individual African states subscribe to international environmental norms, principles and procedures relating to the environment, which constitutes the international environmental regime, which here refers to a 'system of principles, norms, operating procedures and institutions that actors create or accept to regulate and coordinate action in a particular issue area'.[12]

THE AU'S ENVIRONMENTAL REGIME

Figure 3 outlines the institutional structure of the AU. Referring to these institutions, this section outlines the manifestation, application and implementation of the AU's environmental regime, which builds upon the environmental regime established by its predecessor, the OAU.

Several interrelated dynamics drive regional integration in Africa, particulary AU-driven integration efforts.[13] These dynamics are instructive analytical instruments which can be used to review the AU's response to climate change. The first dynamic driving AU integration is the 'management of independence' from colonial states, the provision of African solutions to African challenges, and economic independence. This dynamic entails the consolidation the AU's international identity, or 'actorhood'. The second dynamic is the 'management

Figure 3 The institutional structure of the African Union



Source Pan-African Parliament (PAP), Pan-African Parliament 2006–2007, Johannesburg: PAP, 2007, 52

of interdependence', which relates to the economic, political and social interaction of member states to ensure peace, security and stability. Interdependence fosters adoption of shared norms and the formation of a security community. A third dynamic is the 'management of internationalisation', which refers to the AU's relationship with other international actors. Figure 4 presents an application of these interrelated dynamics vis-a-vis the AU's environmental regime.

One of the earliest conventions adopted in 1968 by the AU's predecessor – the OAU – is the African Convention on the Conservation of Nature and Natural Resources. Its fundamental principle commits member states 'to adopt the measures to ensure conservation, utilization and development of soil, water, flora and fauna resources in accordance with scientific principles and with due regard to the best interests of the people'.[14] The AU's environmental regime is applied and implemented by various AU agencies. Article 3 of the Constitutive Act of the AU contains the objectives of the AU, including, among other things, the promotion of sustainable development, international cooperation, continental integration, and the promotion of scientific and technological research to advance the development of the continent. The functions and powers of the Assembly of the AU, its highest decision-making body (as Figure 3 illustrates), include the determination of common policies of the AU and monitoring the implementation of its policies (Article 9). Consisting of the ministers of foreign affairs of member states, the Executive Council of the AU has to take decisions on areas of common interest, including, for example, the environment, and science and technology (Article 13). Seven specialised technical committees fall under the Executive Council. Environmental issues are addressed by the Committee on Industry, Science and Technology, Energy, Natural Resources and Environment (Article 14).

The Peace and Security Council (PSC) was established in 2002. In the Protocol relating to the Establishment of the Peace and Security Council of the African Union, member states committed themselves to various guiding principles (Article 4), including 'early responses to contain crisis situations', the recognition of the 'interdependence between socio-economic development and the security of peoples and States'. Moreover, in Article 6, the functions of the PSC are outlined as, among others:

- The promotion of peace, security and stability in Africa
- Early warning and preventive diplomacy
- Peacemaking

- Humanitarian action and disaster management
- Any other function as may be decided by the Assembly

The powers of the PSC include the support and facilitation of humanitarian action in the event of major natural disasters (Article 7). Although the Protocol does not explicitly refer to environmental issues, except for the reference to disaster management, it can be deduced that the PSC has the responsibility to warn of, protect against and prevent the impact of environmental occurrences. The PSC has predominantly responded to issues of 'high politics', but has the instruments to respond to the security concerns arising from environmental crises.

The Protocol does provide for the establishment of a continental early warning system (Article 12), which 'shall develop an early warning module based on clearly defined and accepted political, economic, social, military and humanitarian indicators' to analyse continental developments and recommend suitable courses of action.[15]

The AU regards environmental degradation as, among other things, a human rights issue. Adopted in 1999, the Preamble of the OAU's African Charter on the Rights and the Welfare of the Child takes cognisance of the situation of African children, which 'remains critical due to the unique factors of their socio-economic, cultural, traditional and developmental circumstances, natural disasters, armed conflicts, exploitation and hunger'.

The AU Protocol to the African Charter on Human Rights and Peoples' Rights on the Rights of Women in Africa contains, among others, articles on women's rights to a healthy and sustainable environment (Article 18) and the right to sustainable development (Article 19).[16]

Since its inception, the AU has been predominantly preoccupied with the effects of desertification on the continent and the effective implementation of the UN Convention to Combat Desertification.[17] It is now common wisdom that climate change is one of the main drivers of desertification.

In terms of Article 22 of the AU Constitutive Act, the Economic, Social and Cultural Council (ECOSOCC) is composed of various social and professional groups of AU member states representing the diaspora. An advisory organ intended to be a major institution for civil society participation in AU processes, ECOSOCC has been silent in responding to the impact of climate change on Africa. Moreover, none of its eight sectoral cluster committees focuses on climate change.[18]

Adopted as an official AU programme, the New Partnership for Africa's Development (NEPAD) Base Document was one of the first AU statements on the role of the environment. The Base Document includes a programme of action vis-a-vis achieving sustainable development.[19] Moreover, it identified the environment as one of the six sectoral priorities. The environment initiative has targeted eight sub-themes, including combating desertification, conserving wetlands, preventing and controlling invasive alien species, managing coastal areas, monitoring and regulating the impact of global climate change, establishing cross-border conservation areas, improving environmental governance and securing financing. The sole paragraph on global warming reads:

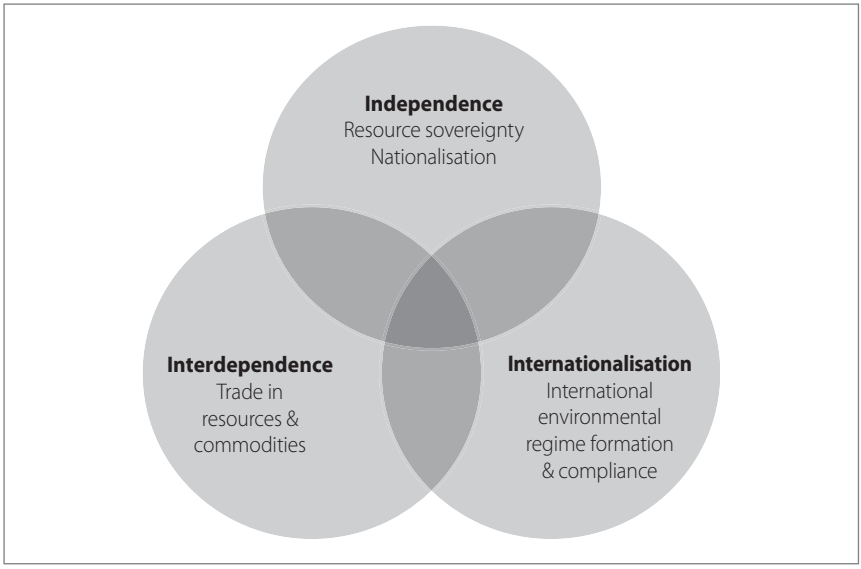
> The initial focus will be on monitoring and regulating the impact of climate change. Labour-intensive work is essential and critical to integrated fire management projects.[20]

In 2006, the Pan-African Parliament's (PAP) Committee on Rural Economy, Agriculture, Natural Resources and Environment agreed to appoint two consultants to analyse the continent's water resources, as well as the extent to which the Kyoto Protocol had been implemented in Africa.[21]

Returning to the notion of the dynamics of integration as illustrated in Figure 2, the AU's 'management' of its 'resource' or 'environmental independence' has predominantly been an AU-driven process, but its 'environmental interdependence' is evident in overlapping regimes in the AU and UN. The result of this has been, as Table 3 indicates, that member states of the AU and its predecessor, the OAU, have since AU/OAU inception adopted environmental principles, norms, operating procedures and institutions that have created or undertaken to regulate and coordinate the AU's actions vis-a-vis the environment.

The AU's environmental regime is one of its oldest regimes. Whereas it commenced with environmental issues in particular, it evolved into a regime which includes the adverse impact of environmental change on human security. Through the ECOSOCC the AU's regime also provides for participation of civil society in, among other things, environmental issues. An important but underutilised AU institution vis-a-vis the impact of environmental change on human security is the PSC. The PSC is bestowed with major power and authority which could be utilised to address the impact of environmental change on natural resources conflict on the continent.

Figure 4 Dynamics of the integration of the AU pertaining to its environmental regimes



Source Adapted from E Best and T Christiansen, Regionalism in international affairs, in J Baylis, S Smith and P Owens (eds), *The globalization of world politics*, 4th ed, Oxford: Oxford University Press, 2008, 436–437

THE AU'S CLIMATE CHANGE REGIME

Unlike its environmental regime, the AU's efforts to introduce and maintain a climate change regime are a relatively recent development. The AU's efforts to establish and maintain its climate change regime is characterised by its application of various strategies to engage international actors. Figure 5 presents a typology of the AU's relations and strategies to establish its climate change regime. Here, the AU's efforts are reminiscent of its 'management' of its 'interdependence' and 'internationalisation' as outlined in Figure 4. The AU has followed various strategies and cooperated with a variety of actors on climate change issues such as through:

- Multilateralism: The United Nations Framework Convention on Climate Change's (UNFCC) political coalitions – Group of 77 plus China, Alliance of Small Island States (AOSIS) and the Africa Group – are based on members' cultural, economic or geographical interests. These coalitions also differ in their degrees of cohesion, objectives and modes of operation[22]

Table 3 Selected AU environmental regimes

Issue	Major regime regulations
Nature, natural resources and environment	African Convention on the Conservation of Nature and Natural Resources (1968) Africa Environment Day (3 March) (2002)
Water	Sharm El-Sheikh Declaration on Water and Sanitation (2007)
Children	African Charter on the Rights and the Welfare of the Child (1999)
Women	African Charter on Human Rights and Peoples' Rights on the Rights of Women in Africa (2003)
Peace and security	Protocol relating to the Establishment of the Peace and Security Council of the African Union (2002)
Human and Peoples' Rights	African Charter on Human Rights and Peoples' Rights on the Rights of Women in Africa (2003)
Sustainable development	New Partnership for Africa's Development (NEPAD) (2001)
Humanitarian intervention	Protocol relating to the Establishment of the Peace and Security Council of the African Union (2002)
Refugees	Convention governing the Specific Aspects of Refugee Problems in Africa (1969)
Equity	African Convention on the Conservation of Nature and Natural Resources (1968)
Responsibility to protect (R2P)	Protocol relating to the Establishment of the Peace and Security Council of the African Union (2002)
Food security	Resolution of the Abuja Food Security Summit (2006)

Source African Union(AU). OAU/AU Treaties, Conventions, Protocols,Charters. 2010. http://www.africa-union.org/root/au/Documents/Treaties/treaties.htm Accessed on: 8 March 2010

- Bilateralism: Adopted in 1992, UNFCC made no specific mention of Africa. However, it requires member states to assist developing member states that are particularly vulnerable to the effects of climate change[23]
- Regionalism: The Africa-EU Declaration on Climate Change adopted in 2008 is illustrative of this

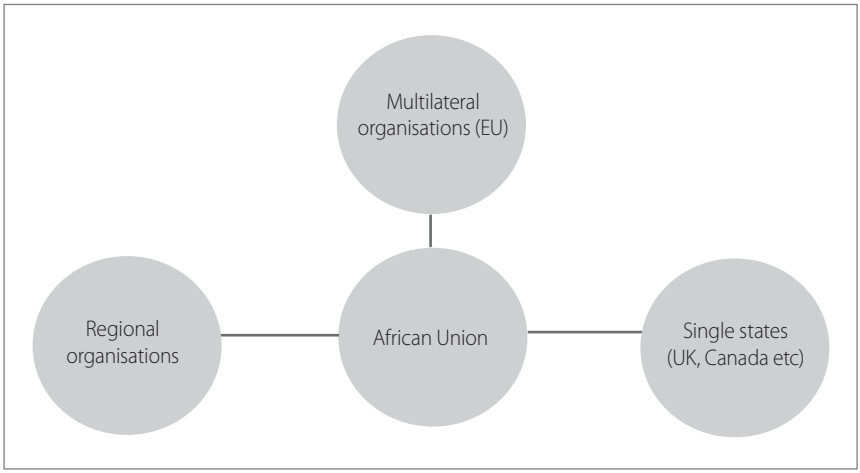
Table 4 Selected AU climate change regimes

Issue	Major regime regulations
Climate change	Action Plan of the Environment Initiative of NEPAD (2003) Decision and Declaration of the Africa Union on Climate Change and Development in Africa (2007) Tunis Declaration and Action Plan (2007) Algiers Declaration onClimate Change (2008)
Deforestation and desertification	Decision on the Implementation of the Green Wall for the Sahara Initiative (2007) Action Plan of the Great Green Wall for the Sahara and Sahel Initiative (2009)
Sustainable development	Climate Information for Development in Africa Programme (2007)

Source African Union(AU). *OAU/AU Treaties, Conventions, Protocols,Charters* (2010). http://www.africa-union.org/root/au/Documents/Treaties/treaties.htm

It was only by 2007 that the AU adopted a common view on climate change. In its 2007 Declaration on Climate Change and Development in Africa, AU member states committed themselves to:

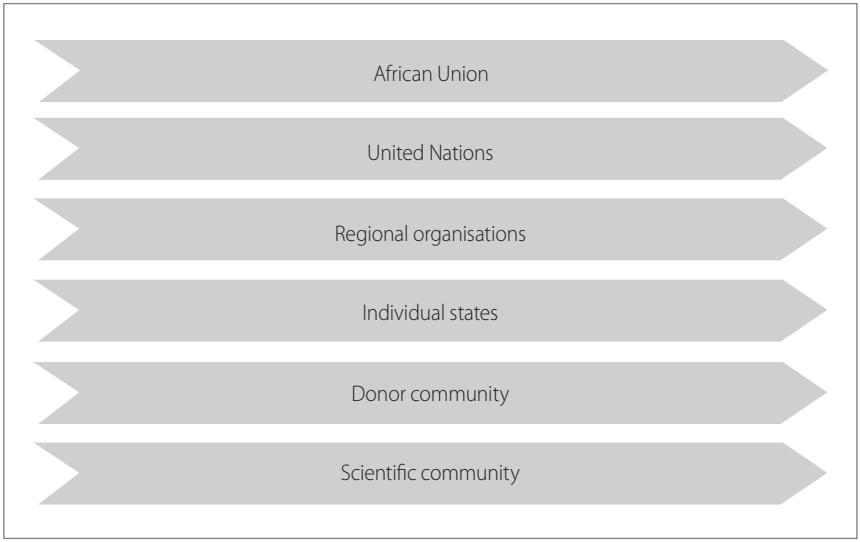
Figure 5 A typology of the African Union's cooperation on climate change



Source Author's own compilation

- Ratifying the Kyoto Protocol in Africa
- Strengthening the effective participation of African countries in the negotiations on the future of the UNFCC and Kyoto Protocol processes
- Funding and promoting science and technology on climate change
- Promoting the integration of climate change and climate change adaptation strategies into the national and subregional development policies, programmes and activities of member states
- Improving public awareness of climate change
- Calling for the streamlining of the funding mechanisms of the Global Environment Facility (GEF) to include the vulnerability index in the resource allocation framework (RAF) formula to improve the access of Africa states to GEF financial resources
- Improving cooperation between national meteorological and hydrological services (NMHSs), regional climate centres (RCC), and regional economic communities (RECs)
- Calling on developed countries to deliver on their climate change commitments such as the polluter pays principle, the reduction of greenhouse gas emissions, and differentiated responsibilities

Figure 6 Parallel efforts to respond to climate change in Africa



Source Author's own compilation

- Requesting consultation with the African Ministerial Conference on the Environment (AMCEN) to establish the necessary mechanisms to follow up the implementation of this Declaration, in collaboration with the United Nations Economic Commission for Africa (UNECA) and the African Development Bank (ADB)[24]

As Table 4 indicates, the adoption of the Climate Change Declaration paved the way for the AU to initiate more efforts to establish a climate change regime.

In Africa, the climate change debate is predominantly driven by external actors including state and civil society organisations.[25] Parallel to these responses of the AU to climate change, are, as Figure 6 indicates, responses to climate change under the aegis of other actors. Some of these parallel responses include, among others, the following:

- In 2006, the Canadian International Development Research Centre (IDRC) and the United Kingdom's Department for International Development (DFID) launched the Climate Change Adaptation in Africa (CCAA) programme. With funding amounting to Canadian $65 million, the CCAA aims to establish a sustainable African institution on climate change adaptation that responds to African needs. Focusing on capacity development, the CCAA conducts education and training workshops on climate risk assessment, policy linkages and project management. In 2008, the CCAA and the African Academy of Science and the University of Dar es Salaam's Institute of Resource Assessment established the African Climate Change Fellowships[26]
- The Yokohama Declaration (2008) between the government of Japan and 51 African heads of states and government
- The Janui Declaration on Climate Change by African members of the Commonwealth
- Gleneagles G8 Communiqué on Africa, Climate Change, Energy and Sustainable Development
- Tunis Action Plan adopted in 2007 by African and Mediterranean states
- The South African Council for Industrial and Scientific Research's (CSIR) Ecosystem Processes and Dynamics Research Group is involved in the three-year African carbon experiment, which is funded by the US National Aeronautics and Space Administration (NASA) and the National Oceanics and Atmospheric Administration (NOAA). The project will ultimately feed into a European Union-funded project, CarboAfrica[27]

- The World Bank's assistance to Africa vis-a-vis climate change includes, among other things, its Forest Carbon Partnership Facility (FCPF). A US$250-million facility, the FCPF is intended to encourage investment to stop deforestation and minimise the impact of climate change in return for access to carbon credits[28]

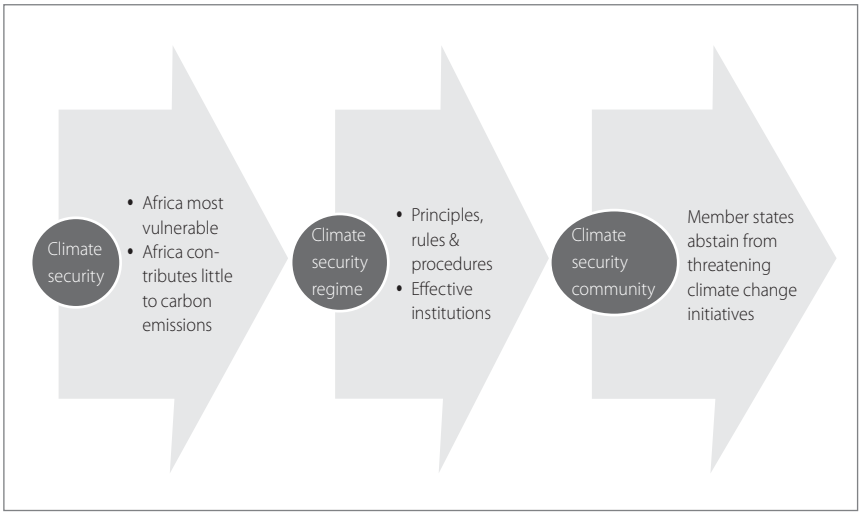
These parallel efforts should ideally be integrated and coordinated to share costs and expertise.

IMPROVING CLIMATE SECURITY IN AFRICA

Climate change is considered as presenting a security challenge 'more complex that the Cold War'.[29] It is now also conventional wisdom that climate change has already, and will continue to affect human security (including ecological sustainability), which may result in human rights abuses, and intra and interstate conflict and wars.[30]

The AU regards climate change as a threat to the continent's future well-being. Notwithstanding this, climate change has not been institutionalised as a security

Figure 7 Proposed climate security regime for the AU



Source R Tavares, Understanding regional peace and security: a framework for analysis, *Contemporary Politics* 14(2) (2008), 113

issue, nor has climate security, which is a more comprehensive definition of the issue. Climate security addresses and implement measures to reduce the impact of greenhouse gas emissions on humans and the environment and to achieve sustainable development.

Climate insecurity is an additional stressor and threat multiplier.[31] Figure 7 contains a proposed climate security regime for the AU as the major peace and security actor on the continent.

The AU needs to develop a climate security policy in terms of Articles 9(1) (a) and 13(1) (b) and (e) of the Constitutive Act of the AU. The fact that Africa is regarded as one of the most vulnerable continents in terms of climate change means that the AU needs to take the initiative to combat the adverse effects on the continent on this matter.[32]

CONCLUSION

The AU's response to climate change follows on from its commitment to the international environmental regime and its own environmental regime. Early signs of an AU climate change regime are emerging but they face several obstacles such as member states' conflicting needs and interests, the hype over bio-fuels and carbon trading, and lack of progress among member states to implement national climate change policies. Parallel efforts to address the impact of climate change on the continent seem to affect the AU's response by diverting funding and expertise to parallel projects.

The following additional recommendations are intended to improve, enhance and sustain the AU's response to climate security:

To AU member states:

- Establish a climate change commission
- Accommodate indigenous knowledge systems
- Develop new and support existing research capacity
- Conduct research on the sociopolitical impact of climate change
- Formalise, adopt and implement national climate change policies
- Share climate change adaptation and mitigation technology
- Improve the role of the private sector through public-private partnerships (PPPs)

- Improve capacities to respond to climate change such as the enhancement of coastal defences (in the case of coastal states)
- Prevent deforestation and desertification

To the AU:

- Engage in normative commitment and development of a comprehensive response to climate change
- Improve AU environmental governance structures
- Adopt a general framework and plan of action on climate change, including standards
- Establish a climate change directorate
- Amend the African peer review mechanism (APRM) to include the effective response to climate change of member states
- Institute environmental peace building
- Foster international collaboration
- Improve negotiation skills vis-a-vis climate change
- Improve early warning mapping
- Cooperate with regional organisations
- Improve public awareness and civil society involvement via the ECOSOCC

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2 Climate change, population surge and resource overuse in the Lake Chad area

Implications for human security in the north-east zone of Nigeria

Freedom C. Onuoha

INTRODUCTION

It is evident that Africa is facing a number of climate shocks that are intensifying poverty, inequality and the disruption of livelihoods. Indeed, concern in the early 1990s over the negative impact of climate change strengthened fears that environmental degradation and demographic pressures would displace millions of people in the developing world and lead to huge social upheaval.[1] Sub-Saharan Africa is among the most vulnerable to the negative effects of climate change, and faces the greatest challenges of adaptation.

The Intergovernmental Panel on Climate Change (IPCC) has found that Africa is already experiencing the negative effects of climate change and will experience greater changes in future.[2] In Africa, the lakes are among the major victims of the deleterious effects of climate change. Without doubt, the lakes are part of the essential natural capital that local people depend on for their livelihood and survival. Although Africa's lakes hold about 30 000 cubic kilometres of water, and yield 1,4 million tonnes of freshwater fish each year, they are among the most heavily exploited of all the continent's freshwater resources.[3] A recent United Nations report reveals that more than 600 lakes in

Africa are declining rapidly owing to the combined impact of climate change and resource overuse.[4]

In the Lake Chad area, climate change is not just a future threat, but also a present danger that confronts the communities living around the lake.[5] An obvious major impact of climate change on the lake is the rapid decline of its surface water. Lake Chad lost over 50 per cent of its water between 1973 and 2002.[6] Yet, the lake, like any other transboundary watercourse, is a vital source of fresh water and other resources that sustain human, livestock and wildlife communities in four African states, namely Cameroon, Chad, Niger and Nigeria.

Over the past four decades the waters of the lake have continued to diminish. This, in turn, has affected aquatic and terrestrial ecosystems, the quantity and quality of fresh water availability, and the wider environment. Adverse impacts include reduced fish stocks, siltation, loss of vegetation and depletion of grazing land. Although the local people have lived with these problems for many years and have evolved ways of coping with them, albeit ineffectively for the most part, their scale and intensity are exacerbated by climate change as this adds another dimension to the matrix of global water insecurity.

Against this backdrop, this chapter examines the emerging and future human security risks posed by the diminishing water resources of Lake Chad for Nigeria, especially the north-east zone. It explores this matter by focusing mainly on how human activities interact with the effects of climate change to induce the rapid shrinkage of the lake, and discusses the attendant implications for human survival and development.

LAKE CHAD: A STRATEGIC TRANSBOUNDARY NATURAL RESERVE

Lake Chad is a unique transboundary natural reserve that crosses national frontiers, linking users across borders and supporting different economic livelihoods. It is located between latitudes 6° and 24°N and longitudes 7° and 24°E. It is the most important natural feature of the conventional basin, and, as Figure 1 indicates, is shared by Cameroon, Chad, Niger and Nigeria. Although Lake Chad is one of Africa's largest lakes, it is one of the least studied lakes compared with other lakes on the continent.[7]

It is an extremely shallow lake – rarely more than 7 metres deep – and has been susceptible to increasing climatic variability and human impact over the

Figure 1 Map showing the shorelines of Lake Chad and its riparian states

Source Microsoft Encarta, Map of Lake Chad (lake) Africa

past 40 years. About 90 per cent of Lake Chad's water comes from the Chari-Logone River, which enters the lake from the south-east, with its sources in the humid uplands of the Central African Republic. Historically, the Komadougou-Yobe River, which enters the lake in the north-west, has contributed about ten per cent of its water.[8]

The main economic activities in the Lake Chad Basin include fishing, agriculture, hunting and pastoralism. Fishing is a major occupation around the lake and all four riparian countries depend heavily on supplies from the lake. The lake has also attracted migrant workers from other African countries, for example from Ghana and Burkina Faso. Over 150 000 fishermen live on the lake's shores and its islands. Recent estimates of annual fish production range from 60 000 to 70 000 tonnes.[9] However, as a result of environmental changes

since the 1970s, there have been considerable changes and a marked decrease in the lake's fish stocks.

The raising of cattle, sheep and camels by local as well as nomadic herders provides additional means of economic livelihood in the basin. The fresh water and grazing lands around Lake Chad have been the traditional convergence point for herders and pastoralists, including the Tuareg, Toubou, Feda, Kanembu, Shuwa, Fulani and Wadai from Chad, Niger, northern Cameroon and northern Nigeria.[10] Some people raise livestock, typically moving closer to the lake for grass in the dry season, and then move away in the rainy, mosquito season. However, after the droughts of the 1970s, many herders shifted from grazing animals (cattle and camels) to browsing animals (sheep and goats), which adversely affected the area's vegetation as these animals consumed the woody plants.[11]

The lake also serves as a source of fresh water for drinking, sanitation and irrigation in the basin area. At its largest in around 4000 BC, the lake was estimated to have covered an area of 400 000 square kilometres. In the early 1960s it had an area of more than 26 000 square kilometres. However, it has shrunk from 25 000 square kilometres in 1966 to less than 1 5000 square kilometres in 1997. And between 1994 and 2004, it receded further dramatically to cover an area of only some 532 square kilometres. This amounts to shrinkage of nearly 90 per cent of its size in 1960.

THREE FORCES DRIVING LAKE CHAD TO EXTINCTION

The progressive diminution of the waters of Lake Chad over the last four decades has been a subject of growing concern for political leaders of its riparian states, environmentalists and scholars. Its progressive shrinkage is attributed to three key forces: resource misoveruse population surge and climate change variability.

Resource mis/overuse

Unsustainable exploitation of the water of the lake by riparian states to support poorly planned irrigation projects appears to be the critical factor in the misuse of the water of the lake. The signing of the Lake Chad Basin Commission (LCBC) Convention as far back as 1964, to a large extent,

signalled an early cooperative impulse by the riparian states to promote and regulate the joint exploitation of the resources of Lake Chad. The primary objectives of the LCBC are to regulate and control the utilisation of water and other natural resources in the basin; initiate, promote and coordinate natural resources development projects and research within the basin area; examine complaints, and promote the settlement of disputes, thereby promoting regional cooperation.[12]

Regrettably, the pattern of exploitation of the lake's water by riparian states has been in sharp contrast to the institutional provisions envisaged in the Convention. By the mid-1970s, riparian states were resorting to unilateral exploitation of the lake's water to sustain agricultural irrigation and development projects. Of particular relevance were the construction of the Yaguou-Tekele Dyke and the Maga Dam by Cameroon in 1979, the Mamdi Polder Project in Chad and a series of dams in Nigeria.[13] The most extensive irrigation project, the South Chad Irrigation Project (SCIP), has been developed in Nigeria.

Coe and Foley, for instance, have found that competing demands for fresh water by the four riparian states of Lake Chad, mostly through massive irrigation projects, account for almost 30 per cent of the observed decrease in lake area since the early 1960s. Until about 1979, irrigation had a modest impact on the hydrology of the region. However, between 1983 and 1994, the volume of water diverted for irrigation quadrupled compared with the previous 25 years, accounting for 50 per cent of the additional decrease in the size of the lake.[14] While irrigation projects have contributed to the drying up of the lake, the decreasing water level, in turn, affected irrigation projects. For instance, the SCIP was designed to irrigate 67 000 hectares, but as water levels in the lake dropped in the late 1980s, no irrigation could take place.[15]

Population explosion

The surge in the human population around the lake in the last few decades has also contributed to resource overuse. Harden has long hypothesised that 'Africa's growing population is the major cause of the degradation and pollution of most of the continent's lakes'.[16] Since the 1960s, human demands for water near Lake Chad have increased rapidly. Between 1960 and 1990, the number of people living in the lake's catchment area has doubled from 13 million to 26

million.[17] In 2007, the basin population was estimated to be slightly above 37 million.[18] Yet, the population is expected to increase by 75 per cent by 2025.[19]

The growing human population in the lake region necessitated the raising of increased numbers of livestock to feed the teeming masses. The combined surge in human and livestock populations led to overgrazing, unhealthy agricultural practices, intense fishing and pollution of the lake. Consequently, the lake's carrying and replenishment capacity has been greatly undermined. This portends serious danger for the future survival of the lake, given the predicted impact of climate change on the basin.

Climate change and climate variability

The chemical composition of the Earth's atmosphere is undergoing rapid change, with consequent effects on Africa's lakes. Increases in atmospheric concentrations of greenhouse gases are expected to cause more rapid changes in the Earth's climate than have been experienced for millennia.[20] Recent environmental trends suggest that Africa is experiencing dangerous extremes in terms of rising temperature and weather events attributable to climate change. Climate change causes alterations in rainfall patterns, water levels and volumes in lakes, ponds, rivers and streams, and the frequency of droughts and storms. Consequently, the arid and semi-arid areas in northern, western, eastern and some parts of southern Africa are becoming drier, while equatorial Africa is getting wetter.[21] Natural watercourses such as Lake Victoria, Lake Chad and parts of the Nile River are gradually drying up due to warmer temperatures.

Historically, Lake Chad received most of its water from the annual monsoon rains that fell from June to August. However, since the late 1960s the region has experienced a series of declines in rainfall, culminating in two major droughts in 1972 to 1974 and 1983 to 1984. Areas of the lake that once experienced a mean annual rainfall of 320 millimetres received less than 210 millimetres. Recently, the United Nations concluded that 'the size of the region affected by this change and its duration are without precedent in hydro-climatic chronicles'.[22]

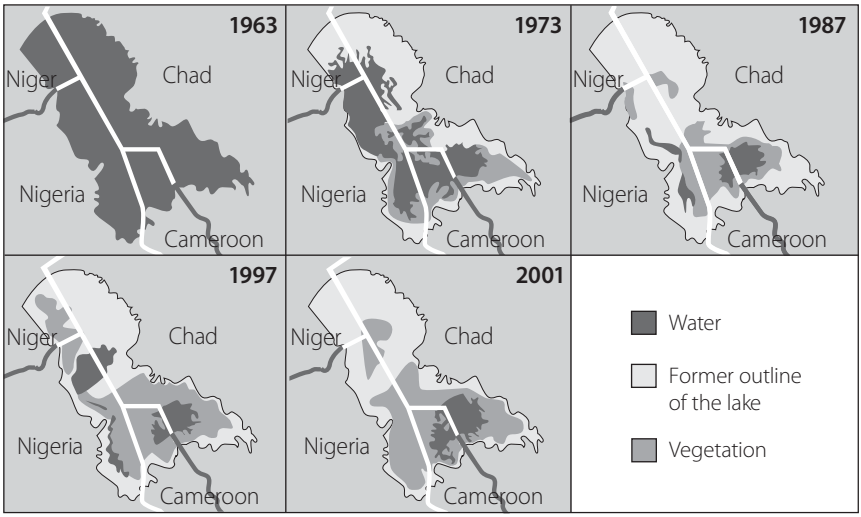
Early studies on the hydrological history of the lake have found that the balance between water intake and evaporation is continually fluctuating, with the result that Lake Chad, owing to its shallowness, is continually changing its

size and shape.[23] These fluctuations reflect variations in rainfall not only in the area of the lake itself but particularly in the watershed areas of the feeder rivers. Connah, therefore, concludes that 'fluctuations in Lake Chad are a fairly sensitive indicator of climate change over a substantial area of Africa'.[24] Although specifics on the impact of climate change on Lake Chad are still unclear, a United Nations study has identified 'climate change as the most important global change relevant to Lake Chad Basin'.[25] A recent study has used parameters like temperature, humidity, evaporation and transpiration to assess the effects of climate change on Lake Chad.[26]

The series of satellite images in Figure 2 shows the dramatic decrease in the size of the lake over the past four decades owing to a combination of climate change and human impact. As the lake shrinks, it moves towards the Chadian and Cameroonian territories, a factor that underpins potential interstate conflicts in the lake's area.

Once the progressive diminution of Lake Chad became more obvious and devastating in the 1980s, the LCBC, in collaboration with the riparian states and donor partners, embarked on several projects to help salvage the lake. Besides the parliaments of the five member countries of the LCBC establishing the Regional Parliamentary Committee in 2004, other initiatives,

Figure 2 Progressive shrinkage of Lake Chad over the last four decades



Source United Nations Environmental Programme (UNEP), vital climate graphics Africa

including studies and environmental projects, have been undertaken. One of these initiatives seeks to reverse land and water degradation trends, and to regenerate the lake's ecosystem. Its implementation is estimated to cost US$ 10,6 million, which will be provided by the World Bank through the Global Environment Facility (GEF) for the integrated management of Lake Chad. Another priority intervention identified has been a major inter-basin water transfer project, the Lake Chad Replenishment Project. This project entails damming the Oubangui River at Palambo in the Central African Republic and channelling some of its water through a navigable canal via the Chari River to Lake Chad. However, the successful implementation of these projects has been stifled mainly by financial constraints.[27]

LAKE CHAD AND HUMAN SECURITY IN NORTH-EASTERN NIGERIA: CURRENT AND FUTURE RISKS

Geographically, the portion of Lake Chad that is situated in Nigerian territory borders the states of Borno and Yobe in the north-east zone of Nigeria. The north-east zone is one of the six geopolitical zones of the Nigerian federation. It consist of the current six states of Adamawa, Bauchi, Borno, Gombe, Taraba and Yobe, with an estimated population of about 18 971 965 million people and an area of 279 363 square kilometres.

The zone is very heterogeneous and accounts for nearly half the estimated 300 or more ethnic groups in the country. Although different religious faiths are practised in the region, the inhabitants are predominantly Muslim. The zone shares international boundaries with Niger, Chad and Cameroon to the north, north-east and east respectively.[28] In 2003, it was estimated that of the 20 million people that lived in the Lake Chad basin, 11,7 million lived in Nigeria, mainly in the north-east zone. The rest of the people included five million in Chad, 2,5 million in Cameroon, 193 000 in Niger and 634 000 in the Central African Republic.[29]

As a unique transboundary watercourse situated at the edge of the Sahara Desert, Lake Chad provides a lifeline to millions of people living in the catchment area. It is used for sanitation, drinking, agriculture, fishing, and religion-cultural activities. Given its relevance to local livelihood and economic progress, further shrinkage of the lake resulting from climate change will undermine the very base of human development in the basin, including in the north-east zone

of Nigeria. The implications of such an occurrence include, but are not limited to, water scarcity/insecurity, falling health standards, food insecurity, poverty and intensified migration, with the tendency to instigate resource and identity conflicts within and beyond the basin.

By transforming the hydrological patterns that determine the availability of water in the world, climate change is expected to account for about 20 per cent of the global increase in water scarcity. The IPCC has predicted reduced rainfall and run-off, and increased desertification in the Sahelian belt near Lake Chad.[30] This would compound the problem of water scarcity in the basin area, which is already known to afflict 300 million people and claim at least 6 000 lives annually in Africa.[31] Nigeria has been identified as one of the countries likely to run short of water in the next 25 years.[32] 'Water scarcity' is defined as a situation where the volumes of water withdrawn from lakes, rivers or groundwater is so large that water supplies are no longer adequate to satisfy all human or ecosystem requirements, resulting in increased competition between users and demands.[33] Situations of water scarcity greatly compromise people's entitlement to water security. Water security entails every person having reliable access to enough safe water at an affordable price to lead a healthy, dignified and productive life, while maintaining the ecological systems that provide water and also depend on water.[34]

Undoubtedly, water security is a core component of the broader notion of human security. When access to water is constrained or disrupted, people become exposed to serious human security risks such as poor health, loss of livelihood, increased vulnerability, poverty and conflicts as a result of competition over a dwindling natural resource base.[35]

Although the lake's surface water and underground aquifers provide fresh water for the local communities, people living around the lake lack access to safe drinking water and proper sanitation. While climate change-induced decreases in annual rainfall have contributed to the reduction of the quantity of water in the lake, pollution as a result of local people defecating and washing clothes in the lake has consequently degraded the quality of the lake's water. For the dependent population, therefore, water scarcity is defined as much by an insufficient quantity as by poor quality.

With less potable water, water-related diseases such as diarrhoea, cholera and typhoid fever have been a common occurrence in the basin.[36] It has been noted that access to safe drinking water is very limited in the north-eastern zone of Nigeria.[37] Health and sanitary conditions in the zone are expected to

worsen, as 'future climate change will directly and indirectly play an important role in determining the future severity of freshwater shortage'.[38]

Climate change-induced shrinkage of the lake's water poses serious threats to food security, aggravating the poverty in the region. People around Lake Chad are among Africa's most chronically vulnerable to food insecurity. However, they have managed to cope with this challenge through mobility, switching of livelihoods, and by adapting to a diversity of food sources. The northern states of Nigeria are among the most vulnerable. The existential condition of the vast majority of the inhabitants of the north-eastern zone was the lowest in 2004. While the prevalence of poverty (in percentages) in the south-south was 35,1, the south-east stood at 26,7, the south-west at 43,0, the north central was 67,0, the north-west was also high at 71,2, and north-east was the poorest with 72,2.[39] Therefore, poverty levels in the north-east zone will increase as further shrinkage of the lake contributes to crop failures, livestock deaths and the collapse of fisheries, significantly disrupting economic livelihoods.

Another implication is the tendency for violent conflicts to erupt over competition for dwindling water resources. The diminution of Lake Chad has contributed to conflicts in two notable ways. First, by intensifying the frequency of contact between and among the major livelihood systems, thereby making them more competitive rather than complementary. Second, it intensifies the pattern of migration as a response to the contraction of the lake.[40]

Consequent upon falling agricultural, fishing and pastoral output, the rate of migration and cross-border movement within the basin has intensified with serious implications for resource and identity conflicts in the north-east zone and even beyond. As the water of the lake recedes, farmers move closer to the lake's shoreline to cultivate the emerging lands. Also, the frequency of pastoralists moving closer to the remaining water to feed their livestock intensifies, thereby accentuating the rate of contact between major livelihood systems (such as herders and farmers) and thus sowing the seed of conflict. According to Anada Tiega, a director at the Lake Chad Basin Commission, 'we are already experiencing some conflict between fishermen and pastoralists, and between fisherman and farmers, and vice versa'.[41]

The risk of conflict degenerating into intercommunal clashes in the region could manifest in the near future if existing political institutions fail to reconcile conflicting interests over access to such shared water resources. In a situation where governance institutions in the basin are weak, inequitable water management can heighten

inequities and water insecurity, resulting in conflicts among users (households, industries and private water firms) and demands (irrigation agriculture, industries).

With the surface water of the lake diminishing because of demographic and climate factors, some reallocations among users and sectors are inevitable, which could lead to competition and deprivation. Urbanisation would exacerbate the level of deprivation, which in turn, would worsen the level of social grievances. As deprived individuals and social groups engage in fierce competition for dwindling natural (freshwater) resources in the lake region and further afield in the north-east zone, future access will increasingly reflect the strength of claims from different users and actors. It could also create problems between upstream and downstream communities in the feeder rivers. When existing political institutions and structures are incapable of resolving these competing claims, the tendency for violent intergroup conflicts over access to shared resources becomes more likely.

More fundamentally, the climate change-related diminution of Lake Chad has blurred international boundaries in the region. Fishermen, particularly Nigerians and Nigeriens, have crossed political borders in pursuit of the receding waters. This has resulted in a complex web of social, economic, environmental and political issues, threatening to spill over into human rights issues and interstate conflicts in the basin. The drifting of the lake away from Nigerian and Nigerien territories towards Chadian and Cameroonian territories (see Figure 2 is propitious to interstate conflicts and tensions.[42]

In the 1980s, for instance, there were allegations of serious infractions and dehumanising treatments meted out to Nigerian fishermen by Cameroonian and Chadian gendarmes.[43] Such tensions over territory and fishing rights still persist in the area. For instance, a Nigerian fisherman recently argued:

It is difficult to determine boundaries on [Lake Chad] water, yet the gendarme from Cameroon and Chad always come after us and seize our fishing nets and traps and we have to pay heavily to get them back.[44]

As a result of the lake's contraction, some farmers have switched to other livelihood systems like fishing. Others have migrated to cities, taking up menial jobs or remaining unemployed, adding to the urban social crises. Lake Chad's diminution has also increased the influx of Udawa nomadic cattle herders from the Republic of Niger as well as the migration of citizens of Chad and Niger further south in search of optimum opportunities. These 'long-distance migrants, usually referred to as Udawa, have been well-armed since the mid-1990s and are willing

to use violence to assure their grazing'.[45] This has contributed to the violent conflicts between herders and farmers in the northern part of Nigeria.

Furthermore, farmers and cattle herders have moved deeper southwards where they have ended up competing for the available scarce resources such as fresh water and arable or grazing lands with other economic groups or with host communities. Harsh environmental trends in the northern part of Nigeria, such as the shrinkage of Lake Chad and desertification, have made the seasonal movement of the Hausa and Fulani cattle rearers to the southern part of Nigeria more permanent. Previously, these pastoralists migrated to the southern part during the dry season and moved back to the north during the rainy season. Because of the deteriorating situation in the region, many of them are now settling down in some areas of southern Nigeria such as, for example, Ilorin, Umuahia, Ogbomoso, Shaki, Ubakala, Uzo-Uwani and Oyo. This has contributed to resource conflicts in these areas with the potential to spill over into ethnic clashes.

STRATEGIES FOR MITIGATING THE IMPACT OF CLIMATE CHANGE ON LAKE CHAD

Climate change is set to worsen the environmental and survival problems faced by the people living around Lake Chad, if measures are not taken to mitigate its impact or to build and sustain the adaptive capacity among the dependent population. To mitigate present and future climate change-related impacts on Lake Chad, the following recommendations are presented.

First, there is a need for the adequate representation and participation of local people in the management of the lake. The role and functions of local communities in the management of lakes are absolutely essential in achieving the goal of sustainable lake management. The management of Lake Chad has operated largely at the supranational level, with little or no involvement of the local people who are directly dependent on the lake's resources. The integration of local communities must go beyond the mere perception of them as stakeholders to their being key participants whose knowledge and participation are critically needed to ensure the sustainability of any project or policy designed to replenish the lake.

For instance, consider the LCBC plans to carry out the inter-basin water transfer project known as the Lake Chad Replenishment Project to salvage the

lake. To enhance the sustainability of such a project, it is crucial to involve the local people to enable them to play a more active role in articulating their needs in relation to their livelihood priorities, as well as to work with the government and environmental groups, the LCBC and donor agencies in support of the new integrated lake management vision.[46]

Secondly, the Nigerian government (federal, state and local governments of the six states of the north-eastern zone) in partnership with environmental groups should undertake a capacity-building programme for local people to help them contribute to safeguarding the lake. Local communities should be empowered to protect both the shoreline of the lake and the adjacent areas by preserving or maintaining natural vegetation by planting new trees or replacing dead ones. Tree planting is one of the most effective ways of controlling climate change because the growing of trees halts erosion and degradation, protects water resources, and reduces carbon emissions. Because the root systems of woody vegetation typically bind soil in place, the vegetation would act as a natural buffer that would help protect the lake from erosion. This, in turn, would assist the regeneration of lost vegetation in the area, which is critical for reviving the lake's replenishment capacity. However, a major challenge envisaged here would be to get enough water or moisture to sustain new plants in the area. One strategy would be to use drought-resistant trees or shrubs. Also, effective legislation should be enacted and vigorously enforced to ensure the protection of the trees by local communities.

Thirdly, there is a need for sustained environmental education at global, regional, national and local levels to raise awareness regarding the degradation of Lake Chad. In addition to sensitising local communities to avoid polluting the lake, the government should collaborate with civil society groups on capacity-building initiatives for local people that assess the risks developing from climate change and how best to adapt indigenous knowledge and assets to respond and cope with the challenges of climate change.

Fourthly, Nigeria is a significant contributor to global carbon dioxide emissions, particularly through gas flaring by its oil industry. The federal government, in addition to supporting international conventions aimed at controlling carbon emission, should start cutting back on carbon dioxide emissions by effectively enforcing stringent legislation aimed at ending gas flaring in the country. This is in addition to investing in the development of other potential sources of clean energy such as wind power and solar energy to reduce reliance

on hydrocarbon fuels such as petroleum products, coal and fuel woods that contribute to carbon emissions.

Fifthly, the federal government should fast track the establishment of a national climate change commission. Such a commission should be tasked with, among other things, the responsibility of conducting extensive research on the subject of climate change; producing regional-based and seasonal climate forecasts (including short, medium and long-term forecasts); working with the local people to identify context-specific climate challenges as well as adaptive capacities in various communities, which can be strengthened and possibly replicated where and when necessary; developing an early warning system and mechanism for detecting emerging environmental trends and disasters; and advising governments, agencies, organisations, communities and individuals on possible climate shocks and mitigative measures that can be adopted.

Finally, the Nigerian government should, as a matter of urgency, institute and sustain a robust network of political ties with co-riparian states and donor partners to promote a paradigm shift in water resource management in the basin, from unilateral utilisation of the water resources of Lake Chad to an integrated water resource management strategy involving regional, national, sub national and local authorities. This will require the strengthening of the LCBC through proactive legislative interventions, financial support and capacity building of staff to enable the LCBC to initiate, promote and coordinate sustainable natural resources development to attain regional cooperation as envisaged in the LCBC Convention.

CONCLUSION

This chapter argues that the downward spiral of the diminution of Lake Chad is a complicated and intricate process engendered by the complex interaction between anthropogenic factors (resource mis/overuse and population surge) and climate change. It posits that further shrinkage of Lake Chad owing to climate change and climate variability will exacerbate human security risks in the north-east zone of Nigeria with attendant implications for national and region stability. Climate change is already transforming the hydrological patterns that determine the availability of water in the world, including in the Lake Chad Basin. This chapter concludes that the situation will be worst in the years ahead if efforts are not made to salvage Lake Chad, which has served and will

continue to serve as a critical natural reserve that sustains human security and development in a semi-arid region.

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3 Climate change, hydropolitics and security in Lesotho

Oscar Gakuo Mwangi

INTRODUCTION

The mountain kingdom of Lesotho, a small landlocked country, has ratified the United Nations Framework Convention on Climate Change (UNFCCC). In addition Lesotho's vulnerability to climate change has been assessed across various socioeconomic sectors. Among these is the water sector, which is economically and politically strategic as water is Lesotho's most abundant and crucial resource. Climate change scenarios paint a gloomy picture for the country's water sector with predictions that the country will eventually become more water scarce, an occurrence which poses a threat to both national and international security. In as much as climate change-related policies have been articulated, Lesotho faces challenges in the implementation of these policies owing to several economic and political factors. A key factor in the water sector is hydropolitics, which occupies a central role in the climate change and security arena in Lesotho. Owing to the 'water-related and politically inspired' interests of the political elite, climate change concerns have been overlooked. Hence they now pose a threat to national and international security.

This chapter is divided into four sections. The first section addresses climate change and conflict, particularly conflicts pertaining to water. The second

section pays attention to climate change and water resources in Lesotho. The third section examines the relationship between climatic change, hydropolitics and security in Lesotho, and argues that, as a result of the hydropolitical interests of the political elite, climate change concerns have been overlooked, and thus pose a threat to security. The fourth section provides insights into the need to securitise – hence politicise – climate change issues in Lesotho so that they become a matter of high politics.

CLIMATE CHANGE AND WATER CONFLICTS

Climate change can be defined as 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods'.[1] Climate change is now considered a major threat to growth and development in Africa. The continent's vulnerability to climate change is a function of several climatic, economic and political factors. Furthermore, it is predicted that climate change will in future adversely affect key socioeconomic sectors as well as the quantity and quality of natural resources.[2]

Although the current academic and policy debate about climate change and conflict provides new insights regarding environmental security, it nevertheless emanates from earlier debates that focus on the relationship between environmental change and conflict. Scholars such as Clionadh Raleigh and Henrik Urdal point out that the literature on climate change and conflict pays attention to two integrated processes that increase resource scarcity.[3] First, increasing temperatures, precipitation irregularities, and adverse weather are expected to worsen existing environmental resource degradation. Second, rising sea levels and additional adverse weather conditions will cause forced migrations that are likely to lead to higher pressures on existing resources in the destination areas, thus enhancing competition over scarce resources. While climate change is usually viewed as a potential future threat, it is also a contributing factor in current conflicts.

In the context of renewable resources such as water, climate change is expected to alter the availability of fresh water and it is predicted that climate change may greatly increase the risk of violent conflict over increasingly scarce resources such as fresh water. Studies indicate that about 1,7 billion people currently live in water-stressed countries and use more than more than 20 per cent

of their renewable water supply.[4] This number is projected to increase owing to population growth and rapid industrialisation. The reduction of the availability of groundwater as a result of climate change is expected to have a severe impact in countries with poor water management practices and vulnerable communities. The quantity and quality of water is, however, currently more influenced by non-climatic factors such as poor governance and management practices.[5]

The potential link between climate change and conflict over water is often perceived in the context of the availability of the resource. This applies to both intra- and interstate conflicts. Significant changes in the quantity and quality of fresh water can give rise to conflict between different users. Such conflicts can occur between users in the same area, or between users in different parts of a river basin.[6] Oli Brown and Alec Crawford argue that climate change and variability are likely to impose additional pressures on water availability and accessibility in Africa.[7] This is, however, relative since climate change will worsen the water stress currently felt by some countries and may ease it in others. Countries that are not currently water stressed are likely to be at risk.

Several studies by scholars such as Meredith Giordano and Aaron Wolfe also indicate that the extent to which interstate conflict over water will occur in future is highly debatable.[8] Some studies indicate that water is not a major cause of interstate conflict, but rather a source of cooperation between countries sharing the same water. Examples include cooperation between hostile states such as Israel and Palestine, and India and Pakistan. Other studies indicate that shared river basins increase the possibility of interstate conflict, as is evident in Africa where they are a potential source of interstate conflict, for example the Kunene, Zambezi, Limpopo, Orange and Nile basins.[9] Water is perceived not as an isolated problem, but rather as closely intertwined with other socioeconomic and foreign policy issues.[10] Research also points out that water is a source of local conflicts where there are no formal rules or agreements on the use of water resources.[11]

CLIMATE CHANGE AND WATER RESOURCES IN LESOTHO

Lesotho is a signatory to a number of international treaties, including the UNFCCC, which it signed at the Earth Summit in Rio de Janeiro in June 1992, and ratified in February 1995. It was through the Lesotho Meteorological Services (LMS), and with assistance from the United Nations Environmental Programme (UNEP) as well as the Global Environment Facility (GEF), that the country set out

to meet its obligations under the Convention through various activities, including the assessment of climate change and climate change-related policies. This led to the compilation of the First National Communication to the Conference of the Parties to the UNFCCC in April 2000. Despite being a small and poor country, Lesotho was the fifth country in Africa and 23rd among developing countries to submit its report. The report concluded that the country is highly vulnerable to climate change particularly in the agriculture, forestry, health, rangelands and water sectors. It recommended the formulation and implementation of sector-specific mitigation and adaptation policies and measures, as well as a national implementation strategy to deal with the problems of climate change.[12]

Lesotho is highly vulnerable to climate change owing to several environmental, geographic, socioeconomic and political factors that contribute to growing levels of poverty in the country.[13] Article 4 of the UNFCCC identifies conditions that make countries especially vulnerable to the adverse effects of climate change. Lesotho manifests several of these conditions since it is a country prone to natural disasters, liable to drought and desertification, has areas with fragile ecosystems, including mountainous ecosystems, and is also landlocked.[14]

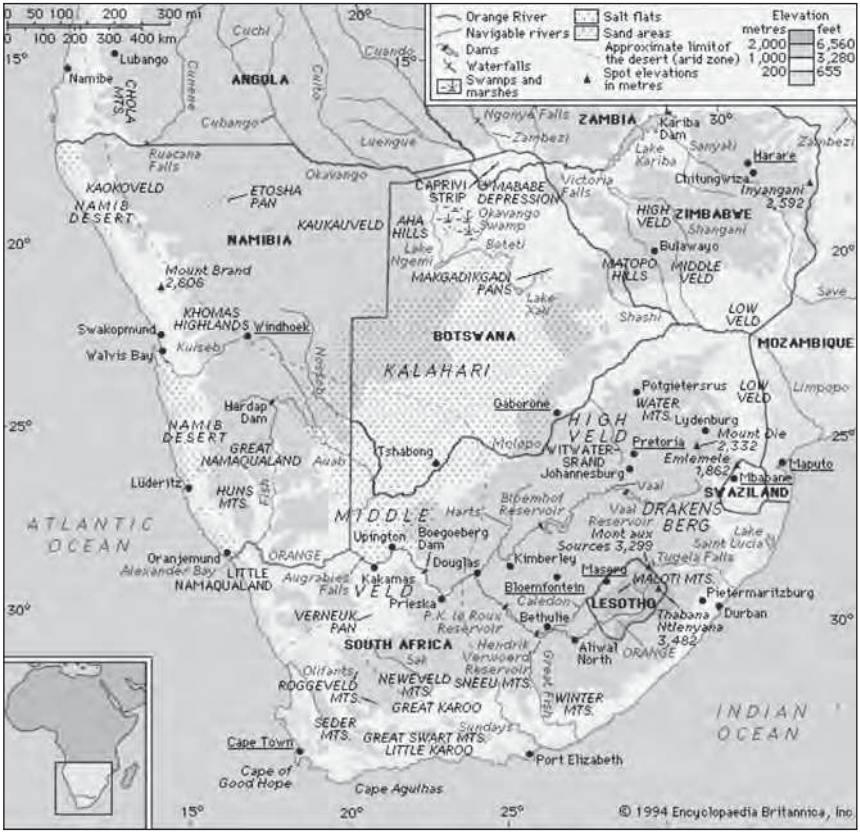
The government of Lesotho has already undertaken studies aimed at assessing the extent to which it is vulnerable to climate change. Conducted by a national climate change study team which made a detailed review of the current climate, the assessment involved two stages of analysis. The first stage analysed the complex relationship between climate and agro-ecological and socioeconomic conditions, while the second stage analysed the development of a number of climate change scenarios. The potential impacts of the climate change scenarios were assessed across several socioeconomic sectors considered likely to be critically vulnerable to climate change. These included agriculture, rangelands and forestry, and water.[15] This chapter focuses on the water sector since it is economically and politically strategic.

Climate change scenarios for Lesotho paint a bleak picture for the water sector. Predictions are that lower precipitation as a result of climate change is likely to result in a reduced availability of fresh water. This situation, coupled with the current population growth rate and necessary levels of service, means that a condition of water stress could be reached earlier than predicted. That will have serious implications for national and international security.[16] The details of the impact of climate change are discussed later in the section. At this stage, however, it is necessary to examine the current state of water resources in

Lesotho from a national and international perspective to fully comprehend the predicted effects of climate change.

Water is Lesotho's most important and abundant natural resource. Nationally, the country's natural renewable water resources are estimated at a total of 5 925 million cubic metres of static water and 341 million cubic metres of renewable groundwater. The national average utilisation of renewable groundwater resources stands at only 1,7 percent, a very small percentage of what is potentially available. Groundwater resources are estimated at 500 million cubic metres per year. The total internal renewable water resources per capita per year are 2 519 cubic metres. The average total available water in Lesotho is about 150 cubic metres per second with

Figure 1 The Orange River Basin



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current national consumption being less than 2 cubic metres per second. Supplies, therefore, far exceed demand. Of the total water withdrawal of 43,6 million cubic metres, industry is the main water user, taking 22 million cubic metres. This is followed by the domestic sector at 21 million cubic metres, whereas agriculture utilises only 0,6 million cubic metres. Improved drinking water sources are available for 79 per cent of the total population, comprising 88 per cent of the urban population and 74 per cent of the rural population.[17]

From an international perspective, Lesotho is located entirely within the Orange River Basin. This basin, depicted in Figure 1, covers an area of about one million square kilometres and is the most developed shared river system in southern Africa.

The main tributaries of the Orange are the Senqu in Lesotho, the Vaal in South Africa and the Fish in Namibia. The mean annual precipitation varies between 2 000 millimetres in the Lesotho Highlands and less than 50 millimetres at the Atlantic Ocean in the west. Lesotho covers only five per cent of the catchment area, but contributes 40 per cent of the run-off.[18] The country is drained by three major rivers which run north-south in a westerly direction, with headwaters in the central and eastern ranges of the Drakensberg/Maluti Mountains. The Senqu has a drainage area within Lesotho of 20 847 square kilometres and a mean annual run-off at the point of exit of 128 cubic metres per second. The Mohokare, which forms the western border with South Africa, has a drainage area within Lesotho of 6 890 square kilometres and an average annual discharge rate of 35,4 cubic metres per second at the point of exit. The Makhaleng, the smallest of the three rivers, runs from the central range to join the Senqu at the South Africa border, registering a mean annual run-off of 16,7 cubic metres per second at the lowest point and covering a drainage area of 2 911 square kilometres.[19] The Orange-Senqu River is an international river shared between four basin states. It is estimated that 1 500 million cubic metres of water per annum is available in this river.[20]

Owing to its abundant and surplus water, Lesotho exports water to its only neighbour, South Africa, through the Lesotho Highlands Water Project (LHWP). This bi-national project between Lesotho and South Africa is aimed at harnessing the water resources of the highlands of Lesotho for the reciprocal benefit of both countries. It is one of the largest water transfer schemes in the world and the relevant treaty was signed on 24 October 1986 by both governments. The project consists of four phases. On completion in 2020, five dams,

water transfer works and 200 kilometres of tunnels will have been constructed between the two countries. More than 2 000 million cubic metres of water per annum will be transferred from Lesotho to South Africa. The project already earns Lesotho substantial revenues in terms of royalties from water deliveries, for example between 1996 and 2004 the country earned US$225 million.[21] Currently, the volume of water transferred under Phase 1 of the project is about 17 cubic metres per second. This is much more than the national consumption of water at less than two cubic metres per second. The annual transfer rate is about 650 million cubic metres. The total volume of water currently stored in the Katse and Mohale dams, which are part of Phase 1 of the project, is about 2 730 million cubic metres.[22]

Although regions of the country may face periods of insufficient rainfall, Lesotho has abundant natural sources of water available throughout the year. Currently, the country is neither water deficit nor water scarce, therefore does not at present require a coping strategy to manage water scarcity. With regard to water, by definition a coping strategy is the policy output of decision makers which seeks to manage water scarcity in some way or another. It is a combination of a series of rational choices that decision makers consider, and then convert into a clearly defined policy option aimed at tackling the problems of water scarcity in a country.[23]

The challenge for Lesotho currently lies not in water scarcity, but rather in the management of its water resources; the deficiency lies in managing the abundance, rather than the scarcity. This is primarily a function of four institutional factors. First, the country's poor water policies and legislation lack a supporting policy and legal environment that ensure the provision of water for various purposes. The Water Resources Management Policy of 1999, for example, does not adequately deal with key areas that relate to water resource development. The country's current legislation in the water sector – the Water Resources Act of 1978 – is not in line with international agreements and developments. Furthermore, the state's institutions such as the Department of Water Affairs do not have the capacity to regulate and enforce water legislation in a meaningful way. Second, the institutional capacity of the state to assess and monitor water resources, especially in the management of critical data and inventories, is limited. Third, the country has poor water conservation and management strategies. These strategies do not take into account important issues such as recycling water for industrial use, the quantity or reasons for water loss

in the country. Fourth, the state has so far been unable to enhance the capacity of rural communities to manage rural water schemes.[24]

Predicted climate change scenarios for the water sector in Lesotho indicate a reduction in surface and subsurface run-off owing to the anticipated lower precipitation. If one considers the current population growth rate, the projected climate change and fresh water availability, it is estimated that the country will enter a period of water stress with less than 1 700 cubic metres per capita per year, and a water scarcity period with less than 1 000 cubic metres per capita per year by the years 2019 and 2062 respectively. This translates to a reduction of slightly more than 60 per cent of the current availability per capita per year. Under climate change, these lower levels of service are likely to be reached earlier than predicted. This will have adverse effects on both national and international security. At the national level, the reduction in the availability of water will have serious ecological consequences leading to the cessation of many water-based economic and social activities. It will also lead to dry springs and wells, lower water tables and higher borehole costs, reduced yields of many water sources, and severe water stress, particularly for the rural population who depend mainly on groundwater. Lesotho's overall hydroelectricity generation and irrigation potential are also likely to be affected by the expected lower surface and subsurface flows. Water-based sport and tourism potential are also likely to be affected by climate change.[25] Nationally, it will impact negatively on human security.

At the international level, a reduction in the availability of water may lead to interstate conflict; hence threatening international security. A reduction in precipitation in Lesotho due to climate change will result into reduced run-off in the catchment area of some of the largest rivers in southern Africa, especially in the Orange River Basin. This is likely to affect several water-based activities in South Africa and Namibia. Owing to predicted dry spells, the yield of many storage dams in the Lesotho Highlands Water Project LHWP is likely to be lower, leading to reduced water exports to South Africa, and lower royalty incomes for Lesotho. These are an important non-tax revenue source for Lesotho, and a reduction of this revenue will result in lower social expenditures with a resultant increase in human suffering and poverty in the country. The predicted lower run-off could also lead to conflicts between Lesotho and South Africa. As already indicated, Lesotho is currently water abundant and is transferring water to South Africa. With the predicted lower run-off, however, South Africa is likely to be increasingly more dependent on Lesotho for water by the year 2075. While the terms for

the transfer of water are set out in the LHWP treaty, conflict is likely to arise since it is expected that it will be pragmatic as well as moral for Lesotho to provide for its domestic water needs before exporting any 'surplus' to South Africa in the future.[26] Scholars like Anthony Turton, for example, indicate the potential for conflict between these two riparian states and others in the region because of the predicted water scarcity.[27] They also point out that two 'water conflicts' have already occurred between Lesotho and South Africa owing to hydropolitics.[28]

CLIMATE CHANGE, HYDROPOLITICS AND SECURITY

As noted elsewhere, the extent to which interstate conflict over water could occur in future is debatable since water is perceived as a source of cooperation and conflict. This section examines climatic change, hydropolitics and security in Lesotho and argues that, as a result of the hydropolitical interests of the political elite, climate change concerns have been overlooked; hence they pose a threat to security. Hydropolitics – the 'authoritative allocation of values in society with respect to water' – occupies a central role in climate change and security.[29] These values centre on water as a source of cooperation and development, and are regularly reflected in the sanctioned discourse of the political elite. According to Anthony Turton, the 'sanctioned discourse' refers to the prevailing or dominant discourse that the policymakers within a sector legitimise in any given epoch. It embodies what may be said, who may say it and how it may be interpreted, thereby leading to the establishment of a dominant belief system or paradigm.[30]

These values on water as a source of cooperation and development are often reflected in the sanctioned discourse of the political elite in Lesotho. Unlike many water scarce countries where the political elite place blame on a number of historical and environmental factors, Lesotho's situation differs. Water abundance, not scarcity, forms part of the political discourse with particular attention being paid to water as a source of cooperation and national development. This is the current basis of hydropolitics in the country and is observed in the LHWP, which is a notable example of interstate political and economic cooperation. The project is a source of much-needed revenue for the country. Royalties from water and project-related customs dues currently account for approximately 28 per cent of Lesotho's GDP. Water, as a source of cooperation and development, and subsequently of peace and stability, forms the current

discourse of the political elite in riparian states.[31] This is evident, for example, in King Letsie III of Lesotho's official inauguration speech of Phase 1B of the LHWP at Mohale on 16 March 2004:

> …what is most significant about the Lesotho Highlands Water Project is that it has laid sound basaltic foundations for peaceful co-existence and has created an environment for our joint economic advancement. The… Project…forms a firm basis for ensuring that Lesotho is duly assisted to graduate from the economic status of a least developed country to that of a developing one… Through this Project, we have demonstrated…that regardless of the differing levels of economic development, we are two neighbours that can cooperate for mutual benefit.[32]

The sanctioned discourse on water and water-related issues of Lesotho's political elite reflects the manner in which political choices are made in as far as environmental issues and security are concerned. Water is currently perceived as a geopolitical instrument of achieving political stability and development through interstate cooperation. Cooperation between riparian states is pragmatic for environmental, economic and political reasons. There is a symbiotic relationship between water and security in South Africa and Lesotho respectively. Water in Lesotho has become an important instrument of foreign policy and hydrodiplomacy. Lesotho is a signatory to various water and water-related international conventions whose obligations it has to fulfil. Cooperation between both riparian states on the basis of peace and security is also prudent since they are part of the same hydropolitical security complex.[33] Hydropolitics pays attention to issues of high politics, hence the political discourse on water and the LHWP tends to ignore current and future environmental concerns associated with climate change as well as environmental degradation. The current hydropolitical interests of the political elite of Lesotho are likely to override future climate change concerns and security, thus creating the conditions for potential future interstate conflicts.

SECURITISATION AND POLITICISATION OF CLIMATIC CHANGE IN LESOTHO

Brown and Crawford aptly point out that the security threat posed by climate change is increasingly becoming a topical issue.[34] They emphasise that it is currently

given unprecedented attention, which indicates that there is a significant shift in the way key political actors and policymakers at the domestic and international levels perceive and discuss the subject. Brown and Crawford note that two reasons are advanced for this. First, it is now becoming increasingly clear that future climate change threatens to undermine development and to aggravate existing drivers of conflict. Second, the 'securitisation' of the climate change debate is more political. Relevant state and non-state actors or stakeholders are now taking it upon themselves to ensure that climate change concerns become a matter of high politics so that countries can formulate and implement sound policies aimed at mitigating such concerns. Securitisation is 'constituted by the inter-subjective establishment of an existential threat within any sector (military, political, economic, societal and environmental) with a saliency sufficient to have substantial political effects'.[35]

Although Lesotho has signed and ratified the relevant conventions and protocols dealing with climate change, such as the UNFCCC, Kyoto Protocol, Vienna Convention and Montreal Protocol, there is not yet a meaningful coordinated national policy to deal with the problem.[36] The country has, however, adopted a number of measures and policies in various sectors with objectives similar to those of the UNFCCC. Some of these are the National Forest Policy (1996/7), the National Livestock Policy (1997), the Environmental Policy (1998), the Water Management Policy (1999), and the Lesotho Science and Technology Policy (2006–2011) (2005). These policies focus, inter alia, on the environment, waste management, energy, land use, health and sanitation, water development, and agricultural reform.[37] In as much as climate change-related policies have been articulated, Lesotho faces challenges in the implementation of these policies because of several economic and political factors. The most serious include budgetary limitations, institutional and cultural rigidities, and technological limitations. There is also a lack of political will on the part of the political elite to effect administrative reforms aimed at enhancing the state's capacity to implement these policies.[38]

A large part of the problem is directly related to the fact that environmental issues in Lesotho have not yet been adequately politicised so that they are not considered a concern of high politics. The potential for conflict arising from climate change is as much as that arising from water as a transboundary resource. In order to enhance political security in the country as well as the region, there is a need for Lesotho to politicise climate change concerns.

Securitising environmental issues politicises them, making these matters a concern of high politics and elevating them to priority issues that require an urgent response at top political level. If they become part of low politics, climate change concerns lose political importance and urgency, and attract less public interest.

Climate change is likely to foster conditions for future intra- and interstate conflicts in Lesotho. Violent intrastate conflicts have erupted at the local level among communities affected by the depletion of arable farming and grazing lands as they compete for scarce resources.[39] Conflicts arising from predicted water stress and scarcity will, at the national level, impact negatively on human security. Conflict at the international level, whether limited to tension or extended to war, will adversely affect political stability not only in Lesotho, but also in the entire southern African region. The potential conflict over scarce water resources as a result of climate change is a threat to security, hence the need to address the problems of climate change at the domestic and international level.

Securitising, hence politicising, climate change in Lesotho requires that the country's political elite take into account a number of factors that require substantial political commitment or will on their part. Politicians should take into account the effects of current and future climate change and recognise the potential adverse effects associated with these impacts. By doing so, climate change issues will be regarded seriously and a matter of high politics. The political will to make these issues the matter of high politics must, however, also be accompanied by the political commitment to increase the capacity of the state to address the problem of climate change and its potential and real effect. This can be achieved through a number of politico-administrative and legal strategies. The enactment and implementation of meaningful legislation that involves all the relevant stakeholders in the process will augment the role of the state in the formulation and implementation of meaningful environmental policies aimed at mitigating environmental problems. Setting up corporatist arrangements with relevant stakeholders will ensure that all actors can safeguard and advance their interests with a view to enhancing environmental, human and political security, and hence political stability. This will also strengthen existing national and regional environmental regimes. Through such arrangements, the state can also mobilise adequate financial and human resources that can be used in the implementation of such policies,

including the adoption of relevant and efficient scientific and technological measures.

Political leaders can sensitise citizens to key environmental issues such as those of climate change through civic education. Climate change and the conservation of the environment and natural resources in Lesotho should be a matter of high politics or national interest, since the adverse effects or impacts of climate change and environmental degradation are likely to deplete or adversely affect its most abundant resource, namely water. There is a need for the political elite in the country to ensure that environmental politics are given the same priority as politics of interstate cooperation, peace and security. The political or dominant discourse should now centre on climate change, as is increasingly happening in the North. Adopting such measures will also enhance North-South cooperation, giving Lesotho the opportunity to attract additional financial assistance from its development partners and so enhance the state's capacity to formulate and implement meaningful climate change policies.

CONCLUSION

Lesotho is currently a water abundant country. However, scenarios indicate that the country will in future suffer from water stress and scarcity as a result of climate change. This creates the potential for future interstate conflict as Lesotho may be unable to supply adequate water to South Africa under the prescribed terms outlined in the LHWP treaty, as Lesotho will have a pragmatic and moral obligation first to meet its own domestic needs. Water conflicts between the two riparian states have, arguably, already occurred, despite the current abundance of Lesotho's water.

To avoid the predicted scenarios, Lesotho now needs to adopt coping strategies that will ensure that it is prepared to address major problems associated with future climate change. In order to adopt strategies that will address the problems associated with the possible impacts of climate change, the country should politicise climate change concerns so that they become matters of high politics and are not relegated to the realm of low politics. When significant or serious political issues are relegated to the realm of low politics they do not attract much political interest at the national level. Securitising and politicising climate change will, however, require much political commitment and will on the part of the political elite, which should be currently reflected in their discourse.

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PART 2

Climate Change and Access to Natural Resources

4 Climate change and access to water resources in the Lake Victoria basin

Donald Anthony Mwiturubani

INTRODUCTION

The Intergovernmental Panel on Climate Change (IPCC) has, as indicated elsewhere in this publication, concluded that climate change and variability have the potential to impact negatively on water availability, and access to and demand for water in most countries, but particularly in Africa.[1] Climate change is expected to alter and hence bring changes to the hydrological cycle, temperature balance and rainfall pattern. This has wide-ranging implications since water is one of the most important of all natural resources for socioeconomic, cultural, political and environmental development. It is a commonly used resource and hence a fundamental economic asset for sustainable development. Water is required in an adequate and sustainable supply for domestic, farming (livestock and agriculture) and industrial use, and other environmental functions on all spatial and temporal scales. It is estimated that globally 70 per cent of water withdrawn is used for irrigated agriculture, 20 per cent for industry and the remaining 10 per cent for other uses including domestic use.[2]

Although water is a renewable resource through the hydrological cycle, it is likely to be significantly affected by climate change and variability primarily

because the main source of water is rainfall – a component of climate. Rainfall change and variability in the arid and semi-arid zones, such as in the Lake Victoria Basin (LVB), will result in the uneven distribution of water resources over time and space, and this may have a significant negative impact on access to and utilisation of water resources.[3] Consequently, climate change and variability are expected to increase the vulnerability of socioeconomic activities through hydrological extremes such as prolonged droughts and extensive floods. It is in this context that this chapter examines the effects of rainfall changes and variations in access to and utilisation of water resources and the resulting conflicts regarding their use in the LVB, with particular focus on the Mara River Sub-basin (MRSB), a sub-basin in the LVB. The chapter begins by describing the state of the LVB, which is followed by an examination of the emerging evidence of rainfall changes and variations in East Africa, and then a consideration of the impact of rainfall changes and variations on the availability of water for different uses. It then proceeds with an assessment of the effects of water scarcity on economic development, followed by a consideration of the likely water-use conflicts, their causes and effects. Finally, there are concluding remarks and recommendations to enhance adaptation to and mitigation of the impacts of climate change and variation.

LAKE VICTORIA BASIN: AN OVERVIEW

Geographically, the LVB includes Tanzania, Uganda, Kenya, Burundi and Rwanda. The latter two countries are part of the LVB catchment area as a number of tributaries originate in these countries.[4] The LVB occupies an area of about 240 000 square kilometres of which about 69 000 square kilometres are the lake itself. The largest part of the LVB lies in Tanzania (44 per cent), followed by Kenya (21,5 per cent), Uganda (15,9 per cent), Rwanda (11,4 per cent) and Burundi (7,2 per cent).[5] Lake Victoria, which is the main water source in the region, is the largest freshwater body in Africa and second in the world after Lake Superior in North America.[6] Water from Lake Victoria is a transboundary resource shared between Kenya, Tanzania and Uganda. The inflows to the lake from major and small tributaries contribute about 13 per cent of the water entering the lake annually, while the remaining 87 per cent comes from rainfall.[7] The White Nile is the only outflow from the lake at Jinja in Uganda.[8]

Most parts of the LVB can be characterised as semi-arid with the exception of some areas close to the lake which have a relatively high rainfall of between 1 200–1 500 millimetres per annum.[9] The LVB is estimated to host a human population of about 30 million. These people engage in several activities in support of their livelihood, including agriculture, fishing, quarrying and mining, hydroelectric power generation and trade.[10] Agriculture, however, is the dominant economic activity in the LVB, supporting over 80 per cent of the population, of which 60 per cent practise rain-dependent agriculture, which generates in the range of 30–40 per cent of basin states' gross domestic product (GDP).[11] Lake Victoria also supports freshwater fishing with estimated annual fish yields of about 500 000 tonnes, which contributes significantly to both local consumption and export earnings in the region.[12]

Although the LVB is known to have a diversity of both terrestrial and aquatic life, it has undergone enormous environmental changes in the last 40 years.[13] Climate change – particularly the decrease of rainfall – and land degradation together with rapid human population increase have been repeatedly recognised as among the major contributors of rapidly evolving changes in the LVB that seriously threaten its ecosystem functions, overall biodiversity and the livelihoods of the basin's population.[14] Water levels in the lake are said to have been decreasing over time, with climate change, land degradation and the overutilisation of water from the lake for hydroelectric generation being cited as the main causes.[15] Overutilisation of water for hydroelectric power generation and other socioeconomic activities are likely to cause tension between the countries sharing the lake, and this may result in water-use conflicts.

The main river of the Mara River Sub-basin (MRSB), a sub-basin within the LVB, the Mara River, originates in south-west Kenya on the steep slopes of the Mau escarpment at an elevation of approximately 3 000 metres above sea level.[16] It then flows for a distance of about 350 kilometres into Tanzania to Lake Victoria, situated 1 100 metres above sea level.[17] The entire basin covers an area of 13 750 square kilometres of which 4 812,5 square kilometres (35 per cent) lies in Tanzania and the remaining 8 937,5 square kilometres (65 per cent) in Kenya. The Mara River is the main water source in the upper and middle parts of the MRSB, while both the Mara River and Lake Victoria serve as main water sources in the lower part. The main water uses in the MRSB include domestic, livestock farming, wildlife maintenance and irrigation for agriculture. Large-scale irrigation is practised on the Kenyan side, in the upper part of this basin.

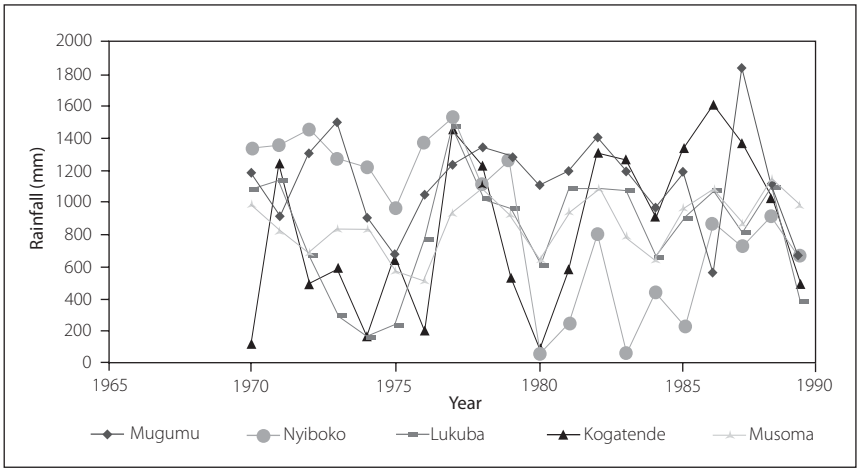
CLIMATE CHANGE INDICATORS

The climate of East Africa has changed dramatically in the last century or so, as it has throughout the world. Kiage and Liu used information from paleo-environmental records of the past 50 000 years, based on the level of Lake Victoria and ice-core records among other indicators, to show that there have been major climate and vegetation changes in East Africa, with warmer and cooler periods, and wetter and drier conditions.[18] However, Mote and Kasser and Gasse investigated ice cores from Kilimanjaro and concluded that the diminished snows and glaciers of the mountain are not due to climate change, but to rainfall changes and variability – mainly decreased rainfall on the mountain.[19] They relate the decrease in rainfall to deforestation around the mountain. Thus, although Mote and Kasser and Gasse blame human activities for being the main cause of deforestation, they fail to give explicit reasons for these activities, which may well be associated with the impacts of climate change. For example, local communities may clear forests in search of water for livestock because of the decrease of water flows downstream. Similarly, the incidences of forest fires tend to increase during the prolonged droughts (dry seasons). In turn, deforestation may expose the land and make an area vulnerable to the negative effects of climate change.

In the LVB, water scarcity and its negative impact on socioeconomic development are attributed to the changes and variations in rainfall, which is the main source of both surface and subsurface water in the region. The IPCC and Hulmes, Doherty, Ngara et al have shown that Africa has experienced an increase in temperature of 0,05°C per decade in the 20th century.[20] On the other hand it is predicted that East Africa's temperature will increase by between 0,2°C per decade (low scenario) and more than 0,5°C per decade (high scenario) in the 21st century. According to the IPCC, the warmer temperatures in East Africa may lead to a five to 20 per cent increase in rainfall for December to February (wet months), and a five to ten per cent decrease in rainfall from June to August (dry months). Rainfall changes and variations are not expected to be constant, but rather more sporadic and unpredictable, resulting in periods of prolonged droughts and periods of high rainfall leading to floods.

East Africa has undergone periods of both prolonged drought and of high rainfall – rainfall changes and variations. In the last 20 years, for example, East Africa has experienced prolonged droughts in 1983/84, 1991/92, 1995/96,

Figure 1 Annual rainfall variations at five rain gauge stations in the MRSB (1970–1989)



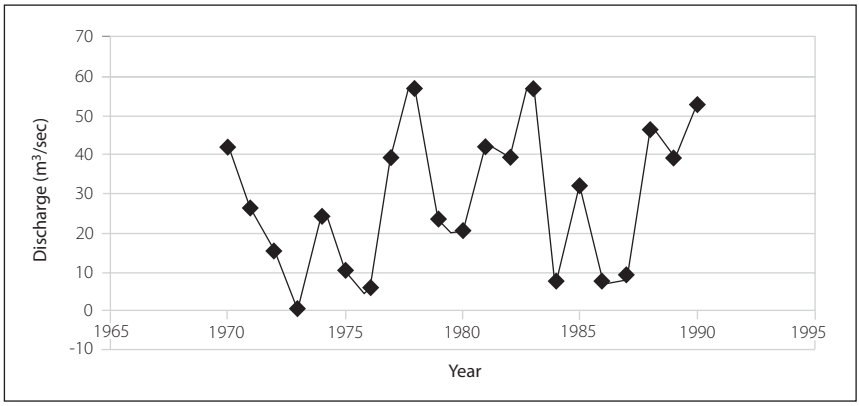
Source Author's own compilation

2004/2005 and the La Niña-related drought of 1999/2001, all of which led to famine in the region.[21] Similarly, the El Niño-related floods of 1997/98 were considered to be evidence of the impact of climate change.[22]

Furthermore, the analysis of total annual rainfall for 21 meteorological stations in selected regions of Tanzania reveal that there is a trend towards decreasing rainfall for more than 13 stations, and a trend towards increasing rainfall for only seven, while one station has recorded a constant pattern.[23] Moreover, it was noted that at most of the stations variability in rainfall cycles was common. Similarly, an analysis of information and data published by the Sokoine University of Agriculture (SUA) shows rainfall variability both over time and space in Tanzania. According to SUA's analysis, the Lake Victoria zone as represented by Bukoba and southern zone represented by Mbeya show a positive trend for both long and short rainy seasons, while the central region represented by Dodoma and the northern region represented by Arusha show a negative trend.[24] The data reveals that areas close to Lake Victoria, such as Bukoba, receive relatively high rainfall compared with areas far away from the lake.

In the MRSB, available data from five rain-gauge stations in Tanzania indicate significant changes and variation in rainfall between 1970 and 1989 as indicated in Figure 1.[25]

Figure 2 Average annual discharge at MRSB (1970–1990)



Source Author's own compilation

Rainfall variations are well correlated with the average annual water discharge in the Mara River, the main river in the MRSB, in the same period (1970–1990). This ranges from 0 to 57 cubic metres per second with the mean annual discharge of 28,4 cubic metres per second as indicated in Figure 2.[26]

Anthony as comment 1 above Traditional environmental management systems related to changes and variations of water resources in semi-arid Tanzania.

Since the main water catchment area for the Mara River is in the Mau forest complex in Kenya, making the MRSB a transboundary entity, the same rainfall trends may have been evident for the whole MRSB. However, other factors such as modified land use and land cover may have contributed to the changes of the river's flow.[27] These variations in the flow of the Mara River significantly affect water availability and hence determine access to and utilisation systems, which, if not properly coordinated, may result in water-use conflicts.

BIODIVERSITY DEGRADATION AND CLIMATE CHANGE

One of the factors influencing rainfall distribution in arid and semi-arid climates is the type of land use and land cover. Change in land use and land cover, particularly the decrease of forests, may alter rainfall run-off and run-off infiltration processes. In East Africa, forested land is said to have decreased extensively in the last three decades or so, at the rate of between one to four per cent, with a two per cent reduction in forests in Kenya, one per cent in Tanzania and four per cent in

Uganda.[28] The main reasons for deforestation include clearing forests and woodlands for agriculture and settlement, mining, wild fires, charcoal production and the overexploitation of wood resources for commercial purposes. All these activities contribute to the increase of carbon dioxide (CO_2) in the atmosphere as the carbon sinks are progressively reduced.

In the MRSB, comparisons of land use and cover between the 1960s and 1996 using land-use/cover maps indicate the major changes to forests and wetlands. Analyses of these maps, for example, indicate the decrease of wetlands on the Tanzanian side of the MRSB by 13 per cent within three decades (1966–1996).[29] The decrease in wetland areas is mainly associated with the decrease in the rainfall. This has resulted either in the dramatic decrease or drying up of water in the swampy areas because of the decline and variability of river flows that feed wetlands. Similarly, an analysis of land-use and land-cover maps on the Kenyan side of the MRSB reveals a 2,3 per cent reduction in forests, while about 30 per cent of the basin was opened up for agriculture between 1986 and 2000.[30] The findings for the Kenyan side of the MRSB, however, show that wetlands have increased by 7,5 per cent in the same period as opposed to the decrease on the Tanzanian side of the MRSB. This difference in the status of the wetlands in Kenya and Tanzania in the MRSB may be due to increased large-scale irrigation on the Kenyan side, hence more water retention in the agricultural land. It may, in fact, reflect a misleading interpretation of LANDSAT images in which water retention in the agricultural land is interpreted as wetlands development.

The decrease or removal of vegetation from the Earth's surface tends to increase surface run-off and consequently reduces the infiltration capacity of the water, although this may depend on other factors such as the nature of the landscape. Furthermore, the increase of surface run-off may increase soil erosion and hence the amount of eroded material that is transported and deposited in the rivers and streams. This, in turn, results in the decrease of the water storage capacity of the rivers and streams, and consequently natural water sources may become seasonal, flowing only during the rainy season. As Ndiiri and Mutie et al observed, in the MRSB the changes in the seasonal variability of the Mara River's flow is thought to have been exacerbated by land use and land cover change over time and the consequent reduction in rainfall in the catchment areas.[31] Jacob, on the other hand, reports that the decrease of Mara River flows is a result of changes to most tributaries from being permanent to becoming seasonal water sources.[32] The decrease of forest cover therefore is expected to

affect water resources availability negatively – mainly through reduced storage – and hence result in water scarcity in the region.

IMPACT OF CLIMATE CHANGE ON SOCIOECONOMIC ACTIVITIES

Rainfall changes and variations significantly affect the availability of water for socioeconomic activities including water for domestic use, crop and livestock production, and hydroelectric power generation, particularly in arid and semi-arid areas in developing countries. Decreased rainfall, for example, is likely to reduce the water available for crops and livestock, the key economic activities of most rural populations in developing countries where rain-fed agriculture is dominant. Globally, however, the potential for food production is projected to increase with increases in local average temperatures ranging from one to three degrees centigrade. Above this temperature range, however, food production is projected to decrease. At lower latitudes, especially in seasonally dry and tropical regions, crop productivity is projected to decrease even with small local temperature increases (1 to 2°C), which will increase the risk of hunger.[33]

In the LVB, where more than 60 per cent of the population depends on rain-fed agriculture for its livelihood, a dramatic decline in the rainfall in the region will have a significant effect on food security. The projected decline in rainfall of between 50 to 150 millimetres per season, and variations and deviations of the rainfall from the normal are expected to reduce food production in the region.[34] The reduction in rainfall may compel people to encroach on marginal lands such as water catchment areas, wetlands and mountain ecosystems for cultivation and the grazing of livestock. In the MRSB in Tanzania, as noted above, 13 per cent of the wetlands, for example the Kubigena wetlands were converted into agricultural land in the past three decades.[35] In the MRSB in Kenya, on the other hand, about 30 per cent of the basin, of which 2,3 per cent is forest land, was opened up for agriculture less than two decades ago.[36] Recently, a similar occurrence has been observed in the Usangu wetlands in southern Tanzania where crop cultivators and livestock keepers encroached on the wetlands owing to the persistent drought in most parts of the country between 1999 and 2001.[37]

According to Parry et al, regional predictions suggest that ten per cent of grain production in East Africa may be lost by 2080 because of climatic changes and variations manifested in the increase of temperature and decline

of rainfall.[38] However, the impact of climatic change on crop production varies considerably between regions and countries, and between types of agricultural production. With regard to Tanzania, for example, Mwandosya, Nyenzi and Luhanga argue that climate change and variations will have more impact on maize production than root crops.[39] The impact of climate change on food production is also likely to be more pronounced in the central part of the country than in other zones in Tanzania. However, it must also be borne in mind that forecasters do not always predict the changes and variations of rainfall over time and space absolutely correctly. Similar observations have been made by Ingram, Roncoli and Kirshen, namely that climate change and the failure to forecast the changes and variability correctly have negatively affected agricultural production in Burkina Faso.[40]

However, the relationship between rainfall changes and variability, on the one hand, and socioeconomic activities on the other is even more complex and interwoven. As noted above, some economic activities such as crop and livestock husbandry, charcoal making and mining contribute to the changes in land use and land cover, especially the decline in forest cover. Deforestation affects the occurrence of rainfall as it interferes with the hydrological cycle and consequently increases carbon dioxide in the atmosphere as carbon sinks are progressively reduced. Crop production may involve the clearing of forests to obtain new land for cultivation in response to greater demand for food owing to the increase in the human population and decrease in food production because of reduced rainfall. On the other hand, traditionally livestock has been grazed on the open grassland and bush country; hence livestock keepers tend to clear forests to extend their pastures. Furthermore, forests may be cleared as a strategy to eradicate tsetse flies, which threaten livestock. This cleared land is eventually used for settlements, crop cultivation or as pasture.

The relationship between economic activities, such as crop and livestock husbandry and charcoal production and water resources changes and variations in the MRSB therefore relates to the ways these activities alter natural vegetation cover, run-off and infiltration, and reduce the capacity of water sources to hold water after the rainy season. As a result, water scarcity is likely to occur particularly during the dry season owing to, among other factors, siltation that reduces the depth of water sources and hence reduces their storage capacity. Deforestation therefore increases the likelihood of both hydrological and agricultural drought, which results in water scarcity and food insecurity for areas

which depend mostly on rain for their agriculture. 'Agricultural drought' refers to the condition in which the water in the soil (soil moisture) is insufficient for crop growing. 'Hydrological drought' refers to the condition where rainfall, as the main source of water, is extremely low, to the extent that there is not enough water to meet the different demands for it.

Water resources are highly sensitive to climate change and variations. Thus the changes in the global climate as a result of increased greenhouse gases such as carbon dioxide, nitrous compounds and methane are expected to affect the availability of water in most parts of the world, Africa in particular. The IPCC indicates that the vulnerability of water resources to climate change is a result of overdependence on rainfall as the main source of water.[41] A reduction in water supply to meet different socioeconomic, political and environmental needs is likely to result in resource-use conflicts among and between different users and uses of water resources.

Climate change and conflicts over water access and use

Climate change and variation are expected to reduce water supply for different uses. As water becomes scarce, competition in accessing and using water sources will intensify. As a result, conflicts (here referred to as a dispute about social, economic, political and territorial-related issues) are more likely to occur as a struggle to utilise this scarce resource increases. Water-use conflicts occur when one water source is used for more than one use by different users and the uses are not complementary. Conflicts over water access and use may also arise from the uneven distribution of available water between uses and users.[42] As such, we can identify several levels and types of water-use conflict.

Conflicts at the household level

At the family level, water-use conflicts relate to the gender division of labour where men and women and youths and adults have different roles. For instance, in the MRSB, men are responsible for taking care of livestock and farming, while women are responsible for household chores and farming. Here the men wanting to utilise some water sources for livestock may be opposed to the women's uses, hence creating water-use conflicts. Furthermore, because of a water shortage, some family activities that require water may not be performed. Depending on which group wields the greater power – men, women, the youth or adults, girls or

boys – conflict is more likely to occur between these groups in the use of the available water for gender-specific activities. For instance, because of water scarcity, women walk up to ten kilometres and back to collect water daily. Collected water is used for domestic chores such as cooking, washing utensils and babies. In some instances, men may request some water for a shower, but when the women refuse to part with their water, given the long distance they walk to collect it, conflict may arise between spouses, particularly because the patriarchal system gives men the right of decision making in the family.

Conflicts at village level

During the rainy season, when water is plentiful, members of one village can access water sources at another nearby village. However, as water becomes scarce owing to prolonged drought, villages may prohibit members from another village from using water sources located within their jurisdiction. This kind of restriction on water access and use has sometimes resulted in inter-village fighting, especially where members of the two villages are from different ethnic groups. Water-access and use conflict at this level involves mainly livestock keepers who take their livestock for water at a nearby village. In some instances, livestock owners migrate with their livestock to areas with permanent water sources where they put more pressure on the resource. Conflicts arise when the local community feels that the immigrants are impinging on their resources.

Conflict between local people and government institutions

As noted, the impact of climate change may result in people encroaching on marginal lands and protected areas in search for water and pasture. Access to protected areas such as game reserves and national parks and their natural resources is prohibited. However, owing to the scarcity of resources, especially water resources, local people do encroach on protected areas for crop production and livestock keeping. This creates not only conflict between the institutions that manage these protected areas and the encroachers, but also human-wildlife conflicts. In 2004, for example, more than 800 families were forcibly evicted from the buffer zone of the Serengeti National Park. These families were alleged to have invaded the area in search of pasture and water because of the persistent drought in their villages. Most parts of the Serengeti National Park lie within the MRSB. A similar example is the eviction of livestock keepers and crop cultivators from the Usangu Game Reserve in southern Tanzania.[43] Livestock keepers in the Usangu sub-basin were in-migrants from different parts of

Tanzania that had been affected by water scarcity owing to prolonged drought. In Kenya, there are water-use conflicts between local people living near the Yala swamp and the regional government authorities that granted a 25-year lease for rice cultivation to Dominion Farms Ltd. The company is accused of blocking the access of over 200 fishermen to the swamp for fishing.[44]

Conflict between livelihood systems

Water-access and use conflict may be caused by competition between groups of people practising different economic activities, such as livestock keepers and crop cultivators. In some places, livestock keepers tend to encroach and use land and water meant for crop production. Similarly, crop cultivators may utilise pastoral land, hence reducing the pasture for the livestock. Water-access and use conflicts at this level are more pronounced during the dry season when water is very scarce than during the wet season. This type of water-use conflict is also manifested between upstream and downstream users of water regardless of whether they practise the same or different economic activities. Users of the Mara River in Tanzania blame the users in Kenya for withdrawing great quantities of water for large irrigation schemes, thus leaving insufficient water to flow downstream. Downstream users of the Mara River also blame upstream users for polluting the water in the river, claiming that the brown water in the river is a result of cultivation along the river banks. This, however, as Waititu noted, is caused by the loss of forest in the Mau complex, the main source of water for the Mara River.[45] Since the Mara River is a transboundary water source, water-use conflicts between downstream and upstream water users on the Mara River, although they effect individuals, can be viewed as an interstate (Tanzania and Kenya) conflict.

Interstate conflict

As water becomes scarce owing to prolonged drought, increased temperature and the decrease of rainfall, competition for this vital resource will intensify. Competition for shared transboundary water resources between nations may occur and lead to conflict regarding access to and utilisation of the resource. In the LVB, there are several shared transboundary water sources, including the lake and its tributaries, such as the Mara River. The Mara River, for example, is a transboundary water source shared between Tanzania and Kenya. The river originates from the Mau forest complex in Kenya and flows through large-scale irrigated agriculture in Kenya to open savanna grassland in the Masai Mara

National Park in Kenya and Serengeti National Park in Tanzania. These national parks are renowned protected areas in the region. The Mara River further flows through small-scale agricultural land (crop and livestock husbandry) in Tanzania before discharging into Lake Victoria. Therefore, water from the Mara River is utilised for domestic consumption, livestock farming, irrigated agriculture, wildlife and environmental maintenance. The likely conflicts regarding access to and use of water from the Mara River will be between upstream users in Kenya and downstream users in Tanzania, and between the wildlife and human populations, which may also spark conflicts between Kenya and Tanzania. An inadequate water supply in the Mara River is caused by two main factors, which impact on each other: climate change, and land use and land cover. Climate change leads to a decrease in rainfall and rise in temperature, hence an increase in evaporation. On the other hand, a change in land use and land cover, such as the deforestation in the Mau forest complex caused by the expansion of agriculture and encroachment on the forests by livestock keepers, alters run-off and infiltration processes, thus interfering in the hydrologic cycle. Inappropriate land use and land cover can result in land degradation as a result of poor planning and ineffective water resource management systems along the Mara River in both Kenya and Tanzania.

CONCLUSION AND RECOMMENDATIONS

Climate change and variability have the potential to impact negatively on water availability, access to and demand for water in most countries, particularly in Africa. Climate change is likely to result in water scarcity, which will consequently result in stiff competition with regard to access and use. As competition for access to and use of water resources for different uses and users intensifies, water-use conflicts are likely to occur. This chapter examines the impact of climate change with specific focus on the effect of rainfall change and variability on water resource availability, access to and use in the Lake Victoria Basin. It is argued that the LVB in particular, and East Africa in general, is experiencing dramatic rainfall changes and variations over time and space, resulting in a decrease of river flows and drying up of other many natural water sources. It is further argued that, owing to the decrease of the water supply for domestic use, livestock and crop production, hydropower production and industrial use, water-use conflicts may occur at different levels such as in the family, among

villages, between ethnic groups, government institutions and local people, between different livelihood systems, and between countries. This calls for the formulation and implementation of national policies and other legal frameworks that are geared towards addressing issues of climate change, particularly the adaptation to and mitigation of climate change impacts. It further calls for stakeholders' dialogue to improve both customary and formal governance systems with regard to natural resources utilisation and management.

Since water resources touch every sector of the economy, it is important to improve water management in order to reduce the degradation of water sources and enhance equitable access to and utilisation of the resource, thus reducing or alleviating sources of conflict pertaining to water access and utilisation. It is therefore recommended that policymakers and planners integrate climate impact adaptation and mitigation measures in the formulation of policies and planning for development projects. It is further recommended that sector-specific policies that relate to the hydrology of water resources, such as forestry, agriculture and mining, be reviewed to include issues of climatic change and variations and their effects.

It is also necessary that countries that share transboundary natural resources such as water, share information on meteorological, hydrological and socio-economic activities, and the way they are practised in order to maximise the potential of the transboundary resources by minimising tensions and conflicts that may otherwise result.

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5 The hydropolitics of the Nile

Climate change, water and food security in Ethiopia

Debay Tadesse

INTRODUCTION

Climate change is real, and its impact is already being felt. Climate change can often exacerbate water problems. It can have a multiplier effect on other factors affecting water resources, for instance where climate change has caused desertification in the Sahel it has led to overgrazing in some areas, which then suffer rapid run-off and flooding. Water is not only a necessity for life, but also a critical component of nearly every type of economic activity, from farming to industry to energy production. Yet despite its importance, it is often badly managed. Given its very unequal distribution across the globe, the management of water needs to address the specific situation of each region.

The Nile is the longest river (6 825 km) in the world. It is also huge in terms of both drainage area and the quantity of water it carries in its watercourse – 84 billion cubic metres of water. The Nile also has more riparian states (Burundi, Egypt, Ethiopia, Eritrea, Kenya, Republic of Congo, Rwanda, Sudan, Tanzania, and Uganda) than any other international river basin in the world. While other countries may have alternative energy sources, a significant percentage of the people of the Nile riparian states depend directly on

the Nile River for their livelihood and as a source of energy for industrial and domestic needs.

Ethiopia, the location of the main source of the Nile, contributes 86 per cent of the water for the Nile Basin states, but utilises less than one per cent of the river's potential for both irrigation and hydroelectric power. Yet, Ethiopia has been synonymous with disastrous famine since the 1980s. For almost three decades, drought and famine have continued to plague this country. The hunger in Ethiopia has become so chronic and widespread that international donors fear that the number of hungry Ethiopians is increasing beyond the world's ability to feed them.

If Ethiopia is to improve and expand its agricultural production, it needs to formulate a development policy that takes into consideration the efficient management of river flows and transfer of water for irrigation and generating hydroelectric power. Therefore, to overcome the problem of recurrent drought and famine it is important for the Ethiopian government to develop a strategic plan that concentrates on water development in the country including the Nile. While this seems to be a pragmatic approach for poverty reduction, and economic and environmental sustainability, downstream Egypt worries that there will be less water for its own growing economy and population.

A major cause of food shortage in Ethiopia is drought (which often causes famine) and floods. These climate change-related disasters have made the nation dependent on food aid. The drought that has affected millions of Ethiopians, and which is exacerbated by deforestation, water pollution, soil erosion and desertification, is currently also affecting the ten Nile Basin riparian states in Africa. The scope of the climate change which has led to the environmental degradation that started in a few East African countries is likely to spread far beyond this region. Intermittent, but frequent drought in Ethiopia causes economic hardship not only for Ethiopians alone, but is also causing a significant decline in the volume of the Nile River that feeds the ten riparian states, including Egypt and the Sudan. Thus, whereas climate change has affected the people of Ethiopia and their food systems that are already vulnerable, over time the geographic distribution of risk and vulnerability is likely to shift.

There are, therefore, problems to be solved: how do we ensure that water is distributed fairly across the Nile Basin, or decide whether water is a commodity or lifeblood, and furthermore, how do we prevent possible military conflicts among the Nile Basin countries. Numerous round table negotiations between the Nile

Basin governments, especially between Egypt and Ethiopia, have so far not led to any concrete or workable agreement, which suggests not only the existence of tensions, but also the complexity of resolving conflicts over the use of water. What is also interesting is that it is not so much the quantity of fresh water available on the surface of the Nile Basin region that makes it a scarce commodity and a source of conflict, but rather it is the uneven distribution and utilisation of water among the riparian states that is contentious. Under the harsh conditions of this region, the competition for scarce water resources is intense, especially where the resources are less developed and shared by other countries.

In addition to the problems stated above, this chapter examines the trends in climate change in Africa and the attendant consequences of environmental degradation associated with water scarcities and the potential conflicts among the Nile Basin riparian states. The chapter also concentrates on the challenges and opportunities that upper riparian states, in particular Ethiopia, are encountering with regard to future water-related development projects. The slow pace of water development suggests that historical, economic and political factors are converging to reduce the potential for water development of the upper riparian states, including Ethiopia.

In short, unless basin-wide water development planning is considered as a viable solution to conflict resolution and poverty reduction, the intensification of climate change in Africa, which will exacerbate the scarcity of water, is likely to lead to interstate conflict.

CLIMATE-INDUCED WATER STRESS

A number of countries in Sub-Saharan Africa (SSA) already experience considerable water stress as a result of insufficient and unreliable rainfall, and flooding. The impact of climate change – including predicted increases in extremes – is likely to add to this stress, leading to additional pressure on water availability, accessibility, supply and demand.

Certainly water is predicted to be the primary medium through which early climate change impacts will be felt by people, ecosystems and economies. Both observational records and climate projections provide strong evidence that freshwater resources are vulnerable, and have the potential to be greatly affected. However, the Intergovernmental Panel on Climate Change (IPCC) report on climate change and water recognises that the impact on water has yet to be

adequately addressed in either scientific analyses or water policy. In contrast to the lack of knowledge on the direction and magnitude of hydrological changes under different climate change scenarios, the prospects of demographic change in the 21st century are known with some certainty. The population in SSA is expected to increase from 700 million in 2007 to 1 100 million in 2030, and 1 500 million by 2050, and populations will increasingly urbanise. Overall water demand can therefore be expected to more than double in the first half of the 21st century, without considering rises in per capita demand for food and water.

In Ethiopia, the figures are particularly alarming. The population is expected to increase from 77 million in 2007 to around 146 million by 2050, an increase of almost 90 per cent. For Ethiopia, extending access to secure water and sanitation, and reducing dependence on unprotected water sources is central to both adaptation and poverty reduction. This is simply 'good development in a hostile climate', in a context where access to water rather than its absolute availability will remain a key challenge. There are multiple pressures on water. Climate change is one of them.

Though changes in climate may affect the whole continent, they may vary across Africa. Climate change in the already arid northern subregion of the continent is expected to accelerate desertification and the gradual decrease in forest cover. In the Sahara and Sahel subregions, rainfall is predicted to decrease, resulting in soil degradation and an increasing occurrence of dust storms. In north-east Africa, more intense dry periods and shorter wet seasons are expected to affect even huge river systems such as that of the Blue Nile, leading to serious water shortages and adverse consequences for the agriculture and forestry sectors throughout the region.

East and Central Africa will also see their agricultural capacity decline. In West Africa, more frequent and longer dry periods are expected to increase the likelihood of crop failure. Coastal areas may also be affected by rising sea levels and the intrusion of salt water into inland freshwater resources. Southern Africa also faces similar threats. The staple food of the region, maize, is particularly susceptible to drought. Wetlands of international importance and wildlife are also under threat from drought in southern Africa. Climate change, therefore, is expected to decrease the food supply, and hence exacerbate the widespread poverty and human insecurity in the region.[1]

One of the tragedies of poverty in Africa is its destructive pressure on natural resources such as land, forests and water on which the livelihood of the current

and future generations depends. Climate change is expected to have devastating effects on Africa: land is being overused and its natural fertility depleted; forests are being ravaged; rangelands are overgrazed; water supplies exhausted, and wildlife eliminated.

Another consideration is that of the total volume of water on the earth's surface, only three per cent is fresh, whereas the remaining 97 per cent is sea water. If the fresh and sea waters were spread evenly, they would cover the globe to a height of 2 700 metres. Similarly, the three per cent of fresh water, which constitutes the bulk of our supply, would still make a 70 metre high layer if it were spread evenly. Of the three per cent fresh water, only 0,3 percent is found in rivers and lakes, while the rest is locked in icecaps and glaciers.[2]

However, it is not so much the amount of fresh water available on the surface of the earth that makes it scarce, but rather its uneven distribution. There is enough water in the world; the problem is that it is often unevenly distributed and unequally available.[3]

GEOPOLITICS OF THE NILE BASIN

Egypt fears that the use of the waters of the Nile by other African countries will increasingly threaten its national security. The concern arises from, for example, Tanzania's announcement that it wishes to undertake a 170 kilometre water pipeline project from Lake Victoria (where 14% of the Nile originates) to supply water to some dry areas in the country.[4] The project is regarded as a direct violation of the 1929 treaty that governs the use of the Nile water by the basin countries.

A former Egyptian minister for water and natural resources, Mahmoud Abou Zeid, maintains that Egypt has reasonable grounds to be concerned about the threats to the use of the river. Recently Kenya, another country on Lake Victoria, said that it 'will not accept any restrictions on the use of Lake Victoria and River Nile' and announced that it would unilaterally withdraw from the treaty. Abou Zeid branded Kenya's move as a breach of international law, describing it as an 'act of war'. Egyptian academic Sharif Elmusa maintains that Egypt is worried by the 'domino effect' of Tanzania's 'act of rebellion against the treaty' in the region. Kenya, Tanzania and Uganda, the three countries on Lake Victoria, have long claimed that the 1929 treaty is an outdated relic of colonial times, maintaining that it is non-binding because foreign rulers negotiated it

without taking local interests into account. The treaty that East African countries are opposed to is the Nile Basin Treaty, which was signed by Egypt and Great Britain acting on behalf of its then East African colonies in 1929.[5]

THE NILE BASIN DISEQUILIBRIUM

To recap, at 6 825 kilometres, the Nile Basin is the longest river basin in the world in terms of drainage area and the quantity of water it carries in its watercourse. Eighty-six per cent of the water originates in Ethiopia.[6] In addition, Lake Victoria, from which 14 per cent of the Nile water originates, is the largest freshwater lake in Africa with the longest shoreline of any lake in the world.[7] It is estimated that the Nile River carries 84 billion cubic metres of the total water resources of 3 400 billion cubic metres of fresh water in Africa.[8] The hydroelectric potential of the Nile River in the upper riparian states is thought to be vast but largely untapped. The Nile also has the highest number of riparian states (states that share the Nile water) of any international river basin.

The basin has an estimated population of 300 million people with an average per capita income of US$282. All these people depend on its waters for survival.[9] It is estimated that by 2025 the number of people who depend on the Nile River will increase to 859 million.[10] Egypt's population, now the second highest in Africa, is presently ten per cent greater than Ethiopia's. However, this number will change and it is projected that Ethiopia will have 20 per cent more people than Egypt by 2025.[11] Desperately poor and undeveloped Ethiopia, where the Blue Nile originates, wants to develop its water for hydropower, irrigation and other needs. Downstream Egypt is concerned that there will be less water for its own growing economy and population.

To date, there is no comprehensive agreement on the use of the Nile River water that binds all the riparian states, and no measure of integrated planning to develop its basin. The few agreements that exist have been concluded between some of the states mainly with the aim of securing the interest of one state, Egypt, and to some extent the Sudan, to the total exclusion of other riparian states, especially Ethiopia.[12]

What makes the Nile River Basin unique and challenging among other international river basins is the total absence of cooperation and coordinated development planning among the ten riparian states. This peculiar feature of the Nile has become an obstacle to effective cooperation with regard to development

and investments. As a result of the lack of regional cooperation and integration, the Nile Basin has not made any significant contribution to the 'welfare, of its close to 300 million inhabitants who are among the most impoverished and who comprise six of the world's ten least developed countries'.

Egypt, the Sudan and Ethiopia are entering a period of increasing water scarcity as a result of improper water-resource management and environmental degradation caused by deforestation and pollution. Conflicts over available water resources are very likely unless a basin-wide planning process is established. Environmental degradation is a direct result of human activity. In the process of transforming resources to satisfy people's material needs, the world releases large quantities of toxic effluent and emissions into the environment. In fact, '[i]t is estimated that both in developing and developed countries the daily impact on climate change includes a release of 17,3 million tonnes of carbon dioxide into the atmosphere; a loss of 64,8 million tonnes of topsoil; destruction of 47 000 hectares of forest; desertification of 346 000 hectares of land; and the extinction of perhaps 100–300 species.'

Some thought could, for example, be given to reducing fuel-wood consumption through the use of efficient energy and technology, and increasing fuel-wood production by planting the right type of leguminous multipurpose trees to help reduce the rate of deforestation. Where deforestation has already reached a stage where dung is burned because there is no more wood, this trend can be reversed in the medium term and the dung can again be used as fertilizer.

GEOPOLITICS AND HYDROPOLITICS ON THE NILE

Modern geopolitics has favoured Egypt because of its strategic position in the Middle East. Major international lenders and development agencies have been loath to support anything upstream on the Nile that might disrupt the vital flow of water to Egypt and trigger instability. Ethiopia has lacked funds to develop its own broad irrigation network. The result is one of Africa's cruelest ironies: the land that feeds the Nile is unable to feed itself.

Historically, Egypt has systematically used its geopolitical and strategic position in the region to give it a near monopoly over the Nile waters. More than any other riparian state including Ethiopia, Egypt has used the Nile River extensively for irrigation and hydroelectric power. Next to Egypt, the Sudan has used the Nile River extensively for similar purposes. In 1895, the Zefta Dam was built; in 1896,

the Gelion Dam, the first really big dam, was constructed, and in 1917 Snar Dam was constructed in the Sudan. By 1926, another dam – the Gebel Awlaya Dam – was built in the Sudan. In addition to extensive irrigation works and a series of smaller dams, Egypt decided to construct the High Dam at Aswan in the 1960s to regulate the flow and annual flooding of the Nile, and provide years of water storage for Egypt rather than depend on the remote reservoirs of Lake Tana in Ethiopia and Lake Victoria in Kenya, Tanzania and Uganda.

In principle, Ethiopia may wish to reserve the possibility of a massive unilateral water development programme for the Blue Nile Basin and other water resources in Ethiopia. In practice, there is no conceivable way it could finance such investments domestically in the short to medium term. Ethiopia needs financial and technical assistance from the international community for its water-related development such as hydroelectric power and modern irrigation. Therefore, a cooperative and coordinated project among the Nile riparian states is subject to the approval of international multilateral and bilateral lending agencies, which may not always share the view of the Ethiopian government with regard to strategies and objectives. The current Ethiopian policy of reserving the right to make unilateral claims on Nile waters in the future, as Egypt has done in the past, is therefore fraught with danger. However, for the past number of decades upper riparian countries that have been embroiled in endless conflicts and general instability have been unable to give full attention to the development of their water resources.

In the absence of any noteworthy challenge in the past, Egypt, in particular, unilaterally implemented a series of major water projects that consequently appropriated large portions of the Nile waters and also brought the Nile's flow within its sovereign jurisdiction. It deployed all human, material and scientific resources to put in place the legal and institutional framework that could enable it to acquire a monopoly over the river. In this connection, Egypt took a major step by co-opting the Sudan and concluding the 1959 agreement to appropriate all the waters of the Nile between them. In this agreement, the Sudan, as a junior partner, was allotted 18,5 billion cubic metres of water, while Egypt retained 55,5 billion cubic metres. As a result, the construction of the High Dam at Aswan began in 1959 as soon as the agreement with the Sudan was signed. The Sudan was also allowed to undertake a series of Nile development projects notably at Roseires and Sennar on the Blue Nile, and at Kashm el Girba on the Atabra. The Sudan is presently considering the construction of other reservoirs because of the urgent need to create more irrigated fields as one way of responding to the growing demands of

the inhabitants for more food to be produced locally.[13] However, Egypt has been able to utilise more than its 1959 Nile Waters Agreement allocation of 55,5 billion cubic metres in almost all years since 1971.

None of the upper riparian states were consulted nor given advance notice of the 1959 agreement between Egypt and the Sudan. Nevertheless, all these states have rejected the 1959 agreement and have expressly stated, on different occasions, that they are not bound by it on the basis of the cardinal principle in the law of treaties. Egypt and the Sudan, however, continue to act as if the Nile starts in the Sudan and ends in Egypt. They have refused to heed the call by other riparian states for the equitable utilisation of their shared resources. In 1994, the International Law Commission adopted the International Law Association's Helsinki Rules that attempted to balance the rights and interests of up- and downstream states.

Distributing water fairly and using it efficiently is crucial to providing adequate water for agricultural and livestock development and for human consumption. However, because of population growth, migration and overgrazing, which have contributed to deforestation and land degradation, the Nile Basin, particularly Ethiopia, is now experiencing serious environmental pollution, as well as drought and desertification in some areas. Some experts argue that the slow pace of regional cooperation in the Nile Basin has been to the disadvantage of Ethiopia even to the point that the Blue Nile, which carries with it valuable fertile soil from Ethiopia, has been feeding Egyptian terraces with more than 1 billion tons of silt per year for millennia.

In addition, Egypt is one of the biggest recipients of US aid (US$2,2 billion/year) and a good friend of the West. This friendship, forged after the signing of the Camp David Accord with Israel in 1980s, seems to assure Egypt that it has both the political clout and economic leverage apropos the giant international financial institutions such as the World Bank and the IMF.[14] Since 1979, Egypt has received US$21 billion in economic aid from the US plus more than US$25 billion in military aid.[15]

Furthermore, a sizeable number of Egyptian professionals are engaged in key positions in various departments of the World Bank, and in environmental and international legal institutions.[16] John Waterbury lists some of the key people in international organisations, including a number of World Bank presidents, the former UN Secretary General, the head of the UN Environmental Programme and senior officials in a number of UN agencies who come from Egypt. This

has undoubtedly played a role in defending Egyptian stakes, in effect strengthening Egypt's unwillingness to enter into water-sharing agreements with the upstream states of the Nile.

CLIMATE CHANGE AND FOOD INSECURITY IN THE NILE BASIN

Ensuring food security in the context of climate change and the growing risk of disaster are two of the greatest challenges of adaptation. The issue of food security attracted considerable attention during the late 1980s owing to the impact of droughts in Africa and concerns about the sociopolitical causes and consequences of famine. Yet, at the same time, the focus shifted away from increasing crop yields to understanding the complex nature of hunger and famines.

The planet's crises – rapid climate change, degraded ecosystems, scarcities of food, water and energy – will outlast the serious economic downturn that now absorbs the attention of global leaders and affects people worldwide. Climate change will affect all four dimensions of food security: food availability, food accessibility, food utilisation and food system stability. It will impact on human health, livelihood, assets, food production and distribution channels, as well as change purchasing power and market flows. People who are already vulnerable and experiencing food insecurity are likely to be the first affected.

Hunger in Ethiopia has become chronic and widespread to the extent, as stated, that international donors fear that the number of hungry Ethiopians is increasing beyond the world's ability to feed them. By 2000, about 13 million Ethiopians had been saved by 1,7 million tons of food aid from the US alone.[17] Water and food security are closely related. Reliable access to water increases agricultural yields, providing more food and a better income in rural areas, which are home to three-quarters of the world's hungry people. If water is a key ingredient of food security, lack of it can be a major cause of famine and undernourishment, particularly in food-insecure rural areas such as in Ethiopia where people depend on local agriculture for both food and income.

Food security will also be affected through possible internal and international migration, resource-based conflicts and civil unrest triggered by climate change and its impact. The volume of water allocated to agriculture and water-management decisions will determine whether African societies achieve economic and social development and environmental sustainability.

AGRICULTURAL DEVELOPMENT AND CLIMATE CHANGE

Analyses of the impact of climate change suggest that agro-ecological systems are the most vulnerable. Agriculture in low-latitude developing countries is expected to be especially vulnerable because the climate of many of these countries is already too hot. Further warming is consequently expected to reduce crop production significantly. These effects are exacerbated by the fact that agriculture and agro-ecological systems are especially prominent in the economies of African countries and the systems tend to be less capital and technology intensive. Predictions of the effects across regions consequently suggest large changes in the agricultural systems of low-latitude (mostly, developing) countries.

The economic well-being of societies has so far exerted the greatest demand on the world's water resources. The major economic role of water is its relationship with agriculture. This is certainly true at a national level, where food security issues and national economic performance are related, albeit in a complex way. However, it is certain that irrigation and the control of crop timing can have an equal effect on the macroeconomics of a country or region. Low-income producers can increase food production significantly by having reliable access to water and through improved water-harvesting practices.

At the local level, agriculture is the mainstay of many rural communities, and the availability of adequate water enables the production of food for household nutrition and for sale at local markets. In addition, the availability of irrigation water enables more crops to be grown per year, and the economics involved in the selling of produce, in irrigation and in year-round farming increases employment opportunities, which has direct economic benefits for a local community.

The combination of land degradation and annual rainfall variability often causes crop failures. To stabilise and even boost agricultural production, it has become necessary to expand irrigated agriculture in Ethiopia. The lowlands of the country, with their large flat and fertile land, hold great potential for the development of large-scale irrigation schemes. The potential gross irrigable area is estimated to be 3,5 million hectares. To date, only five per cent of this land is utilised.[18]

Agriculture is the basis of the Ethiopian economy. It accounts for the lion's share of the total GDP, in foreign currency earnings and in employment creation. Both industry and services are dependent on the performance of agriculture,

which provides raw materials, generates foreign currency for the importation of essential inputs and feeds the fast-growing population.

In spite of its importance in the national economy, agriculture is subsistence based at household levels, where the mode of life and operation has remained unchanged for centuries. Agricultural productivity has been deteriorating continuously, rendering a good proportion of households unable to feed their families and frequently dependent on food aid.

Future demand for water by farming, including livestock production, will be influenced by strategies for food security, and increasing food supply in Ethiopia is closely linked to the utilisation of and access to water. Water shortages are increasingly becoming a serious impediment to intensifying agriculture with about one-third of the people in the region living in drought-prone areas at present.[19] In these areas, drought-proofing measures such as soil and water conservation, improved water-harvesting techniques, minimum tillage, improved crop selection and varieties, and small-scale irrigation will be important elements in the region's food security strategies.

Food security refers not only to the availability of food, but also to stable access to quality food. If one talks in terms of only rain-fed production, it remains necessary to address the well-known problems in the Nile riparian states of low productivity, high variability as a result of the lack of water control and the scarcity of off-farm employment and uncertain incomes. While irrigation seems the obvious measure for improving agricultural productivity, it has the additional benefits of being able also to provide a basis for growth, income and employment in the overlooked rural areas, thereby mitigating one cause of urban migration.

ENERGY

Energy transition and climate vulnerability are very closely connected, as the world's poor struggle over a dwindling resource base that is being further degraded by the impacts of climate change. There is a need both to improve energy access and to link it more closely to the climate agenda, the revitalisation of rural areas, and the improved management of urban development that has dominated the changing energy landscape of recent decades.

Water is an essential resource in all industries that have a major influence on economic performance at the national level, but also at local and household

levels. Water also plays a large role in power generation in many countries whether through cooling, or directly through hydroelectricity generation. Water transport is also important in many parts of the world, allowing access to markets as well as generating its own economy.[20]

A clear manifestation in SSA's underdevelopment and economic backwardness is the meagre use of commercial energy. Electricity and oil are critical energy inputs in a developing economy as they contribute greatly to the production process. For economic and financial reasons these modern energy sources have been made available largely to urban areas. Rural energy requirements such as for domestic, rural-based cottage industries and handicrafts are mainly supplied by traditional energy sources. For instance, a study on Ethiopia's energy sector shows that about 94,7 per cent of the total energy supply is from biomass, of which household consumption constitutes 89 per cent. Other sectors of the national economy, notably agriculture, transport and industry, account for only 7,2 per cent of total energy consumption.[21]

Rural energy initiatives in Ethiopia have remained undefined and largely shelved owing to financial constraints and low levels of technological advancement or simply through neglect. The rural energy problem in Ethiopia will continue to be one of the chief causes of underdevelopment and poverty unless it is given the proper attention it deserves.

For Ethiopia, an energy transition would be characterised by a move from the present levels of subsistence energy usage based on human and animal labour and fuel-wood resources, to a situation where households, services and farming activities use a range of sustainable and diversified energy sources. The benefits would be greater resilience in the production system, higher productivity, improved efficiency and higher incomes for farmers, and the factors contributing to climate change in Africa, such as deforestation, overgrazing, desertification and so forth, which are driven primarily by poverty, would be reduced.

Promoting food security by raising agricultural productivity and establishing sustainable production systems will inevitably mean increasing the energy inputs required for water supply management, crop fertilisation and agro-processing, as well as for the provision of community lighting and drinking water. Small pumps have made a significant contribution to successful irrigation in some African countries producing vegetables and even rice. For instance, Egypt developed a vast system of capillaries in the form of irrigation canals. It has one of the most extensive irrigation systems in the world, but also one of the

most efficient. The Egyptian government has built more than 10 000 kilometres of canals in the Nile Delta. As a result, hardly any of the river water, or silt, now reaches the Mediterranean Sea.[22]

CLIMATE CHANGE AND THE ENVIRONMENT

The rapidly increasing populations of the region are outstripping water supplies in most countries in the Nile riparian states and placing immense pressure on the water resources and the environment. The risks of a shortage of water sources and the threat of increased soil erosion as a result of poor land management practices, deforestation, overgrazing, and sediment transport are a rapidly increasing problem which affect water quality, aquatic ecology and reservoir volumes this region. When the rates of cutting the vegetation exceed the replanting rates, soils in the cleared areas become unstable and susceptible to erosion, particularly in vulnerable areas, such as on steep slopes or in arid or semi-arid regions.

Another consideration is that just as water brings life to soil, so it can also destroy it. Soil can conserve water, but when it is loose, it can severely degrade water resources. Catchment management through soil and water conservation, tree planting and improved land-use practices is critical everywhere, but nowhere more than in Ethiopia where soil and water resources are abundant, but appear to be scarce and slowly disappearing. Soil erosion in areas which have lost their vegetation cover because of increased human activities, rapid increases in population and widespread poverty can contribute to land degradation. Soil erosion may also result in severe flooding owing to a reduction in the remaining soil's capacity to absorb water.

Biomass energy conservation (efficient use of vegetation and tree planting) impacts directly on the everyday life of the whole rural population, and is a powerful factor in raising awareness of the need to protect the environment at the individual and household levels. When an individual feels the direct impact on his or her own family and the local environment, it is a short step to environmental awareness at a more global level. This is enhanced when educational institutions are included in awareness-raising activities.

Water flow is essential to the viability of all ecosystems. Unsustainable levels of extraction of water for other uses could diminish the quantity of water available to maintain an ecosystem's integrity. As land is cleared and water demand

for agriculture grows, and water is taken for other human uses at the expense of natural ecosystems, the need to protect these resources and establish a policy geared to water development becomes apparent. If this is not done, water will continue to be used in a manner contrary to sound environmental policy, which will inevitably lead to the further disturbance and degradation of natural systems and will have a profound impact upon the future availability of water resources. Actions to ensure that the protection of the environment is taken into account as central to water management are critical if present trends are to be reversed.

WATERSHED MANAGEMENT

In a situation where 60 per cent of the African continent is covered by transboundary river basins, about 300 million people, a third of the continent's population, are already experiencing water scarcity. Half of the African countries will suffer from water stress by the year 2025.[23] Shared water utilisation plays, and will continue to play, a significant role in interstate relations. Moreover, population growth and the onslaught of recurrent drought and famine in some parts of the African continent will intensify the demand for fresh water.

Watershed management involves an array of nonstructural (e.g vegetation management) and structural (e.g engineering) practices.[24] Soil conservation practices and land-use planning activities can be employed in watershed management, as can the construction of dams, establishing protected reserves, and developing regulations to guide road building, timber harvesting, agro-forestry practices, irrigation, and other type of activities. The unifying focus in all cases is how these various activities affect the relationship between water and other natural resources in a watershed. The common denominator or integrating factor is water.

Watershed management is an integrative way of thinking about human activities that have an effect on, or are affected by, water in a given area of land.[25] Watershed management includes a set of tools, or techniques, namely the physical and regulatory or economic means for responding to problems or potential problems involving the relationship between water and land uses. This is both the dilemma and the strength of watershed management. In practice, individuals, local governments, and various groups that control land in a political

framework that has little relationship to, and often ignores, the boundaries of a watershed usually decide upon activities involving natural resources.

Activities are undertaken independently, often with little regard to how they affect other areas. Yet, despite this real world of disaggregated, independent political and economic actions, it remains a fact that water and its constituents flow downhill and ignore political boundaries. It must be recognised, however, that practices relating to resource use and management around the Nile Basin do not depend solely on the physical and biological characteristics of watersheds. Institutional, economic and social factors, such as the cultural background of rural populations and the nature of governments, need to be fully integrated into viable solutions that meet climate change (environmental), economic and social objectives.

Arable land and water resources are becoming increasingly more scarce as the Nile Basin's population increases. These scarcities, and the human responses to them, pose challenges to sustainable development and will have serious environmental consequences. Changing weather patterns and climatic conditions add uncertainty to future land and water resource management. It is unclear where and how much freshwater supplies will vary with changes in climate induced by global warming. What is clear is that the increasing water demands caused by a changing population and economic development pose greater problems in most of the riparian states in the Nile Basin area.

RECOMMENDATIONS AND CONCLUSION

Ethiopia will need to use water more efficiently in agriculture as an input that has great value because of its scarcity. The more efficient use of water in practices including traditional water-harvesting and moisture control to modern irrigation systems (mostly small-scale irrigation schemes), combined with the use of improved technology, inputs and agricultural services, will contribute significantly to improved food security and mitigate the impact of climate change on the Nile River.

If the water is carefully distributed, the Nile carries enough fresh water to meet the existing and future needs of the ten riparian states. In other words, presently there are regions that suffer severe drought, while others are heavily flooded; some regions have ample water in winter, but not enough in summer; some regions abound in water during certain years, but are threatened by droughts in other

years. Thus, the management of the Nile water is largely a question of the redistribution of a natural resource, given certain physical, economic, environmental and social constraints.

Despite the gravity of the problems in the Nile Basin countries, and the size and extent of the Nile itself, the basin has been given far less attention by the world community than it is due. Although there are economic and political reasons behind the worldwide neglect of the Nile Basin, it is the Nile riparian countries themselves that should draw the world's attention to the Nile. Fortunately, where there was stagnation and pessimism in the past, there are positive views and optimism about the future. Firstly, Egypt faces the prospect of having to share the river with its upstream neighbours far more extensively than before. Then, some of the civil wars in the region have ended. Furthermore, under a new generation of leadership, more countries are committing themselves to transform their economies for the better and some encouraging results are being observed.

However, not only is international funding of water development projects largely precluded, but any delay in reaching new international agreements allows Egypt to continue with its desert reclamation policy without considering the implications for the rights of the upstream riparian states. The continuation of Egypt's desert reclamation policy will greatly complicate future negotiations because it will establish a prior use of the water. Ethiopia has a strong interest in reaching an agreement in the near to medium term so that international help can be secured and so that Egypt does not commit increasing quantities of water to new desert reclamation projects.

The ten riparian states of the Nile Basin must provide a means of protecting the quality of the Nile water and the environment from degradation. They must follow the regulations of international water utilisation on transboundary waters known as the Helsinki Rules: that transboundary water has to be shared equitably and reasonably among riparian countries.

The unequal utilisation of the Nile water by all riparian states is detrimental for economic development, and does not help to mitigate climate change in the region. The unequal utilisation of water becomes an even greater issue if one considers the current changes in the climate that have a direct impact on the scarce resource of water.

The key objectives of Ethiopia's development strategy should be to slow down the degradation process through reforestation programmes, technologically

oriented irrigation systems, and by developing hydroelectric power which could greatly reduce deforestation in Ethiopia. In addition, it is crucial to establish a regional plan for the balanced and equitable utilisation of the Nile water among the riparian states of the Nile Basin. If Ethiopia is to improve and expand its agricultural production, its strategy and water development plans must involve the coordinated management of river flows and transfer of water for irrigation and hydropower development.

The lack of agricultural and technological development is causing Ethiopia immense environmental stress, which is slowly also beginning to affect other Nile Basin riparian states, especially Egypt and the Sudan. It is vital that water be used efficiently in order to provide adequately for agriculture and livestock development and for human consumption. However, population growth, migration and overgrazing have contributed to deforestation and land degradation, thus the Nile Basin is now experiencing serious environmental pollution. Drought and desertification in some areas are evidence of water misuse.

The only sustainable way of avoiding future conflicts and minimising drought which leads to famine and increased poverty is to manage the water of international drainage basins in Africa through cooperative and systematic collaboration among the basin states. Therefore, there is no reason for the countries of the Nile not to negotiate their shared resource on the basis of the universally acceptable principle. As already stated, unfortunately, there is no comprehensive agreement on the Nile binding all the watercourse states and no measure of integrated planning to develop its basin to date.

Furthermore, agriculture is the basic unit of socioeconomic development. However, Egypt makes extensive use of advanced irrigation technologies which continue to dominate the region, while the upper riparian states remain underdeveloped and practice inefficient farming. Thus these states will inevitably find themselves effectively precluded from the water development process and unable to participate actively in any water development policy process nationally and among the Nile Basin countries. Therefore, not only must the upper riparian states have increased access to Nile River water development, but Egypt should also participate in this process of cooperation and collaboration which could benefit all the riparian states.

The economic and cultural destinies of approximately 300 million people are bound to the Nile River and its tributaries, from Central and East Africa to the Mediterranean Sea. Indeed, with so many interests vying for water in

such a sprawling region, the Nile has long been a source of conflict. The ten riparian states have a high rate of population growth (3% on average) that could cause water to become an even more scarce resource. No other river basin in the world is shared by as many states as is the Nile. Currently, the Nile riparian states are home to 40 per cent of Africa's population and comprise ten per cent of its land mass.

However, to restate, it is not so much the amount of fresh water available to the Nile riparian states that makes it scarce, but rather its uneven distribution and inappropriate usage coupled with deforestation, desertification, overgrazing and pollution, which lead to environmental degradation and so contribute to underdevelopment. In addition there is a lack of the use of technology for the benefit of the people of the region.

When it comes more specifically to Ethiopia, the above problems are manifest mainly through drought, famine and civil unrest. The images of starving children and the deep-rooted poverty that is seen in the international media is not a divine curse, but the result of inadequate developmental policies especially related to water. Former romantic images of the region have been replaced by gloomy and disastrous forecasts, pictures of victims of perennial drought and reports of concurrent political confusion and social conflict.

Although drought, food scarcity and starvation are mainly caused by scant and unsustainable rainfall, it is estimated that the Nile River in Ethiopia alone carries 84 billion cubic metres of the total 3 400 billion cubic metres of water available in Africa. To expand its agricultural production and improve its development strategy, Ethopia must coordinate the management of river flows and the transfer of water for irrigation and hydropower development.

When one considers that the Nile Basin countries include five of the world's poorest countries and is home to one-third of the African population and totally dependent on the Nile water, the need for policies geared to regional cooperation is vital. In addition, for Ethiopia, which provides most of the Nile water and has the second highest population in SSA with a three per cent per annum population growth, water-related development is a top priority Therefore, allocations of water resources to meet basic human needs, food security, energy and economic development, while maintaining the integrity of aquatic ecosystems, is much needed in this region. Moreover, the need to shift away from reliance on emergency aid to long-term investments, including irrigation and watershed management, is imperative.

Finally, in Ethiopia, a transition to sustainable energy systems is needed to accelerate the growth of basic food production, harvesting and processing. However, breaking the current energy bottleneck must also be sustainable and environmentally sound, socially acceptable and economically viable. Such a transition involves a commitment to long-term development goals and requires innovative policy and technological solutions.

Governments should provide an enabling policy framework covering management, planning and service delivery functions for adaptation to facilitate and support the efforts of local governments and other actors. They should ensure that devolved administrative responsibilities are matched by resources and technical capacity. In addition, governments need to invest more in climate and meteorological information, biophysical monitoring and early warning, and to integrate such data in their planning.

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PART 3

Climate Change and Natural Resource-Use Conflicts

6 Silence on climate change and the natural resources conflict in Nigeria

The Niger Delta region experience

Bonnie Ayodele

INTRODUCTION

Worldwide concern regarding climate change and global warming has provoked debates and stimulated thinking among political leaders and civil rights and environmental activists. Their concerns are based on recent findings that demonstrate the precarious state of the Earth brought about as a result of mankind's irresponsible activities. With disaster as a looming reality, the Earth is almost at a point of no return as it faces environmental threats which include atmospheric and marine pollution, global warming, ozone depletion, the dangers of pollution by nuclear and other hazardous substances, and the extinction of various wildlife species.[1]

The international community has recognised this situation and consequently undertaken a number of actions, initiatives and meetings which eventually culminated in the Stockholm Conference of 1972 and the establishment of the United Nations Environment Programme (UNEP).[2] The establishment of this programme is witness to the relevance of the environment to the sustainability of human development. Through the institution of the UNEP, the UN has been instrumental in the development of a number of initiatives, conventions, summits, conferences, protocols and meetings, including, for example, the

Vienna Convention for the Protection of the Ozone Layer (1985) and the UN Earth Summit in Rio de Janeiro, Brazil.[3]

However, despite these international endeavours, increased industrialisation has resulted from man's drive towards further exploration and exploitation of the world's natural resources to feed industrial demand. The use of technology to complement industrialisation has exacerbated the environmental crisis. While the reckless exploitation and exploration of natural resources has continued at fever pitch, the assault on the environment has not abated. According to Annan, reckless exploitation of the ecosystem has been going on for more than two century. [4] He opines:

> [F]or more than two centuries, ever since the Industrial Revolution generated advances in living standards such as the world had never seen or imagined, economic development has rested in no small part on some irresponsible activities and assumptions…that the environment and the atmosphere have been filled with emissions that now threaten havoc in our lifetime in the form of global change. Humanity has felled forests, depleted fisheries and poisoned soil and water alike with these, leaving the majority of humankind behind in poverty, squalor and despair.[5]

Unfortunately, mankind's reckless exploration and exploitation of the environment and natural resources has left the majority of the world's population in poverty and has consequently become a potent source of volatile conflict. However, in 1997, more than 180 countries gathered in Kyoto, Japan, in search of a coordinated international response to environmental damage called global warming or climate change.[6] The provisional agreement reached appeared to mark a significant step forward in arresting the human assault on 'the commons' resources'.[7] Even though the commitment seems to have faltered, the Kyoto gathering nevertheless marked a positive effort to sensitise the global community to climate change and global warming, and the impact and consequences of irresponsible living and exploration/exploitation of natural resources. The meeting set in motion a renewed call to address climate change and the need to take action for the preservation of humanity.

However, while the call to address the challenges of climate change has been embraced by virtually all governments and scientists, this global drum beat seems to be of little concern to African governments or civil society groups. Rather it is a climate of deafening silence that has enveloped the continent.

Ironically Africa's vast natural resources, which have been explored and exploited by multinational corporations in collaboration with African elites, have made these resources more of a curse than a blessing. This situation has left the African people at the bottom of the ladder of world poverty. In this context, this chapter continues the debate on climate change and global warming by specifically focusing on the Niger Delta region of Nigeria.

In Nigeria, a country of rich natural resources, the exploration of these gifts of nature has brought multiple curses on the people and the environment. In the Niger Delta area in particular, the natural resources curse syndrome has left the environment depleted and degraded. Gas flaring, oil and water pollution, bush burning and the emission of carbon monoxide, all a result of oil exploration, have left people dehumanised and subservient to poverty. This situation has also contributed to many and various conflicts, such as for the control of the natural resources, and this has fostered militancy. While the Nigerian government's approach to the militant agitation linked to the natural resources conflict is cosmetic, it appears to be completely silent on the issue of climate change to which the region has been exposed because of the natural resources exploration. Nigeria does not appear to have considered any policies apropos climate change or global warming.

Therefore, in addition to examining the issues of climate change, global warming and natural resources conflicts in the Niger Delta region of Nigeria, this paper also offers policy recommendations that could help to address the threats of climate change and resources conflicts. The thrust of the paper is to investigate the climate change-natural resources conflict nexus in the region, which is the economic nerve centre of the country and accounts for about 90 per cent of Nigeria's foreign earnings. Furthermore, the chapter assesses how the natural resources exploration in the region exacerbates climate change and feeds into the complex nature of natural resources conflicts. Finally, the paper underscores the need for proactive policy responses on the part of the Nigerian government to mitigate the effects of climate change and natural resources conflicts.

CLIMATE CHANGE AND NATURAL RESOURCES CONFLICTS

Research into the area of natural resources and conflict has revealed that there is a relationship between natural resources (environment) and conflicts. Scholars such as Colliers and Hoeffler,[8] Indra de-Soysa,[9] and Djankov

and Reynal-Querol[10] have provided in-depth analyses into the relationship between natural resources ('the resource curse') and conflict.[11] By focusing on pockets of intrastate conflict and rebel movements in Africa, they show how natural resources-rich poor nations go to war. With examples of the civil wars in Angola, Liberia, Sierra Leone and the Democratic Republic of the Congo (DRC), they argue that conflicts are fuelled by greed for and grievances over natural resources. These revelations have continued to enjoy wider debate among students of conflict studies.

The era of increased industrial activity and man's search for environmental resources has intensified and accentuated the pattern of conflicts. This has led to a different perspective of natural resources conflict, but which still follows the above lines of thought on the nexus between natural resources and conflict. This perspective argues that natural resources exploration leads to climate change, and this eventually snowballs into volatile conflict. Following the logic that natural resources are products of the environment, for example oil is found in the sea or in the earth, so also are diamonds or gold, their exploration could result in environmental crises which contribute to climate change which may eventually lead to conflict. This position will be validated later in the paper with the Niger Delta experience.

This perspective is better expressed in the studies of Cilliers[12] and Holmberg.[13] Both argue that natural resources exploration is more likely to produce conflict in resource-rich poor and fragile African states. Cilliers, in particular, takes his cue from the UN Secretary-General, Ban Ki Moon, who made a direct link between climate change and resources exploration in the conflict ravaging Darfur, the Sudan. According to him, amid the diverse social and political causes, the Darfur conflict began as ecological crisis, arising at least in part from climate change. The changing rainfall pattern since the early 1980s and the resource competition primarily over grazing and water that Arab nomadic herders and black farmers. By 2003 it evolved into the full-fledged tragedy we witness today.[14]

Moon's statement shows that one of the most tragic conflicts in Africa was fuelled by climate change and natural resources contestation. Thus, there is an overwhelming correlation between the two issues.

Reinforcing the natural resources-climate conflict argument, the findings of Homer-Dixon, the chief researcher on the Environmental Change and Acute Conflicts Project (ECACP), present another perspective. He posits that

environmental degradation has led to a scarcity in natural resources and is fueling civil conflicts within the poorest states in the international system.[15] The Toronto Group and the Swiss Peace Foundation's Programme in Environmental Conflicts (ENCOP) – represented by the work of Gunther Beachler who spearheaded a vast research programme on ecoviolence – corroborates this position.[16] From an environmental security perspective, it is argued that ecological transformation alters the sociopolitical fabric of a society, disrupts productive relationships and ultimately adversely affects the establishment of constraints in and mechanisms of social peace.[17] Hence, conflict can be generated through the scarcity of resources by encouraging the elites to take possession of the resources, marginalising the poor and having a debilitating effect on economic and social innovation – what Homer-Dixon terms the 'ingenuity gap'.[18] According to Homer-Dixon:

> Many developing countries face increasingly complex, fast moving and interacting environmental resources scarcities. These scarcities can overwhelm efforts to produce constructive change and can actually reduce a country's ability to advocate reform. Consequently, environmental scarcity sometimes helps to drive society into a self-reinforcing spiral of violence, institutional dysfunction and social fragmentation.[19]

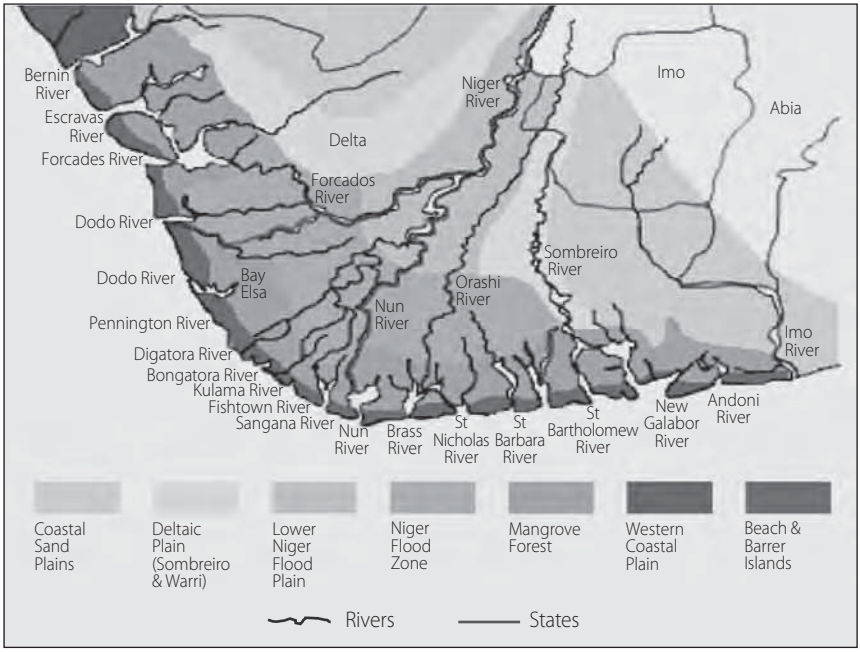
Homer-Dixon captures the situation of contestation in many poor countries experiencing climate change. Scarcity, on the one hand, and, on the other, the abundance of natural resources have made Africa in general, and Nigeria in particular, worse off in all facets of human development as exploration of the environment for natural resources, and resultant scarcities, have resulted in many conflicts. Holmberg argues that, even without acute climate change, many countries in Africa are experiencing water scarcity, deforestation, desertification, environmental degradation and many other related problems. With climate change, however, the situation is becoming worse as about 340 million people already lack access to safe drinking water, and as much as two-thirds of all arable land is estimated to be affected by degradation. This is compounded by a variety of factors, including poor governance, population pressure, inadequate or ambiguous land tenure rights, and inappropriate farming technologies.[20] Indeed, this position is similar to the experience of the Niger Delta region. Massive climatic change has been brought about by

the exploration and exploitation of natural resources and this has resulted in conflict.

THE NIGER DELTA

The Niger Delta is located on the Atlantic coast of southern Nigeria where the River Niger divides into numerous tributaries. It is the second largest delta in the world with a coastline spanning about 450 kilometres, terminating at the Imo River entrance. With well over 5 200 oil wells in the area, and about two million barrels of crude oil per day that pass through 275 flow stations and are exported through ten terminals, the region has been subjected to the greatest environmental abuse recorded in sub-Saharan Africa.[21] The 7 000 square kilometres of swamp, forest and plains present limitless opportunities for ecotourism. The ecology of the area is highly diverse and supports numerous species of terrestrial and aquatic flora and fauna and human life. Its 15 million

Figure 1 The Niger Delta area of Nigeria



Source Niger Delta Development Commission (NDDC), Profile, Abuja, NDDC, 2003

inhabitants, comprising more than 40 ethnic groups, is spread over 6 000 communities. About 1 500 of these host oil multinational corporations and their operations.[22]

Figure 1 shows the Niger Delta region of Nigeria and areas where oil resources are explored. It is the economic nerve centre of Nigeria, accounting for a large chunk of the country's foreign exchange. The region is abundantly rich in oil reserves making the country the largest oil producer in the entire sub-Saharan Africa and the second largest reservoir of natural gas.

The discovery of commercially viable oil resources in the Niger Delta region of Nigeria has brought mixed fortune to the country. Paradoxically, it has been a source of wealth (blessing) and a source of crisis (curse). For many, oil and gas exploration in Nigeria is a curse to Nigeria's political and economic interests.[23] According to Saro-Wiwa, barely eight years after the discovery of oil it became a curse as it was the underlying motive of the 1967–1971 civil war that ravaged Nigeria.[24] Apart from this, the predatory Nigerian elite and government have little to show for oil wealth, making Nigeria a 'shadow state' – a concept used by Reno to explain the relationship between corruption and politics in natural resources-rich poor countries.[25]

While this chapter does not digress into the political economy of oil, it is clear that the conflict engulfing the Niger Delta region finds robust interpretation in the natural resources conflict/curse thesis.

Ironically, the Niger Delta region is the most underdeveloped and poorest region in Nigeria. Unfortunately, the people of the Delta are not only poor, but their environment has become the victim of ecoviolence. In a recent United Nations Development Programme (UNDP) report on the Niger Delta, analyses of the paradoxes of the Niger Delta as a region revealed that the region has enormous resources which account for 'upwards of 80 percent of Nigeria's foreign exchange earnings and about 70 percent of government revenue, yet, [it is] suffering from administrative neglect, crumbling social infrastructure and services, high unemployment, social deprivation, abject poverty, filth and squalor, and endemic conflict'.[26] The report outlines a series of environmental crises and concludes that the environment is very important to the Niger Delta people 'where nearly 60 percent of the population depends on the natural environment – living and non-living – for their livelihoods'.[27] It further reveals the extent of the impact of climate change on the local environment, stating that

> industralisation, urban development, and oil and gas exploration and exploitation have infringed on the people and their environment resulting in alteration of habitats, biodiversity loss, deforestation and pollution. Concretely, the manifestation of the environmental problems include flooding, siltation and occlusion, erosion, shortage of land for development, canalization, oil spills, gas leaks and flares, subsidence, depletion of forest resources, erosion, effluent and waste from oil operations.[28]

Another report released by Nigeria's Community Research and Development Centre (CREDC), entitled *Coping with climate change and environmental degradation in the Niger Delta of southern Nigeria*, highlights in detail the climatic and environmental changes that have occurred in the Niger Delta region and shows the relationship between these changes and poverty and conflict[29].

ENVIRONMENTAL CHANGES RESULTING FROM NATURAL RESOURCES EXPLORATION IN THE NIGER DELTA

One of the causes of climate change and global warming is gas flaring and oil spills. This is also one of the most devastating environmental occurrences in the Niger Delta. Perhaps gas flaring is as old as the discovery of oil in the region. However, it has not abated, but rather is on the rise. Nigeria flares about 24 billion cubic metres of associated oil annually.[30] Almost 70 per cent of the oil fields in the Niger Delta flare their gas every day. Most oil communities live with this reality and, at 13 000 to 14 000 °C these flares produce 35 million tons of carbon dioxide and 12 million tons of methane – more than the rest of the world. [31] This criminality contributes greatly to global warming and poses a health hazard to the people. Of more concern is the inability of the oil industry regulators in Nigeria to enforce the laws on gas flaring reduction effectively in accordance with the World Bank Global Gas Reduction Partnership (GGRP).[32] The industry is yet to comply with the deadlines for gas flaring as demanded by the government, making this a continuous dilemma for the region.

While the issue of gas flaring is one of the fundamental problems contributing to climate change in the region; the second is oil spillage, another major contributor to climate change. Oil spills devastate the environment and generate conflict between the host community and oil multinationals. The US

Department of Energy estimates that over 4 000 oil spills discharge more than 2 million barrels of crude into the land and coastal water of the Niger Delta.[33] Of these spills, 50 per cent are due to corrosion, 28 per cent to sabotage by aggrieved communities, 21 per cent to oil production operation, and one per cent to drilling, the inability to control oil wells effectively, failure of machines, and inadequate care in loading and unloading vessels.[34]

One of the most visible consequences of the numerous oil spills has been the loss of mangrove trees, which, as figure 2 indicates below, were once sources of both fuel wood for the indigenous people and a habitat for the area's biodiversity.

A second environmental change is coastal erosion and flooding**.** The rise in sea level and flooding are already affecting millions of people worldwide. It is estimated that ten million people are at constant risk of coastal flooding. Moreover, in general, floods are causing three million people to be homeless every year. Nigeria is not excluded from this climatic problem. The occurrence of coastal erosion in the Niger Delta has been reported by the Nigerian Environmental Study/Action Team.[35] The team also reported that the rise of the sea level and repeated ocean surges will not only exacerbate the problems of coastal erosion that are already a menace in the Niger Delta, but will also

Figure 2 Oil spills

Source Report on Climate Change in Niger Delta – Community Research and Development Centre (CREDC). 2005, Portharcourt

increase the problems of floods and intrusion of sea water into freshwater sources and ecosystems, thus destroying such stabilising systems as mangroves, and affecting agriculture, fisheries and general livelihoods.

Some areas in the coastal region have been obliterated by coastal erosion. In Forcados, for example, communities have been displaced and some oil wells have been lost to the ocean owing to erosion. Coastal erosion poses a serious problem for the people and economic activities in the Niger Delta, especially the traditional occupations such as farming and fisheries. Erosion has also affected vegetation, especially the mangroves and forest. Another adverse effect of the sea level rise in the Niger Delta is the increased salinity of both surface and underground water owing to the intrusion of sea water. This has led to the death of aquatic plants and animals that cannot tolerate high salinity. Sea water intrusion has already had a serious impact on food security, agricultural activities and the availability of fresh water.

Recently, it was discovered that there is a high rate of underground water pollution which is threatening the human life in the oil communities of Ekerekana in the Okrika local government area, Eleme in that area and Woji

Table I Climate change and environmental impacts in the Niger Delta

Issues	Impacts	Policy response
Oil drilling and exploration	Destruction of farmland; dislocation of economic activity and people; biodiversity affected; youth violence; food insecurity	Poor legislation and haphazard exploration policy
Gas flaring and oil spills	Water and air pollution; global warming; environmental pollution; health crises; destruction of farmlands, fisheries and aquatic resources; increased industrial effluent and solid waste	No policy on gas flaring as oil industry does not comply with gas flaring reduction laws
Coastal erosion and flood	Floods; pollution of fresh water; destruction of mangroves, agriculture, fisheries; sea water rising	National Emergency Management Agency (NEMA) is ill-equipped to manage crises
Deforestation/ degradation	Scarcity of land; destruction of forest; biodiversity loss; extinction of wildlife; lack of fresh water	No definable national policy

Source Author's own compilation

in the Obio- Akpor area of Rivers State.[36] A study of water samples from these communities collected by the Department of Earth Sciences of the University of Gothenburg in Sweden showed that large quantities of hydrocarbon had polluted their water sources. The laboratory analysis showed large quantities of hydrocarbon to be present in their streams and even in boreholes sunk in the area. This is clear evidence of oil exploration activities leading to the degradation of the environment.[37]

A third environmental change is deforestation and land degradation, both of which are affecting large areas of the Niger Delta because of the high levels of industrial activity by multinational corporations (MNCs). According to the federal government of Nigeria, deforestation and land degradation have been on the increase in the Niger Delta and western part of Nigeria. The minister of environment has stated that 37 per cent of the country's forest reserves were lost between 1990 and 2005 as a result of illegal and uncontrolled logging, incessant bush burning, the gathering of fuel wood and clearing of forests for other land uses.[38] He further alerted the nation to the looming danger of declining soil productivity, desertification, loss of aquatic life, coastal and soil erosion, loss of biodiversity, and water and air pollution. There has already been a change in the vegetation of the Niger Delta. There is almost a complete absence of primary forests as a result of deforestation and degradation. Uncontrolled logging activities, acid rain, oil exploration and exploitation, urbanisation and mining activities have contributed and continue to contribute to the loss of vegetation. The changes in vegetation have vast implications for biological productivity, consequently affecting biomass production. These changes have led to the impoverishment of the biodiversity and various plant species, while the regeneration rate of biomass has declined significantly and has affected the amount of fuel wood available for the local people.

Despite these findings the issue of climate change in Nigeria is yet to receive the desired attention, despite the vulnerability of the country and the imminent danger associated with such change. This is compounded by the lack of genuine policy responses and coping strategies that can mitigate the effects of such change. Over the years, industrial activities in the oil-rich region of the Niger Delta have reached fever pitch. They have left the environment degraded, trees and forests depleted, water and air polluted, fisheries poisoned, thus leaving the majority of the people in the area in poverty, squalor and despair.

THE NIGERIAN GOVERNMENT'S POLICY RESPONSE AND MITIGATION STRATEGIES

The manner in which poor and vulnerable countries can design coping strategies to mitigate climate change depends largely on how they can stabilise greenhouse gas emissions, improve the capacity of their agencies and educate their people on a green environment. Although managing climate change is still problematic for poor nations like Nigeria, it is important for these countries to draw up realistic policies that can effectively mitigate against the abuse of natural resources that induces climate change.

It is imperative for the Nigeria government to formulate a policy agenda that takes into consideration the symptoms of its vulnerability and its way of adapting. This implies mainstreaming its climate change adaptation measures into sustainable development policies within the context of the impact of climate change on the Niger Delta. In this respect, the government must take into consideration the recommendations of the Intergovernmental Panel on Climate Change (IPCC) that pointed out that sustainable development can reduce a country's vulnerability to climate change by enhancing the adaptive capacity that will allow government agencies to cope with climate change challenges.[39] The Adaptation Master Plan, a strategy put in place by the Nigerian government recently, aims to fine-tune modalities for incorporating sustainable development and early warning strategies in its preparedness and response to the effects of climate change. The Master Plan includes the National Action Plan to Mitigate the Effects of Climate Change, the Adaptation Strategies of Action in Nigeria, the National Ozone Programme of Action, the National Forestry Development Programme and the National Action Plan to Combat Desertification and National Capacity Self-Assessment (NCSA).[40] While these action plans are laudable, their implementation may remain very problematic as most government policy responses to the environmental crisis in the Niger Delta have been only recorded on paper and have not seen the light of the day.

Collaboration between the three tiers of government and civil society organisations with regard to effective and targeted initiatives to reduce environmental degradation and developing the necessary partnership for promoting sustainable development in Nigeria is also very important. There is a need for effective collaboration between and among governments and civil society to develop the concept of an integrated approach. This means combining several development strategies

into a coherent unit so that it will be more effective.[41] The integrated approach must recognise people as an important element of development, determine their needs and design an all-encompassing strategy to address these needs. An integrated approach must also seek to understand the nature of climate change and design a coping strategy peculiar to its character. It must involve and engage the people through participatory partnership. The strategy must prepare communities to respond to changes in the climate and to non-climate shocks. This would go a long way to reducing vulnerability to adverse changes in the environment. Finally, the integrated approach accommodates all actors, including the government, international organisations, civil society organisations, non-governmental organisations, and the multinational corporations.

Another major policy goal that is yet to be met with action is to ensure the sustainable use of forests and check desertification encroachment. It must be noted that the Nigerian government claims to have begun extensive reforestation and afforestation programmes such as the community-based tree planting programmes and control of fuel-wood extraction from the reserves. In addition, the establishment of the National Afforestation Programme to be funded by the Ecological Fund Office under a programme known as the 'Presidential Initiative on Afforestation Programme for Economic and Environmental Sustainability' involves the planting of several millions of trees annually. This initiative is also meant to serve as an instrument for community and regional development as well as for employment creation and youth empowerment. While it appears to be a laudable effort, again its implementation could be problematic, as previous experience has shown. The destruction of trees (as in the case of Abuja city) and deforestation actions continue unabated; fuel-wood extraction is still the order of the day in most towns and villages in Nigeria.

Finally, the need to adopt some of the general approaches to climate change in Nigeria is imperative, particularly:

- Oil industries must be reorganised with better operational legislation
- NEMA, in collaboration with the multinational corporations, needs to develop an early warning system as a prerequisite for adaptation, particularly to predict and prevent the effects of oil spills, gas flaring, floods, sea level rise, droughts and tropical cyclones, as well as for indicating planting dates to coincide with the onset of the rainy season and predicting whether there will be disease outbreaks in areas prone to epidemics

- Education and awareness creation on climate change among various levels of government, institutions and individuals is a necessary step in promoting adaptation to climate change
- It is necessary to improve the links between research, decision making and policy implementation. This should emphasise research findings and disseminating the results to the correct target groups, linking research to existing local knowledge of climate-related hazards and involving local communities in adaptation decision making
- Capacity building is needed to ensure involvement in the further development and refinement of the modelling work underlying predictions of climate change and to provide the necessary human resources to research institutions to design and facilitate adaptation strategies
- Good governance is imperative. When societies strain under additional burdens caused by climate change, continued efforts must be made to improve governance practices

It is evident that the need to adapt societies to climate change gives rise to a whole agenda of actions, many of which build on what has been done to date, but with several new priorities, including:

- Promoting economic growth. Sustainable economic growth will be as important as ever in a climate change perspective and will enhance the ability of countries to undertake the adaptation strategies necessary in different sectors of society. It will be necessary to engage multinational corporations to adhere to environmentally friendly policies and practices, and enter into development programmes with host communities
- Curbing deforestation. Deforestation is a substantial contributor to greenhouse gas emissions. Afforestation programmes can help provide carbon sinks while generating local employment as well as fuel wood

CONCLUSION AND RECOMMENDATIONS

In Nigeria, the issue of climate change has received little public attention. However, the situation is gradually changing as people, government and civil society organisations are challenged and respond to this by learning about causes, impacts and coping strategies. Proactive action and mitigating strategies

are also being undertaken by the government to manage the adverse impacts of climate change.

The Niger Delta region of Nigeria has been affected more than ever by climate change. The exploration of natural resources, especially the oil activities, has rapidly expanded and intensified the crisis of environmental degradation. Its effects on the environment have produced climatic change which has ignited into volatile conflicts in the region. Thus, two interrelated negative pressures have been identified. These are the environmental tragedy-cum-climate change, and conflict that has enveloped the region.

In conclusion, the Nigerian government must take seriously the issue of climate change. The mainstreaming of climate change into the national policy agenda is a positive development. This will help in providing a holistic and integrated approach to combating the effects of climate change. The issues of environmental accountability, monitoring and education should also be accommodated in the agenda.

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7 Putting tested wisdom into practice

Relevance and applicability of Nyakyusa traditional conflict resolution practices to contemporary environmental challenges in Tanzania

Ipyana Mwamugobole

INTRODUCTION

Tanzania is a diverse country both ecologically and culturally with more than 120 different ethnic groups. Each of these ethnic groups is rich in indigenous knowledge, ethno-veterinary and traditional ecological knowledge. Admittedly, not many of these ethnic groups still live according to their traditional lifestyles. 'Modernity', including formal education, has caused many, if not most, of these traditional practices to be eroded. Encouragingly, however, there is still hope when it comes to conflict resolution. A good number of Tanzanians still resort to traditional methods of settling disputes instead of going to the courts of law. Except for criminal offences, the law in Tanzania encourages alternative dispute resolution practices based on customary laws. This chapter revisits such practices among the Nyakyusa of the southern highlands of Tanzania. Focusing specifically on natural resource-related conflicts, the chapter argues that it is time to borrow from the old in order to solve such conflicts, which are on the increase in the country owing to global climate change.

The Nyakyusa people

The Nyakyusa live in the southern part of Tanzania, in a region called Mbeya in the Rungwe district. The Nyakyusa area is surrounded by mountains, such as Mount Livingstone and Mount Rungwe – a fertile area on the northern part of Lake Nyasa.[1]

The Nyakyusa people also enjoy the use of rivers such as the Lufilyo, Mbaka, Kiwira and Songwe.[2] The Nyakyusa number approximately 750 000.[3]

The first inhabitants of the Nyakyusa land were called 'abiliima'. The origin of this group of people is not clear, for it has been argued that the group consisted of people with different origins and background. For example, some members of this group are said to have been invaders from Bukinga (now known as the Makete district in the Iringa region), while some are said to have been kin to the Bungu, people from near Lake Rukwa. History claims that many of them were hunters who also gathered honey. Among the first crops to be cultivated by these people were millet, beans and pumpkins.[4]

The chiefs of the Nyakyusa are said to be descendants of the invaders, while the common people are believed to be descendants of the original occupants of the area. Many agree that the Nyakyusa chiefs had a special relationship with the chiefs of the Kinga area because it is believed that they used to perform rituals together in an area belonging to the Nyakyusa people, namely Lubaga.[5]

The Nyakyusa were and are considered to be agro-pastoralists, since many of them are good at crop rotation, with beans, sorghum, squash, millet, yams and corn being the main food crops. The men and their sons are responsible for clearing and hoeing the land.[6] They spend much time working in their fields, and this is considered the mark of a wise man. The Nyakyusa use crops for food, making beer, trading and hospitality. Previously, crops were also used for barter trade.[7] The Nyakyusa people also keep livestock such as cattle, goats and sheeps.[8] Women and girls are good at decorating their houses, cutting grass for cattle, and cooking. They also work on the farms, especially seeing to the weeding and harvesting.[9]

PRE-COLONIAL NYAKYUSA AND UNDERSTANDING THE ENVIRONMENTAL CHALLENGES

As James Giblin and Gregory Maddox, for example, state, some historians would like to depict pre-colonial Tanzanian communities as communities living in

peace with nature.[10] However, both authors consider the above assertion as one of the biggest failures one can commit, because to do so means that such historians, wittingly or unwittingly, ignore or underestimate the initiatives taken by the people of that time in the whole process of adaptation. Many agree that such historians would like to show that pre-colonial societies started to suffer depopulation, ecological disasters and economic exploitation under colonial rule and not before.[11] However, Kimambo, who is considered one of the 'founding fathers of Tanzanian history', states: 'It is not true to think that communities of less developed countries like Tanzania depended more on nature and did little to shape it.'[12] The reality is that floods, drought, excessive rainfall and other calamities were experienced by pre-colonial societies in nearly all parts of Tanzania. This affirms that pre-colonial societies experienced difficulties and therefore had to develop different ways of dealing with environmental challenges, including the moral and ethical perspective.

In contrast to their neighbours, during pre-colonial times the Nyakyusa had nothing more than what came from the land (soil), water and forests. This implies that they were people who depended totally on the environment and were therefore sensitive to the environment around them. Their understanding of the environment was that one is rooted in and connected to nature and that outside nature there is no life. Through the generations they insisted that one belonged to one's environment and, therefore, where one was born is where one would be buried. In short, the Nyakyusa people's understanding of nature was that one comes from nature, one survives from nature, and from nature one is buried.[13] The Nyakyusa believed that there was not any place which could have sustained them other than the place of their origin. It was said that a man enjoyed greater security of life and property in the chiefdom in which he had been born, in which he had village-mates with whom he had grown up, and in which he had claims for care and protection on his father's village-mates.[14] This is perhaps one of the reasons why the Nyakyusa people were always afraid to move from their location to another even in the case of famine, floods or diseases. One may argue that such an understanding encouraged them to value and respect their environment. Because of this respect, they sought a moral and ethical perspective for environmental preservation.

Before considering the wisdom (morals and ethics) of and ways in which the Nyakyusa people dealt with conflicts brought about by environmental challenges, it is important to be familiar with their natural environment:

- **Water sources:** The Nyakyusa's concept of water is that it comes from the gods and this popular understanding made the people fear the destruction or degradation of any water source.[15] Many used water from their sources for drinking purposes. It was prestigious if one, especially an elder, cleaned his body with water from the water sources. Such people called themselves, 'umoga inyibuko'
- **Rivers:** For the Nyakyusa people, three rivers are of great importance: the Mbaka, Lufilyo and Kiwira. All three these rivers flow into Lake Nyasa. The Nyakyusa people used these rivers for fishing, swimming, feeding their cattle and other domestic animals, to mention but a few of their river-related activities
- **Forests:** This was another important natural resource for the Nyakyusa people, for it was in the forests that worship and rituals took place.[16] Since they were seen as places of worship and of God, forests commanded the special respect of many people and especially any forest surrounding their communities. The Nyakyusa's neighbours, who shared traditional beliefs very closely with the Nyakyusa people, developed a proverb which states: '[T]he forest is our skin, and if one removes the skin of a human being, the result is death.'[17] This ethic explains why deforestation was not acceptable, especially in the Lubaga forests where many rituals took place, including rain making[18]
- **Land:** For the Nyakyusa people of pre-colonial times, land was wealth and therefore prestige. Although the chiefs controlled the land, land ownership was essential because this distinguished an adult from a child. Land was among the first gifts a father could give to a son.[19] Although the land was controlled by the chiefs, this did not mean that they were the owners of the land, since once one received a portion of land, one was expected to own that land until death. Even after the owner's death the land was not returned to the chiefs, but went to the heirs of the deceased[20]
- **Trees:** Not only forests, but also trees were of great importance to the Nyakyusa people. Trees were symbols of the reign of a chief. During the installation of a new chief, trees were planted. However, it is not clear where the seedlings were obtained. This suggests that propagation was probably practised. Some of the favourite trees for the Nyakyusa people were the 'unsyunguti' (*trichillia supp*), the 'umwale' (*chorophora excelsa*) and the 'indola' (*ficus*). Other popular trees were the 'umpandapanda'

and the 'inguti'. Trees were believed to add dignity to the homestead.[21] It was under trees where a chief and his headmen used to sit to settle disputes.[22] It was also from trees that medicines of different sorts were obtained[23]

ENVIRONMENTAL PROBLEMS AND NATURAL RESOURCES-USE CONFLICTS

During better seasons conflicts over natural resources were not of any concerns in the communities, and therefore the people lived in peace. However, it was not always a good season, since floods and droughts occurred and thus natural resources became a concern for the people. During natural catastrophes such as floods or droughts, scarcity of natural resources in the Nyakyusa area became evident and this led the community to compete for the use of the now limited resources. This disrupted the community's customary systems that encouraged the fair and just sharing of these resources.

People who cultivated near or on river banks were victims when floods occurred, because their crops were easily washed away by the flood waters, leaving them without food. Seeking to survive, some of the Nyakyusa people became involved in theft or refused to repay what they had previously (during a preceding catastrophe) taken from a neighbouring society. These people started fighting with one another, a situation which later led to fighting between one family and another, and eventually involved the whole community, since at that time all family matters were considered a community matter.

Stealing also took a toll during that era. Because of the presence of dangerous wild animals, many thieves were killed accidentally, not by wild animals but by the owners of farms, who mistakenly thought it was a lion in his crops, whereas it was actually a fellow human being looking for some sustenance. Disastrous conditions resulted not only in the stealing of crops alone, but also of cattle and other domestic animals. The results, however, were the same – death of the thieves. Besides these deaths, this situation also caused disunity among the people of the same clan.

The most frequent conflicts arose between farmers and pastoralists. During periods of drought, farmers encountered problems not on account of the drought itself, but also owing to the tendency of some pastoralists to practise unfair pasturing methods. Farmers often complained of pastoralists deliberately feeding

their livestock where the farmers had already planted their food crops. This was common practice as during droughts pastoralists had little to feed their cattle. As scholars such as Theodor Meyer and Monica Wilson have pointed out, it was not easy for a Nyakyusa pastoralist to leave his cattle to die while crops survived.[24] However, this tendency caused great conflict, with the farmers on the one side and the pastoralists on the other.

Trees were also affected when there were environmental problems such as droughts, since the pastoralists could not avoid using the planted trees as feed for their animals despite knowing that such areas were restricted for use by the chiefs. This resulted in many conflicts between the pastoralists and their chiefs, and that was considered a serious offence. While the understanding of many was that no one should misuse 'clean rivers' (in the sense that animals were not expected to pass through or drink from them) and their sources, some individual members did secretly pass through these rivers with their cattle and let them drink from these restricted waters.

Although, many of the Nyakyusa people did not wish to migrate to other places during floods or droughts, they had no alternative but to move to neighbouring countries such as Zambia and Malawi, some even going as far away as South Africa. Unfortunately, only a few were able to return to their place of origin. For those who opted to remain, peace was not their lot, for everyone was competing either for new land far on the banks of the rivers or they were trying to force other people who had not been much affected by the floods to give them a portion of their land – which they were not altogether willing to do. The eventual outcome was not without violent conflict.

Those who had migrated also faced conflict. While on their way to their new location with their cattle, they were accused of failing to control their cattle and preventing them from eating other people's crops. Hence there was conflict with the indigenous people both with those along the route and with those in their destination regions.

These environmental challenges compelled some of the Nyakyusa people to develop the habit of trying to accumulate excessive property and goods for fear of the scarcities of tomorrow. This was a new experience, since it had not been common practice before floods and droughts occurred. For the Nyakyusa people of the time it was accepted practice to pick two or three mangoes from a person's trees before or after greeting the owner. However, during droughts or floods such practices changed. Some of the people wanted to have large lands,

bigger than they needed, because they feared the future. Others began practising what had once been considered unlawful among the communities. For example, they fished for undersized fish during the night. This caused conflict between the fishermen who considered the fishing of undersized as unlawful and those who continued fishing for these fish. Those not involved in the fishing of small fish considered these fishermen and society in general as traitors who had betrayed them by fishing for small fish. Their view was based on their understanding that the people's collective decisions applied to the whole community.

PREVENTION AND ALTERATION OF NATURAL RESOURCES-RELATED CONFLICTS

The impact of the various conflicts brought about by the scarcity of natural resources was very severe and resulted in the breakdown of the unity which once existed between the community members. This was unacceptable to the people, for even their rituals related to normal social functioning and a positive future depended on their beliefs and harmony among the people of the community concerned. The welfare of the chiefdom was seen to depend upon harmony between the chief and his village headmen and priests, and between the chief and his kinsmen. Any friction between them could result in public misfortune as well as illness for the individual at fault.[25] To alter and/or prevent these conflicts which resulted from environmental occurrences such as floods and droughts, which, in turn, led to a scarcity of natural resources, the Nyakyusa people employed traditional conflict resolution techniques:

Communication: The first step was that, under the direction of the chiefs, the community leaders frequently communicated in public and privately to all the people, including women and children and not only to certain individuals, that all natural resources were theirs.

Satisfaction: At this time the people were also taught to be satisfied with what they each got. This became mandatory and was listed by the chiefs as one of the sources of conflict as they argued that dissatisfied people where those causing conflict within the communities. Land disputes and conflicts because of theft were associated with the nature of dissatisfied people – those who would have liked to have accumulated more land, trees and pasture.

Conservation: Recognising the importance of environmental preservation, the communities implemented a policymaking process. Not only did

the communities make policies, but also discussed them publicly. A proposal became a policy only after the contributions from all members of the community had been heard by the appropriate authority, again through discussion. Discussions were held under a special tree called the 'indola', a special, very stable tree indicating that the decisions made under that tree were supposed to be respected by all. It was during such sessions that the type of punishment against defaulters and violators (individuals who disregarded the rules made by the community) was discussed.

Representation: They chose representatives from among themselves to form a body to oversee the environment, and especially to ensure that the people were conversant with the rules. This body also had to ensure that every individual community member or newcomer who was in need of a farm was given a portion of land, mainly from the undeveloped area which belonged to the community in general and not to any individual.

Education: Since the communities did not have schools and/or colleges, the family was considered a school or university of a kind. It was through the family that policies were interpreted and knowledge passed from generation to generation. Families were also responsible for making sure that the policies were implemented and respected.

Punishment: Any person convicted of a 'crime', especially of stealing or disobeying the community's rules was punished severely.[26] Punishments included burning both the offender's hands and sometimes even burying a thief alive.[27]

These rules or policies were mentally recorded by the Nyakyusa and were orally transmitted through discussions within a community.

The Nyakyusa took significant measures to deal with the conflicts and also to preserve their environment and restore peace and unity among their people. With regard to water sources and rivers, any person who took his cattle to restricted water sources was considered an 'undosi' or witch by the Nyakyusa community. When the people called someone an 'undosi' or witch, they did not mean that the person was really a witch, but rather that his or her action was similar to witchcraft. Also, if water from a river which was meant for domestic use was directed to a farm by sly or cheating individuals, especially during the night, upon their action being discovered, they were also considered as witches just like those using domestic water sources and rivers for their cattle. This had the necessary deterrent effect on the persons concerned, since no one liked being referred to as a witch.

The fishing of undersized fish was prohibited by the community. One can argue that this approach probably stemmed from the poor understanding of the transgressors that all big fish were once small. According to the regular fishermen, the fishing of small fish would mean that they would in time not have big fish. However, it is important to note that the idea of acquiring and killing all (resources) at once was discouraged by the Nyakyusa people. Thus they felt compelled to discourage fishing by using a traditional medicine called 'unkondo', which killed big and small fish alike, but rather encouraged the use of 'umoono', which allowed small fish to pass and held only the bigger ones.[28]

With regard to the forests, herding cattle through a forest was prohibited. Furthermore, it was frequently said that if cattle accidentally entered any of the forests, they disappeared for ever. This did not mean that the gods took the cattle, although many thought of it thus. Others argued that this was a punishment meted to the owners of the cattle by the chiefs to alert them to the importance of taking good care of their cattle.

Trees were to be preserved. However, that did not mean that the community was not allowed to cut down trees for firewood for cooking their food. There were special treed areas where the people were allowed to cut as much wood as they could, but this was not in those forests preserved for worship services or the trees planted by the community. Furthermore, the people could go to the community's undeveloped land and cut firewood. The same rule applied as that for a person in need of new land: he asked a chief for land and was given an undeveloped piece so that he could develop it.[29]

TRADITIONAL WISDOM AND CONTEMPORARY CHALLENGES

It is not difficult to see that the lifestyle of the Nyakyusa people was not very different from the experiences of many of today's societies, if one considers the situation then and compares the two. Conflicts arising from a scarcity of natural resources, which again is the result of environmental occurrences, are the real experience of many societies in Africa. Conflicts and other negative conditions brought about by harsh environmental conditions affirm that '[o]ne remains healthy in a holistic sense only by living in harmony with the whole creation'.[30] What one can do, however, is take heed of the wisdom of yesteryear in those measures used to prevent and resolve conflicts. This will benefit today's

societies if this wisdom could be applied to the present and be combined with new world technology to form stable and reasonable policies that help to preserve the environment.

The most important step towards the resolution of conflicts in this context is by empowering people through words and deeds. This does not refer to an understanding of the importance of natural resources – this they may already have acknowledged for many years – but rather to the understanding that natural resources belong to them, to their societies and to the whole country. Why through words and deeds? People are accustomed to hearing that natural resources belong to them, but in some societies the natural resources are reserved for some 'powerful' people. Hence it has been their experience that the natural resources, which are said to be for the whole community, contribute little or nothing to either their economic or social development. Today's policymakers, while they make great overtures by telling the people about the importance of environmental conservation and preservation, should rather copy the way of the Nyakyusa kings of assuring their people, through words and deeds, that whatever surrounds them is for the benefit of the community.

The presence of people who do not seem to be satisfied with what they get until they have excess reminds all people presently involved that the work is not yet done, especially that of empowering the people to understand that natural resources are for all and not for one or a few individual members of the community. Sometimes such people are among those who do not take care of the marginalised members of their community. For them, wealth is the first priority and their only concern. A former president of Tanzania, Julius Kambarage Nyerere says: 'The creation of wealth is a good thing and something which we shall have to increase. But it will cease to be good the moment wealth ceases to serve man and begins to be served by man.'[31] The accumulation of natural resources, as happens today, shows that wealth has begun to be served by some individuals. Such people ought to be reminded to have a sense of shame. In Nyakyusa, such people were called 'unsitasoni' or 'akakyaji', meaning a person who has no sense of shame in or who cannot measure the effects of what he does. Both have a negative connotation and this practice continues among the Nyakyua people.

Policymaking which does not involve cooperation with the people at the grass-roots level always brings conflict in a community, since it is not easy for people to accept a decision of which they are unaware.[32] These conflicts based on participation (or lack thereof) usually occur between indigenous people and the

authority, for example the government or like organisation. The participatory approach to policymaking which involves the whole community concerned will not only prevent conflicts, but will also make it possible that the type of information or understanding of the policy will be well conveyed to all, including the children, and therefore will make it possible for the children to acquire the same positive understanding that their parents have. Many of the present conflicts resulting from new policies about environmental conservation to a large extent involve young men and women, who would not have become so involved had the subject been well understood by their parents or guardians. Prime examples of such conflicts are those linked to national parks, water sources and mining, just to mention a few. Young men and women are energetic enough to form a movement when they feel they are being oppressed. However, the formation of such movements can be more orderly if these young people have a better understanding of policies through discussing the issues with people they trust, such as their parents.

The present generation has a sense of having been colonised, that is of having had 'visitors' in their history that took the natural resources from the traditional communities. This supports the thinking that when the ownership of natural resources like forests, water sources and rivers, and other similar resources is removed from a traditional community by any authority without mutual consultation and agreement, the people develop a sense of resistance, even suspicion.[33] Not only does this cause conflict, it also breaks the resolve in the community members concerned of devoting themselves to taking good care of such resources and instead fosters a feeling of estrangement from the resource. Consequently, they pass responsibility for its care to the new owner. Such communities no longer heed regulations regarding the use of the resource, since they have been excluded from taking care of it.

Policies which require the people to change their normal lifestyle should not be implemented before there has been enough time for the people concerned to be properly educated in this regard. If one asks what was done in many developed countries regarding sanitation, one will hear something like this: 'We allowed enough time for the minds and hearts of a new generation to be educated, and that ensured our victory.' While our governments are making a great effort to ensure that information on environmental preservation and the consequences of failing to apply it reaches parents, children must also be targeted. The parents of today are not the only means of passing information to the next generations, as in

pre-colonial times, and this strongly suggests that schools should be included in the process.[34] This will ensure that, when children grow up informed of environmental challenges and how to prevent conflicts brought about by the scarcity of natural resources, the whole community will benefit. When such children become adults, they will no longer need to be educated on this matter, rather it will be their way of life. This situation calls for the introduction of the special study of the environment and environmental challenges, not only in secondary schools and colleges – some may already have started such programmes – but by introducing the subject in primary schools too.

The penalties imposed by authorities mandated to conserve the environment before the public has had time to digest all the information are inhuman and therefore unjust. The example of the Nyakyusa people, who first allowed time for the people to become familiar with a policy before applying penalties, suggests that the present authorities should adopt a similar approach to prevent conflict.

Although one cannot claim to have found all practices in traditional communities of earlier times to be positive and it is not the intention of researchers to convince people that everything practised by those communities was fair and worthy of emulation, nevertheless, including indigenous people as members of any body working on environmental challenges and conservation should be the norm. Indigenous persons serving as part of such an authoritative body will help officials to interpret the native people's reaction to any new policy thus helping to avert conflict. Furthermore, local people involved with official or authoritative organisations will be able to alert the authority, for example the chiefs (where they still exist) and other leaders of, for instance, NGOs or other social bodies within the society, to any negative impacts of not consulting the indigenous community.

THE APPLICATION OF CUSTOMARY RULES AND LAWS AND INDIGENOUS KNOWLEDGE IN DEALING WITH CLIMATE CHANGE

In many societies there are people who perceive creation as a work of God. Such an understanding has led many people, especially during the pre-colonial times, to respect creation in line with the requirements of their traditional religion. The same approach should be applied when dealing with climate change.

The responsibility for emphasising this approach should not rest with religious leaders alone, but with all persons dealing with the challenges brought about by climate change.

Droughts, floods and other equally harrowing occurrences are the experiences of today. However, in trying to deal with such challenges people engage in various activities, including those which do not take climate change into account. Needing an adequate harvest, some people use fertilisers and pesticides which negatively affect water quality and soil fertility. For the same reason, agriculture is intensified, thus aggravating soil degradation and erosion. However, it is in such situations that the old customary rules and laws could help to stem the increase of the problems already cited by discouraging those who want to 'have it all' without considering the impact of their actions on other members of the community.

Environmental and conservation education has often been touted as one of the most effective ways to influence people's attitudes towards the environment and thus solve the problems of natural resources management. However, in the difficult situations of real life, especially in poorer countries, this strategy often has not worked. The fact is that even among people who were aware of the problems and knew they should not cut down trees, but needed more land for growing crops and fuel for cooking their food, the result was the stripping of forests despite the people's better knowledge. The old wisdom, however, calls for more than education. It calls for clearly stating the results, risks and the benefits of dealing with climate change positively. It calls also for participatory measures where environment specialists share their expertise, while also welcoming the peoples' experience in working on the challenges of climate change.

CONCLUSION

This chapter tries to present a picture of the life of the Nyakyusa people during pre-colonial times as a way of affirming that the challenges presented by environmental changes, which have a tendency of causing conflict in a community, are not new phenomena. Droughts and floods, which lead to famine, were a reality in many Nyakyusa communities. Conflicts as a result of competition over scarce natural resources caused disunity and bred mistrust among members of those communities. Since these are phenomena which have been experienced by communities and the outcomes of which have been observed, it is logical to

consider the prevention measures and resolutions applied by the Nyakyusa in resolving and/or preventing conflict.

The conflicts did not alienate the communities for ever, for they were able to return to their previous status quo. This is what compelled them to look for 'policies' to direct them to live in peace with one another and with the environment. However, cooperation between chiefs and members of the communities made it possible for the policies to be accepted for the benefit of the people and the preservation of the environment even during catastrophic times.

Aware of the challenges people currently face, and the danger of insecurity, especially as a result of insufficient natural resources or the unjust sharing of natural resources, this paper calls for the people of today to consider the lifestyle of primitive societies in search of the benefits of the peaceful sharing of natural resources. A shortage of natural resources is a lesser risk than the unjust and unfair distribution of those resources in a community. It is a fact that in many African countries, even those that are rich in different natural resources, people suffer poverty owing to the unjust and unfair distribution of the resources. Having said that, it does not mean catastrophes caused by climate change will not affect the continent. However, the application of the wisdom from the past on how to deal with the situations will make a difference. Justice and fairness will provide security in African societies in times of scarcity and in times of wealth in natural resources.

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8 Anthropogenic-induced climate change and the resulting tendency to land conflict

The case of the Soutpansberg region, South Africa

Tibangayuka A Kabanda and Christopher Munyati

INTRODUCTION

This chapter analyses the changes in the environment of the Soutpansberg Mountains in the Vhembe district of the Limpopo Province, South Africa, as a result of anthropogenic interference at a local level. General principles can then be formulated from an understanding of observed results. The local level phenomenon is very important because it feeds the regional and global scales. Although the small-scale features have little direct effect on the planetary scale simply because they are treated as rather unimportant, nevertheless they tend to modify the state of the planetary scale significantly.[1] Globally averaged features are defined as the arithmetic mean of many local features.

This study pays attention to climate change that is associated with humans depleting the indigenous vegetation in the central part of the Soutpansberg, thus interfering with rainfall dynamics. An imperative has emerged that stresses the need to view people-environment relations in terms of the interaction between all aspects of the environment at various spatial scales.[2] In the 1960s, forced removal policies in South Africa led to an estimated four million people being relocated into segregated urban and rural areas.[3] As a

result, the current situation in the Vhembe district (Soutpansberg) in the former Venda homeland is that 87percent of the population is concentrated in only nine percent of the total land. The scarcity of natural resources such as land is known to trigger competition for the meagre supplier available among both individuals and communities, and even institutions, thus affecting human security. Furthermore, environment changes brought about by human activities set in motion a series of changes that enhance disasters, such as desertification or the loss of vegetation cover, which, in turn, leads to reduced soil moisture thus affecting agricultural productivity;and increased soil erosion and run-off, leading to increased flood volumes in some areas and a reduction in rainfall in others. It has been found that livelihoods in the study area have been negatively affected by anthropogenic-induced climate modifications.

Since it is fundamental to consider environment and society as a unit when one examines the livelihoods of the population, environmental changes caused by anthropogenic interference and its impact will be investigated. Strategies for improving both the quality of the natural environment and people's quality of life require that consideration be given to the analysis of a composite view of this interaction between people and the surrounding environment and the impact each has on the other.

The high frequency of droughts in the past 40 years in Africa as a whole has renewed concern about possible anthropogenic causes of climate change such as through poor agricultural practices and overgrazing.[4] Other anthropogenic factors that might have contributed to the recurrence of droughts in Africa and other developing countries include planned population redistribution that has taken place over time,for example the village-forming programmes in Tanzania and resettlement linked to the construction of the Kariba Dam in Zambia. Migration and population movements have also been taking place in many other African countries, from pre-colonial times to the present.[5]It has been observed that population redistribution was undertaken mainly for administrative convenience, either to ensure a convenient supply of labour or even to facilitate the quick suppression of any possible indigenous opposition to the administration.

In the Soutpansberg region, high human population concentrations have negatively affected the eastern edge of the Soutpansberg mountain range, resulting in localised pressure on woodlands and forests for purposes of settlement

and subsistence agriculture.[6] In some localities of the Soutpansberg, where the mountain is accessible and fertile, people moved upslope as a result of increasing population pressures and shortage of land for cultivation. This is a typical example of a mountainous environment where forest gave way to agriculture.[7] The expansion of resource use on mountain slopes and watersheds is a result of the declining productivity of former agricultural lands, rising population numbers and socioeconomic pressures from within and outside the mountain region. According to Mphaphuli, large-scale deforestation in the Soutpansberg in the areas of Tshakhuma, Tsianda and Lwamondo started from 1979 and it is still continuing to date. However, the western part of the Soutpansberg features conserved indigenous forests, although it has shown a progressive reduction in rainfall in recent years.

In the Soutpansberg the lowland environments are more densely populated than the mountain areas owing to the forced resettlements of the 1960s. Therefore, the mountain has become the target for settlement and other forms of development. However, this becomes a serious problem if such fragile ecosystems are used without considering the limitations that they impose.

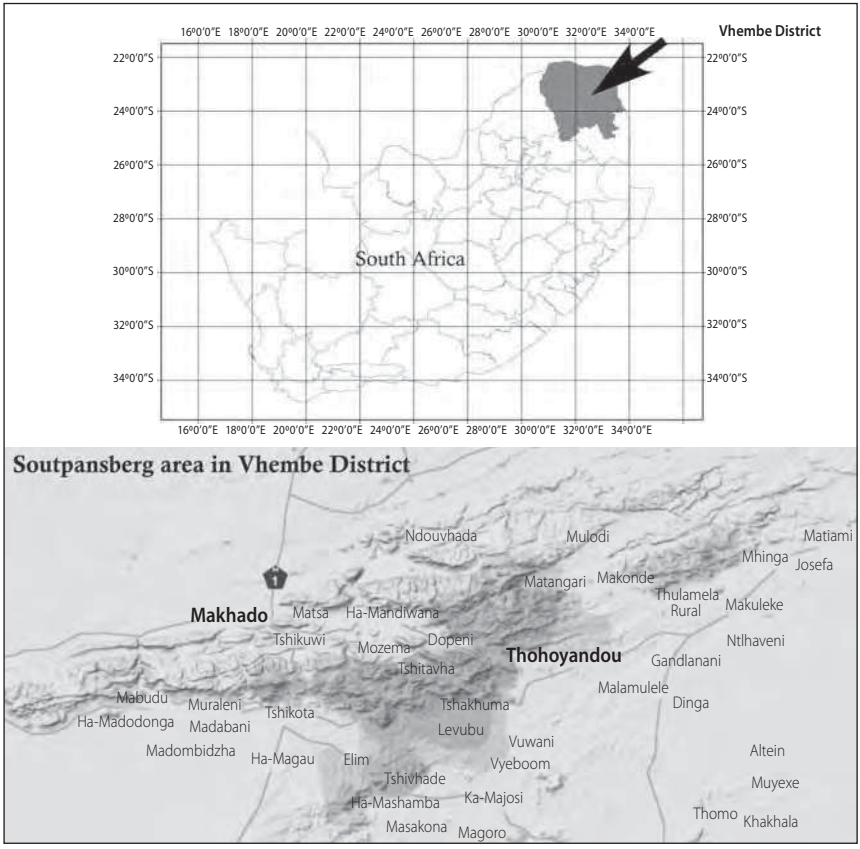
Currently in South Africa the issue of land disputes is addressed by the land claims of communities. This is part of the government's land redistribution-land reform programme. The main objective of land reform is to bring about a just and equitable transformation of land rights in South Africa. This objective has a number of dimensions. Firstly, landreform must address the gross inequality in landholding. Secondly, it must provide sustainable livelihoods in ways that contribute to the development of dynamic rural economies. Thirdly, particular attention must be given to the needs of marginalised groups, especially women, in order to overcome past and present discrimination.Fourthly, rural people themselves must participate fully in the design and implementation of land reform policies.[8]

A claim can be settled in total by giving back all the land under claim, or the settlement of a claim can be part land restoration and part financial compensation. Partial financial compensation is permissible where there is land that cannot be restored to the claimants because it has been developed into another vital government development such as a forestry plantation or a town.[9] However, the issue that is not considered when returning the land to the original owner is the compensation due as a result of environmental change caused by anthropogenic effects that might have affected the area.

THE STUDY AREA

The Soutpansberg is the northern most mountain range of South Africa (Figure 1). Its topographical zone lies between 23° 05'S and 22° 25'S and 29° 17'E and 31° 20'E. From east to west, the Soutpansberg spans approximately 210 kilometres. From north to south it is 60 kilometres at its widest and 15 kilometres at its narrowest. Its altitude ranges from 250 metres above mean sea level to Hanglip, the second-highest peak at 1719 metres, and Letjuma, the highest peak, at 1748 metres, on the western half of the mountain.

Figure 1 The Soutpansberg area



Source TA Kabanda, Climatology of long-term drought in the northern region of the Limpopo Province of South Africa, Unpublished PhD thesis, School of Environmental Sciences, University of Venda, South Africa, 2004[10]

The conservation status of the Soutpansberg Mountain's bushveld vegetation unit of the savannah biome is officially categorised as 'vulnerable'.[11] The unit consists of a rainfall gradient distribution of dense deciduous woodlands and evergreen montane forests with a poorly developed grassy layer, as well as relatively open savannah in some places. Outside the Vhembe district, exotic eucalyptus and pine plantations on the Soutpansberg range put added pressure on the maintenance of the status of the Soutpansberg Mountain bushveld vegetation unit. Generally, the vegetation communities in the Soutpansberg Mountains occur as east-west bands, following the orientation of the ridges of the mountain range, along the easterly moisture flow from the Indian Ocean.

The following are some of the important functions of the mountain vegetation in terms of rainfall regulation in the Soutpansberg:

- Increases the altitude of the mountain, hence lowering the lifting condensation level (LCL) closer to the high humidity content (vegetation level) to enhance the formation of clouds
- Increases evapo-transpiration and contributes to cloud formation over the mountains
- Reduces the absorption of atmospheric radiation directed at the Earth's surface.
- Maintains high humidity closer to the ground

Moist wind flows up the eastern slopes of the ridges and creates orographic lifting, which is coupled with the convection from daily heating.This leads to the development of showers and thunderstorms that can build up very rapidly.[12]

In recent years it has been recognised that mountains are one of the key factors in defining the geographical distribution of the climatic zones on various scales. Mountainous regions are very effective in extracting moisture from the ambient atmospheric flow through various orographic precipitation mechanisms.[13] The complex geography of the Soutpansberg acts as a major and permanent modifier of the region's climate.

MATERIALS AND METHODS

Applied environmental research has always contained an element of awareness of the societal implications and boundary conditions associated with

environmental concerns. Therefore the discussion regarding environmental change should incorporate a societal component, a need acknowledged in this section since it targets natural scientists, social scientists and policymakers. 'Materials and methods', therefore, attempt to integrate these targeted audiences, while minimising technical details like statistical methods.

Rainfall

Monthly rainfall data was obtained from the South African Weather Service (SAWS). Data from long-term reporting stations (≥ 30 years), which account for more than 90 per cent of the data available, were used. The stations were cross-correlated and those with high correlations (r ≥ 0,8) were chosen. The stations are spatially distributed from east to west along the Soutpansberg.

The data was standardised, thus further calculations were performed on anomalies rather than on the original data. Seasonal rainfall data (October–March) anomalies time series were obtained using the Z-score $(x_i -)/$) where $x_i$is the data value for a given season in year *i*, while and are the sample estimates of the population mean and standard deviation respectively.[14] The study area's rainfall is unimodal, where the rains start in October and end in March.

Coefficients of variation (CV)

Coefficients of variation (CV) for seasonal rainfall were computed to assess the spatial behaviour of seasonal rains over the study area.

CV = ŏ/μ where: ŏ = Standard deviation for the seasonal rainfall and is the season mean.

Remote sensing

Landsat TM images (30m spatial resolution) were selected for determining the changes in forest cover and human settlement. Owing to the unavailability of longer-term images,the images used were dated 6 October 1990, 28 October 1998, 30 August 2000, and 16 September 2006 (WRS 169-76); where WRS stand for Worldwide Reference System. All these images were cloud free. From each image, the north-western quadrant, which covers the Soutpansberg Mountains, was utilised.

Table 1 Time Series of population Distribution for Vhembe district, Limpopo and South Africa

YEAR	Vhembe Population	% of Provincial Population	Provincial Population (Limpopo)	National (South Africa)
1994	1 089 444	24,08	4 524 950	38 901 307
1995	1 103 418	24,07	4 585 058	39 627 904
1996	1 117 597	24,05	4 646 094	40 374 427
1997	1 132 008	24,04	4 708 084	41 141 459
1998	1 146 609	24,03	4 771 022	41 929 619
1999	1 161 431	24,02	4 834 706	42 738 841
2000	1 176 466	24,01	4 899 342	43 571 006
2001	1 191 929	24,00	4 965 481	44 428 214
2001	1 198 252	23,99	4 994 505	44 819 866
2002	1 210 459	23,99	5 046 417	45 499 932
2003	1 222 790	23,98	5 098 844	46 193 756
2004	1 239 358	23,97	5 169 475	47 137 186
2005	1 261 526	23,97	5 262 160	48 081 466
2006	1 272 395	24,05	5 291 458	48 606 643
2007	1 280 023	24,05	5 323 185	48 897 554
2008	1 289 612	24,05	5 363 093	49 447 753
2009	1 297 349	24,05	5 395 267	49 743 669

Source Water and Environmental Affairs Republic of South Africa, Water Services National Information System (WS NIS), 2009, http://www.dwaf.gov.za/dir_ws/wsnis/default.asp (Accessed 15 December 2009)

Population and demographic trends

Table 1 indicates the time series of the population size of each of Vhembe district together with Limpopo Province and South Africa (National Population). The population estimates are interpolated and extrapolated based on the 2001 Census population and annual growth using STATS SA population growth formulae.From the table, the population growth rates

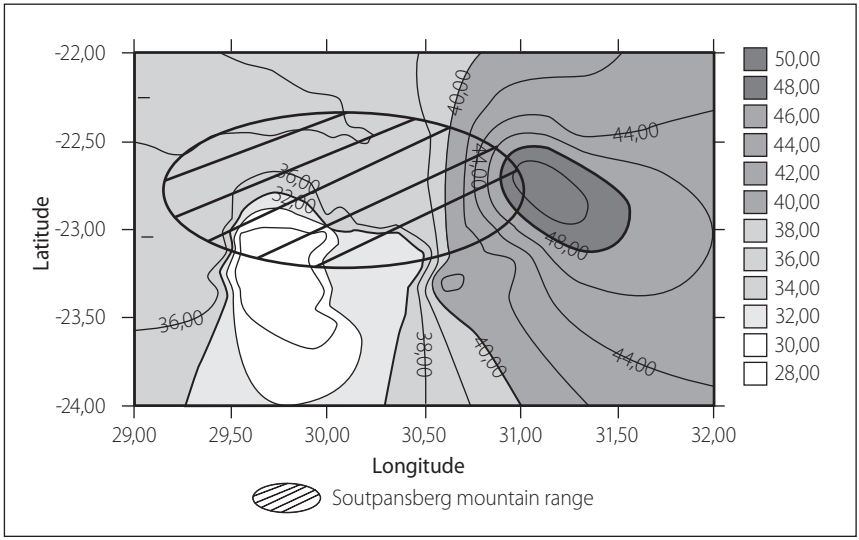
starting when South Africans were counted as citizens of a democratic country can be deduced.

The population of the Vhembe district is currently approximately 1,3 million people. It continued to grow by 1,3 per cent each year between 1995 and 2009, which is approximately the same growth as that of the province (Limpopo).

Rainfall distribution

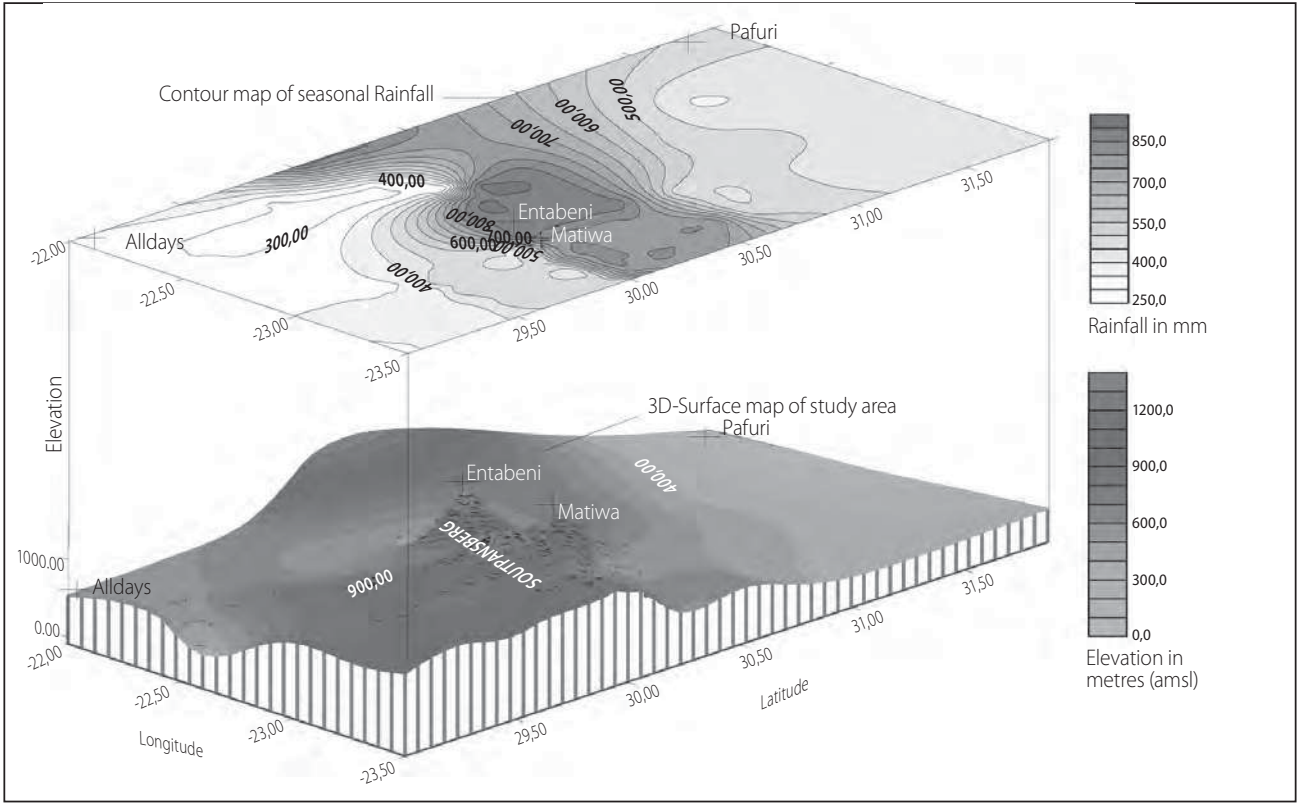
Mountains dramatically modify geographical rainfall patterns. As Figure 2 shows, the Soutpansberg mountain range triggers substantial orographic rainfall from the moist easterly winds. The mean seasonal rainfall at Entabeni, the highest observation station in the area, exceeds 850 millimetres. On occasion, the total annual rainfall exceeds 2000 millimetres. On the other hand, only 200 to 300 millimetres of seasonal rain falls on stations which lie in the rain shadow of the mountain or in low-laying areas such as Pafuri and Alldays. In the Vhembe district, with the Soutpansberg mountain range aligned northeast to southwest, most of the precipitation is captured by the mountains along the eastern part,

Figure 2 Mean seasonal rainfall contour map superimposed on a 3-dimensional topographic map



Source T AKabanda, Climatology of long-term drought in the northern region of the Limpopo Province of South Africa

Figure3 Coefficient of variations for Vhembe district rainfall



Source T AKabanda, Climatology of long-term drought in the northern region of the Limpopo Province of South Africa

with decreasing amounts falling over the mountain further westward, even though some western peaks are higher in elevation than those in the east.

It should be emphasised that local variations cannot be estimated accurately, because of the sparse rainfall measuring network in the area. Even ground-based

Figure 4 Longitudinal rainfall variations

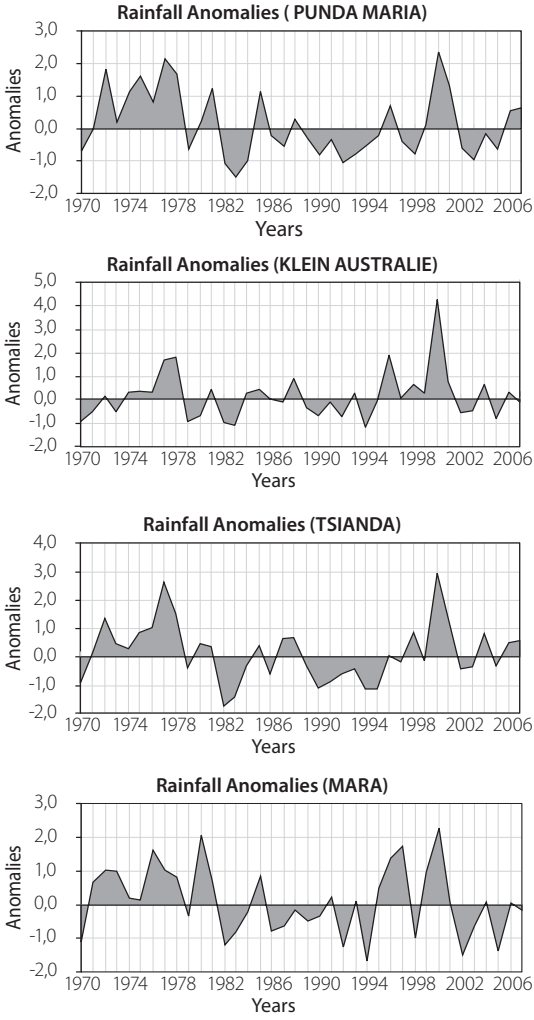
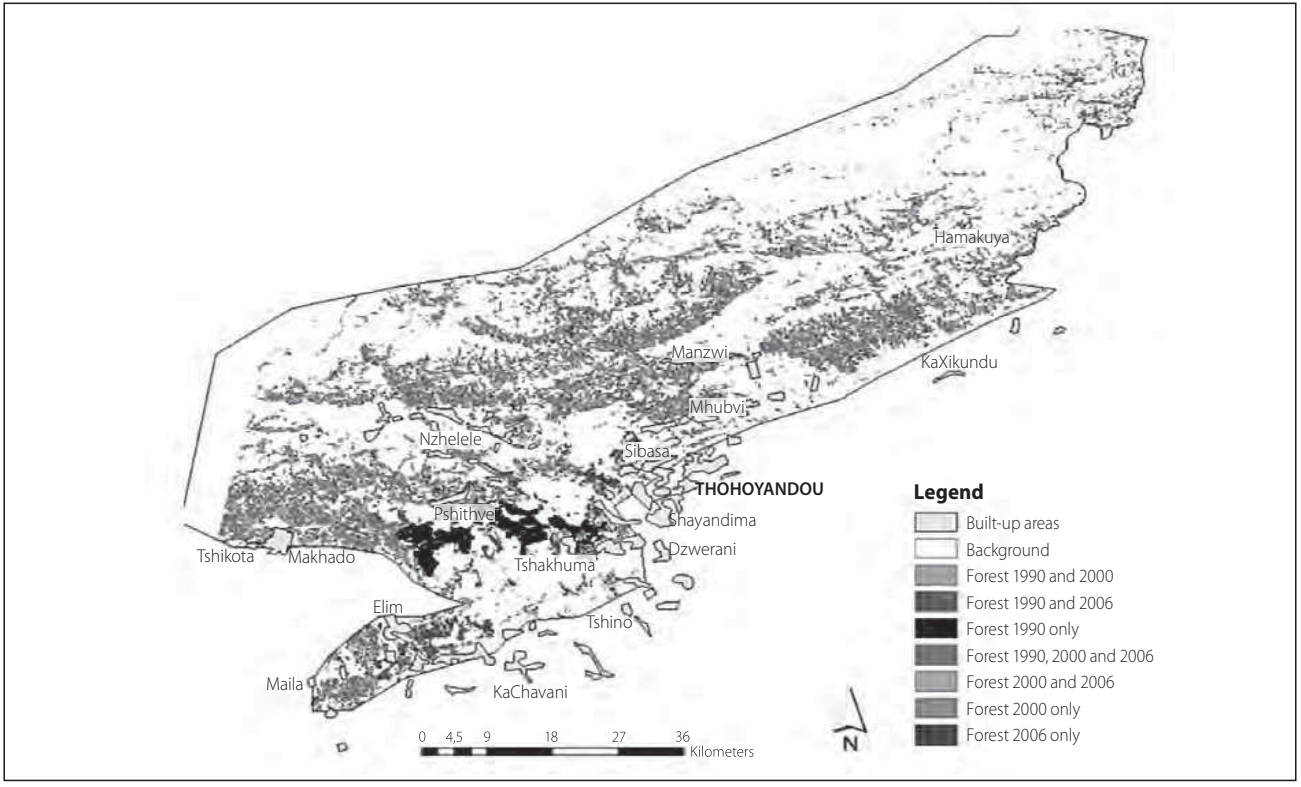


Figure 5 Forest cover change map for the whole image analysis area



Source C Munyati and T A Kabanda, Using multitemporal Landsat T M imagery to establish land use pressure induced trends in forest and woodland cover in sections of the Soutpansberg Mountains of Venda region, Limpopo Province, South Africa, ***Regional Environmental Change***, 9(1) (2009)

weather radars and satellite-based methods generally underestimate the amount of orographic precipitation.[15] Only a dense network of rain gauges can accurately assess the amount of rainfall in such a complex terrain. Surfer, a Windows software package, was used to draw Figure 2. Coordinates, elevation and mean seasonal rainfall values of rainfall stations were used.

Coefficients of variation (CV)

Figure 3 shows a dipole feature that exhibits relatively high values of CV (greater than 44%) on the eastern side of the study area, while low values (30%) are on the western side. The probable reason for this is that since moisture-laden wind flow emanates from the east, orographic lifting over the Soutpansberg Mountains plays a big role in enhancing precipitation in that area and this is enough to spill over the mountain and be experienced on the other side. Thus, local effects contribute to the rainfall variation on the eastern side, although to a variable degree. Variation is low on the western side and this can be attributed to drier air after much of the moisture has been shed on the eastern side. Another factor might be that the western-side rainfall is due to mean wind field only, since strong local effects such as mountains are missing.

Longitudinal variation of rainfall

Longitudinal rainfall variations are presented in Figure 4. The stations were selected based on different sections of the Soutpansberg Mountains: Punda Maria is the easternmost point of the mountain or the entrance of the moisture flow from the Indian Ocean. Mara station is the westernmost point on the Soutpansberg or, in this case, the exit point of the easterly flow. Klein Australie and Tsianda are found in the middle of the Soutpansberg. From Figure 4, it is noted that after the late 1970s rainfall in the area depicted a high frequency of below normal levels with varying magnitude. The reason for this observation is argued in the discussion section in this chapter. Klein Australie maintained rainfall closer to the long-term average, while Mara, which is far to the west, reports far below the average. The other stations are relatively better than Mara. It should be noted that the rainfall increase during 1999/2000 is due to the floods that occurred in southern Africa and which devastated Mozambique.

Forest cover change, Soutpansberg Mountains

Areas of concern are shown as dark patches in Figure 5. These areas were detected as forest cover up to 1990.

This is in agreement with Mphaphuli, who observed that large-scale deforestation in the Soutpansberg in the areas of Tshakhuma, Tsianda and Lwamondo started in 1979 and is still continuing to date.

The photographs in Figure 6 were taken on 29 October 2008 by the author to show the contrasting vegetation cover on the Soutpansberg. The top left side of Photo A shows the indigenous vegetation that still exists on the mountain, while Photo B shows the cleared forests.

Environmental impacts on the sustainability of the livelihoods

White farmers settled in the Soutpansberg in the late 19th century.[16] These farmers quickly increased in number, and almost as quickly embarked on plantation and orchard crops. The pattern is typical in that the number of farming units increased and peaked in the mid-20th century (Figure 7). What is distinctive, however, is that the area being farmed has declined from the mid-20th century at least at the same rate as the previous increase. Thus, whereas the pattern for the decline in farming for South Africa as a whole is one of only a modest decrease in the area under commercial farming, implying an increasing

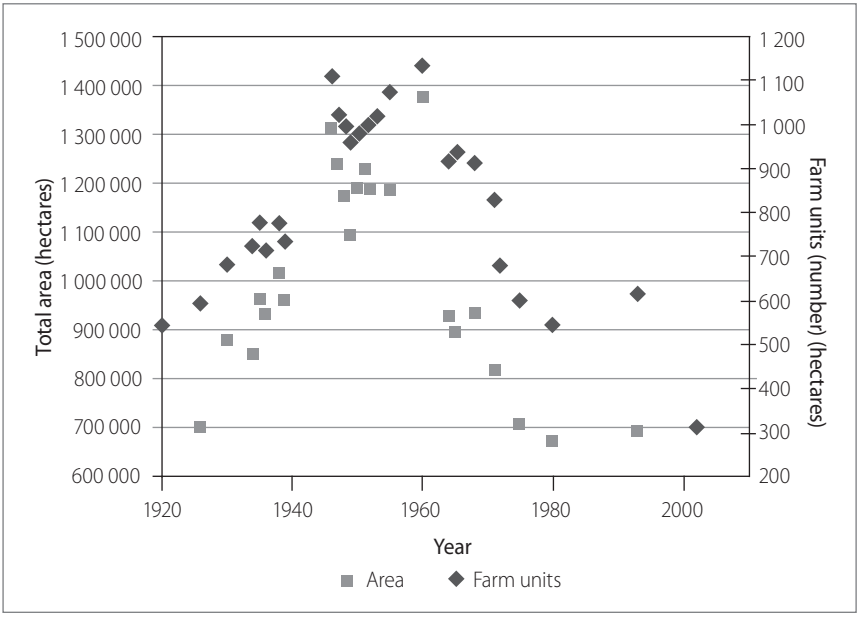
Figure 6 Two photos showing large-scale deforestation in the Soutpansberg at Tshakhuma

Source Author's own compilation

average farm size as the number of units drops, in the Soutpansberg the area of land being commercially farmed has declined by about two-thirds. It is certain that the reduction in farm units has resulted in farm workers losing their jobs.

The dynamics, thermodynamics and micro-scale cloud processes of the mountain climate of the Soutpansberg have been altered by the clearing of the natural woodland and forest cover, and by settlement expansion. This, in turn,has enhanced local anthropogenic climate change which is manifested in the western part of the Soutpansberg Mountain. The timing of the decline of commercial farms in the Soutpansberg, as indicated in Figure 7, coincides well with the reduction in rainfall in the western Soutpansberg (Mara station) and large-scale deforestation within the Soutpansberg (east) in the areas of Tshakhuma, Tsianda and Lwamondo that started from 1979 as observed by Mphaphuli. The development of a town, Thohoyandou, as indicated in Figure 5, in the east of the Soutpansberg into a city is exacerbating the situation in the west, because of the clearing of the forests and construction of concrete structures. These enhance the absorption of atmospheric radiation directly by the Earth's surface, thus diminishing moisture availability for deep cloud formation.

Figure 7 Commercial farms, Soutpansberg, 1920–2002



Source Aliber et al, Excerpt from draft report, Livelihoods after land reform – South Africa component

As for the underlying reasons for the drying of the region, the hypothesis is that it has been primarily caused by the population movements brought about by land dispossession and the previous government's spatial planning. It can now clearly be argued as follows: historically, much of the rainfall in the area was generated by the Soutpansberg range through a combination of the orographic effect (by which mountains focus air currents upwards to a level of condensation) and evapo-transpiration from natural vegetation. With the removal of the indigenous black populations from low-lying areas and their subsequent crowding into the relatively hilly and mountainous areas of the eastern Soutpansberg, that is around Thohoyandou (see Figure 5), the natural vegetation was disturbed where it most matters. This disrupted and thus diminished the extent of evapo-transpiration affecting the formation of rain-bearing clouds. The irony is that, because the weather systems tend to move from east to west across the Soutpansberg range, the effect has been experienced most especially to the west of the Soutpansberg, in the areas that were largely reserved for white commercial farming, even though there the natural vegetation on the mountain has remained intact (conserved).

Most of the labourers on the commercial farms in the western Soutpansberg lost their jobs as the environment changed owing to less rainfall, and consequently many farms were abandoned. Most of these people moved to nearby towns (i.e. Thohoyandou, Louis Trichardt and Elim) to seek casual jobs and enter informal trading. Others are expanding their farming activities up the slopes of the Soutpansberg to sustain their living.

This unprecedented movement of people from farms that have failed because of climate change to the neighbouring towns and villages in the Vhembe and-neighbouring districts has started to fuel violent conflicts. Reports of xenophobia are now common in the Limpopo Province of South Africa, where foreign nationals may be rounded up, beaten and even killed.[17] It has been argued that natural resources-driven conflict may be induced by the scarcity of resources. The overuse and declining quantity and quality of the non-renewable resources or the mismanagement of renewable sources, such as forests, may cause tension over the shrinking resource base. Owing to rapid population growth in the Soutpansberg, land has become a scarce resource. Scarcity and mismanagement may also induce migration, forcing people to look for new resources to replace the depleted local resource base. This may lead to conflicts between natives and immigrants within national borders or internationally.

CONCLUSION

In this chapter empirical data from the Soutpansberg area of the Limpopo Province in South Africa is used to analyse physical events and processes and then link the information to human activities. This data includes rainfall, Landsat TM images and district demographic information. Furthermore, land-use and landcover changes are examined in the context of the influence of anthropogenic factors on the area and the consequent impact on the sustainability of the livelihoods of the population. The result shows that rainfall in the western part of the Soutpansberg is progressively diminishing, although the area features conserved indigenous forests. At the same time, the eastern part, with its alarming environmental destruction that includesthe loss of forest and biodiversity, soil erosion and land degradation, still enjoys relatively enough rainfall. Hence, it is observed that the injustices of land dispossession, population forced removals and overcrowding in the Venda homeland put pressure on scarce resources such as land, thus contributing to anthropogenic climate change and the resulting propensity for conflict.

This chapter presents a typical example of anthropogenic-induced climate change which has exacerbated the scarcity of natural resources in the Vhembe district of South Africa. Since the scarcity of natural resources is known to trigger competition for the meagre supplies available among individuals, communities and even institutions, this affects human security. Furthermore, livelihoods in the study area have been negatively affected by anthropogenic-induced climate modification. Subsistence agriculture in rural areas depends on rainfall; therefore a decrease in rainfall will lead to a reduction in farming output. This, in turn, leads to the rural population migrating to urban areas, which again can lead to conflicts in access, ownership and the use of meagre resources in towns.

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PART 4

Vulnerability and Adaptation to Climate Variability

9 Carbon

An exploration of soil carbon sequestration potential in Bukoba district, north-west Tanzania

Byjesh Kattarkandi, Mariana Rufino & Pablo Titonell

SYNOPSIS

The adversities of climate change related to greenhouse gases (GHG) emissions emphasise the importance of carbon sequestration in the terrestrial ecosystem. Therefore, research needs to quantify the potential sequestration capacity of soil, a major terrestrial sink. To this end an attempt was made to study the effect of variability in topography, land use and farm types (classification based on socioeconomic indicators) on soil carbon sequestration, a textural property of the soil which affects the carbon storage potential.

The research was conducted at Butaiyabega village, Bukoba district in north-west Tanzania near Lake Victoria. Plausible farming practice scenarios were described and analysed to predict the potential carbon sequestration. The soil samples were collected from three different depths from different land-use fields of different farm types across different topographic classes. The potential or attainable carbon sequestration based on soil texture was calculated for all the land uses and a dynamic simulation model (FIELD) was used to simulate different management scenarios for ten years to quantify the total soil carbon stock in the upper layer of soil of annual cropping fields.

The results showed that the textural property of the soil does not vary significantly among different land uses. The maximum carbon stock that can be sequestered in the upper 30 centimetres of the soil profile was estimated to be 90 tons per hectare? (90t ha-1) based on the textural property. Soil carbon concentration differs significantly between home gardens (Kibanja) and other land uses and the difference was found to be significant in all topographic classes where most of the organic matter is deposited the soil carbon concentration in the home garden soil of the upper topographic level was significantly different from the mid-valley and valley floor topographical classes. The crops and management of the different land uses of the different farm types were similar except in the home gardens where management changes with the socioeconomic status of the farm household. The simulation results showed that the incorporation of residue and cattle manure increases the soil organic carbon build-up and that saturation can be reached by adopting the particular management scenario continuously for more than ten years. The soil's textural property has enormous potential for carbon storage.

After identifying the major potential land-use types for clean development mechanism (CDM) projects, it becomes necessary to do a trade-off between the potential land-use type and its availability taking into account the socioeconomic perspective. Future research should be focused on the feasibility of these management scenarios and be evaluated before they are considered as CDM projects.

INTRODUCTION

Global warming is considered a major threat to the future of humankind and the Earth's ecosystems, even though the extent of the threat in the long term is not yet known with certainty. The Intergovernmental Panel on Climate Change (IPCC) has expressed its concerns about the possible threats, particularly to agriculture and subsistence farmers in developing countries.[1] Scientific research for possible mitigating options has gained momentum during the last two decades. It is, however, necessary to revisit the present crisis situation by using a more environmentally friendly approach and thereby provide an economic incentive for the poor. Different, 'unhealthy' land-use changes and activities result in the accelerated release of CO_2 and other GHGs. Carbon accumulates in the atmosphere at a rate of 3,5 billion tons per annum. A major portion is contributed by the burning of fossil fuels and the conversion of tropical forests to agricultural production.[2]

The hazardous trends in global climate changes – rising temperatures, higher frequency of droughts and floods, and so on – are the consequences associated with the increase of atmospheric GHG concentrations. Scientists are exploring several options to reduce emissions as well as to mitigate the consequences due to increase in concentration of the GHG in the atmosphere.

The third session of the conference of the parties to the United Nations Framework Convention on Climate Change (UNFCCC) in 1997, in Kyoto, Japan, urged participating countries to find ways to reduce GHG emissions to the atmosphere. According to Bass, Dubois, Costa et al, the reduction target can be achieved through two major processes:[3]

- Reducing anthropogenic emissions of CO_2
- Creating and/or enhancing carbon sinks in the biosphere

Three main categories of activities which can help to reduce atmospheric carbon are carbon sequestration, carbon conservation and carbon substitution. Of these activities, carbon conservation has been found to have the greatest potential for rapid mitigation of climate change, whereas carbon sequestration takes place over a much longer period of time. However, it can be anticipated that carbon sequestration will become an important feasible option for the mitigation of global warming. Soil carbon is the most important component for sequestrating carbon in agro-ecosystems.[4]

Many studies on the determination of soil carbon sink capacity, including that of Albrecht and Kandji, maintain that this can be altered by judicious management or manipulation.[5] Soil carbon sequestration implies transferring atmospheric CO_2 into stable soil pools and storing it securely so that it is not immediately re-emitted. Studies by the Food and Agricultural Organisation (FAO) and Batjes advocate soil carbon sequestration as a strategy for reclaiming land, mitigating global climate change and improving the livelihood of resource-poor farmers.[67]

On the one hand, improved crop management practices, for example reduced tillage, manure application, mulching, composting, fallowing, crop rotations and agro-forestry, improve CO_2 uptake from the atmosphere, as well as contribute to erosion control and enriching the biodiversity. On the other, soil organic matter (SOM) or soil carbon plays an important role in determining and improving the productivity and fertility status of the soil. According to the United Nations Environment Programme (UNEP), promoting carbon sequestration in degraded

African soils by implementing the Kyoto Protocol and other international agreements provides a promising avenue for addressing issues as well as lending the necessary support to the rural poor.[89]. Carbon sequestration in small-scale farming systems is promoted as a win-win strategy by increasing carbon storage and thereby contributing to improving the livelihoods of the local smallholders through sustainable land use and management practices.[10] However, Vagen, Lal and Singh describe the natural processes and factors involved in carbon sequestration as highly complex.[11] Further research is recommended, especially in sub-Saharan Africa, to establish the opportunities for interventions at both different topographical and farm levels. Sanchez, Shepherd, Soule et al maintain that it has been noted that population pressure increase together with marginal farming in the last two decades has resulted in the further fragmentation of land into smaller entities.[12] This, together with land degradation and depletion of soil fertility, has resulted in the need for more land for the cultivation of basic foodstuffs in African countries. Soil carbon sequestration in degraded sub-Saharan African farms is likely to be found in the form of SOM in the long run, but the residence time (the length of time carbon exists in the soil) depends on the type of management and the bio-physical factors of the soil.

Carbon sequestration practices are likely to be considered for incentives from ecosystem proponents.[13] However, soil carbon sequestration is not eligible for carbon credits under the clean development mechanism (CDM) of the first commitment period of the Kyoto Protocol, but it is hoped to include it in the next round of talks to be held in 2012. Many studies have emphasised the importance and correlation between soil texture and soil organic carbon. Studies by Hassink and by Six, Conant, Paul et al have found that fine-textured soil has a higher organic carbon and nitrogen content than coarse-textured soil.[1415] The size of the soil carbon pool depends on the silt and clay proportion in the soil and their relationship. The SOM portion is highly susceptible to loss during cultivation and yet responsive to differences in clay content where soils are not disturbed by tillage. The mechanism which explains the phenomenon of the physical protection of the SOM in the soils is:

- Adsorption of organics to the surfaces of clays or coating of organics by clay particles.
- Entrapment of organic matter in small pores in aggregates inaccessible to microbes.

Cultivation results in the breaking down of the aggregate structures, thereby increasing the exposure and availability of the carbon associated with them. The aim of this study is to prove this relationship of texture (clay and silt) and soil carbon content and explore the attainable potentiality of carbon storage.

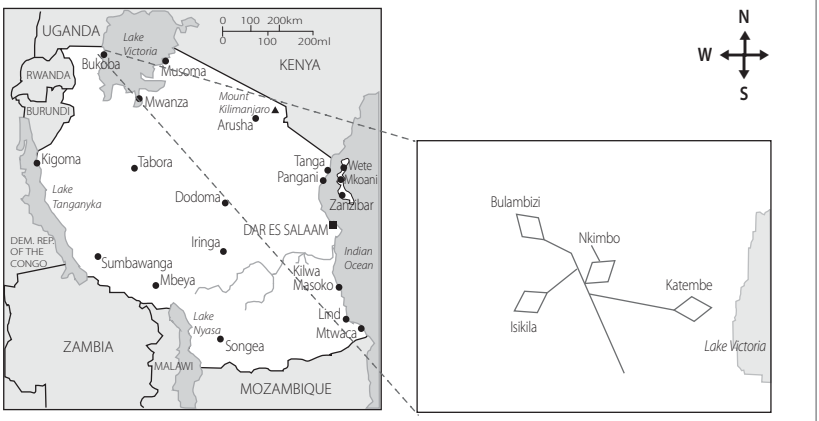
An attempt was made to list the factors influencing the variation of soil carbon status in relation to socioeconomic conditions, the soil's physical properties and the topographic variations of the study site. Several pertinent questions informed this research:

- How do soil carbon stocks vary across different land-use types?
- How do they vary with different topography?
- How do they vary with different farm types (based on resource categories) within land-use types?
- What is the change in total carbon sequestered in the soil within the same topographic units after a certain time and type of management of the soil?
- What is the change in soil carbon stocks in fields that have undergone recent changes in land use? How do the current carbon stocks of the current land-use type compare with the benchmark values obtained in the previous land use?
- What would be the contribution of different cropping patterns (land-use types/farm types) in terms of carbon stock increases with respect to the maximum soil carbon that can be sequestered using the Feller and Beare empirical equation?[16]
- How is the long-term soil carbon build-up influenced by the management decisions (using a simulation model)?
- A general assessment of which land-use types could have more potential for carbon sequestration projects and what possible natural resources conflicts could be anticipated that have to be overcome

DESCRIPTION OF STUDY AREA

The study was conducted in a village in the Bukoba district of Tanzania. The village Butaiyabega is, as Figure 1 indicates, located in the high rainfall zone of the district (10° 26-27'S and 31o 46-47'E). The annual average rainfall is 2100 millimetres, distributed in a bimodal pattern. The soils are anthri-humic ferralsols developed from sandstone and shale materials.[17] The sampled sub- villages are Bulambizi, Nkimbo, Isikila and Katembe.

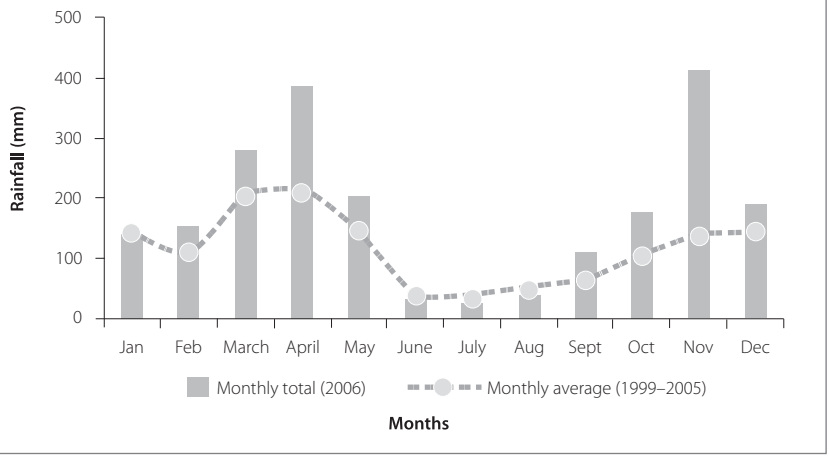
Figure 1 Geographical location of the study site



Source Author's own compilation

As Figure 2 indicates, the rainfall distribution throughout the year shows two peaks: one in March, April and May, and then another peak in October, November and December.

Figure 2 Average and monthly total precipitation of the site during the field work



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The bimodal nature of the rainfall enables farmers to grow two crops per year. However, the main cropping season is from October to December when all the fields are planted with mixtures of maize, beans, cassava and sweet potatoes. The average temperature of the area is 20°C, with large seasonal variations.

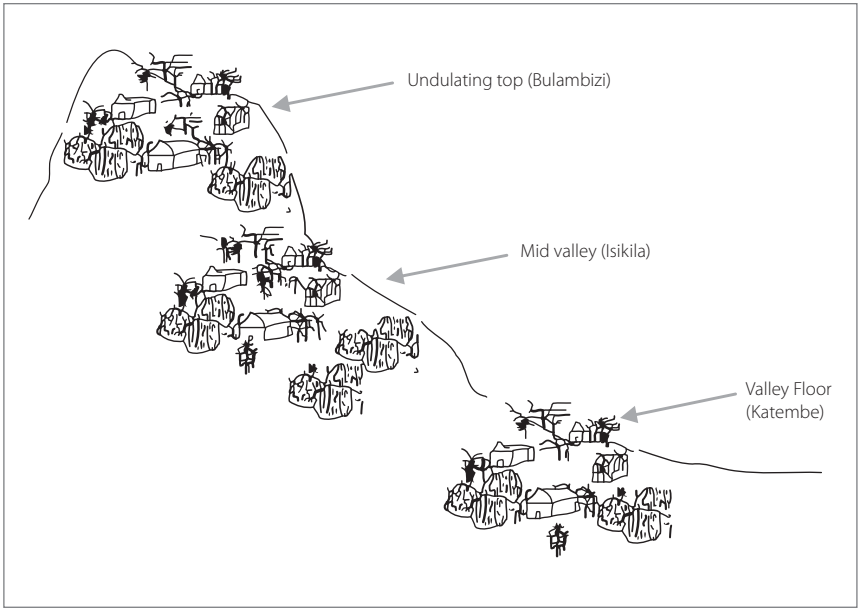
Site description

The topographic characteristic of Butaiyabega village, as Figure 3 indicates, is very steep to moderately steep with long to moderately long complex slopes.

The three main topographic units are:

- **Undulating summit or top:** This area lies on the summit of a hilly region and is well drained. The soils are deep and also well drained. The average slope of the area is about 2–15 per cent, with an average elevation above sea level of 1 310,8 metres

Figure 3 Topographic positional representation of the studied villages



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- **Mid-valley or erosion plane:** This area has an average elevation of 1 267,03 metres. The slope ranges from 20–40 per cent
- **Valley bottom:** The average elevation of this class is 1 133.6 metres, with an average slope of about 0–5 per cent The four sub-villages fit into the different categories as follows: Bulambizi – first category, Nkimbo and Isikila – second, and Katembe – third

Land use and cultivation

In Butaiyabega, the farming system consists of three types of land use: the homestead gardens (Kibanja); annual cropping area (Kikamba), and permanent communal grazing grasslands (Rweya).

The homestead gardens (Kibanja)

These fields contain a mixture of perennial and annual crops. Most of the fields are planted with perennial crops like bananas (*Musa sps*) and robusta coffee (*Coffea canephora*), and annual crops like cassava (*Manihot esculenta*), beans (*Phaseolus vulgaris*), maize (*Zea mays*) and taro (*Colocasia esculenta).* The annual crops are grown twice a year during the rainy season. They are planted between the perennial crops of banana and coffee and act as living mulch.

Annual cropping area (Kikamba)

Kikamba fields are considered to be abandoned Kibanja and the soil is less fertile compared to the Kibanja fields where the soil requires no additives. The crops comprise annual crops only, that is maize, sweet potato (*Ipomea batatas*), cassava (*Manihot esculenta*) and yams (*Dioscorea sps*).

Communal grazing land (Rweya)

This communal grassland is mainly used as grazing for cattle herds. The grasses are cut and carried to feed non-grazing cattle. The main grass species found are *Eragrostis spp., Hyparrhenia spp., Hyperthelia spp. and Loudetia spp.* The Rweya land is also used for growing annual crops by rotation Bambara nuts *(Vigna subterranea)*, cassava and yams are cultivated and cash crops like tea (*Camellia sinensis*) and timber such as *Eucalyptus spp.* are grown on a large scale in Rweya. After one crop has been grown, normally the area is left fallow for a minimum of four to five years before it is cultivated again. Locally, these fields are called 'omusiri'.

Farm types

To study the differences in carbon status of the soils of different farm types based on economic indicators, the sampled farm households were classified into three groups.[18] The three groups or farm types were grouped according to six socioeconomic indicators. From the 74 households surveyed, six criteria, as indicated in Table 1, were chosen to classify farms in order to determine the potential carbon sequestration of different farm types among the sampled households.

The classification was done on the assumption that the above criteria influence the soil carbon content and potential ability for further carbon sequestration or storage in the soil. Soil carbon changes within different groups of farm households in the same topographic position were analysed. The management associated with land-use change can alter the soil organic carbon substantially. General socio-economic indicators of farms in the three different topographical levels are provided in Table 2.

The cluster analysis was done using Primer (Primouth UK). A detailed preliminary survey of 74 random farm households from the village of Butaiyabega was conducted to collect data about the various components of the farms. The farms

Table 1 Criteria used in categorising farms

Criteria used in categorising farms into different groups	Description of criteria
Tropical livestock unit	TLU conversion factors are: 19 cattle = 0,70; sheep and goats = 0,10; pigs = 0,20; chicken = 0,01
Available household labour	Man days per year. One man day equated at 5 working hours per day of adult household member
Kibanja size	Land area in hectares
Livestock management	Grazing outdoor, non grazing indoor and teethering
Total labour hired	Man days per year
Farm income	Tanzanian shilling

Source Author's own compilation

Table 2 General socio-economic indicator of the sampled farms (n=9 at each location)

Indicator	Sub – Villages		
Farm characteristics	Bulambizi	Isikila & Nkimbo	Katembe
Average Kibanja size (hectares)	0,6975	0,68625	0,45
Average household size (# of members)	7,44	7,33	5
Household labour (Man days /year)	773	636	491
Farm Income ('000 Tz shilling /year)	25	23	19
Total Live stock Unit (Include cattle, pig and goat)	0,9288	1,56	0,621
Manure (# tins /month)	399	385	133
Livestock. Management. (major livestock)			

Source Author's own compilation

are classified by cluster analysis according to socioeconomic criteria collected through a preliminary questionnaire, including:

- Total livestock unit
- Kibanja size
- Livestock management
- Household labour
- Farm income
- Hired labour

Soil sampling and analysis

A soil profile study was conducted to gain an understanding of the characteristics of the soil. Samples were taken at fixed depths of 0–30, 30–60 and 60–90 centimetres and composite samples were also collected from all the different land uses. The samples were analysed for total carbon (g kg^{-1}) and clay and silt fraction by infrared spectral reflectance measurement.[20]

Estimating the corrected carbon stock

The management impact on the SOM is so huge an efficient protocol is needed to quantify the carbon stock. The bulk density, a key parameter in quantifying the carbon stock, is measured during sampling and measurement. The use of parameters like concentration, soil bulk density (BD) and soil thickness may be sufficient for accurately assessing the quantity of SOM or carbon stock.

The carbon stock is corrected by using the measurement of the equivalent soil mass. The soil mass of each layer is calculated by the following equation:

Equation 1

$M_{soil} = B.D. * T * 10000\ m^2\ ha^{-1}$

M_{soil} = Soil mass per unit area (tha^{-1}T = Thickness of the layer in metres

Assessing the soil carbon storage potential with respect to current management

Land use and management practices influence the SOM storage and loss, and it has been found that in the tropics clay and silt fraction influence the SOM build-up in the soil that has low activity clay (LAC).[21] Feller and Beare proposed an equation, which can represent the critical threshold of soil organic carbon to a depth of 10 centimetres.

Equation 2

C (‰) = 0.32 (%silt + clay [0-20µm]) + 0.87

This equation was used to quantify the potential carbon storage in the soil based on the clay and silt content.

Equation 3

Δ C ($t\ ha^{-1}$) = Maximum attainable carbon stock – Current carbon stock

Assessing the impact of management on soil carbon content through dynamic simulation scenario development

The scenarios developed for assessing the impact on the soil carbon content in the first 30 centimetres are:

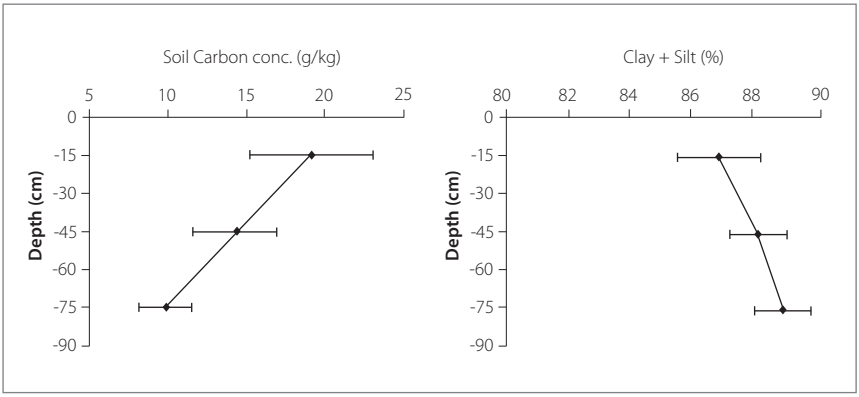
- With no organic input
- Incorporation of 50 per cent of crop residue
- Incorporation of 100 per cent of crop residue
- Incorporation of 100 per cent of the residue plus 500 kilograms of cattle manure per season
- Incorporation of 100 per cent residue plus 1 000 kilograms of cattle manure per season

The dynamic simulation model FIELD developed by Tittonell, Corbeels, Van Wijk et al was parameterised and validated for Bukoba high rainfall zone conditions considering the average maize grain yield from Kikamba is 1,1tha^{-1} and the surface biomass 3tha^{-1}season^{-1}.[22] The soil carbon and clay + silt fraction data were analyzed for descriptive statistics and analysis of variance using SPSS version 12,0 for windows.

RESULTS AND DISCUSSION

- Soil carbon (%)
- Topographic classes
- Undulation top

Figure 4 Average carbon concentration (gkg^{-1}), clay and silt fraction (%) in Kibanja land use in the upper topography position (error bar represents SD)



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Kibanja

Most of the farm households sampled in the Kibanja area in the upper topographic position (summit) had an average slope of 5–10 per cent. The soil analysis results, as Figure 4 indicates, showed the average carbon concentration (gkg^{-1}) of Kibanja (homestead gardens) to be 19, 2, 14, 3 and 9,9 respectively at depths of 30, 60 and 90 centimetres. The clay and silt content increased with depth at an average of 87, 88, 89 per cent at depths of 30, 60, 90 centimetres respectively with a standard deviation of 1, 16, 0,75 and 0,89.

Table 3 Carbon and clay and silt content of soil of different land uses

Sub village (Topographic position)	Land use	Depth	Clay + silt (%) (SD)	SOC (gkg^{-1}) (SD)
Bulambizi	Kikamba	0–30	87,1 (0,4)	19,5 (0,05)
		30–60	88,1 (0,1)	10,3 (0,22)
		60–90	88,5 (0,4)	8,6 (0,40)
	Rweya	0–30	79,34	19,6
		30–60	88,05	10,2
		60–90	88,76	6,6
	Omusiri	0–30	85,93	12,5
		30–60	87,72	8,5
		60–90	88,66	7,0
	Eucalyptus plantation	0–30	82,11	17,1
		30–60	84,68	13,1
		60–90	86,38	6,6
	Pine plantation	0–30	74,02	7,9
		30–60	87,74	2,1
		60–90	88,06	2,0

Source Author's own compilation

Kikamba (annual cropping area) and other land uses

The average soil carbon concentration (%) present in the samples taken at various depths in Kikamba showed a decrease from the top layer to the bottom. The average values found were 1,95, 1,03 and 0,86 per cent respectively at 0–30, 30–60 and 60–90 centimetres. The clay and silt fraction showed an increasing trend with no significant differences between the various depths, as indicated in Table 3. The clay and silt fraction was found to be 87,1, 88,1 and 88,5 per cent at the different depths. The sampled Kikamba fields are on plains or have a slight slop of about 2,3 per cent.

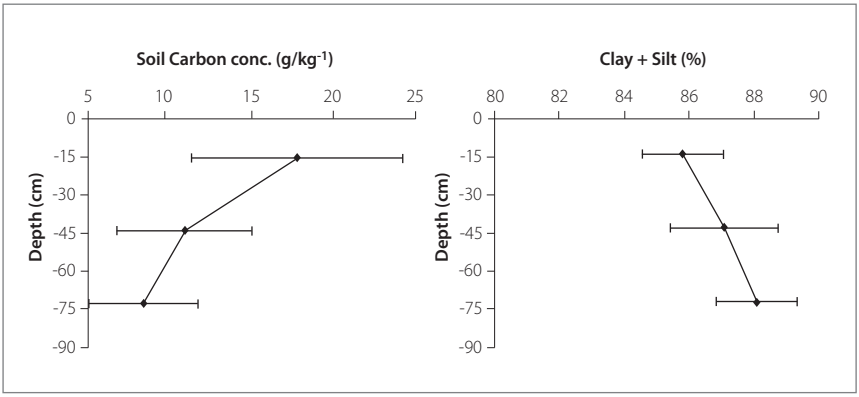
Mid-valley

Kibanja

The organic carbon concentration of the soil of the sampled households in the Kibanja area in the mid-topographical class decreased with the increasing depths. The average carbon concentration was 17,8 (30cm), 12,2 (60cm) and 9,8 (90cm) (gkg^{-1}) with a standard deviation of 0,03, 0,12 and 0,18 respectively.

Figure 5 indicates that the clay and silt fraction increased with depth as found in the upper topographic position with averages of 85,8, 87, and 88,2 per cent and an average standard deviation of 1,3, 1,6 and 1,2 respectively.

Figure 5 Average soil carbon concentration (gkg^{-1}) and clay and silt fraction (%) changes with depth



Source Byjesh Kattakandi, Mariano Rufino, and Pablo Titonell; Bukoba, Tanzania; 20 August 2007

Table 4 Carbon and clay and silt content of the soil in 3 different horizons of the profile (Isikila)

Sub village (Topographic position)	Land use	Depth	Clay + silt (%) (SD)	SOC (gkg^{-1}) (SD)
Isikila	Kikamba	0–30	83,19 (3)	18,6 (0,8)
		30–60	84,33 (4)	11,5 (0,7)
		60–90	84,23 (8)	8,4 (0,6)
	Rweya	0–30	79,28	11,7
		30–60	80,93	5,9
		60–90	–	–
	Omusiri	0–30	80,22	7,3
		30–60	84,12	5,3
		60–90	–	–
	Eucalyptus plantation	0–30	83,46	19,0
		30–60	89,32	11,7
		60–90	90,03	6,4

Source Author's own compilation.

Kikamba (annual cropping area) and other land uses

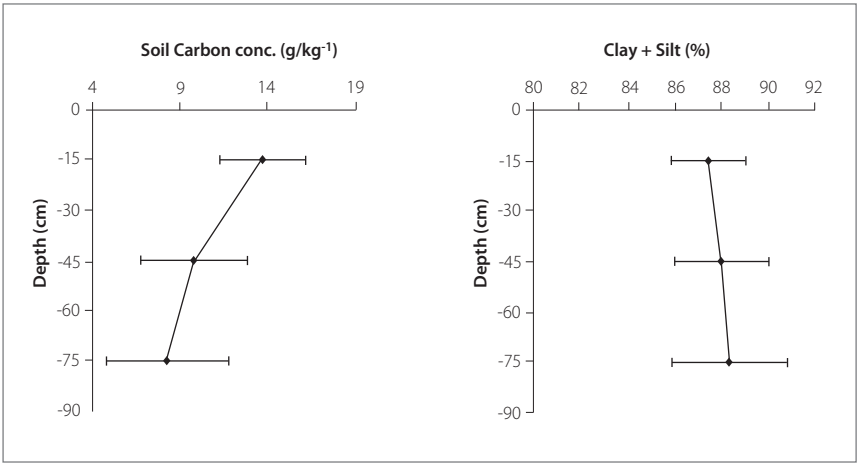
The sampled land-use types in the mid-valley topography slope more than those of the upper topography. The slope ranges between 20–30 per cent, especially in the communal grassland (Rweya) near to the households sampled. The carbon and silt and clay content of the sampled land types are provided in Table 4.

Valley bottom

Kibanja

The valley followed the same trend of decreases in carbon concentration (gkg^{-1}) along the soil profile. The average soil carbon content (gkg^{-1}) at the three depths was 13,7, 9,8 and 8,3 with standard deviations of 0,15, 0,25 and 0,27 respectively.

Figure 6 Average soil carbon concentration (gkg^{-1}) and clay and silt fraction (%) changes with depth



Source Byjesh Kattakandi, Mariano Rufino, and Pablo Titonell; Bukoba, Tanzania; 20 August 2007

The clay and silt content also showed the same trend as for the other topographies with increases in content. There was no significant difference in average clay and silt content (%) between different sampling depths in homestead land use (Kibanja). Figure 6 indicates that the average clay and silt content along the profile was 87,4, 88 and 88,3 with standard deviations of 1,6, 2 and 2,4 at depths of 0–30, 30–60 and 60–90 centimetres.

KIKAMBA AND OTHER LAND USES

Soil samples were analysed for clay and silt fraction and soil carbon concentration (gkg^{-1}) for Kikamba (annual cropping) and other important land uses in the sub-village. The clay and silt fraction and soil carbon concentration (%) for the different depths are given in Table 5, providing a general overview of the physical status of the soil. Table 5 also provides the carbon content and clay and silt fraction of the soil for the different land uses. Most of the household heads of the sampled households of the Katembe sub-village, which is situated near the shore of Lake Victoria, are fishermen. The farms are located in an area of slight to moderate slope.

Table 5 Carbon and clay and silt content of the soil in 3 different horizons of the profile (Katembe)

Sub village (Topographic position)	Land use	Depth	Clay +silt (%) (SD)	SOC (gkg^{-1}) (SD)
Katembe	Kikamba	0–30	86,9 (2,2)	14 (0,4)
		30–60	86,9 (2,4)	13 (0,3)
		60–90	87,8 (2,0)	11 (0,4)
	Rweya	0–30	81,44	9
		30–60	87,67	2
		60–90	87,54	2
	Omusiri	0–30	54,45	13
		30–60	76,87	9
		60–90	86,37	5
	Eucalyptus plantation	0–30	85,61	16
		30–60	86,48	9
		60–90	87,09	8
	Pine plantation	0–30	80,05	7
		30–60	85,86	5
		60–90	85,93	4

Source Author's own compilation

ANALYSING ACROSS DIFFERENT TOPOGRAPHY AND LAND USE

The soil carbon concentration (gkg^{-1}) was found to be significant ($p<0,05$) in the upper layer of the Kibanja soil in all topographical classes. As Table 6 indicates, other combinations in depth and land use were found not to be significant ($p>0,05$).

Table 6 Analysis of carbon concentration and clay and silt content across topography and land use

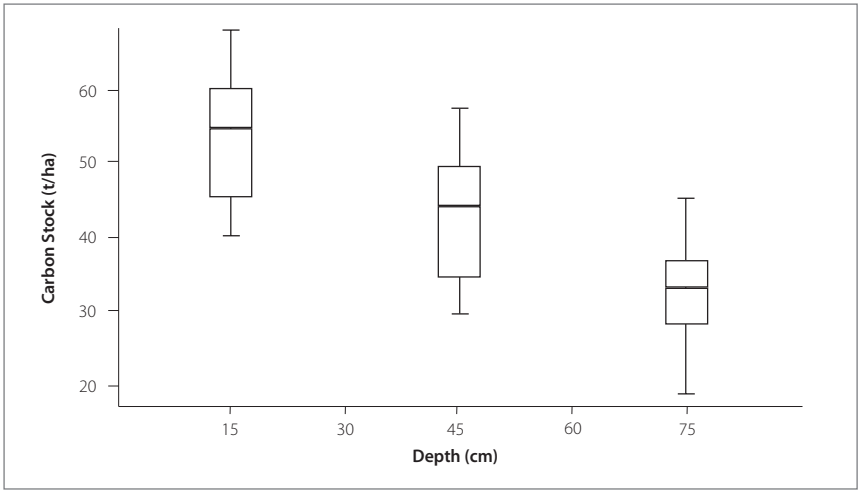
	Land use	Kibanja			Kikamba		
Topography class	Depth	0–30	30–60	60–90	0–30	30–60	60–90
	Soil carbon content (p value)	0,046*	ns	ns	ns	ns	ns
	Clay + silt	ns	ns	ns	ns	ns	ns

Significant $p < 0,05$ ns – Not significant

Source Author's own compilation

The significant carbon content status of the Kibanja upper soil layer is mainly due to the difference in management compared with that of other land uses. Furthermore, there are not enough samples testing the soil carbon concen-

Figure 7 Carbon stock (t ha^{-1}) at different depths and for different farm types in Kibanja soil



Source Author's own compilation

tration (gkg^{-1}) and clay and silt content of the other various land uses at the different topographic locations.

SOIL HORIZON CARBON STOCK IN DIFFERENT FARM TYPES

An analysis of the average carbon stock (tha^{-1}) showed a significant difference between the stock at various depths in all topographical positions from the upper 30 centimetres of the profile. The average carbon stock was found to be 52,8t ha^{-1}, 40,9tha^{-1} and 33,1tha^{-1} respectively for 30, 60 and 90 centimetre depths. However, as Figure 7 indicates, no significant differences were observed in carbon stock of the upper soil layer of Kibanja soils of different farm types.

SOIL CARBON STATUS IN DIFFERENT FARM TYPES IN UPPER TOPOGRAPHIC POSITION

Kibanja

As Figure 8 indicates, the soil carbon concentration (gkg^{-1}) varies among farm types. It also tends to vary with the depth of the profile in different farm types situated in different topographic positions .In the valley the Farm type 1 had the largest soil carbon concentration. The soil carbon concentration increased from Farm type 1 to Farm type 2 and it decrease in Farm type -3. However, this trend was not seen in the upper topographic and mid-valley positions. Figure 8: Soil carbon stock (t ha^{-1}) at different depths in Kibanja soil in different farm types.

TOTAL CARBON STOCK IN KIBANJA UPPER SOIL (30 CM)

The first level investigated for total carbon stock (tha^{-1}) was at 30 centimetres, the depth at which major soil manipulation occurs and the majority of roots are concentrated. The Kibanja receive high organic input which is important for improving the physical and biological property of the soil.

Table 7 presents the total carbon stock present in the Kibanja located at different topographical positions and its variation with different farm types. The

Figure 8 Soil carbon stock (t ha-1) at different depths in Kibanja soil in different farm types

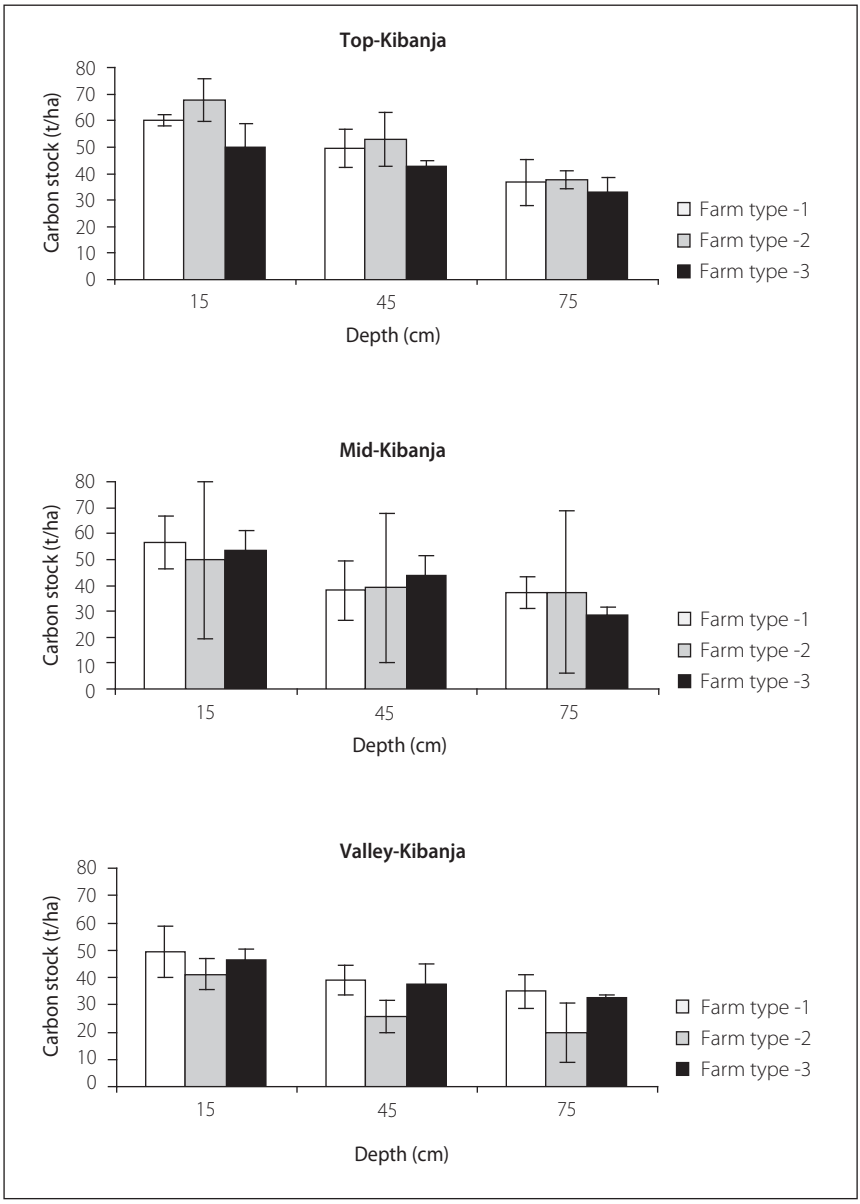


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Table 7 Average carbon stock in the upper Kibanja soil levels (0–30 cm) within farm types in different topographical classes

Topographic position	Average carbon stock (t ha^{-1})		
	Farm type 1	Farm type 2	Farm type 3
Ridge top	60,1	67,7	50
Mid-slope	56,6	53,4	49,8
Valley bottom	49,5	41,2	46,4
S.E.D [Standard error differences of mean]. – Topography – 5,81; Farm types – 5,81; Topography X Farm type – 10,06			

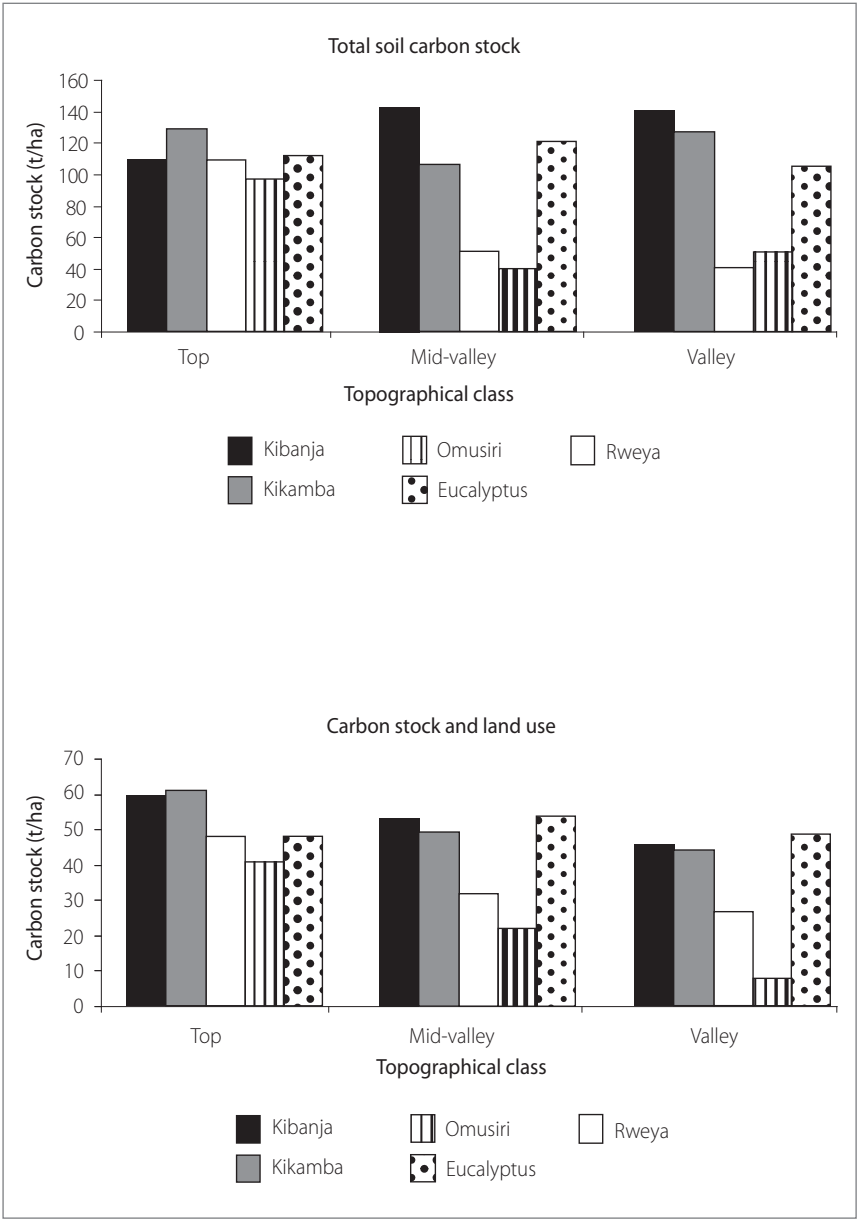
Table 8 Mean upper to total soil carbon stock ratio of farm types in different topographic positions

	Ratio of upper to total carbon stock (tons ha^{-1})		
Topographic position	Farm type 1	Farm type 2	Farm type 3
Ridge top	0,414	0,454	0,406
Mid- slope	0,432	0,424	0,434
Valley bottom	0,401	0,476	0,402
S.E.D. – Topography – 0,0268; Farm types – 0,0268; Topography X Farm type – 0,0465			

mean carbon stock (tha^{-1}) was found to be higher on the ridge top than in the bottom of the valley, even though the difference is not statistically significant (P>0,05%). The Farm type 2 had greater soil carbon content at first depth of sampling (upper layer) than the Farm types 1 and 3.

The ratio of the upper level carbon stock to the total carbon stock in a specific level (tha^{-1}) is calculated to find any differences in the topography and farm type combination. As Table 8 indicates, farm type 2 has the highest ratio, followed by type 1 and then type 3, but the mean value is not statistically significant (P>0,05%).

Figure 9 Carbon stock at first sampling depth (0-15 cm) in all land uses



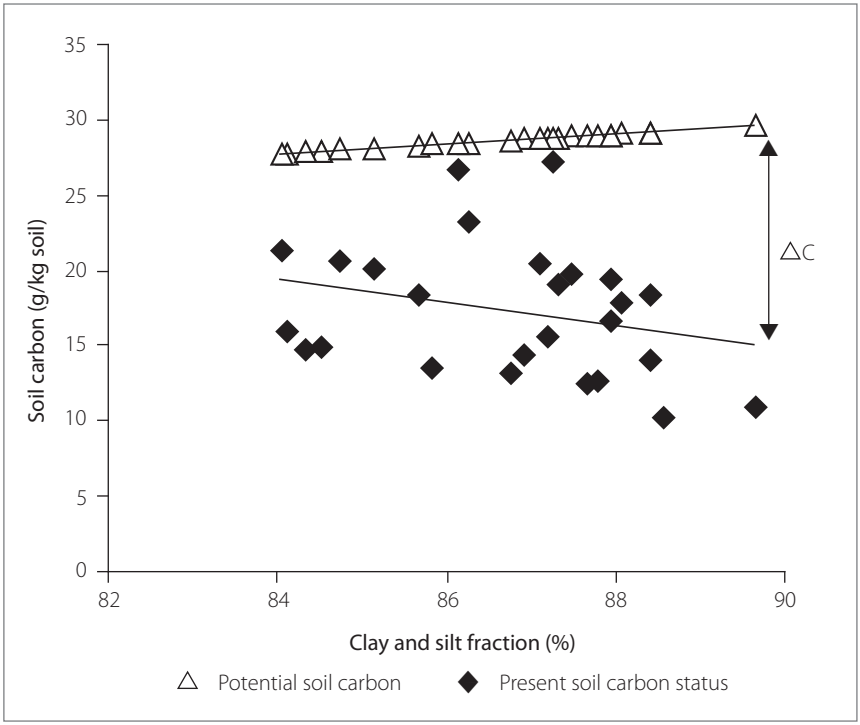
Source Author's own compilation

TOTAL PROFILE SOIL CARBON STOCK IN DIFFERENT TOPOGRAPHIC POSITIONS AND LAND-USE TYPES

As Figure 9 indicates, no clear trend was identified in total soil carbon stock among the different land uses. Most carbon is contributed to the soil through management and this affects the upper surface of the soil. The total carbon stock of the soil decreases from the upper topographical position to the mid-valley and then to the valley. In the Rweya, the total soil carbon content profile is lower in the mid-valley because the soil is not deep enough to take samples at three different depths, but these are collected only from two, 0–30 and 30–60 centimetres.

The recalculation of the carbon stock by using Equation 1 and 2 resulted in substantially higher values than previously calculated. This applies to all topographical classes in the Kibanja.

Figure 10 Potential to sequester carbon by improved management



Source Author's own compilation

Table 9 The average attainable carbon (ΔC) content (g kg^{-1}) based on the clay and silt (%) content

Average attainable ΔC (g kg^{-1})	Topographic position		
Land use	Top	Mid-valley	Valley floor
Kibanja	9,46	10,54	15,3
Kikamba	9,24	8,91	15,2
Rweya	13,126	14,54	17,93
Omusiri	15,9	19,23	5,29

**data not available

Source Byjesh Kattakandi, Mariano Rufi no, and Pablo Titonell; Bukoba, Tanzania; 20 August 2007

With corrections having been made for depth, Figure 9 shows a positive correlation in soil carbon stock and most samples following the same trend. All management activities that influence the biological and physical properties of the soil take place in the upper level, and this could be the reason for the changes in the carbon stock.

ASSESSING THE SOIL CARBON POTENTIAL STORAGE WITH RESPECT TO CURRENT MANAGEMENT

The potential soil carbon saturation level of the soil (ΔC) can be quantified using Equation 3, and possible alternatives for reaching this from the current situation can be investigated, as indicated in Figure 10. Quantification exercises and the investigation of possible options for increasing the carbon status of the soil is done by simulation studies. The clay and silt content of the soil samples differ only narrowly so that the saturation point had less variation.

Raising the present carbon content (gkg^{-1}) of the soil to the potential content can be achieved through management. The addition of organic material along with proper management conducive to carbon sequestration is needed to reach the potential level. Table 8 shows that the differences increase for both the Kibanja and Rweya from the upper to the bottom of the valley topography. In the case of the Kikamba, the difference is less in the mid-valley topography than in the upper topography and valley floor Table 9.

SIMULATION RESULTS: CARBON BALANCE

A simulation study was conducted for ten years since the fields were used for cultivation twice in a season. Table 9 gives the average annual carbon balances for the Kikamba field for Scenarios 1–6. The six different scenarios are as follows:

- Scenario 1: No organic input to the system
- Scenario 2: 50 per cent residue incorporated
- Scenario 3: 100 per cent residue incorporated
- Scenario 4: 100 per cent residue (from same field) plus 500 kilograms cattle manure ha^{-1} $season^{-1}$
- Scenario 5: 100 per cent residue (from same field) plus 1000 kilgrams cattle manure ha^{-1}
- Scenario 6: 100 per cent residue (from same field) plus 2000 kilograms cattle manure

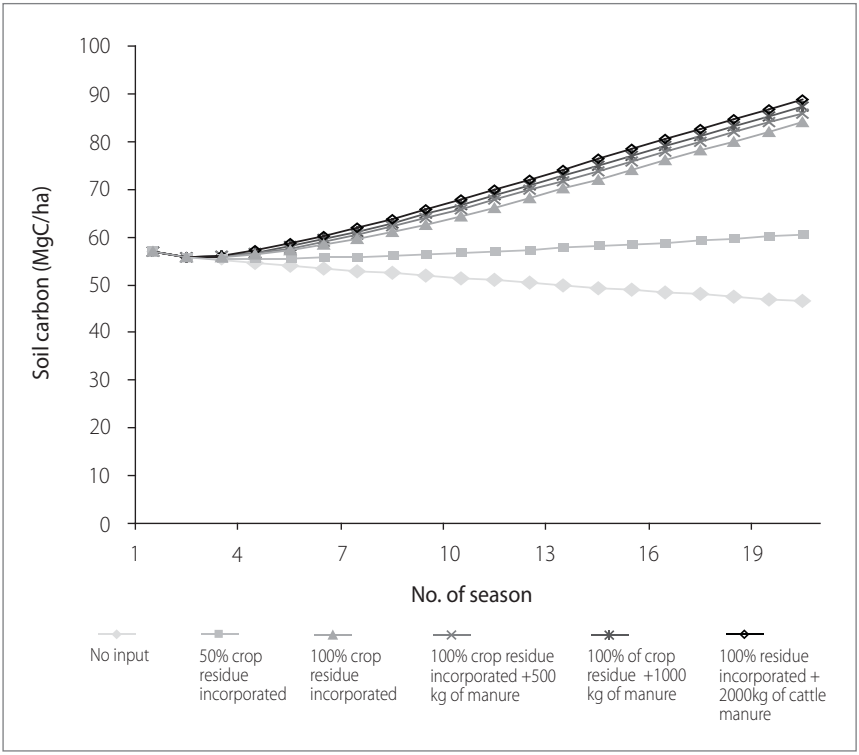
The initial soil organic carbon stock of the simulated field was 56,8 t ha^{-1}. The surface biomass was found to increase in Scenarios 2–5 and decrease in Scenario 1. Thus it is obvious that in Scenario 1 no additives were given to the soil and the soil carbon was lost owing to decomposition and soil erosion. Through simulation, the average surface biomass for 20 seasons (10 years) was found to be 4, 6, 7, 9, 11, 4, 11, 6, 12,

Table 10 Annual carbon balances ($tCha^{-1}yr^{-1}$) simulated for different types of management of the Kikamba field

	Scen 1	Scen 2	Scen 3	Scen 4	Scen 5	Scen 6
Average total biomass at harvest	5,4	9,1	13,3	13,7	13,9	14,05
Average surface biomass at harvest	4,6	7,9	11,4	11,6	12,0	12,04
Total organic input to the soil	–	2,3	6,33	6,5	6,6	6,7
Δ C (Potential attainable or sequestrable carbon)	–1,03	0,37	2,7	2,9	3,04	3,2

Source Author's own compilation

Figure 11 Simulated change in soil carbon content in the first 30 cm in the Kikamba for different scenarios



Source Author's own compilation

12, 04 tons per hectare per year (t $ha^{-1}year^{-1}$) Table 10. The above simulated scenarios show that in these soil types the maximum attainable carbon storage can be reached in ten years after intervention. Inputs (additives) considered for the simulation were crop residue from the same field and cattle manure only. Scenarios 4, 5 and 6 showed that using cattle manure only adds little with regard to carbon in the soil The rate of increase of carbon in the soil in the last three scenarios is 0,2 t Cha-$1yr^{-1}$.

In Bukoba, the other organic input available is grass from the Rweya, which can be added as mulch. This was not used in the simulation study because large quantities were not available for widespread use, nor was the data regarding the nutrient content available. The simulation is done for ten years as the maximum attainable carbon content is on average 90 $MgCha^{-1}$. See Figure 11.

The values are the means for a ten-year (two-season year^{-}) period of cultivation of the Kikamba fields.

CONCLUSION

The organic carbon concentration of the soil (gkg^{-1}) decreases with depth because management and manipulation have greater influence in the top 30 centimetres of the soil profile of all the different land uses. The carbon in the top layer varies widely with the different farm types, depending upon management and organic inputs. Fields away from the household show decreased soil carbon content with different land uses.

Eucalyptus and pine plantations differ in soil organic carbon (SOC) across the various depths, but the carbon content of the upper soil is greater in eucalyptus plantations than in pine, which can be ascribed to greater litter fall in the eucalyptus. Furthermore, the sampled eucalyptus plantation in the upper topographical position is four to five years old, while the sampled pine plantation is younger. Therefore, the age of the eucalyptus plantation may influence the present SOC.

The land-use type which has the potential to sequester carbon is the Kikamba where maize was grown. Maize could be a substitute for bananas and cassavas as the main staple food considering the importance of the Kikamba land use. Where there is systematic management, the Kibanja land use has huge potential to sequester carbon owing to a multiple and mixed cropping pattern.

To increase our understanding of the carbon sequestration processes in relation to climate change, long-term studies lasting several decades are essential. Knowledge of carbon exchange fluxes is essential for understanding the long-term dynamics of carbon sequestration in agro-ecosystems in general and grasslands in particular. The tillage regime also affects the aggregation status of SOM and it may cause the disruption of aggregates and stimulate the release of easily decomposable carbon compounds. Carbon depletion after ploughing is possibly related to increased aeration and the destruction of aggregates by ploughing. If there is no tillage, the field retains a protective surface cover of residue and partially decomposed materials near the surface.

In Bukoba there is little hiring of labour and there is also little destructive tillage using machines. Carbon sequestration as an environmental service will

be important at the next round of the UNFCCC when Bukoban farmers can be shown to be of economic benefit with their CDM projects. The texture of the soil is good enough to store substantial amounts of carbon even at the deeper levels. The chemical composition of the organic matter added to the soil is important for increasing the time the carbon remains in the soil and also for the slow decomposition of the organic matter. Researchers found the use of green manure crops to increase the soil organic carbon storage to be highly successful in Bukoba.[23]. Further research should focus on certain factors important in claiming carbon credits:

- Increase in the movement of organic matter to the deeper layers
- Incorporation of good quality residue which can improve the SOM
- Reduction of soil loss through erosion, tillage, residue removal, drainage and other forms of disturbances, but especially the loss of clay and silt through soil erosion
- Increase in the proper land sequestration management measures
- Recognition of the importance of micro-organisms and soil in the soil carbon sequestration process
- Management of intensive cultivation which results in soil aggregate destruction and soil biodiversity loss
- Giving preference to the term 'attainable' rather than 'potential' when considering SOC sequestration because it takes into consideration factors that limit the input of carbon into the soil system
- The necessity of an analysis of socioeconomic trade-offs between the most viable potential sequestration land use and its availability for successful CDM project implementation

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10 Climate variability, pastoralists' vulnerability and options

The case of the Borana of Northern Kenya

Tari Doti

INTRODUCTION

The livelihoods of pastoralist communities largely depend on livestock. Pastoralism is practised in a sensitive and insecure environment characterised by highly spatial and temporal rainfall distribution, which often results in long, dry periods. Therefore, pastoralism, as an economic activity, is indeed a precarious enterprise because it depends heavily on sensitive ecological systems.

Climate change has been primarily caused by selfish and shortsighted human activities such as massive industrial production and deforestation, among others. Currently, climate change poses a threat to human development in terms of security and livelihood. This sentiment has been underscored abundantly by various scholars and renowned personalities in many forums.

Climate change and pastoralists' livelihood are interlinked processes: pastoralists and their livestock depend directly or indirectly on the environment, hence threats from climate change, particularly persistent drought, have far-reaching consequences for them. Severe drought affects the availability of water resources and forage for livestock, and long periods of drought have led to the loss of large numbers of livestock in most pastoral areas.

The Borana pastoralists have adapted to the cyclic tendencies of the droughts, and with time have come to rely on traditional coping strategies aimed at minimising losses from drought or facilitating recovery thereafter. These coping mechanisms include manoeuvres aimed at managing natural resources through flexibility and spreading risk, and include strategies such as mobility and/or migration, communal land ownership, large and diverse herds, herd separation and splitting, informal social security systems, forming economic alliances with non-pastoral communities, and engaging in non-pastoralist activities like farming and charcoal burning.

Unfortunately, these strategies that have served the communities very well in the past are inadequate in the light of the frequent occurrence of droughts, rapid social and economic changes and deteriorating climatic conditions. This is in addition to the presence of other factors such as cattle rustling, the proliferation of small arms, social and economic marginalisation, poor government policies, illiteracy, population explosion and the displacement of pastoralists, which exacerbates their vulnerability amid the challenges already posed by climate change.

This chapter assesses the vulnerability of the Borana pastoralists of northern Kenya to climate variability and explores the indigenous coping mechanisms used hitherto.

There are about 200 million pastoral households with an estimated billion head of livestock worldwide.[1] The pastoral system uses about a quarter of the available land worldwide and provides ten per cent of the world's meat production.[2] In Kenya, about 16 per cent of the total land surface is utilised for arable farming and dairy production, while the remaining 84 per cent is classified as arid and semi-arid, and this sustains the pastoral livestock production system and wildlife.[3]

Livestock production contributes significantly to the national GDP of the Kenyan economy. It is estimated that about 70 per cent of livestock are found in the arid and semi-arid areas of Kenya.[4] This shows that the contribution of the arid and semi-arid areas is crucial for the development of the country. However, over many years, the pastoralists of northern Kenya have faced challenges that have undermined their economies and traditional way of life.[5] Among other things, these challenges include recurring drought, climate change, ethnic conflict, political and economic marginalisation, high population growth and competition for rangeland.

The genesis of the marginalisation of the pastoralists of Kenya can be traced to the beginning of the colonial era when colonists introduced grazing blocks to curtail the free movement of livestock in search of water and pasture.[6] This was meant to limit the mobility of the pastoralists to make them amenable to the new governance system and minimise pastoral ethnic conflicts over natural resources. However, this division created ethnic consciousness and disrupted the traditional mode of access to the natural resources, reciprocity among different ethnic groups and mutual assistance during droughts and other calamities.[7]

After independence, nothing much improved for the pastoralists. Indeed, both ecological and political relations deteriorated following the extensive droughts of 1968 and 1973, and the secessionist war popularly called 'Shifta' in the northern part of Kenya.[8] It was also between 1968 and 1973 that donor countries and international development agencies initiated programmes aimed at improving the livestock production and market integration of the pastoralists. The guiding philosophy for this programme was predicated upon the argument propounded by Garret Hardin's 'tragedy of the commons', which held that traditional communal land ownership was wasteful and inherently degraded the environment.[9] The government was therefore encouraged to promote the private ranching of livestock to conserve the environment better. Traditional pastoral production systems demand mobility, but the actions of the government prevented this movement through land alienation, the demarcation of grazing boundaries and the mechanisation of boreholes, which encouraged pastoralists to remain in one place. Yet, the essence of pastoralism is constant movement from one place to another in pursuit of water and pasture, and hence the proposed limited mobility of the pastoralists challenged the very mode of their production systems and realities.[10]

Pastoralism continued to suffer as the government priority was dominated by the need to conserve the environment, eliminate poverty and spur economic growth through export agriculture.[11] Pastoralism was seen to offer less to the state in terms of resources for the export market, hence was of less economic value to the government. Also because some pastoral communities like the Borana, Turkana and Pokot cross state boundaries in search of pastures and water, they are believed to lack reliability, political loyalty and even to pose a threat to national security.[12].

The challenges of pastoralism go beyond political governance. In recent years, the impact of inherent problems associated with climate change on

people's livelihoods has generated public debate. A substantive report by the Intergovernmental Panel on Climate Change (IPCC) confirmed the occurrence of potential threats such as increases in temperature, heat waves, flooding, storms, droughts leading to famine, population displacement, the possible outbreak of diseases, decline in agricultural production and migration to urban areas.[13] (See also Barnett and Adger).[14]

In Kenya, climatologists project a substantial increase in the annual average temperature of between 3–5°C by the end of the millennium because of climate change.[15] The increase in temperature brings consequences such as a loss of moisture and an increased evaporation rate. Coupled with declining precipitation, climate change worsens the aridity of the pastoral rangelands and affects a number of resources such as water, pasture and the edible fruits that pastoralists depend on.[16] The ensuing consequences would be the decimation of livestock in large numbers, which could significantly affect pastoralist livelihood and security.[17] Livestock define the economic, social and political hub of the pastoralists. For pastoralists to lose their livestock is to lose their entitlement, which makes them vulnerable and valueless in the society.[18]

While climate change affects crop and livestock production, the impact is felt even more keenly for pastoralists, because they inhabit fragile arid and semi-arid areas where the possible occurrence of drought becomes more frequent with climate change. Furthermore, pastoralists depend on an ecologically sensitive environment which responds drastically to changes in the climate. They also face other non-climatic stressors such as poor soil quality, weak infrastructure, armed violence, poverty and poor governance. All these factors combined render the pastoral communities even more vulnerable to climate changes.[19] Interestingly, pastoralism has been resilient despite all these challenges. Pastoralists have implemented a wide range of adaptive mechanisms to cope with socioeconomic, political and environmental stresses.

CLASSIFICATION OF PASTORALISTS

Pastoralists can be classified depending on their migratory behaviour and engagement with other non-pastoralist economic activities.[20].

Nomadic pastoralists move from one place to another in pursuit of water and pasture for their livestock. Their migration patterns follow well-defined traditional stock routes that avoid disease vectors such as tsetse flies and ticks.

Owing to their nomadic nature, they depend heavily on their livestock for their livelihood. In some instances they may establish cordial relationships with crop farmers who provide them with grains in exchange for livestock, livestock products or money from the sale of livestock.

Transhumance pastoralists have a permanent homestead where the old, sick, young and disabled reside as the rest of the family members move with the livestock from place to place. They split their herds so that the weak and lactating livestock remain at the homestead, while the rest move from place to place in search of water and pasture. This group practises subsistence farming in areas with favourable weather conditions.

Agro-pastoralists are nearly completely permanently located and engage in farming. They own farmlands where they grow crops and keep small herds of livestock that graze on communal land. Occasionally, they experience conflict with regard to crop and livestock land use.

WHO ARE THE BORANA PASTORALISTS?

The Borana are a pastoralist ethnic group living in northern Kenya and southern Ethiopia. They form a large part of the Oromo nation and moved into the present day Kenya in about the 16th century during their major expansion migration.[21].

At present, the Borana are found in the Moyale, Marsabit and Isiolo districts in Kenya.[22] According to the census of 1999, they were estimated to number about 200 000– 300 000.[23] The Borana are divided into two major parts known as 'sabbo' and 'gonna'. The sabbo are further divided into three clans collectively known as 'sabbo sadenni', whereas the gonna are divided into the 'haroressa' and 'fulele', which comprise 14 clans. The Borana have a complex social and political system known as 'gada'.[24] The gada system defines the relationship between people, natural resources (water, land, fauna and flora, etc) and nature (God).

They are predominantly cattle keepers, although they also rear goats and sheep which serve as petty cash in times of need. Owing to the changed weather, they have diversified their herds to include camels which are highly resistant to drought.

The majority of the Borana are Muslims with a small percentage being Christians and traditionalists. Indeed, 75 per cent of the Waso Borana were converted to Islam by 1952.[25] Despite having different religious affiliations, the Borana recognise the gada system, which confirms their unity.

UNDERSTANDING CLIMATE CHANGE: SCIENCE VERSUS BORANA LOCAL KNOWLEDGE

According to science, global warming is mainly caused by the accumulation of greenhouse gases forming a thin layer in the atmosphere that traps excess heat and radiates it back to the Earth causing the global temperature to rise.[26] Notably these gases include carbon dioxide, nitrous oxide and methane, which result from burning fossils and from deforestation. Other natural activities such as the Earth's orbital characteristics, volcanic eruptions and variations in solar output also increase the accumulation of greenhouse gases in the atmosphere.[27]

The Borana pastoralists use indigenous knowledge to describe changes in the climate and climate variability. They rely on environmental indicators to illustrate changes in the ecological processes caused by climate variability. Such indicators include the frequency of droughts, the dryness of rivers and streams that used to flow throughout the year, changes in rainfall patterns in time and by prediction, the disappearance of certain grasses or forage and herbaceous plant species, bush encroachment of rangelands, the intensity of floods and run-off, bare and barren soil, the frequency of conflicts, the mating pattern of livestock, the changing season of certain flowering plants, and the prevalence of certain insects, birds and diseases.

CLIMATE VARIABILITY AND INDIGENOUS COPING MECHANISMS

The vulnerability induced by climate change led the pastoralists to develop various coping mechanisms over the years which they have relied on to minimise their risks. However, changing trends in environmental, political and social pressure have limited the available indigenous choices, creating greater vulnerability for the pastoralists.

The Borana devised an indigenous method to cope with the most common adverse effect of climate change – severe drought. To mitigate the impact of drought, they developed a natural resources management pattern by being flexible and spreading their risk by employing strategies such as mobility, communal land ownership, large and diverse herd sizes, and herd separation and splitting.[28] Apart from the traditional coping systems, other actors like the government and non-governmental organisations also played a role in intervention,

and developing and implementing adaptation strategies to reduce vulnerability to the impacts of climate change.

The Borana occupy tribal territorial grazing land, which they classify as wet- and dry-season grazing areas. These ecologically classified grazing areas are used alternately, depending on the weather conditions. The wet grazing areas are used only during the wet season because they dry very quickly and therefore lack water for the livestock during the dry seasons. The dry grazing areas are potential areas such as pockets of highlands, riverine ecosystems and flood plain which are used during droughts.

The Borana keep large herds of livestock which serve many functions such as a form of insurance, investment and a hedge against drought. Large herds increase the chances of livestock survival during droughts and the outbreak of diseases. They are also used to feed large families as well as to build social alliances and future security through gifts to friends and clan members. The livestock given out as gifts could eventually be redeemed during bad times in the form of reciprocity.

The diversity of livestock herds has ecological and economic implications. Different herds such as cattle, camels, goats and sheep have different water and pasture requirements and different resilience to drought and diseases. The diversity of the herds ensures risk distribution. For example, small stock like goats and sheep have high fecundity and hardiness to drought, which make them suitable for post-drought reconstitution strategies.[29]

As already stated, the Borana move from one place to another in search of water and pasture during dry periods. This mobility enables them to exploit and utilise widely dispersed pastures at times when they are nutritious. The movements also facilitate an escape from drought and diseases both locally and across national boundaries. Herd separation and splitting into either home-based ('warraa') or satellite camps ('fora') are crucial for mobility and resource management. This ensures minimal use of the water and pastures reserved for dry-period grazing. The Borana also parcel out livestock among relatives ('dabarre') living in different geographical locations to increase the chances of survival during droughts or outbreak of disease.

Communal land ownership and management of natural resources are central to pastoralism because they ensure that herd owners can move freely in search of water and pasture in different locations at different times of the year. The Borana maintain a mutually helpful relationship with agricultural communities such as the

Burji and Konso, on whom they lean during hard times. This relationship is cultivated through gifts or the exchange of grains for livestock or livestock products.

Sometimes the Borana engage in non-pastoral activities such as farming, small business and wage labour to cope with adverse events. Urban migration to seek wage employment increased by almost 450 per cent between 1962 and 1969 and after the successive droughts.[30] Migrants send remittances to their rural families to buy food, clothes, build shelters and restock livestock. The Borana living in Moyale, Sololo and Marsabit have also perfected the skills of farming which they acquired from their neighbours. They grow food crops such as beans, maize, sorghum and teff, and cash crops like khat in Marsabit.[33] They also rear poultry, which was considered an abomination in the past.

Borana traditional law provides for informal security arrangements among the community. The Borana have an informal social security mechanism known as 'bussaa-gonofa' which creates binding social security relationships between the clans. This system is mutual and voluntary, and can be enforced by the traditional laws. The purpose of the bussaa-gonofa is to help restock the herds of poor clan members who lose livestock through natural or man-made calamities. Unfortunately, this system is declining owing to widespread poverty in the region and the modern individualistic lifestyle.

CLIMATE VARIABILITY AND THE BORANA VULNERABILITY: SOME UNDERLYING CAUSES

Apart from the climatic variability, there are other non-climatic occurrences that predispose the pastoralist Borana to the adverse effects of climate change:

Shifta war or 'Dhabaa' period

As the name suggests, the dhabaa period illustrates tragically how political strife and repression have led directly to impoverishment, loss of livelihood and famine among the Borana pastoralists, particularly the Waso Borana.[31]

It is alleged that, by the 1950s, the Borana were the wealthiest and the most productive pastoralist group in East Africa.[32] They traded their surplus animals to predominately Somali traders, who, in turn, marketed the beef to the growing urban populations and sold the livestock to European ranchers.[33] The Borana's fortunes turned dramatically following the independence movements of the early

1960s, mainly attributable to two factors. Firstly, they were victims of political miscalculation and state repression; secondly, they suffered the effects of the prolonged drought in the region during which they lost large numbers of livestock.

The Borana, particularly the Waso, were victims of political miscalculation and state repression because they joined the Somali secessionist movement fighting the government of Kenya. In an attempt to crush the rebellion, Waso Borana were put into concentration camps and brutalised by government forces. Their livestock were either killed or confiscated. By 1971, they had lost about 95 per cent of their livestock and were in a state of genuine starvation, surviving on famine relief provided by the Catholic Relief Services.[34] This situation was made worse by the prolonged drought which affected any recovery strategy. By 1984, an estimated 40 per cent of the Borana population of the Isiolo district lived in poverty in or around the administrative townships, eking out a living as charcoal burners, firewood gatherers, paid herders, night watchmen or prostitutes.[35] The traditional social system of reciprocity, stock loans and reliance on kin also crumbled in the region.[36]

Drought

Prolonged and frequent periods of drought degrade rangeland resources and lead to starvation and the death of livestock.[37] The decimation of livestock has severe implications for pastoralists as their survival depends on their livestock.

The impact of drought has been witnessed in most parts of northern Kenya. For example, between 1979 and 1980, the Turkana of northern Kenya lost about 70 per cent of their livestock because of drought.[38] The Borana lost large herds of livestock to the multiple droughts of 1983/1984, 1991 and 1992, which were experienced in Obbu and other Borana pastoral regions.[39]

Drought periods also correlate positively with increased incidences of ethnic conflicts over stiff competition for water and pasture, which sometimes extends across borders. Pastoral insecurity determines grazing areas. When insecurity is high, livestock herds tend to concentrate in small secure grazing zones, while leaving large tracts of land unused in most of northern Kenya. However, in certain extreme circumstances such as severe drought, insecurity becomes a secondary issue to the pastoralists.[40] Access to dry-period grazing areas is limited by the fact that cattle raids among neighbouring communities increase during droughts. A good example is the abandoned grazing land on the borders

between the Gabra and Borana of Marsabit and Moyale, the Somalis and Borana of Isiolo, the Garre and Ajuran of Wajir and the Garre and Murule of Mandera. Because government security forces are inadequate or absent in most pastoral areas owing to their vastness and remoteness, most pastoralists acquire illegal arms for self-protection, hence aggravating the problems of proliferation of small arms and light weapons and creating an environment conducive for criminals engaged in commercialised livestock raids.[41]

During droughts pastoralists are faced with two tragic situations which affect their capacity to cope with the drought and feed their families. There is decreased herd productivity owing to the high mortality rate, reduced or no milk production, no calving, and animal weight loss that affects the market value of the livestock. Pastoralists tend to reduce their livestock numbers during a drought out of desperation and to provide food for their families.[42] Unfortunately, during droughts, livestock become emaciated and lose weight and do not attract competitive bids because buyers do not wish to take risks. Thus, the pastoralists are offered a highly discounted price for their livestock.

Cattle rustling and small arms proliferation

Cattle rustling is sometimes seen as a restocking strategy after periods of drought. However, the insecurity caused by cattle rustling and the use of small arms has made pastoralism a risky economic business. Localised conflicts over the use of natural resources and exploitation are endemic in most pastoral and agro- pastoral systems. In former times, traditional norms and principles guided raiding activities, but at present cattle raiding has evolved into a more complex cross-scale dynamic. It has changed from being a quasi-cultural practice with an important element of livelihood enhancement into a more predatory activity that occurs on a large scale and is more violent.[43]

Conflicts in pastoral areas are driven by a host of factors. Mwaura and Schemeidl observed that conflicts in the Horn of Africa tend to have a political dimension in the sense that states are either involved in handling the conflict or become the arena for such conflicts. They noted the example of the democratic reforms and multiparty system in Kenya where the government fuelled ethnic animosity and rivalries in order to portray democratic reforms as chaotic and unacceptable to the people.[44] Sometimes ethnic conflict such as predatory raiding resonates with political events at the national level, especially

when inter-ethnic political rivalry and competition are present during national elections. During such an electioneering period, politicians have been found to instigate ethnic conflicts so as to appear heroic and improve their reputation and political standing in the communities.[45]

Because of the vastness of the Borana rangelands and the poor terrain, the presence of government officials and forces in these areas has been a serious problem for a long time. The Borana have to rely on their own defence system to protect their livestock from external aggressors. They do so by acquiring sophisticated weapons to match those of their adversaries. These are easily obtainable through the porous borders of Kenya, Uganda, Ethiopia, Sudan and Somalia. As a result, the availability of small arms and light weapons has continued to create a desperate situation of permanent insecurity in the pastoral areas as well as making raiding easier but much more dangerous.[46]

Criminals and businessmen commercialise cattle raids to make quick money from the sale of stolen livestock in a readily available local market, neighbouring countries or foreign markets.[47] They even finance the purchase of illegal guns to be used in raids and indemnify raiders in the case of casualty or death. A number of stolen livestock have been intercepted on their way to the local market or at the local abattoir after raids.[48]

Tragedy of the open access

While communal land ownership among the Borana has been a drought-coping strategy, the inherent problem of public good associated with non-excludability and non-rivalry regarding the use of resources becomes a challenge.[49] For example, during severe droughts, the Borana of Isiolo as well as the Somalis from the neighbouring districts make for the wet grazing land of the Ewaso Ngiro swamps. Competition with regard to the use of scarce resources leads to overstocking, which degrades the rangeland land through overgrazing. As rivalry in exploitation increases and resource bases dwindle, conflict between the communities sometimes become inevitable.

Government policies and land tenure systems

Development strategies used by the independent Kenyan government closely followed the colonial blueprint. The government implemented policies which

promoted the cultivation and irrigation of pockets of potential areas in arid and semi-arid Borana rangeland purportedly to spur economic growth.[54] This strategy of promoting export agriculture accentuated the migration of cultivators into pastoral rangelands, thus depriving the Borana of access to dry-season pastures and making them vulnerable to drought. In addition, in Marsabit and Isiolo, the encroachment of rangelands by national game parks and reserves pushed the Borana into a fragile ecosystem prone to frequent droughts.

Land tenure systems in pastoral areas are a controlled access system. The local county councils hold the land in trust for the communities as stipulated in the Constitution of Kenya. The land thus becomes communal property which cannot be used as collateral to secure loans from the banks.

CONCLUSION AND RECOMMENDATIONS

Climate change and its variability have extreme consequences that affect vulnerable communities like pastoralists who have limited options for adaption. Climate change severely affects the livelihood of pastoralists because they depend heavily on livestock, which, in turn, depend on the natural environment for production and survival. Therefore, the effect of drought, low precipitation, incidences of diseases and pests, and high temperatures induced by climate change affect the availability of pasture and water supplies for the livestock, and pasture and water are critical for their survival.

Climate change will exacerbate the drought situation, leading to competition over scarce resources and conflicts among resource users. The spillover consequences of drought are cattle rustling and the acquisition of small and light weapons for use in raids. Some pastoral households are compelled to seek an alternative livelihood such as wage labour in urban areas, farming, charcoal burning, making illicit brews, prostitution, theft and thuggery, in an attempt to mitigate the effects of economic stress.

Over time, the Borana pastoralists have adapted to climate change through indigenous mechanisms, but unfortunately their adaptation strategies are losing efficacy owing to socioeconomic, political and environmental change. Therefore, given the severe consequences of climate variability on their livelihood and security, the existing indigenous coping mechanisms of the Borana should be complemented with modern coping approaches to cushion them from extreme

vulnerability. It is recommended that the government and other actors implement sustainable and effective intervention measures such as the following:

- Developing appropriate drought cycle management strategies at every stage of the drought, including, for example, water tracking, fodder provision, livestock reduction and warning systems for herders
- Providing drought early warning systems and awareness campaigns
- Drilling boreholes and servicing existing ones, building dams, wells, water pans and harvesting run-off
- Providing veterinary services, training and seminars on better methods of livestock husbandry
- Providing adequate security in the pastorals areas and promoting peaceful ethnic coexistence, indigenous methods of resource sharing and conflict resolution in pastorals areas
- Avoiding the unnecessary creation of administrative boundaries in the pastoral areas, which were sometimes sources of conflicts
- Providing good and convenient livestock markets and encouraging pastoralists to diversify their livelihood through farming, small businesses, and so on
- Providing basic infrastructure such as roads, school and health centres

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11 Dynamics of cultivated land and its association with rainfall variability in Botswana

Implications for food security under climate change

Nnyaladzi Batisani

INTRODUCTION

Changes in the cultivation of land are an important indicator of agricultural output stability and reliability. Over the years, urban expansion driven by employment opportunities in urban centres and declining rainfall have led to the conversion of agricultural land to the built environment, thus threatening food security in semi-arid regions. Climate variability and change add another stressor to food security in these regions. An understanding of the spatial and temporal extent of the variability of land cultivation and its association with rainfall is needed to help policymakers assess the likely impacts of climate change on food security.

The goals of this chapter are to explore the change in land cultivation across space and time as well as the rainfall phenomena for any sign of climate change in semi-arid Botswana, and also to examine the relationship between rainfall variability and the extent of land cultivation, and the ensuing policy implications for food security amid climate change.

To these ends, the chapter determines the trends and variability of land cultivation and its correlation with rainfall. The chapter also analyses rainfall

variability and annual trends in that variability. The results show extensive variability in land cultivation over time and a significant decrease in land cultivation across the nation over the years, with a high correlation of 0,8 between land cultivation and annual rainfall. The results agree with earlier studies showing the rainfall patterns and variability across Botswana. The results also show a trend towards decreased rainfall throughout the country, which is associated with a decrease in the number of rainy days. Both the drying trend and decrease in rainy days agree with climate change projections for southern Africa. The chapter finally discusses policies that the government could adopt to improve food security in the country in the midst of climate change.

Food security in many African countries is at a critical juncture. Unlike some periods in the past, when the continent has been able to meet most of its food requirements from domestic agricultural production, the future raises some serious challenges, including population growth, declining soil productivity, global financial meltdown and climate change. At the same time, opportunities exist for increasing production through a combination of improved technology, expansion of cropland, and soil productivity maintenance.[1] Agriculture remains a driving force for economic development in the Southern Africa Development Community (SADC). It is the primary source of food and employs 61 per cent of the region's population, accounting for close to eight per cent of the region's GDP. Despite the importance of the sector in the economies of SADC countries, agricultural growth rates have been both low and highly variable across the region, averaging only 2,6 per cent per annum in the last decade.[2]

Of the numerous explanations for the sector's poor performance the most significant are insufficient investment in agriculture, poor access to agricultural inputs (especially fertilisers and improved seed) and to markets, and low levels of technology development and dissemination. These factors have resulted in limited growth in the average yields of key crops and in low labour productivity. Other factors include adverse climatic conditions and HIV/AIDS, both of which threaten the livelihood of farming households.[3] This low agricultural productivity calls for the strengthening and transforming of agriculture in the region so that it stimulates much-needed economic growth and contributes measurably to poverty reduction. Increasing food production will help ensure that food prices remain low, thus creating a conducive environment for the development of a broader commercial economy. Cultivated land is a fundamental input for

food production, hence its dynamics are closely linked with food security and human existence.[4]

Society is becoming increasingly concerned about the consequences of climate change for food systems and, in a number of regions, for food security. There is also concern that meeting the rising demand for food will lead to environmental degradation, thereby exacerbating the factors which are in part responsible for climate change, and, in turn, further undermining the food systems upon which food security is based.[5] Climate change will have a negative impact on agriculture and food security across the globe because a large portion of the world's food is grown as rain-fed crops where climate variability plays an important role in determining productivity. Rain-fed agriculture remains the dominant source of staple food production and the foundation of the livelihood of the majority of the rural poor in sub-Saharan Africa (SSA). Hence an enhanced investment in agriculture by a broad range of stakeholders will be required if this sector is to meet the food security requirements of tomorrow's Africa.

Nevertheless, production uncertainty associated with between and in season rainfall variability remains a fundamental constraint to many investors who often overestimate the negative impacts of climate-induced uncertainty. Climate change is likely to make matters worse with increases in rainfall variability being predicted. The ability of agricultural communities and agricultural stakeholders in SSA to cope better with the constraints and opportunities of the current climate variability must first be enhanced for them to be able to adapt to climate change and the predicted future increase in climate variability.[6]

Hansen, Dilley, Goddard et al noted that climate variability contributes significantly to poverty and food insecurity.[7] Thus proactive approaches to managing climate variability in vulnerable rural communities and among institutions operating at community, subnational and national levels is a crucial step towards achieving the millennium development goal of eradicating extreme poverty and hunger. Downing and Ziervogel and Calder observed that there is limited understanding of how climate variability currently impacts food systems and associated livelihoods.[8] This relationship needs to be better understood before assessing the impact of climate change on food security. Therefore this chapter tries to contribute to this understanding by evaluating rainfall variability and trends and their relationship to the amount of land cultivated on an annual basis.

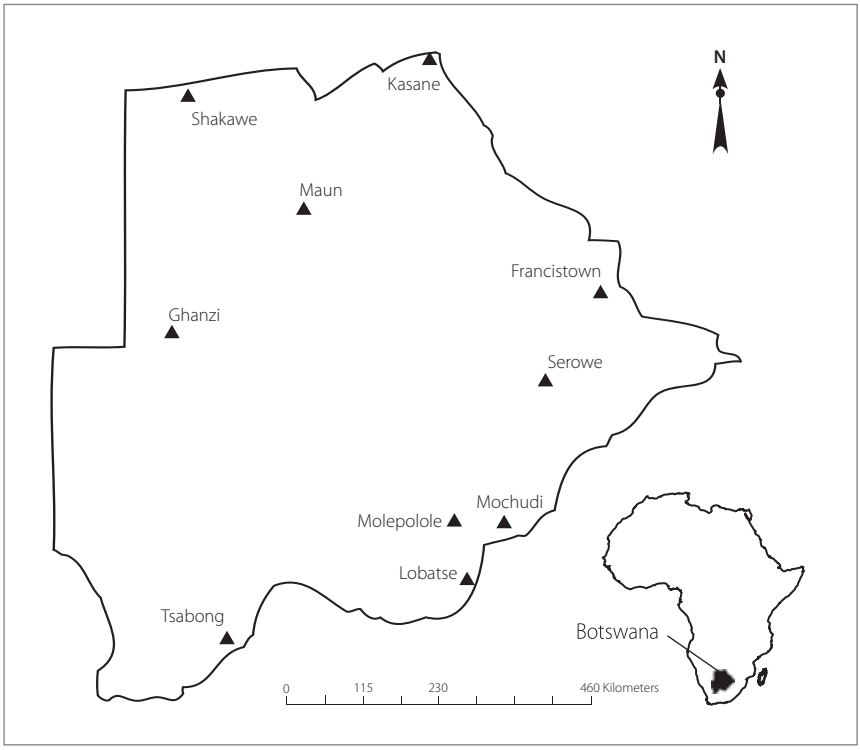
MATERIALS AND METHODS

Study area

Botswana is a landlocked country in southern Africa (Figure 1). It lies approximately between latitudes 18° and 27° S and longitudes 20° and 29° E, a region covered by approximately 582 000 square kilometres, and has a population of 1,7 million people.[9] The landscape is flat to gently rolling; the Kalahari Desert, located in Botswana's south-west, covers nearly 70 per cent of the country, with the remaining areas being primarily tropical grassland and savanna. Thus soils are generally sandy and infertile.

Botswana is mainly semi-arid to arid owing to its position under the descending limb of the Southern Hadley cell circulation. Almost all rainfall

Figure 1 Location of weather stations used in the analysis



occurs during the summer months of November to March: in early summer, the interior thermal low and moist north-easterly flow deepens, allowing upper westerly waves to bring isolated rainfall; in mid to late summer, tropical easterly systems and continental troughs edge into Botswana.[10] During these periods, rainfall mostly occurs in two to four-day spells with occasional heavy rainfall accounting for the bulk of the precipitation.[11] This climatic environment means that the presence or absence of a few weather systems makes the difference between a wet or dry year and thereby makes Botswana prone to weather hazards, including floods, droughts, and veld fires. Owing to the intensity of the rainfall, flash floods are commonly experienced on a local scale, although widespread flooding on a national scale sometimes occurs. For example, the combination of a tropical low in early February 2000 and a tropical depression later that month resulted in floods that ravaged the southern African subregion, including Botswana, causing extensive damage to infrastructure and property.

Data and methods

Rainfall data from the Department of Meteorological Services for the 31-year period 1975–2005 and information regarding the extent of cultivated land at agricultural region level from the Ministry of Agriculture form the basis of the analysis. The data set includes the monthly rainfall figures for eight stations that are fairly evenly spread within the agricultural regions across the country, as well as the total land cultivated annually per agricultural region. Lobatse meteorological station is in the southern region, Mochudi and Molepolole stations are in the Gaborone region and Serowe is in the central area. Tsabong and Ghanzi station are in the western region, while Maun, Kasane and Shakawe stations are in the Maun region.

Basic descriptive statistics were calculated to evaluate rainfall variability. These statistics include annual minimum rainfall, annual maximum rainfall, annual mean rainfall, and standard deviation, coefficient of variation, coefficient of skewness, and coefficient of kurtosis. Pearson's correlation was used to determine the relationship between annual rainfall and the extent of the land cultivated annually at various annual rainfall lag levels, while the Mann-Kendall test (MK) was used to determine annual rainfall trends, monthly rainfall trends, and trends in rainy days per year by considering the statistic *S*.[12]

$$S = \sum_{i=2}^{n} \sum_{j=1}^{n} sign\ (X_i - X_j) \quad (1)$$

where x_j is the sequential data value, n is the length of the time series, and sign $(x_i - x_j)$ is -1 for $(x_i - x_j) < 0$, 0 for $(x_i - x_j) = 0$, and 1 for $(x_i - x_j) > 0$. The mean $E(S)$ and variance $V(S)$ of the statistic S were obtained as:

$$E(S) = 0 \quad (2)$$

$$V(S) = \frac{n(n-1)(2n+5) - \sum_p^q t_p\,(t_p - 1_j)(2t_p + 5)}{18} \quad (3)$$

where n is the number of (monthly) values in the set, t_p is the number of ties for the p^{th} value, and q is the number of tied values. The second term represents an adjustment for tied or censored data. The standardised statistical test (Z) was computed by:

$$Z = \begin{cases} \dfrac{S-1}{\text{var}(S)} \text{ if } S > 0 \\ 0 \text{ if } S = 0 \\ \dfrac{S+1}{\text{var}(S)} \text{ if } S < 0 \end{cases} \quad (4)$$

Positive Z values indicate increasing trends and negative Z values indicate decreasing trends. When testing either increasing or decreasing monotonic trends at a p significance level, the null hypothesis is rejected for absolute values of Z greater than $Z_{1-p/2}$ obtained from the standard normal cumulative distribution tables. In this chapter, significance levels of p = 0,05 and 0,10 are applied.

The explained variation (R^2) of the correlation between annual rainfall and number of rainy days per annum was also assessed. The point of this assessment was to see if a station's rainfall could be explained more by the total number of days with rain or by individual large rainfall events.

RESULTS

The descriptive statistics for annual rainfall across stations are presented in Table 1. The mean annual rainfall across Botswana ranges from 312,1 millimetres at Tsabong in the extreme south-west to 574 millimetres at Kasane in the extreme north. The standard deviations are surprisingly low, ranging from 137,4 to 195,6 millimetres. The mean values of the coefficient of variation for the country is 37,15

Table 1 Botswana's annual rainfall

Stations	R_m	R_x	R_e	SD	C_v	C_s	C_k	Annual trend	*p*-value
Francistown	183	911,6	474,5	190,9	0,40	0,45	-0,04	-2,36	0,02[a]
Ghanzi	162,2	857,5	433,7	150,5	0,34	1,08	2,22	-2,24	0,03[a]
Kasane	329,1	939,4	574,0	162,4	0,28	0,88	0,31	0,21	0,83
Lobatse	291,3	829,8	511,7	148,5	0,29	0,41	-0,78	-2,16	0,03[a]
Maun	195,2	940,3	427,8	161,7	0,37	1,06	1,83	-1,17	0,02[a]
Molepolole	149,5	851,6	458,8	195,6	0,42	0,39	-0,75	-1,51	0,01[a]
Serowe	222,9	970,2	442,4	180,1	0,40	1,36	1,95	-0,10	0,09[b]
Tsabong	53,6	664,2	312,1	137,4	0,44	0,54	0,27	-1,72	0,09[b]

per cent, and these coefficients are higher than 30 per cent for all stations except Kasane (28,3%) and Lobatse (29,0%), thus suggesting less variation in rainfall at these two stations. As is typical for rainfall, all stations are positively skewed, with the mean value of the coefficient of skewness being 0,78 for the country. However, three stations (Serowe, Maun and Ghanzi) are appreciably more skewed than this mean and three stations (Molepolole, Lobatse and Francistown) are notably less skewed. The more skewed stations thus have more events with lighter rainfall and the less skewed stations have fewer events with heavier rainfall.

The mean value of the coefficient of kurtosis is 0,63 for Botswana, but again there is a split among the stations on either side of this figure. As expected, stations with strong positive skew have the most peaked (leptokurtic) distributions, whereas those with negative skew have the flattest (platykurtic) distributions. The two stations nearest the mean skewness have the most 'normal' kurtosis. There appears to be no discernible spatial trend in any of the descriptive statistics, except that rainfall increases from south-west to north-east across Botswana.

In Table 1, the abbreviations are as follows:

- Annual minimum rainfall (R_m)
- Annual maximum rainfall (R_x)

Table 2 Trends of monthly rainfall

Station	Month											
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Francistown	-0,36	-0,65	0,70	-1,35	-1,27	1,41[b]	-0,17	-2,49[b]	-1,92[a]	-1,96[b]	0,37	0,52
Ghanzi	-1,52	0,13	-0,18	-0,63	-0,69	1,59	0,38	-1,13	-1,69	-1,80	0,37	-1,23
Kasane	-0,58	-0,13	-1,04	0,79	-0,69	1,14	0,00	1,35	1,03	-1,1	0,42	-1,07
Lobatse	-2,45[b]	-0,02	-1,25	-0,80	-0,10	-0,68	-1,81	-2,66[b]	-2,01[a]	-0,28	-1,01	1,33
Maun	-0,71	-0,91	-1,17	-0,02	-0,97	0,28	0,38	-0,85	-1,44	-1,54	-0,06	0,91
Molepolole	-2,27[a]	-0,06	-1,38	-0,15	0,69	0,57	-0,81	-2,48[b]	-2,52[b]	-0,37	0,59	0,97
Serowe	-0,47[a]	-0,73	-0,81	-0,48	0,31	2,04	-0,60[a]	-1,21	-2,07[a]	-0,41	0,66	0,11
Tsabong	-0,94	-1,90[a]	-1,01	-0,15	0,90	-0,77	-1,47	-2,19[a]	-1,18	-0,13	-0,84	0,91

[a] Significant at p<0,05 [b] Significant at p<0,10

- Annual mean rainfall (R_e)
- Standard deviation (SD)
- Coefficient of variation (C_v)
- Coefficient of skewness (C_s)
- Coefficient of kurtosis (C_k)
- Trend in annual rainfall (Annual trend)
- Significance level of that trend (*p*-value)
- R_m, R_x, R_e, and SD are in millimetres

The application of the Mann-Kendall (MK) test to annual rainfall (Table 1) indicates statistically significant negative trends for seven of the eight stations. The annual rainfall shows significantly decreasing trends for Francistown (-2,4 mm/year), Ghanzi (-2,2 mm/year), Lobatse (-2,2 mm/year), Tsabong (-1,7 mm/year), Molepolole (-1,5 mm/year), Maun (-1,2 mm/year) and Serowe (-0,5 mm/year).

Table 2 portrays monthly rainfall trends for eight stations over the last 30 years. The trends are generally towards drier conditions, especially during the months of January, February, and March – the latter part of the crucial rainy season. Lobatse, Molepolole and Serowe show significantly decreasing rainfall trends of -2,5, -2,3 and -0,5 millimetres per month for January, and Tsabong has a significantly decreasing trend of -1,9 millimetres per month in February. There is also an especially strong trend towards decreasing rainfall in the late winter/early spring dry season. August shows significantly decreasing trends for Francistown, Lobatse, Molepolole and Tsabong; September displays significantly decreasing trends for Francisown, Lobatse, Molepolole and Serowe, and October reflects a significantly decreasing trend for Francistown. Only one significant increasing trend appears in the table – ironically, for Francistown in June.

The only apparent spatial trend is that the three stations to the north and north-west (Kasane, Maun and Ghanzi) have no months with statistically significant temporal trends.

Table 3 shows mean annual rainy days, trends in rainy days per year, and the explained variations of the correlations between rainy days per year and annual rainfall. The mean number of rainy days is highest for Maun in the north-west (37) and lowest for Serowe in the south-east (22). The three stations in the north-west (Shakawe, Maun and Ghanzi) have much higher numbers of rainy days than the three stations in southern and eastern Botswana (Serowe, Mochudi and Tsabong). The number of rainy days per year shows a clear decreasing temporal

Table 3 Mean number of rainy days per year (MRD)

Stations	MRD	RD trend	*p*-value	R^2
Ghanzi (western region)	33	-1,04	0,03[a]	0,10
Maun (Maun region)	37	-1,43	0,15	0,85
Mochudi (Gaborone region)	24	-1,04	0,30	0,26
Serowe (central)	22	-1,04	0,30	0,41
Shakawe (Maun region)	35	-1,14	0,26	0,69
Tsabong (western region)	24	-2,18	0,02[a]	0,06

[a] Significant at p<0,05

trend at all stations, although only the trends at Ghanzi (-1,0 day per annum) and Tsabong (-2,2 days per annum) are statistically significant. Explained variations between the number of rainy days per year and the annual rainfall are high for two stations (Maun, 85% and Shakawe, 69%), moderate for two stations (Serowe, 41% and Mochudi, 26%), and low for two stations (Ghanzi, 10% and Tsabong, 6%). There are no spatial trends in the rainy day statistics or the explained variations calculations.

Table 4 Mean area of land cultivated per year (MCL)

Region	MCL (ha)	CL trend	*p*-value	R	r1	r2
Southern	15 530	-2,05	0,03*	0,35	0,81	0,61
Gaborone	8 111	-1,06	0,04*	0,33	0,52	0,49
Central	28 436	-0,07	0,06*	0,41	0,75	0,53
Francistown	18 886	-1,19	0,05*	0,31	0,72	0,56
Western	2 153	-0,11	0,76	0,16	0,13	0,11
Maun	3.157	-0,85	0,83	0,30	0,27	0,13

*Significant trend

Table 3 gives the mean number of rainy days per year (MRD), the trend in rainy days per year (RD trend), the significance level of those trends (*p*-value), and the explained variation of the correlation between rainy days per year and annual rainfall (*r*) for each region.

In Table 4, the following are presented:

- Mean area of cultivated land per year (MCL)
- Cultivated land per year (CL trend)
- Significance level of those trends (*p*-value)

Explained variation of the correlation between amount of land cultivated per year and same year rainfall (*r*), previous year's rainfall (*r1*), and last two years' rainfall (*r2*).

Therefore, Table 4 illustrates the mean annual land cultivated per agricultural region, trends in land cultivated, and the explained variations of the correlations between annual rainfall of the same year and at 1- and 2-year rainfall lags and the amount of land cultivated. The mean annual land cultivated is highest for the central region (28 436) and lowest for the western region (2 153). There is a decreasing trend in land cultivation across the country. The area of land cultivated is highly correlated to the previous year's rainfall, but less correlated to the current ploughing season (current year's rainfall).

DISCUSSION

The results show modest spatial trends, but strong and coherent temporal trends in the rainfall and cultivated land data from Botswana. Spatially, these findings are consistent with those of Chipanshi and Ringrose and Chipanshi, Chanda and Totolo.[13] They found that there is a south-west to north-north-east rainfall gradient across the country and that rainfall variability exceeds 40 per cent in south-western Botswana (represented by Tsabong in this chapter), is about 35–40 per cent in the north-east (represented by Francistown), and less than 30 per cent in the far north (represented by Kasane). The spatial trend in cultivated land follows a dissimilar trend to rainfall, with regions of high rainfall displaying a decreasing trend in cultivated land, while the more arid regions (western and Maun) show less decrease in land cultivation. In addition, the results indicate that annual rainfall totals are explained more by the number of rainy

days at Maun and Shakawe in the north, but more by isolated, intense events at Ghanzi and Tsabong in the south-west; annual rainfall at Serowe and Mochudi in the south-east is explained by a balance between the number of rainy days and intense events. In sum, the findings agree with studies in other semi-arid regions, for example western Mediterranean and southern Africa studies that highlight intra- and inter-annual variability of rainfall.[14].

Although annual rainfall variations of about 50 millimetres would be considered low in some climatic regions, such variations could mean the difference between a good harvest and complete crop failure in semi-arid environments with traditional rain-fed agriculture, such as Botswana. There is much interest in using seasonal to inter-annual climate forecasts to help agriculture and other sectors compensate for these variations, but the interactions between the complexities of policy and of local rainfall responses to El Niño-Southern Oscillation events and other large-scale climate forces suggest that such forecasts and their implementation will be unreliable for the foreseeable future.[15]

Temporally, the trends for the 31 years of the study period are even clearer. Rainfall and the amount of cultivated land have been decreasing across Botswana. Moreover, the number of rainy days has decreased across the country, especially in the drier areas. General circulation model projections of climate change – reported by the Intergovernmental Panel on Climate Change via Boko, Niang, Nyong et al and using the SRES A1B emissions scenario – estimate rainfall decreases of 30 to 40 per cent by 2080–2099, with the greatest decreases taking place during the already dry winter season.[16] The projected rainfall decreases are associated with decreases in the number of rainy days and in the average intensity of rainfall.

The results of this chapter broadly agree with this scenario, displaying trends towards decreasing rainfall (including significant decreases during winter months) and decreasing numbers of rainy days. This research does not investigate changes in rainfall intensity over time. It does, however, analyse skewness and kurtosis of the rainfall distributions and explained variations between the number of rainy days per year and annual rainfall. These analyses show that some stations receive more rainfall from low frequency, high intensity events, whereas other stations get their rain through more frequent, less intense events. If climate change were to bring decreases in the number of rainy days and the average rainfall intensity, these station differences would make little difference – all areas would experience rainfall decreases from the one or other mechanism.

It is important to note that the drier the climate, the greater the rainfall variability, therefore it is likely that rainfall variability will increase as Botswana continues to dry. Land cultivation is highly correlated to rainfall, therefore it too will decrease.

These results suggest that climate change is already affecting Botswana through decreases in rainfall, and with this, less land being cultivated, begging an important question concerning adaptation: what policies can help the country's dry area farmers adapt to climate change? The government has an important role to play. It could increase support for applied research in dry area agriculture and for disseminating research findings and pre-season rainfall forecasts through an expanded agriculture extension service. It could increase support for education in rural areas, fostering higher education opportunities for rural youths and young adults so they could learn about the latest dry area farming technologies, as well as climate change. The government could also help rural communities diversify their economic structures so that they are not so dependent on agriculture. These and other strategies to reduce the impact of climate change are policies that the Botswana government should undertake or expand upon, regardless of climate change because they make good sense in a highly variable semi-arid climate.

CONCLUSION

To help understand the association between rainfall variability and changes and the amount of land cultivated in semi-arid environments, and to place that understanding in the context of climate change and food security, this chapter explores rainfall variability and trends in Botswana and its association with the cultivation of land. The results agree with earlier studies showing a south-west to north-east gradient of increasing rainfall, but of decreasing rainfall variability across the nation. The extent of the land cultivated is highly dependent on rainfall variability and has been decreasing over the years. Importantly the findings show a trend towards decreased rainfall throughout Botswana and with it a reduction in the annual cultivation of land implying that drier conditions mean even greater rainfall variability than presently is the case and so less land cultivation, which, in turn, threatens the already precarious food security situation in the country. This decrease in rainfall is associated with decreases in the number of rainy days.

Both the drying trend and the decrease in rainy days agree with the climate change projections for southern Africa, suggesting that climate change is well underway in Botswana. These results have important policy implications for the government to help its dry area farmers adapt to the changing climate

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PART 5

National Environmental Legislations, Policies and Climate Change Mitigation and Adaptation

12 Reducing emissions from deforestation and forest degradation (REDD)

Legal and policy challenges for Tanzania

Joy Faida and Eliamani Laltaika

INTRODUCTION

Climate change has been identified as the leading human and environmental crisis of the 21st century. Bearing this in mind, the 13th Conference of Parties (COP) to the United Nation Framework Convention on Climate Change (UNFCCC) held in Bali, Indonesia, from 3 to 15 December 2007 adopted the Bali Plan of Action, which, among other things, addresses 'policy approaches and positive incentives on issues relating to reducing emissions from deforestation and forest degradation in developing countries; and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries'.

Biological carbon sequestration involves the storing of CO_2 in forests and soils. This type of sequestration is considered natural in the sense that forests or soil naturally store CO_2.[1] REDD is a concept born out of this mitigation strategy. It is an innovative way of encouraging forestry conservation through financial incentives regulated at the international level.

Taking Tanzania as a case study, this chapter discusses the pact to reduce emissions from deforestation and forest degradation (REDD) and its potential

to address the climate change crisis while ensuring sustainable development. The chapter argues that given Tanzania's inherent culture of forestry conservation, potentially it stands to gain from the REDD initiatives. The chapter proceeds to identify legal and policy challenges Tanzania may encounter, including addressing rural poverty, which is one of the underlying causes of deforestation and forest degradation. The chapter concludes that steps should be taken to ensure that REDD does not become 'another missed opportunity' for institutional, legal and policy reasons.

BACKGROUND ON TANZANIA

The United Republic of Tanzania, the largest country in East Africa, is located between 1° and 12°S latitude and 30° and 40°E longitude. The United Republic comprises Mainland Tanzania and Tanzania Zanzibar. It is a vast country with a total area of 945 087 square kilometres comprised of a land area of 883 749 square kilometres (881 289 square kilometres mainland and 2 460 square kilometres in Zanzibar), plus 59 050 square kilometres of inland water bodies.[2] Tanzania shares borders with several countries including Zambia, Malawi and Mozambique to the south, Uganda and Kenya in the north, the DRC in the west, among others. Tanzania is home to the highest point in Africa, this being the ice-capped Kilimanjaro Mountain which is 5 950 metres high.[3]

In 2005 Tanzania had a total population of about 36,2 million people (about 17,7 million males and 18 million females). Agriculture (including livestock) is the dominant sector of the Tanzanian economy, providing livelihood, income and employment to over 80 per cent of the population. It accounts for a large percentage (56%) of the country's GDP, and about 60 per cent of its export earnings in the past three years, thus making a significant contribution to the national GDP compared to other sectors. Agriculture is the main source of employment and livelihood for more than two-thirds of the Tanzanian population. It is an important economic sector in terms of food production, employment generation, the production of raw materials for industries and the generation of foreign exchange.[4]

Tanzania is a developing country. It has a relatively large population and the economy is largely driven by agriculture. This makes it very vulnerable to climate change. Additionally, its location on the eastern coast of Africa, adjacent to the Indian Ocean, makes it all the more susceptible to drastic effects of

climate change, including rising sea levels. Furthermore, the high dependence on agriculture may arguably suggest a high rate of poverty. As with many developing countries that depend almost solely on agriculture, the per capita income levels are rather low. Tanzania is one of the poorest countries in the world with a gross national income (GNI) per capita of only US$280.[5]

REDUCED EMISSIONS FROM DEFORSTATION AND FOREST DEGRADATION (REDD): AN INTERNATIONAL PERSPECTIVE

The REDD mechanism is premised on the notion that loss of forest cover around the globe contributes immensely to global greenhouse gas emissions and ultimately to climate change. While in the past the transport and industrial sectors were held responsible for large amounts of global carbon dioxide emissions, more recent studies indicate otherwise. According to the Stern Review, the loss of natural forests around the world stemming from deforestation and forest degradation is responsible for between 10–25 per cent of global emissions, this percentage being greater than the annual contribution of the 'notorious' transport sector towards global greenhouse gas emissions.[6][7] Premised on this fact therefore, there is apparently an enormous contribution that can be made towards the reduction of global emissions through reduced deforestation and forest degradation. The Stern Review, however, does not apportion specific amounts of emissions derived from deforestation and forest degradation respectively.[8]

Forests perform a very crucial function in the global carbon cycle. They store about half of the Earth's terrestrial carbon.[9] When forests grow, they absorb the carbon dioxide in the atmosphere sequestering it in the trees and soil. As such when these forests are cut or degraded, the carbon dioxide that has been absorbed is released into the atmosphere. This can happen immediately if the trees are burned or gradually through the natural decaying process.[10]

Original forest vegetation holds about 20 to 50 times more carbon per unit area than the ecosystem that replaces it.[11] Moreover, tropical forests store more carbon per unit area than do non-tropical forests.[12] It should follow therefore that the reduction of deforestation and forest degradation in the tropics should be treated as a matter of urgency.

What REDD seeks to do essentially is to reduce emissions from deforestation and forest degradation in developing countries. There are high rates of

deforestation and forest degradation in developing countries that still do have forest cover. According to an Earth Trends' finding, Africa and South America have the highest rate of deforestation.[13] Under REDD, the idea is to compensate reduced emissions in these countries or basically to pay developing countries for the carbon value of their trees.[14]

According to some commentators, REDD means 'reduced emissions from deforestation and forest degradation', with others defining it as 'reducing emissions from deforestation in developing countries'.[15] While the former definition seems broader, embracing deforestation and other forms of forest degradation and thus evidently including more countries in this category, the latter is narrower, being limited to deforestation only.[16] Whatever the definitional differences, the idea remains clear: reducing emissions from forest degradation.[17]

ORIGINS OF REDD

The idea of REDD is a fairly new one, the movement having come into existence only in 2005 at a seminar of experts in Bonn, Germany, following a proposal made by the Papua New Guinea ambassador.[18] Thereafter, a submission was made by both Papua New Guinea and Costa Rica suggesting two approaches to REDD: firstly, developing a protocol on REDD, and secondly, revising the Marrakesh Accords to accept 'avoided deforestation' as a project activity under the clean development mechanism (CDM) in the first commitment period.[19]

At the 13th COP session held in Bali in December 2007, the UNFCCC parties adopted a decision on reducing emissions from deforestation in developing countries.[2021] The Bali Action Plan, the primary document adopted at this session, refers to work on reducing emissions from deforestation and forest degradation.[22] It is on the basis of these decisions that the COP has since established a process to develop a new legal instrument to address these issues.[23]

Deforestation in the context of REDD has been defined to mean 'direct human-induced conversion of forested land to non-forested land'.[24] Deforestation in the context of the UNFCCC and the Kyoto Protocol may be traced back to the period when some parties wanted the concept of 'avoided deforestation' to be included as an eligible project under the Kyoto Protocol's clean development mechanism in the first commitment period.[25] This proposal was, however, rejected and 'avoided deforestation' was excluded from the CDM during the first commitment period.[26] The reason for rejecting the proposal was that a number

of UNFCCC parties, mainly developing countries, had several technical concerns.[27] Consequently, developing countries have only two forest-related activities under the CDM – afforestation and reforestation.[28]

The Bali Action Plan and the COP 13 decision on reducing emissions from deforestation are also quite significant as they introduced three other notions besides that of reducing emissions from deforestation and forest degradation.[29] The three other matters are the role of conservation, the sustainable management of forests and the enhancement of forest carbon stocks in developing countries.[30] Interestingly, these three ideas, which are separated by a semi-colon from the rest of the COP 13 decision, which refers to policy approaches and positive incentives to reducing emissions from deforestation and forest degradation in developing countries, were subject to contention.[31] This separation generally means that the policy approaches and positive incentives of REDD would not apply to these areas.[32] This is because reducing emissions is distinguished from deforestation and 'avoided deforestation' – a term that generally refers to the conservation of existing stocks of carbon dioxide.[33] This means that no country should get carbon credit for doing nothing to their carbon stocks as there is no change in the stocks.[34]

CURRENT STATUS OF REDD IN TANZANIA

Tanzania has already been identified as a suitable country to receive funding under the REDD mechanism, given its favourable circumstances mentioned earlier. In that regard therefore a number of steps have been undertaken in the spirit of effecting REDD. In terms of institutional arrangements regarding REDD, which is an environmental policy that falls within the jurisdiction of the Vice President's office; the Department of Environment is currently being coordinated by the National REDD Task Force Team whose secretariat at the moment is based at the Institute of Resource Assessment (IRA) of the University of Dar-es-Salaam.[35] The National REDD Task Force Team currently runs a website where REDD information may be found.[36]

At the same time, steps have been taken towards establishing a National REDD Strategy and Programme.[37] Some of these include the development of a carbon trading concept note by the Ministry of Natural Resources and Tourism; the development of a forest carbon partnership facility (FCPF) and a readiness plan idea note (R-PIN); ongoing consultations among stakeholders

at the national level to identify roles and responsibilities and to agree on fundamental principles of REDD; the identification of areas of implementation whereby the participatory forest management (PFM) scheme is said to provide a good entry point for REDD; and the identification of deforestation spots for initial demonstrations.

The proposed REDD strategy will seek to address a number of pertinent issues relevant for the effective implementation of REDD. Such issues include, but are not limited to the following: institutional set-up and coordination of REDD issues at both national and local levels; strategies and modalities for promoting awareness and development, and dissemination of REDD information; training and human resources capacity building in all aspects of project development, management and certification; good governance and compliance with forest law; mechanisms to ensure intersectoral coordination; database management and information sharing, and certification mechanisms and procedures.[38] It appears that the proposed REDD strategy will attempt to address various pertinent issues facing the forestry sector and its suitability for REDD.

It is remarkable that Tanzania has embraced REDD as reflected by all the interim measures underway and a clear indication of an existing political will that is needed for the successful implementation of any policy. Tanzania therefore stands to benefit greatly from the positive incentives, while making a noble contribution towards the mitigation of climate change. This chapter now discusses why Tanzania is well suited to the ideals of REDD and includes an overview of its forestry resource base and state of deforestation.

TANZANIA FORESTRY RESOURCE BASE

According the National Forest Policy of Tanzania of March 1998 (Forest Policy), Tanzania is richly endowed with forest cover, having about 33,5 million hectares of forests and woodlands.[39] About two-thirds of this total area consists of woodland situated on public lands. Of that total forest area, about 13 million hectares have been gazetted as forest reserves. The Forest Policy further adds that there are more than 80 000 hectares of the gazetted area under plantation forestry; 1,6 million hectares under water catchment management, and about 19 million hectares on general land.[40] These forests are a habitat for wildlife, bees, unique natural ecosystems and genetic resources. Forests also provide an important economic base for development.[41]

DEFORESTATION IN TANZANIA

The Forest Policy alludes to the fact that there are no clear statistics on the rate of deforestation. Nevertheless, it estimates that between 130 000 and 500 000 hectares are cleared annually. The policy gives the main causes of deforestation as the following: clearing for agriculture, overgrazing, wildfires, charcoal burning, overexploitation of wood resources, illegal mining, pit sawing and illegal harvesting for building materials.[42] It is believed that deforestation occurs mainly in unreserved forest land. However, it also affects reserved forest lands because of the inadequate implementation of sustainable forest management.[43]

Owing to the high rates of deforestation, the annual forest carbon emissions in Tanzania between 2000 and 2005 were equivalent to 32,6 million tones of Carbon (MtC).[44] The average annual deforestation that occurred between 1990 and 2000 led to the loss of 400 000 hectares, placing Tanzania fourth out of 12 countries with the highest deforestation rates.[45] Given Tanzania's rich forest resource base and the high rate of deforestation, it is argued that there is enormous potential for any mechanism whose implementation and effectiveness is linked to these two factors. REDD therefore stands a great chance of success if all relevant issues are addressed.

LEGAL AND POLICY FRAMEWORK RELATING TO FORESTRY IN TANZANIA

The National Forest Policy 1998

Tanzania first adopted a National Forest Policy in 1953 and reviewed this policy in 1963.[46] The policy sought primarily to detail ways in which the forest and tree resources could be managed sustainably to meet the needs and desires of society and the nation at large.[47] The policy did not seek to provide for the sustainable development of forest resources. The concept of sustainable development, which was coined only in the 1990s, did not at that time form a basis for natural resources exploitation.[48]

The National Forest Policy of 1998 was adopted at a time when the global community had taken cognisance of the crucial role that forests play in regulating the global environment. This followed the 1992 United Nations Conference on Environment and Development held in Rio de Janeiro, Brazil. It is therefore

no surprise that the overall goal of the National Forest Policy bears undertones of sustainable development, a key principle underpinning the Rio Conference. Accordingly, the policy is to 'enhance the contribution of the forest sector to the sustainable development of Tanzania and the conservation and management of her natural resources for the benefit of present and future generations'.[49]

The policy enumerates four main goals: the sustainable supply of forest resources; increased employment and foreign exchange earnings; ecosystem stability through the conservation of forest diversity, water catchments and soil fertility, and enhanced national capacity to manage and develop the forest sector in collaboration with other stakeholders. Based on the above objectives, the policy prescribes four policy areas: forest land management; forest-based industries and products; ecosystem conservation and management, and institutions and human resources.[50]

The Forest Act (No 14 of 2002)

The Forest Act of 2002 (No 14 of 2002) (Forest Act) repeals a number of laws including the Forest Ordinance, Cap 389, the Export of Timber Act, Cap 274, and the Grass Fires (Control) Act, Cap 135. The Act also provides for the management of forests and other related matters.[51] More specifically, however, the objectives of the Act include promoting and enhancing the contribution of the forestry sector to the sustainable development of Tanzania, and the conservation and management of natural resources for the benefit of present and future generations; and encouraging and facilitating the active participation of the citizens in the sustainable planning, management, use and conservation of forest resources through the development of individual and community rights, among many other objectives.[52] One of the most outstanding features of the Act is arguably participatory forest management (PFM), which takes place in the form of joint forest management (JFM) and community-based forest management (CBFM). While both JFM and CBFM involve the participation of members of the public, under JFM the agreement is between the government at central government and local council level and the public or private sector. On the other hand, CBFM is essentially managed by the members of the village.[53] The PFM has been viewed as a good entry point for the REDD as it makes it possible for private individuals and communities either to partner with the government at different levels, or for the

government to grant exclusive management to such parties.[54] About 11–13 per cent of forests on general lands are being managed through the PFM system, which provides encouraging prospects for REDD.[55]

LEGAL AND POLICY CHALLENGES FOR REDD IN TANZANIA

While Tanzania seems well set for REDD in terms of the relevant forest resource base as well the initiatives that have been taken by the government, there are still areas that may render the implementation of the mechanism difficult. Undoubtedly, the successful implementation of REDD would require a favourable policy environment which would promote its implementation, effective institutional arrangements for decision making and coordination, adequate capacity, both physical and human, to engage in carbon assessments and related activities, among others.[56] The following are some areas that will need to be addressed: lack of capacity in terms of institutions and trained personnel in forestry matters; weak enforcement of the law, deforestation and inadequate finance.

Inadequate financing of forestry sector

Many developing countries suffer from a deficit budget syndrome. Owing to the low income levels and weak economies that depend largely on agriculture, the taxable resource base is almost non-existent. Consequently, many developing countries have to resort to borrowing from international agencies in order to make up for deficiencies. This ultimately boils down to the insufficient financing of various governmental sectors in the country. A nation is left with no choice but to prioritise certain sectors that will receive a large portion of the available resources, leaving other sectors literally destitute.

This situation largely characterises Tanzania where the forestry sector has constantly received less than one per cent of the total national budget according to the Forest Policy. The insufficiency of funds is arguably responsible for exacerbating other problems within the sector, including weak law enforcement and inadequate capacity as there are simply no resources to pay law enforcers and provide the relevant training of personnel. Such a situation, it is argued, will largely render the efforts to implement REDD futile. In order for REDD to function successfully and produce any meaningful results apropos its primary objective – mitigating

climate change – it is undeniably important that the forestry sector on which this mechanism will rely is vibrant and operating effectively.

Clearly the forestry sector in Tanzania is one of the disregarded ones, considering that it receives less than one per cent of an already small national budget. This situation is rather unfortunate, given the important role of forests in the environment. One would expect that with the increased awareness about the global environmental, such as climate change, more resources would be allocated to environment-related sectors. The situation notwithstanding, an immediate change of policy has to be effected in that regard. Tanzania may use this opportunity to advocate for increased donor funds for the forestry sector on these grounds. The very essence of REDD highlights the significance of forests in the fight against climate change, the protection and management of which requires adequate funding. [57]

Deforestation

While developing countries that have high rates of deforestation automatically qualify for REDD, given the potential carbon sequestration contribution they would make from avoiding or reducing deforestation, continued deforestation largely challenges the effective implementation of the REDD mechanism. For many developing countries such as Tanzania, deforestation is promoted not only by rural poverty, but also by government-supported policies such as agriculture as well as wood-based industries. Such practices may render REDD futile if not immediately addressed. As earlier noted, Tanzania depends largely on agriculture, making the clearing of forest lands for cash- and food-crop growing an inevitable activity. In the light of REDD, which seeks to discourage deforestation, this approach (deforestation) is irreconcilable. While it is clear that Tanzania has to review its approach, it is also clear that this is not likely to be an easy task given that agriculture is Tanzania's backbone.

In addition, the Forest Policy names forest-based industries and products as one of its four policy areas earmarked for development?.[58] Such a policy is likely to conflict with any approach that seeks to 'protect' forests from being cut. A forest-based industry largely relies on harvesting trees for wood and other forest products. It is doubtful that a forest-based industry can continue to operate in the context of REDD. Unless a certain balance is struck, these two policies are likely to clash.

Besides large-scale agriculture, deforestation in Tanzania is largely driven by activities such as charcoal burning, illegal mining, illegal harvesting for building materials and subsistence agriculture, as has previously been noted. All these practices are arguably caused by rural poverty as the locals especially resort to them as a means of livelihood – the existence of forests is crucial to their survival. In many places, poverty-stricken and hungry people who would otherwise go without food go to the forest to collect edible plants and fruits as well as leaves of wild plants and in the process cause forest degradation. Rural poverty as the root cause of such unsustainable forestry practices must be addressed in order to reduce deforestation.

Institutional challenges

In the implementation of any policy, the role of institutions, including the coordination of activities, and the actual implementation and enforcement of the policy, cannot be overstressed. Institutions should be designed to suit the effective implementation of a particular policy, but more particularly they should have adequate human resources with the right training and technology.

Tanzania's legislation and policies currently do make provision for the relevant institutions for the effective implementation of REDD. Section 10 of the Forest Act, for instance, establishes a National Forestry Advisory Committee. As the name suggests, this body is largely an advisory one. However, despite the Act prescribing the qualifications of members to ensure that they have the necessary expertise in forest management, as expressed in section 10.2(a), it is said that these professionals are not qualified to manage REDD matters. REDD requires personnel trained in matters of carbon assessment and certification, among others.[59]

Given the above scenario, the lack of technology must be included among the challenges. Institutional incapacity includes non-existent technology even though there may be trained personnel. Given that Tanzania lacks the trained personnel necessary for REDD, it is unlikely that technology relevant to REDD will be available. This is likely to hinder the effective implementation of REDD in Tanzania. In recognition of the endemic lack of technology in the developing world, the international community has made it obligatory for developed countries to facilitate the transfer of technology so greatly needed in addressing climate change.[60]

Weak law enforcement

Tanzania's high rate of deforestation may be indicative of the poor enforcement of its forestry laws which are not being enforced effectively, especially at local level. This situation may be linked to the inadequate financing of the forestry sector which, in turn, accounts for the lack of human resources needed to manage the forests and enforce the laws. It has been reported that at the Uluguru Mountain Forests of the Uluguru Mountains of Tanzania, which is one of the eastern arc bloc mountains, there are only four government forestry officials.[61] They are responsible for 13 forest reserves covering over 200 square kilometres of forest.[62] Obviously, these personnel cannot be expected to manage the area that they are required to supervise. Consequently, large areas are likely to remain unsupervised, encouraging practices such as illegal harvesting. REDD will require the strict enforcement of laws against deforestation and forest degradation.[63]

LEGAL OVERLAP OF FOREST LANDS AND GENERAL LANDS

The Forest Act establishes several types of forests including national forest reserves; local authority forest reserves; village forests and private forests.[64] Three of these broad categories – national forest reserves, local authority forests and private forests – may occur on general lands. The Land Act 1999 (Act No 4 of 1999) defines general land under section 2 to include lands which are not reserved. Unreserved forest land therefore means that such forest is not officially gazetted under the law.[65] This gives rise to a problem whereby forests on general lands are open to the public and therefore prone to illegal activities because of the lack of regulations. It has been previously noted that there are about 19 million hectares of forest on general lands, which is almost 54 per cent of the total forest cover. That accounts for a vast area, which ideally should be regulated and monitored through officially designated forest reserves. In the absence of such measures then, a vast area of Tanzania's forests will fail to provide the REDD initiative with the necessary resource base.

CONCLUSION AND RECOMMENDATIONS

A number of conclusions may be drawn from the above discussions. Firstly, Tanzania is undoubtedly an ideal candidate for the implementation of REDD

based on its rich forest cover and high rates of deforestation. It is therefore not surprising that certain developed countries such as Norway have chosen to finance certain REDD initiatives in Tanzania. Under the Forests and Climate Partnership National Strategy for Reduced Emissions from Deforestation and forest Degradation (REDD), Norway has pledged NOK 500 million to Tanzania.[66] This is in keeping with Norway's international Climate and Forest Initiative launched in 2007 under which Norway has committed itself to disburse up to NOK three billion annually.[67] However, coupled with its forest resource base Tanzania has displayed an attractive political will that favours REDD. This is reflected by all the initiatives that have been taken thus far such as the establishment of a National REDD Task Force Team and the proposed establishment of National REDD Strategy and Programme, among others. It is imperative that a policy such as REDD is supported by the government as it is responsible for creating the working environment including promulgating favourable policies.

The PFM mechanism under the Forest Act is particularly suited to REDD as it will engage members of the public in the process. The role of public participation in environmental governance cannot be overstressed. However, the existing policies that are inconsistent with REDD cannot be overlooked. These include the heavy dependence of the agricultural sector on forest lands, the forest-based industries, the culture of deforestation and the inadequate financing of forestry monitoring activities.

Evidently Tanzania requires urgent capacity development.[68] The government ought to invest in building capacity, both human and physical, at national and local levels to engage in activities such as the assessment of carbon, monitoring and evaluation of carbon increments, and the development of carbon projects. There is need for training in forest inventories, mapping and database development. Additionally Tanzania should lobby for technology that is relevant for REDD from its developmental partners.

There is also a dire need to address policy inconsistencies.[69] However, this is likely to be a difficult task and the government will certainly have to attempt to strike some balances. It is suggested that Tanzania explores the possibility of using alternative sources of fuel such as biofuels for instance. REDD should also be aligned with other developmental policies such as poverty eradication. In this regard, therefore, Tanzania could lobby for more developmental funds for poverty eradication. This would enlarge the objective of REDD to include poverty eradication, making it more holistic.

The existing political will and available funds from donors can make REDD a success. For many developing countries, many developmental projects are hampered by lack of financial resources. Whether they are health projects, environmental, or poverty eradication projects, 'funds' is the buzz word. While there appears to be an abundance of resources for REDD, misappropriation in a poverty-stricken nation cannot be ruled out. It is therefore imperative that available funds are utilised effectively in addressing all the concerns, including capacity both human and physical. In the event that these issues are addressed, then Tanzania may be able to sit back and enjoy the benefits of REDD while also making a noble contribution to the mitigation of climate change.

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13 The link between climate change, law, sustainable development and livelihoods in Uganda

Godard Busingye

INTRODUCTION

One of the key challenges that climate change poses to science is determining which climate patterns are due to naturally occurring climate variability and which are the result of human activity. The fact is that climate change has occurred, is occurring and may continue to occur, and its occurrence threatens the very essence of human existence. Some of the effects of climate change can be mitigated, while others will be unavoidable in this century, regardless of efforts to reduce greenhouse gas emissions. Nevertheless, the magnitude of the problems caused by climate change is so enormous that it is projected that by 2080 600 million people worldwide will suffer from malnutrition as a result of climate change.[1]

Over time a number of causes for climate change have been identified, including widespread warming owing to increased greenhouse gas concentrations in the atmosphere, and a combination of increased greenhouse gas concentrations, natural climate variability, and land-use change.[2] In most cases, climate change may be attributed to land-use patterns which occur as a consequence of conflict with regard to the use of natural resources.

The majority of scientists remain confident that human-induced climate change will continue. Consequently, they have devised ways of detecting the occurrence of climate change over a very long period of time. Some of these methods involve the use of palaeo-records – the natural archives of past atmospheric, terrestrial and marine environments which include tree rings, cave deposits, corals, Antarctic ice cores, lake and marine sediments, sand dunes, and coastal and glacial deposits. Palaeo-records provide direct and indirect (proxy) evidence of atmospheric, terrestrial and marine conditions and also take account of the causes of past greenhouse gas changes and their impact on global climate. Direct evidence, such as air trapped in ice sheets, enables researchers to reconstruct the composition of our atmosphere over thousands of years, while proxy evidence of past climates can be obtained by examining the growth rate of trees or the chemical composition of fossils.[3] Among the many factors known to influence climate change is the presence or not of vegetation, or to be more particular, forest cover. Forest cover has been shrinking globally largely owing to the increase in the population and hence the demand for land for settlement and other basic human needs.

In the case of Uganda, the proportion of land covered with forest decreased from 21,3 per cent in 2001 to 18,3 per cent in 2006, and the reduction in forest cover caused tremendous climatic changes in the country during the period in question.[4] Indeed, where climatic factors become unfavourable, natural disasters such as floods or drought strike. This places livelihoods at high risk especially because of inadequate local capacity to deal with such occurrences and the limited access to alternative livelihood options. Regardless of its underlying causes, climate change influences disaster risk profiles and exacerbates environmental hazards that have a further impact on development processes.[5]

The link between climate change, law, sustainable development and livelihoods seems to be of little concern to either the government or the citizenry of Uganda. However, these interlinked issues are as much a reality as their consequences and the improvement or deterioration in the people's livelihoods. Uganda has enacted a number of environmental laws, including its constitution, all of which refer to the concept of sustainable development either explicitly or implicitly, but none makes the direct link between climate change, the law, sustainable development and livelihoods as a complex but coherent relationship. It may take one considerable time and a good amount of scrutiny to discern this relationship from the provisions of the written law and the actual practice of both the government and the citizenry. The lacunae in the law and the latter's

failure to spell out this relationship clearly leads one to believe that policymakers and legislators in this country may not be bothered about the ultimate consequences of their legislative process, which is climate change. Toeing the line of the law, the citizens engage in serious development activities in a bid to improve their livelihoods, but do not bother whether their activities have a direct bearing on climatic patterns in the country or not.

In Uganda, the link between climate change, law, sustainable development and livelihoods is either not well understood or is not regarded to be of any consequence to the people's way of sustaining themselves. Policymakers and legislators, however, are quick to highlight the most revered environmental concepts such as sustainable development and even to include them in the country's legislation, but they fail to link them to the people's livelihoods, which themselves are influenced by, but also have a great impact on climate change. Crucially, there has been little progress in mainstreaming climate change adaptation measures within existing poverty alleviation policy frameworks. At the same time, there has been no deliberate research to show the extent to which climate change and environmental issues, more broadly, have been integrated in the poverty reduction strategies.[6]

It is possible that globally significant progress could have been made in confronting poverty and environmental challenges. Nevertheless, the environment, which sustains human activities, has continued to be degraded by various nations in all regions and progress towards a sustainable future has been slow or negligible.[7] However, the link between climate change, law, sustainable development and people's livelihoods can be easily understood if these variables are clearly described.

It is beyond doubt that the law is a veritable tool in shaping people's attitudes towards social phenomena and that, while keeping in line with the law, people undertake various activities in a bid to improve their livelihoods, usually, however, without bothering whether or not their activities have a direct bearing on the climatic patterns of the country.

This research seeks to investigate whether there is a viable relationship between climate change, law, sustainable development and livelihoods in Uganda, and, if so, whether that nexus can be utilised to attain a common position on environmental conservation and an improvement in the people's livelihoods. Contextually, this research is premised on the understanding that every person in one way or another depends on the environment for a living. The degree of

dependence, however, varies, with poor people showing a greater need to depend on the natural environment than better-off persons.[8] Overall, the nature of human activity, such as subsistence farming, commercial farming, pastoralism, mining and lumbering, typically determines the relationship between human beings and the environment, and ultimately the level of livelihood one enjoys and the type of climate change patterns that will emerge. An understanding of the key conceptual issues will shed more light on this relationship.

CONCEPTUAL UNDERPINNINGS

It may be misleading to attach specific definitions to any terms used in this chapter because definitions have the effect of sealing off knowledge, the assumption being that the author is the only knowledgeable person in that regard, which often may not be the case.[9]

The term 'environment' as defined under the National Environment Act (U), Cap. 153, means the 'physical factors of the surroundings of human beings, including land, water, air, climate, odour, taste, the biological factors of animals and plants and the social factor of aesthetics and including both the natural and built environment'.[10] This broad definition of 'environment' correctly portrays the role of environmental law in the improvement of livelihoods in Uganda; it places the human being at the centre of all the other phenomena, thus showing that people cannot live in isolation of what surrounds them. It also shows that human activities in relation to the environment can either destabilise or enhance it, the ultimate result being climate change.

In this discussion, 'poverty', which may be a yardstick for gauging whether a people's livelihood is improving or not, is generically understood to mean a situation where people lack productive means and household assets and have little or no income, few livelihood opportunities and insufficient access to basic services such as health, education, food, water and sanitation. It suffices also to note that the opposite of poverty is not being rich or wealthy. Probably one can consider well-being as the opposite of poverty and the lack of well-being as poverty. Research carried out by the Research and Analysis Working Group (R & AWG) approached the problem of poverty from a sociological point of view.[11] The researchers identified a number of factors contributing to poverty including the death of breadwinners, early pregnancies, high fertility rates, sickness and old age. These factors predispose victims to becoming poor and also to falling

below or further below the minimum poverty level in future. According to the same study, not being poor equates to material, bodily and social well-being, physical safety and freedom of choice of action. In this article the same meaning of the concept of 'poverty' is used.

The empirical measurement of poverty is based on the known and traditionally computed 'paid-for labour per individual' in a household. It is noted with concern that the concept of 'household paid-for labour', which is used as an index in this respect, conspicuously ignores the gender configuration of households, namely the social attributes of women and men in the households and the aggregate distribution of women and men, either as children or adults, and the elderly, sick and disabled persons in any household. This type of computation ignores the in-put or contribution of some members of households, particularly that of women, children, the sick, disabled and the elderly in the whole process of environmental degradation or enhancement, attainment of certain livelihood levels and the whole process of climate change. It suffices to note that since the labour input of these persons in the overall household well-being is traditionally not computed and paid for, their contribution to the whole process of climate change is not easy to determine empirically and hence little or no attention is paid to them in regard to service deliveries or other important government programmes.[12]

The computation of household income, which forms the basis for calculating GNP and GDP, the indicators of either well-being or poverty, therefore, creates a wrong impression about the livelihoods of individuals in households and the impact of their activities on climate change patterns. This is because the figures arrived at in either case constitute the total income of paid-for labour in a household divided by the number of household members.[13] It has been observed particularly in Uganda that fewer members of any given household are employed in out-of-home paid-for labour than remain at home to support and supplement the income earned by those in formal employment. The activities of those remaining at home, a large group, are largely concerned with the primary exploitation of the natural environment and are likely to have a greater negative impact on the environment than those of the people engaged in out-of-home income-earning activities. It is, therefore, contended that the standard method of computing either GNP or GDP is suspect and misleading when assessing the impact of human activities on people's livelihoods and the general impact of these activities on climate change.

Unfortunately, this is the revered livelihood assessment tool adopted by policymakers, although it conspicuously leaves out the major component of the population, the women. Women in one way or another, contribute to the welfare of their households although they do not earn paid-for income, and their activities also greatly impact on climate change patterns. Indeed, there may be individual households that have a lot to eat, but less to sell, they might be considered poor On the other hand, households whose members earn a monetised income and spend much of it on the purchase of food items may be regarded as better off because their incomes are computed and included in the measurement of either GNP or GDP, yet their livelihoods may not be far different from those of their counterparts who are not in the formal employment sector.

The illustration based on the computation of either GNP or GDP clearly demonstrates how definitions of terms such as 'poverty', 'well-being' or even 'livelihoods' by scholars may mislead the public and other stakeholders who may wish to make interventions aimed at improving people's livelihoods. It is proposed that, in the formulation of conceptual frameworks for livelihood studies, descriptions of terminologies should be adopted so that whoever is interested in determining whether an individual is poor or not, or the magnitude of the impact of his or her activities on climate change, makes an informed decision about the situation based on well defined criteria.

This chapter emphasises that the genesis of the confusion in which humanity finds itself in trying to determine aspects such as the contribution of particular livelihood styles to the whole process of climate change lies in the purported attempts of scholars to give discrete and, at times, scientific definition to fluid terms such as law. Law requires a certain minimum degree of regularity and certainty, for without this it would be impossible to assert that what was operating in a given territory amounted to a legal system.[14] Under the command theory, for instance, law is viewed as the command of the sovereign.[15] According to Hart, for society to survive there must be legal obligation rules that restrict violence, theft and deception. Hart goes further to state that men (and women) always find such rules necessary because of man's nature as a partly selfish but partly cooperative creature, his typical wish to survive, and the limited resources of the world.[16] After a careful synthesis of the views these legal philosophies offer, I take the view that law is a veritable tool in the shaping of people's behaviours and attitudes towards the social phenomena that surround them; it has a direct bearing on climate change patterns since it is the driving force behind human activity.

In carrying out livelihood studies, it is important to understand that culture, religion, ideology and social opinion also have great influence on the way people relate to each other and to other aspects that affect and condition their day-to-day activities as they strive to eke out a living from their environment. Their attitude towards the environment is also conditioned by the same variable. A people's lifestyle, whether nomadic, or that of subsistence farming, fishing, lumbering or plantation or commercial farming is a reflection of their relationship with the environment; it has a direct relationship with the climate change patterns of a given area.

The underlying relationship between law and a people's attitude towards their lifestyles largely determines whether they will harness the environment in a sustainable manner or not. This relationship, in turn, determines whether or not their activities will sooner or later translate into climate changing patterns.

Specifically defined, sustainable development is the utilisation of the environment by the present generation in a manner that does not compromise the ability of future generations to enjoy their rights in respect of it. This concept was well articulated in 1987 by the World Commission on Environment and Development (WCED), commonly known as 'Our common future', which gave the term a broader perspective.[17] WCED observed that humanity has the ability to make development sustainable and to ensure that it meets the needs of the present without compromising the ability of the future generations to meet their own needs.[18] According to WCED, the concept of sustainable development does not imply absolute limitations on the present state of technology or of social organisation on environmental resources and the ability of the biosphere to absorb the effects of human activities; rather it implies that in the utilisation of the environment now, the present generation must be reminded that their activities have a direct bearing on how their tomorrow will be.

In planning for tomorrow, humanity of necessity plans for the future generations, the selfish nature of human beings notwithstanding. Indeed, present generations find themselves interacting with 'future generations' which they bring into the world through the normal process of reproduction, whether consciously planned for or not. On the face of it, one talks of planning for future generations, yet it is a person's desire to live a decent life tomorrow that inspires him to harness or even improve the environment now. Intergenerational equity, therefore, becomes an inevitable outcome of the present generations' desire to live a decent life tomorrow.[19] In this regard, while planning to achieve the highest levels of livelihoods, the present

generations equally plan to enhance their environment, a process that may improve climate patterns at the same time.

The concept of intergenerational equity has now become part of the corpus juris of both national and international states and organisations. This implies that planning to reverse the negative effects of climate change has become part and parcel of the present generations' lifestyle, though they may arrive at this approach unconsciously in some cases. In the locus classicus of *Juan Antonio Oposa and Others v The Hon. Fulgencio S. Factoran and Another,* the court was called upon to decide the issue of whether the petitioners in that case had a duty to protect the interests of generations yet unborn.[20] In that case, the petitioners, who were minors, brought an action on their own behalf and on behalf of generations yet unborn. Their petition was grounded in a claim that the defendants were destroying the country's natural forest cover at a rate that would deny both the petitioners and future generations the right to benefit from those forests. The petitioners' claim was upheld on the grounds that they had a responsibility to preserve the rhythm and harmony of nature for their full enjoyment or a balanced and healthy ecology by averting the negative effects of climate change that would result from the depletion of the forest cover. The Oposa case discussed constitutional rights of children to a right and clean environment. The discussion was based on the provisions of the 1987 Constitution of the Republic of the Philippines, namely Article III, Section 11 which provides for free access to the courts and quasi-judicial bodies and adequate legal assistance not to be denied to any person by reason of poverty; and Article XIII, 3) which provides for appropriate legal measures for the protection of human rights of all persons within the Philippines, as well as Filipinos residing abroad, and provide for preventive measures and legal aid services to the under-privileged whose human rights have been violated or need protection. The discussion in essence relied on the principle of intergenerational equity because by holding that the children had a right to protect their environmental interests, the court was protecting the rights of children across generations.

In Uganda, the intergenerational equity principle is embedded in Article 39 of the 1995 Constitution as at 15 March 2006. Specifically, Article 39 of the Ugandan Constitution provides that 'every Ugandan has a right to a clean and healthy environment'. It is opined that the phrase 'every Uganda' is not limited to the present generations of Ugandans alone, but includes even the generations of Ugandans yet unborn, for when born, such will be governed by the same law,

if it is still in force then. Under section 3, the National Environment Act, Cap. 153, enacted just before the 1995 Constitution was promulgated, extends the right to a 'healthy environment' and the obligation to maintain and enhance it to 'every person'. The vivid difference between the terminology used in the two pieces of legislation, the constitution and the Environment Act, namely 'every citizen' and 'every person' respectively, can be explained by referring to the analogy of constitutional or limited jurisdiction of any sovereign state over persons. 'Every person' under the Act, therefore, could not have been intended to cover every person across the globe since the constitution limits both the legislative and judicial scope, and the application of the responsibility to enhance a clean (healthy) environment to 'every Ugandan'.[21]

It is contended that sustainable utilisation of the environment greatly contributes to the uplifting of a people's livelihood because it enables them to reap the benefits of nature now and in the future, and in a more conducive climatic environment. In a legalistic form, and as a guide to the citizenry, Uganda has adopted and incorporated the concept of sustainable development in its legal system, including the constitution. The purpose of the legislative process is largely to act as a guide or reminder to the citizenry so that they do not abrogate their promulgated responsibilities. It is important to note, however, that in order for the legislative process to be of value to society, it must align with the psyche of the citizenry, lest it be rendered ineffectual. Based on that analogy, it becomes clear that sustainable development is the ideal, at least at the legislative level, but must either be naturally resident in a people's psyche, that is in their culture, religion and ideology, or otherwise impressed upon society either through rewards or punishments prescribed by the legislators. It, therefore, becomes logically and analogically clear that human development and other needs of the present generation may not be in consonance with the ideals of the legislators, but rather, they may be conditioned by the acts of the latter. Therefore, sustainable development as a development tool is and will continue to be a guide to mankind in his day-to-day endeavours to eke out a livelihood from the environment, but may not be the norm.[22]

THE NEXUS BETWEEN CLIMATE CHANGE, LAW, SUSTAINABLE DEVELOPMENT AND LIVELIHOODS

The nexus between climate change, law, sustainable development and livelihoods in Uganda is a theoretical and practical phenomenon. It is theoretical in

the sense that it is incorporated in the country's legislation and hence informs the citizenry of their rights and obligations if they are to enjoy a better livelihood. It is practical in the sense that it cannot be bypassed. People may carry out development ventures only within the prescribed limits of the law. For instance, they must take the tenets of the environmental impact assessment regulations into account before reaping the maximum benefits from their ventures, or they may have to forfeit all benefits if they act contrary to the law. The maximum benefits people derive from their undertakings are those that can be used to meet their ever-increasing life needs – this would be a basic principle of sustaining a good livelihood. The reverse to this is also true: failure to adhere to the scientifically established rules of development may impact negatively on climatic patterns and, in turn, on the people's livelihoods.

The enjoyment of environmental rights, therefore, has to be understood by referring to the country's commitment to steer human development in the desired direction so that the nexus between these parameters is completed. An analysis of this nexus reveals that there is a direct relationship between law and overall human activities in relation to their environment, sustainable development, livelihoods and climate change. Humanity, which is conditioned by law, is thus allowed to carry out only those acts that will enable it to continue reaping the benefit of the world's natural resources now and in the future in a sustainable manner.

Law guides and regulates human activity in relation to particular ecosystems such as wetlands or hilly and mountainous areas. In cases where human activity may be deemed to be out of line with the existing environment, the law in Uganda requires that the initiators of such activities carry out environmental impact assessment studies to establish the likely effects of those activities on the existing environment.[23] Environmental impact studies may entail assessments for proposed projects or developments or environmental audits for projects or developments undertaken before the promulgation of the National Environment Act and its subsequent regulations. In all these cases a developer is required to provide for measures to mitigate or cope with the effects of such projects on the environment.

By guiding human activity in relation to the environment, the law essentially achieves its main objective of conserving the environment and all the natural resources that abound in it for the benefit of both the present and future generations. In extreme cases, however, such regulation may impair the development

of the communities living in any given environment, particularly those living in marginal lands such as wetlands and hilly or mountainous areas whose only means of survival are dependent on the harnessing of such lands. In most of those cases, such people may not have adequate alternative means of livelihood; their poverty levels may thus escalate if the law does not provide for alternative means of survival.

Law, therefore, must strike a sustainable balance between human means of survival and environmental conservation if it is to address the livelihood needs of the citizenry. It should permit reasonable utilisation of the environment and the natural resources that abound in it so that the people's means of livelihood are not unduly hindered, while at the same time requiring them not to interfere unduly with the life supporting system of the ecosystems, namely the environment in which they live. Such a balance paves the way for the people to improve their livelihood since they will be in a position to carry out sustainable ventures or activities that are a condition precedent to their enjoyment of the right to a clean and healthy environment and also improved social and material well-being.

In determining the extent to which people contribute to changes in climatic patterns, it becomes important to observe that poor people, like their counterparts who are determined to live above the poverty line, do contribute to environmental degradation through their overuse of natural resources. Well-off persons, however, may show less dependence on the natural environment and hence may appear to contribute less to its degradation because they can afford alternative technologies that enable them to meet their day-to-day needs away from the natural environment, while poor people may not. In the case of Uganda, for instance, when hydroelectric power tariffs were raised, every person, well-off or poor, was affected albeit in different degrees. Some people were excluded from the bracket of those who use hydroelectric power for a number of purposes in their homes including lighting and cooking. The well-off persons quickly switched to alternative energy sources such as solar energy, petrol- or diesel-powered generators, afri gas and electric power inverters, and they also bought power-saving equipment, all of which are out of the reach of poorer persons. Despite the fact that every person in the country pays taxes, either directly or indirectly, when it comes to the distribution of social facilities and amenities, the poor are not specifically targeted or helped to enjoy the same benefits as their better-off counterparts. It is the well-off who are more able to switch to alternative means of livelihood once economic conditions become

unfavourable. While government development policies and strategies treat each person as an equal, this relegates the poor to a worse-off position in terms of meeting their day-to-day livelihood needs.

It is recommended that government policies and strategies should take into account the specific needs of the poor and give them the attention they deserve when the general economic environment in the country deteriorates; every citizen should be given an equal opportunity to improve his level of livelihood, depending on the social placement of the person at the time under consideration. It is when every citizen is enabled to live within the available means that each can appreciate that his existence depends on a complete cycle of events – the relationship between climate change, sustainable development and actual livelihood styles pursued and enjoyed by each member of society.

The analysis made in this regard becomes meaningful when there is a fundamental paradigm shift from the current development-centred strategies to pro-people development approaches. Such approaches should build on the priorities and capabilities of poor people to harness the environment if they are to be helped out of their poverty through the law. Bearing in mind that the way people harness the environmental resources has a bearing on whether or not their activities will enhance or degrade the same environment, law can be used as a medium to condition human activity in the direction that can avert or at least minimise the possible causes of climate change. Law, which is understood to be a veritable tool for social engineering, therefore, must be tailored in such a manner that it is capable of steering individual and government action to take care of the immediate environmental needs of poor people as and when these arise. The poor people's agricultural or pastoral land needs, and their ability to adapt, cope with and mitigate the adverse effects of climate change, for instance, and be able to manage such land in a sustainable manner should be made a priority by the government.

To achieve this objective, the law must take into account the costs the poor would incur or the benefits they would be able to derive from the environment or be denied if such a law was not in place. It should also take into account the capabilities of the poor to manage the environment without any external intervention or their ability to integrate modern technology (if it becomes available to them) in their day-to-day activities in relation to the environment they live in. The law should also create incentives to attract poor people to other activities apart from those that are traditionally understood to be their sole sources of livelihood such as agriculture and nomadism. At the same time, the law should

create disincentives to dissuade them from viewing fragile ecosystems such as wetlands and hilly or mountainous areas as their next havens in the series of the lands they have degraded or helped to degrade owing to unsustainable ways of utilising the environment.

This chapter emphasises that the fundamental objective of the law should be to influence human activities positively so that people view the environment as a resource that will enable them attain a sustainable livelihood and not merely as a good available for use and misuse. This understanding will help to influence how each individual manages the environment he lives in. When people understand the value of their environment and treat it as their personal precious property, it becomes easy for them to change their behaviour by distributing the benefits and costs among all the beneficiaries.

THE PROJECTED RELATIONSHIP BETWEEN CLIMATE CHANGE, LAW, SUSTAINABLE DEVELOPMENT AND LIVELIHOODS

Future climate change patterns seem to be marginally important compared with other development issues. It is, however, clear that climate change, climate variability and the associated disaster risks will seriously hamper future development.[24] In Uganda, climate-related disasters are estimated to contribute to over 70 per cent of natural resources disasters and destroy an average of 800 000 hectares of crops annually. This makes economic losses in excess of Uganda shillings 120 billion.[25] It is important to observe that usually a people's culture plays a big role in the way they relate to their immediate environment. The successful observance and implementation of the written law today and tomorrow is largely dependent on how the revered cultural values of the people are taken care of in the written law. Most African communities, albeit to varying degrees, depend on the direct harnessing of environmental resources in their natural setting. Their activities in this regard are conditioned largely by their cultural values. For instance, nomadic communities such as the pastoral Bahima in the cattle corridor of Uganda keep large stocks of domestic animals that gradually overgraze the lands they occupy. Overgrazing leads to land degradation, an aspect that precedes other aspects of environment change, such as the lowering of the water table and drying of boreholes that may culminate into climate change. The cattle corridor, which is a fragile ecosystem, depends seasonal water sources and rain water for human

use and crop and livestock production. The prolonged and severe drought of 1999/2000, for instance, caused a severe water shortage which resulted in the loss of animals, low milk production, food insecurity, increased food prices and had a general negative effect on the country's economy.[26]

Agriculturalists in sparsely settled lands such as the protected areas of Kibale and Mubende in Uganda still practices shifting cultivation, while those in heavily populated areas such as Kabale in the southern part of Uganda and the Bagisu and Sabiny on the slopes of Mount Elgon practise permanent monoculture that gradually degrades the areas in question. A degraded environment is a precursor to adverse climate change patterns and the escalation of the deterioration of livelihood levels, because the yields per square unit of land decline gradually making it difficult for people to sustain a favourable standard of living, and also to stay ahead of the internationally fixed poverty line of one US dollar per day.

On the other hand, cultural values of certain communities such as the fishing or hunting communities and even herbalists demonstrate the value such communities attach to their environment. This is usually expressed in cultural norms and/or taboos that bar members of those communities from carrying out activities inconsistent with the communities' general interests. For instance, fishing and hunting at night and burning of vegetation is condemned by those communities. The prohibition of fishing at night may be intended to prevent the catching of immature fish, since there would be no community supervision of the fishermen's activities at night. The prohibition of hunting at night is probably intended to prevent the killing of immature or expectant female animals or even the only males of specific animal communities. Herbalists attach great importance to certain plants to the extent that they will tell other members of the public that if they break a leaf or a branch of one such plant, it will bleed profusely and the culprit will pay heavily to appease the angered community 'gods'. Such cultural measures are inherently intended to conserve the environment for sustainable utilisation of the concerned communities and its future generations.

It is opined that the current relationship between climate, law, sustainable development and livelihoods will be maintained if such community values are taken care of in the written law, so that the concerned communities see the actual value of abiding by the current laws.

At this stage, it is no longer disputed that law is capable of influencing human behaviour in relation to the environment, especially if it embodies or takes account of the people's ingrained cultural values. Where the cultural aspect is lacking in

the law, the people it is intended to serve will not readily obey it. Instead the state machinery, on the basis of its statutory laws, will compel individuals to obey the law by using unpopular sanctions including arrests and detention. The reference to the law as a tool that is capable of influencing human behaviour should be a reference to both the written or hard and the unwritten or soft law, the latter largely consisting of people's cultural values. The 'soft' law is unconsciously observed by individuals whose minds it permeates, while due obedience to the former is possible because it employs sanctions. An understanding of this phenomenon will engender sustainable development that goes hand-in-hand with the enhancement of climate change patterns. Existing or identifiable traditional knowledge that can be utilised to avert the adverse effects of climate change should be revered and disseminated to a large section of the population so that it is used to that end.

In Uganda, for instance, certain communities associate certain areas of the environment with community 'gods' and these are thus conserved for the habitation of such gods and ritual performance. Thus the culturally conserved environment has been harnessed to meet the day-to-day needs of the people concerned in a sustainable manner. This conserved environment, in turn, contributes to the sustainable management of the environment in a number of ways, including acting as a food and medicinal reserve and modifier of the climatic conditions.

Those familiar with the geography of Uganda know of the very old and legendary tree in the Mubende district popularly known 'Nakayima', which has been conserved for decades as a ritual place of the 'goddess Nakayima'. Nakayima is believed to possess blessings particularly for barren women and those interested in making a fortune through business. The tree is now conserved as a cultural heritage site for Ugandans and many local and foreign tourists to Uganda visit the place. From an environmental perspective, the tree remains one of the relics of the now-disappearing high tropical forest species in the country; it also adds to the aesthetic value of the place and earns local and foreign currency for the local people and the country at large.

The Bujagali Waterfalls on the River Nile in the Jinja district are another example of a place traditionally conserved for its religious value. The popular belief among the inhabitants of the location of these falls is that they are a home of the Budhagali god who is worshiped by most of the local people in the area. The waterfalls are also a tourist attraction that draws thousands of foreign and local tourists annually.

Local communities in areas where natural resources are conserved for 'divine' purposes reap many environmental benefits including the establishment of a market for their local produce from the thousands of visitors to those areas, which helps to improve their livelihoods. Such communities save money and human energy because they do not have to walk long distances to gain access to such conserved natural resources.[27] An inference could be made to the effect that the constitutional provisions under Articles 39, 50 and 245 of the Constitution of the Republic of Uganda to conserve the environment for both the present and future generations cater for the conservation of 'divine places' in the country as well. These provisions are reinforced by Article 3 of the Constitution (Amendment) (No.2) of Act 2005 which mandates Regional Assemblies under the Regional tier system of governance to handle cultural matters relating to the traditional or cultural leader, clan and sub clan leadership, cultural and traditional practices (cultural funeral rites) and cultural institutions by establishing specialized committees for them. The money and energy saved under these this provision could be used to service other more pressing human needs of these communities and the conserved natural resources help in the maintenance or modification of the environment for the enjoyment of all the people, believers and non-believers alike. Losing touch with cultural values would, therefore, be detrimental to the whole process of environmental conservation; in the long run it contributes to the lowering of the standards of living of the people concerned.

In addition to factors such as religion, given prominence in this chapter, Kiss and Shelton consider that philosophy is crucial in understanding the relationship between nature and humanity.[28] According to them, the two merge to form the basis upon which environmental law is based. These scholars further contend that the cohesion of every society and community is based upon and maintained by a value system such as common religion, philosophy and ideology. Their views are accorded high respect in this research although they are not specifically elaborated upon in as much as that may be, the present research emphasises the role of culture, which is the total expression of a people's philosophical orientation towards given phenomena such as law and the environment.

It is opined that in order for culture to attain the force of law, it must first qualify to be a people's custom. A custom in this regard is a cultural value that has passed the test of time and whose application or mention is hardly questioned by those who believe that it exists. In Uganda, when an element of customary law is incorporated into statutory law, then it ceases to be referred to as customary law.

At the same time, any local custom that is repugnant to the written law is void to the level of its inconsistence with the written law. Since Uganda is a country built on colonial religious philosophy, it is apparent that any custom that is contrary to any of the received religious values will also be void.[29] The influence of religion, particularly Christianity, has been thoroughly entrenched in the development paradigms of this country.

It is also important to note that the existence of a strong legal framework, at least in document form, does not guarantee respect for the norms it incorporates. The government of Uganda, for instance, has relentlessly proposed and, in some cases, leased out vital areas of nature conservation, which also have cultural value, to investors, largely foreigners. Currently some of the remaining high tropical forests in the country located on the Kalangala Islands have been cleared to pave the way for the growing palm oil industry, which the government contends is a better use of the place in terms of improving the citizens' livelihoods. A controversy has also unfolded over the government's proposal to allocate part of the Mabira high tropical forest located in the central region of Buganda to a sugarcane-growing investor for the same reason of improving the citizens' livelihood. From a scholar's viewpoint, it seems paradoxical for the government to promulgate some of the best environmental laws in the world and yet proceed to propose and implement programmes that are at variance with such laws. One would expect development to take place at any rate, but before such development is sanctioned by the government, adequate mitigation measures as required by the country's environmental laws should first be adhered to. This seems to be the missing link between the government's policies and legislation, the zeal of the country's politicians to eradicate poverty from the country and the scientific articulation of environmental principles. In the long run, government policies and the resultant laws will fail to address the issues of improved livelihoods and managed climate change because the environment upon which these values would have to be maintained will have been degraded, creating the worst-case scenario in terms of climate change.

CONCLUSION

Climate change is a reality. It has occurred and continues to occur and its causes are known. It may, however, not be easy to reverse, based on the trend of events identified in this chapter that range from government development strategies to other

factors such as the need for more land upon which people's livelihood activities can be conducted. The link between climate change, law, sustainable development and people's livelihoods is least understood and addressed by policymakers and legislators, despite it being a reality. The gap between actual knowledge of the relationship between these variables and the government's continued urge to improve people's livelihoods by encroaching on vital and culturally sacrosanct natural resources impacts negatively on climate change. The intention to improve livelihoods through law will never be achieved because this will not come about until human activity, which is driven by the laws put in place by the government, focuses more on improving climatic patterns rather than affecting them negatively.

Traditional livelihood practices, which continue with or without formal legal direction, offer governments trying to improve their people's livelihoods and manage climate change patterns a better option because inherent in them is the idea of respect for where one reaps, thus unwittingly conserving the environment and thereby contributing to improving climate change patterns. It is, therefore, recommended that if governments are to achieve their targets in terms of improving the people's livelihoods and realising improved climate change patterns, they must first address issues that relate to natural resources conservation, bearing in mind that the traditional means of livelihood are inherently sustainable in terms of engendering positive trends in climatic patterns.

Deliberate research to show the extent to which climate change and environmental issues have been integrated in the poverty reduction strategies of Uganda should be undertaken so that the results obtained can be used to address climate change issues since these and people's livelihoods are interdependent.

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11 In patriarchal societies, women's household labour is never considered 'labour' and, therefore, not paid for and hence not included in the computation of the aggregate national income of the society in which they live.

12 Where household GDP is low, one may think that there are only a few household members in that family; where the household GDP is high, one imagines there are many members to that particular household. Realistically, however, the lower the household GDP, the larger the number of unpaid household members, and vice versa.

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20 Here reference is made specifically to the Constitution of the Republic of Uganda as at 15 February 2006.

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Africa is among the most likely vulnerable regions of the world that are to be negatively impacted by climate change. The continent's vulnerability to climate change arises from a combination of many factors, including extreme poverty, high rate of population increase, frequent natural disasters such as droughts and floods, and agricultural systems that are heavily dependent on rainfall. Under-development in some African states has also been a function of existing protracted natural resource conflicts and climate change worsens the situation. Climate change is a major threat to livelihood security in Africa. This monograph encompasses papers from different disciplines and draws case studies from across Africa. It covers a range of issues relating to vulnerabilities, adaptation and mitigation of climate change and conflict management. Information provided in this monograph is expected to form the basis for decision makers across Africa to formulate and implement appropriate policies to curb the impacts of climate change.

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