Isaac N. Luginaah
Ernest K. Yanful *Editors*

Environment and Health in Sub-Saharan Africa: Managing an Emerging Crisis

Selected Papers from ERTEP 2007, July 17-19 2007, Ghana, Africa

Springer

Environment and Health in Sub-Saharan Africa: Managing an Emerging Crisis

"*This page left intentionally blank.*"

Isaac N. Luginaah · Ernest K. Yanful
Editors

Environment and Health in Sub-Saharan Africa: Managing an Emerging Crisis

Selected Papers from ERTEP 2007,
July 17-19 2007, Ghana, Africa

Springer

Editors
Dr. Isaac N. Luginaah
University of Western Ontario
Dept. Geography
London ON N6A 5C2
Canada

Dr. Ernest K. Yanful
University of Western Ontario
Dept. Civil & Environmental
Engineering
London ON N6A 5B9
Canada

ISBN 978-1-4020-9381-4 e-ISBN 978-1-4020-9382-1
DOI 10.1007/978-1-4020-9382-1
Springer Dordrecht Heidelberg London New York

Library of Congress Control Number: 2009926884

Preface

This book is the second edited compilation of selected, refereed papers submitted to ERTEP 2007. The book is organized into 10 chapters along four of the key themes that were discussed at the conference: Environmental Health Management; Mining and Environment; Environmental Monitoring and Policy Development; and Sustainability and Social Responsibility. It is hoped that the contents of the book will provide an insight into some of the environmental and health management challenges confronting the developing world and the steps being taken to address them.

The first three chapters under the Environmental Health and Management theme discusses issues related to food security and related environmental distress in sub-Saharan Africa. Chapter 1 argues that pervasive poverty and low agricultural productivity are important factors in understanding food insecurity in the region, and broader global processes are examined. This chapter maintains that while poverty undermines individual and household access to sufficient food through market purchase, land inequalities, corruption, structural adjustment programs, civil conflict, HIV/AIDS and the role of the World Trade Organization Agreement on Agriculture are decisive. The authors argue that achieving food security in sub-Saharan Africa requires policies and actions that are integrated with efforts to reduce poverty, enhance livelihoods and incomes and increase agricultural output, while also paying attention to underlying structural factors that bear on agriculture in the region.

Chapter 2 discussed the notions that environmental conditions in dry regions of Sahelian Africa projected to worsen with climate change, and that the agricultural capacity of many areas are likely to deteriorate further in coming years, with migratory pressures therefore continuing to rise with several consequences. The chapter examines the evolving environmental distress migration patterns from the Upper West Region of Ghana to the more fertile lands of the Brong-Ahafo Region where migrants are able to access farmland in different leasehold relationships; and how these migrant farmers are connected to an intensifying system of domestic 'food aid' (i.e. non-market transfers) back to the region, providing a crucial means of coping with its precarious food insecurity.

Chapter 3 examines how best to integrate environmental quality and conservation of natural resources into food security and rural development policies in resource-poor settings. Using agroforestry as a case study, this chapter synthesizes empirical field studies carried out in the southern Africa region for over a decade, and

discusses how the potential impacts of the technological advances made in research and development have been compromised by policy and institutional gaps. With particular cognizance of the socioeconomic context in southern Africa, the chapter identifies options for removing institutional and policy constraints in order to facilitate the diffusion of agroforestry and unlock its potential to satisfy both food production and global environmental goods.

The Mining and Environment theme examined the potential environmental impacts of mining on local communities in increasingly fragile ecosystems. The aim is to increase awareness of the risks and impacts of mining and other human–environmental health threats among miners by placing these hazards into the broader livelihood context of the miners. The chapters under this theme explain miners' risk perceptions and an evaluation of potential livelihood alternatives. Chapter 4 presents the results of research that were conducted in the vicinity of Satellite Goldfields Limited in Mporhor Wassa East District, Ghana. The increasing number of surface mines in Ghana and the consequent adverse effects of mining operations on the environment have been of great concern to the local communities, government and non-governmental organizations over the last decade. This chapter identifies the potential environmental impacts of mining and ore processing at Satellite Goldfields Limited on the environment. The results show that fugitive dust levels were generally high during the dry seasons and that the fugitive dust levels far exceeded the Australian and New Zealand maximum guideline value of 4.0 g/m^2/month when the project was under construction. The levels reduced markedly over the years. Total suspended solids and iron levels exceeded the Environmental Protection Agency (EPA) guideline values in streams that received direct discharge from the mining and ore-processing areas. Furthermore, ground vibration and airblast levels were predominantly below the set trigger limit of the seismograph. Waste management practices at the mine, especially segregation of contaminated and uncontaminated waste at disposal sites, were found to be inadequate and require some attention.

Chapter 5 presents the findings of research that aimed at increasing awareness of the risks and impacts of mercury and other human–environmental health threats among small-scale miners in Ghana by placing these hazards into the broader livelihood context of the miners themselves. This chapter outlines the two main components of the partnership project on human and environmental health with small-scale gold miners in Ghana: the understanding of miners' risk perceptions and an evaluation of potential livelihood alternatives. Through participatory approaches, the authors assessed community perceptions of bodily exposure to mining-related toxicants and proposed culturally and gender-sensitive risk communication and mitigation tools. The ultimate goal of this research is to further interdisciplinary studies among African scientists and mining communities to enhance livelihood conditions in a high-risk environment.

The rapid increase in international environmental norms has contributed to the establishment of substantive and procedural regulations that have influenced national environmental legislative enactments and judicial pronouncements. Under the Environmental Management and Policy Development theme, three chapters are featured. Chapter 6 draws linkages on environmental management, development

and human health. It is argued that poverty in Africa is a leading factor contributing to environmental degradation. Overexploitation of the natural environment has led to widespread deforestation and serious land degradation. In other regions, urban growth, industrialization and mining activities have put the environment under stress, and have also led to the outbreak of diseases posing significant threats to human health. Slow and uneven progress has been made towards sustainable environmental management in Africa. Examples are provided on countries that have adopted environmental management tools, and those that have sought ways of reclaiming degraded environments.

Chapter 7 discusses the availability and effectiveness of environmental legislations in sub-Saharan Africa. It is observed that while governments in the region have moved rapidly in putting together policies and legislations to deal with the environmental crisis, practical action on the ground continues to lag behind. Some of the reasons for this include lack of financial and human resources and lack of appropriate legal frameworks. Further, it is argued that key environmental policies adopted by sub-Saharan countries do not only amplify environmental discourses from rich countries, but also that they in many ways serve strategic interests of rich nations. Environmental policies of countries in Africa are largely dictated by developed nations, through various mechanisms including international conservation organizations, and tend to militate against the livelihoods of poor communities in developing countries. The chapter also points to potential pitfalls that may arise due to the wholesale adoption of these environmental policies. The chapter concludes proposing that sustainable solution to the current environmental crisis lies in beyond tinkering with bureaucratic details of developing countries and criminalizing livelihoods of the poor. The root of the problem lies at the current pattern of production and consumption.

In Chapter 8, the authors examine how industrial clustering can be used to improve the impact of green manufacturing practices by enabling reduced energy and water consumption levels, solid waste and wastewater minimization strategies and increased participation in corporate socially responsible activities. The performance of the Old Ardbennie Industrial cluster in Harare, Zimbabwe, is presented as an example. Levels of water and energy savings, solid waste minimization, wastewater reduction and corporate social responsibility achievements by members of the cluster are determined through both questionnaire surveys and interviews, in addition to monitored data. The results show that the cluster had 15.76% savings in water consumption. However, effluent management by cluster members was still poor with most companies using the municipal pipes for untreated effluent disposal. Potential for trading in waste was identified. Reduction in solid waste was 2.71% and no effective reduction in energy consumption was observed. In general, the results showed that a positive relationship existed between participation in cluster activities and achievement of green manufacturing.

The chapters under the Sustainability and Social Responsibility theme assessed sustainability in the context of the current environmental assessment methods and their shortcomings within a rather bleak and precarious environmental situation in sub-Saharan Africa's future. Chapter 9 advances the area of environmental

assessment by developing a method of evaluating the sustainability implications of industrial activity (products and processes). The authors conclude that it is evident that assessing sustainability requires a cross-disciplinary study of factors and interactions linking demography, consumer demand, economic activity, industrial activity and resource use to sustainability.

Chapter 10 presents a discussion of the future of environmental degradation in sub-Saharan Africa. While acknowledging the relative role of population growth and unsustainable agriculture practices in environmental degradation in the region, the chapter considers the role played by excess consumption, poverty and HIV/AIDS, corrupt African states and international capital in determining the future of natural resources in Africa as critical. The authors argue that the relationship between states and international business corporation has been particularly detrimental to the region's environment, and will continue to present a formidable threat to natural resources, especially as the World Trade Organization becomes more influential in ensuring unrestricted movement of international capital. Alternative imagination by the New Partnership for Africa Development (NEPAD) that sees Africa's development beyond the current economic and political order is critical for arresting future environmental degradation.

London, ON Isaac N. Luginaah
London, ON Ernest K. Yanful

Acknowledgements

The Editor wishes to thank the authors of the chapters for their contribution to this volume. Publications coordinator, Robyn Gaebel, did an excellent job handling the selected manuscripts and communicating with the authors. Alex Dolson, Shahenda Abou-Aly, Cindy Quintus and Erin Cullen provided editorial assistance in the compilation of chapters for the original conference proceedings. Funding for the conference was provided by the Geotechnical Research Centre and Research Western at The University of Western Ontario, Duke University Pratt School of Engineering, the Canadian International Development Agency, Ministry of Local Government, Rural Development and Environment, Ghana, Goldfields Ghana Limited, Newmont Ghana Gold, AngloGold Ashanti, Tema Oil Refinery, Shell Ghana Limited, Volta River Authority, Ghana, Zoomlion Environmental Limited, New Times Corporation, Graphic Communications Group Limited and Ghana Telecom.

"*This page left intentionally blank.*"

Contents

Contributors

Nathaniel D. Aguda Department of Geography, Queen's University, Kingston, ON, Canada K7L 3N6, 1nda@queensu.ca

Albert O. Ainoo Gold Fields Ghana Ltd. (Tarkwa Mine), P. O. Box 26, Tarkwa, Ghana, aainoo@goldfieldsghana.com

Oluyede Clifford Ajayi ICRAF Agroforestry Programme, P.O. Box 30798, Lilongwe 03, Malawi, ajayi@gmx.net or o.c.ajayi@cgiar.org

Festus K. Akinnifesi ICRAF Agroforestry Programme, P.O. Box 30798, Lilongwe 03, Malawi, f.akinnifesi@cgiar.org

Newton Amegbey University of Mines and Technology, P. O. Box 237, Tarkwa, Ghana, na.amegbey@umat.edu.gh

Godwin Arku Department of Geography, Social Science Centre, The University of Western Ontario, London, ON, Canada N6A 5C2, garku@uwo.ca

Daniel Bagah Faculty of Integrated Studies, Wa Campus, University of Development Studies, Wa, UWR, Ghana, banliebo2@yahoo.ca

Rachel Benzer-Kerr Department of Geography, The University of Western Ontario, London, ON, Canada N6A 5C2, rbeznerkerr@uwo.ca

Sebastian Chakeredza ICRAF Agroforestry Programme, P.O. Box 30798, Lilongwe 03, Malawi, schakeredza@africa-online.net

Hans Chapman Florida A&M University, Tallahassee, FL, USA, hanschap@eng.fsu.edu

Abel Chikanda Department of Geography, Social Science Centre, The University of Western Ontario, London, ON, Canada N6A 5C2, achikand@gmail.com

Tarsha N. Eason (Dargan) Florida A&M University, Tallahassee, FL, USA, eason@eng.fsu.edu

Sylvester Galaa Faculty of Integrated Studies, Wa Campus, University of Development Studies, Wa, UWR, Ghana, sgalaa@yahoo.com

Nicole Laliberte Department of Geography, Pennsylvania State University, 336 Walker Building, University Park, PA 16802-5011, USA, njl148@psu.edu

Isaac Luginaah Department of Geography, The University of Western Ontario, London, ON, Canada N6A 5C2, iluginaa@uwo.ca

Charles Mbohwa Fulbright Scholar, The Supply Chain and Logistics Institute, Atlanta, GA 30332-0205, USA, Charles.mbohwa@isye.gatech.edu

Paul Mkandawire Department of Geography, Social Science Centre, The University of Western Ontario, London, ON, Canada N6A 5C2, pmkandaw@uwo.ca

Simon Mng'omba ICRAF Agroforestry Programme, P.O. Box 30798, Lilongwe 03, Malawi, SMngomba@cgiarmw.org

Mathew K. Nkrumah Faculty of Integrated Studies, Wa Campus, University of Development Studies, Wa, UWR, Ghana, mk1950_2000@yahoo.com

Yaw A. Owusu Florida A&M University, Tallahassee, FL, USA, owusu@eng.fsu.edu

Peter Rwakatiwana Department of Mechanical Engineering, University of Zimbabwe, P. O. Box MP. 167, Mt. Pleasant, Harare, Zimbabwe

Gudeta Sileshi ICRAF Agroforestry Programme, P.O. Box 30798, Lilongwe 03, Malawi, sileshi@africa-online.net.

Raymond S. Suglo University of Mines and Technology, P. O. Box 237, Tarkwa, Ghana, rsuglo@yahoo.ca

Petra Tschakert Department of Geography/Alliance for Earth Sciences, Engineering, and Development in Africa (AESEDA), Pennsylvania State University, 315 Walker Building, University Park, PA 16802-5011, USA, petra@psu.edu

Tony Weis Department of Geography, The University of Western Ontario, London, ON, Canada N6A 5C2, aweis@uwo.ca

Introduction

Isaac N. Luginaah and Ernest K. Yanful

Although global environmental concerns are often categorized under broad themes such as climate change and desertification, environmental problems of concern to many of the world's vulnerable groups living in marginal areas tend to have immediate consequences that affect the quality of life, livelihood and in many cases survival. Global climate change and variability affecting developing countries have resulted in increasing human and economic activities that tend to impact negatively on the environment and food security. Such impacts have created huge environmental challenges for governments in these developing countries and require mitigating solutions. Recent world summits have highlighted the need to develop environmental technologies and policies to protect fragile ecosystems. The purpose of the First International Conference on Environmental Research, Technology and Policy, ERTEP 2007, was to discuss grassroot environmental issues, assess efforts by government machinery and identify what communities and corporate entities can do as a social responsibility to mainstream and maintain environmental protection and integrity for sustainable development. The 3-day conference attracted some 250 people delegates from 18 countries. Invited plenary lectures on policy were presented by high-ranking officials from the Ghana Government, including the sector Ministers for Local Government, Rural Development and Environment, Lands, Forestry and Mines, and Women and Children's Affairs. Osagyefuo Amoatia Ofori Panin, the Okyenhene (Ghana) opened the conference. Other plenary and keynote speakers included Dr. Ulf Jaeckel, Federal Ministry for the Environment, Berlin, Germany; Ms. Joyce Aryee, Ghana Chamber of Mines; Mr. Charles Darku, Volta River Authority, Ghana; Mr. Lars-Ake Lindahl of the Swedish Mining Association; Dr. Wanda Günther Risso, University of Sao Paulo, Brazil; Mr. Peter Steblin, City Engineer, City of London; Professor George Nakhla, Universty of Western Ontario, Canada; and Dr. Clement Dorm-Adzobu and Mr. Philip Acquah, Ghana. The plenary lectures were followed each day by technical breakout sessions during which more

I.N. Luginaah (✉)
Department of Geography, University of Western Ontario, London, ON, Canada, N6A 5C2
e-mail: issac.luginaah@uwo.ca

than 100 papers were presented under the seven themes of the conference: Environment, Health and Safety; Oil and Gas Extraction and Environment, Forestry and Environment; Mining and Environment; State-of-the-Art Technologies for Environmental Performance and Protection; Integration of Gender in Environmental Management; Environmental Monitoring Institutions and Policy Development; and Sustainability, Corporate Investment and Social Responsibility.

Nearly all technical papers presented at ERTEP 2007 were reviewed by a theme of international referees selected on the basis of their expertise in the subject area. Each paper was reviewed by at least two referees and written comments were sent to authors for the preparation of revised papers. Following the conference, the Editors of the current volume Professor Isaac Luginaah and Professor Ernest Yanful (ERTEP 2007 Conference Chair), and three editorial assistants, Robyn Gaebel, Cindy Quintus and Alex Dolson selected a number of papers dealing with environmental health and management challenges in the developing world.

Part I
Environment Health and Management Issues

"*This page left intentionally blank.*"

Characteristics and Determinants of Food Insecurity in Sub-Saharan Africa

Paul Mkandawire and Nathaniel D. Aguda

Abstract This chapter discusses the persistence of food insecurity in sub-Saharan Africa. Although pervasive poverty and low agricultural productivity are important factors in understanding food insecurity in the region, broader global processes are examined. It is argued therefore that, while poverty undermines individual and household access to sufficient food through market purchase, land inequalities, corruption, structural adjustment programs, civil conflict, HIV/AIDS and the role of the World Trade Organization Agreement on Agriculture are decisive. The chapter reveals that control over key policy decisions in the agriculture sector is increasingly taken from national states. Achieving food security in sub-Saharan Africa requires policies and actions that are integrated with efforts to reduce poverty, enhance livelihoods and incomes, and increase agricultural output while also paying attention to underlying structural factors that bear on agriculture in the region.

Keywords Food security · Sub-Saharan Africa · Livelihoods

Introduction

World food security is not only a relatively easy agreed-upon political goal, but is also a top-notch global priority. The global consensus on the need for universal access to food is manifest through the Millennium Goal # 1; the goal aims at halving, between 1990 and 2015, the proportion of people who suffer from poverty and hunger. Yet, food insecurity is increasingly becoming a major crisis facing countries of the developing world, with sub-Saharan Africa being the most vulnerable region. The United Nations Report (2008) indicates that overall, higher food prices are expected to push many more people into absolute poverty, with estimates

P. Mkandawire (✉)
Department of Geography, The University of Western Ontario, Social Science Centre, London, ON, Canada N6A 5C2
e-mail: pmkandaw@uwo.ca

I.N. Luginaah, E.K. Yanful (eds.), *Environment and Health in Sub-Saharan Africa: Managing an Emerging Crisis*, DOI 10.1007/978-1-4020-9382-1_1,

suggesting that the increase will be as many as 100 million, most of them in sub-Saharan Africa. The Food and Agricultural Organization (FAO) estimates that some 820 million people in the developing world still lack access to sufficient food, despite progress made in worldwide food production and global commitments to eradicating hunger (FAO, 2006). The greatest challenge to reducing hunger and undernourishment facing sub-Saharan Africa is manifest in the number of undernourished people which has increased from 169 million in 1990–1992 to 206 million in 2001–2003.[1] This region has the highest prevalence of undernourishment, with one in three people lacking access to sufficient food (FAO, 2006). The FAO's projections further estimate that by 2015, the region will contain about 30% of the undernourished people in the developing world, compared to 20% in 1990–1992.

However, when these disturbing figures are set against the fact that already one-and-a-half times more food is currently being produced than the amount required to feed the entire world, it does not only begin to reveal the social and geographical unevenness of global food production and consumption pattern, but it also calls into question whether further undifferentiated increase in the global food production will in any case resolve the problem of food insecurity. Furthermore, the strategy to addressing food insecurity through further increase in food supply is rendered even more questionable given the enormous burden that agriculture is already exerting on the environment (Weis, 2007). When the food security in the sub-Saharan Africa is examined in the context of these imbalances, it provides more scope for understanding the nature of factors that militate against both the efforts towards equal access to sufficient food and the actions aimed at reversing the declining food situation in the region. In seeking to explore key determinants and characteristics of the food insecurity problem in Africa, we begin from the question of why Africa, a net exporter of food at the time of decolonization in 1960s, now imports 25% of its food; with virtually every country as a net food importer (Bello, 2008). In this chapter we begin to unpack the food insecurity problem in the sub-Saharan region by arguing that poverty and declining agriculture productivity are responsible for the growing food insecurity in the region. While depravation and poor agriculture productivity are important, it is further asserted in this chapter that growing political instability, unaccountable political regimes, enduring legacy of colonial land inequality, structural adjustment programs promoted by the World Bank (WB) and the International Monetary Fund (IMF), and the World Trade Organization Agreement on Agriculture have a decisive influence on African agriculture and food security.

This chapter proceeds by examining how persistent poverty contributes to entitlement failure, and how the collapse of entitlements undermines the capacity of families in the region to achieve household food self-sufficiency. To demonstrate these causal links, we draw largely on related approaches of livelihoods and vulnerability. We then interpret the declining food security trend within the context of

[1]It is important to note, however, that the prevalence of undernourishment (proportion of undernourished people in the region) declined from 35 to 32% during this period. This decline is attributed to the region′s population rising more quickly than the number of undernourished people.

corrupt regimes and civil conflicts that persist in the region before the role of historical and contemporary global processes on the African food security are examined. The chapter concludes by recommending that meaningful efforts to understand and address food insecurity on the African continent need to be holistic. Efforts to enhance food security should go beyond the narrow focus on improving soil fertility and should also seek to address broader processes that undermine food production.

Food Security – A Livelihood's Approach

Food security simply refers to access to enough food by all people at all times to ensure an active and healthy life (Maxwell et al., 2000; Maxwell, 2001). While this concept has been defined differently in various circles, three key components – availability, access and adequacy – have now claimed centre stage in the food security discourse. *Availability* refers to the physical presence or supply of food from the household to the national scale, either through own production or markets. *Access* addresses the ability to obtain appropriate and nutritious diet, and is concerned particularly with food obtained through the market and the factors or resources that influence demand for food. *Adequacy* implies that food should be sufficient in quantity and also provide variety. As well, its quality should be sufficient to ensure a good health.

It is now widely recognized that food insecurity is more than just a failure to produce sufficient food: it also involves lack of access to sufficient food as a result of failure of livelihoods to guarantee this access. Contemporary analysis on food security has been shaped largely by Sen's "entitlement approach" to hunger and starvation. According to Sen (1981), hunger and starvation ought to be viewed in terms of the collapse of the entitlements of particular demographic or occupation groups, rather than purely in terms of deficient food output. Sen defines entitlement as "the set of alternative commodity bundles that the person can command" (1981:46) and explains that it refers to what a person can obtain, rather than what the person needs to avoid starvation. Dréze and Sen (1989) argue that although "food production is one of the most important determinants of entitlements" (p. 25), it is by itself inadequate for an understanding of famines, starvation and hunger. Sen's approach suggests that personal and household food insecurity be analysed in terms of those factors that make entitlements of a section of the population fall short of their minimum food requirements. These factors include variables such as ownership patterns, unemployment, relative prices and wage–price ratios (Sen, 1993).

For many poor households in sub-Saharan Africa, the primary concern is the lack of adequate financial resources to access their daily food supply needs, rather than being a matter of the availability of those needs. As Sen (1983) has indicated, poverty is essentially a matter of entitlement and capabilities: ". . . the most important deficiency of traditional development economics is its concentration on national product, aggregate income and total supply of particular goods rather than on 'entitlements' of the people and the 'capabilities' these entitlements generate" (p. 754).

The poor often suffer from inadequate supplies of food and malnutrition, mostly due to the combination of a lack of purchasing power and high food prices. Food security for many poor households is, therefore, closely related to their purchasing power, or their ability to earn an adequate income for themselves and their families. The World Bank (2003) asserts that while global food availability has increased, wide variations exist among countries and regions. The Bank points to insufficient purchasing power in the hands of poor people as the source of inadequate food, and not global constraints on aggregate food production. According to the Bank, although food prices have fallen to record lows, many poor people still do not have the purchasing power to buy enough food.

Closely related to the concept of entitlement is that of vulnerability. The concept of vulnerability refers to "the insecurity of the well-being of individuals, households or communities in the face of a changing [ecological, economic, social, or political] environment" (Moser, 1996:2). According to Moser, these changes in environment often result in increased risk and uncertainty. Vulnerability can also be explained as a combination of exposure to risk, and of the ability of households and individuals to cope with, or recover from a "shock" or deterioration of current status (Maxwell et al., 2000; Watts and Bohle, 1993). Adger (2005) states that vulnerability is a state of susceptibility to harm from exposure to stress associated with environmental and social change and from absence of capacity to adapt. People are vulnerable to hunger when they "risk ongoing lack of access to the food they require in order to live healthy lives" (Watts and Bohle, 1993:45). The concept of vulnerability provides an important conceptual framework for analysing access to food because any attempts to reduce hunger require a sound understanding of which people lack this access and why (DeRose and Millman, 1998). Unfortunately, frameworks for integrating longer term vulnerability in food security analyses are largely absent, and most existing analyses, often applied in the context of early warning systems, focus on transitory risks (Lovendal and Knowles, 2007). Recent estimates suggest that little progress has been made in reducing extreme poverty in sub-Saharan Africa, and that even the most optimistic estimates suggest the Millennium Development Goal of halving the number of people living on less than US$1 per day in the African region will miss the mark by a wide margin (United Nations, 2008).

In many countries in the sub-Saharan region, the number of people in poverty line is actually rising, and this trend is directly affecting the ability of the population to obtain sufficient food to live a healthy life (World Development Report, 2008). In Malawi, for example, about 53% of the population is classified as poor (Malawi Government, 2006). Most smallholder farmers in the country are unable to undertake critical crop and land management tasks because at peak periods (January to February) most of these households are short of food, and opt to look for food through temporary lease farming or "ganyu", rather than working on their own plots. Casual labour is engaged on the tea and tobacco estates during agriculture peak periods, which also happen to coincide with the months of food insecurity in the rural areas (World Development Movement, 2002). In a few other countries, there has been a decline in poverty over the past few years but the number of the poor, nonetheless, remains unacceptably high. For example, despite return to democratic

rule in 1999, and subsequent improvement in social indicators, 50% of the people in Nigeria are still classified as poor, and 40% of the population is considered as food insecure (Agbola, 2008). Another widely known example where poverty and food insecurity are mutually reinforcing is Ethiopia, where over 50% of the people live below the poverty line. About 85% of the population reside in rural areas and subsist on agriculture, but 50% of rural households face chronic food deficit (Diao and Pritt, 2006). Because most people in African countries live in extreme poverty, they are perpetually in state of food insecurity. The task of searching for food occupies a central place in the daily lives of the majority of people in the region.

As evident the approaches of entitlement and vulnerability are crucial in understanding food insecurity at the individual and household levels. As Clover (2003) states, today most common definitions of food security begin with individual entitlement, though recognizing the complex linkages between the individual, the household, the community, the nation and the international community. These two concepts provide the framework to analysing the extent to which households are able to adequately meet their food needs. This framework shifts the emphasis from environmental and demographic causes and pays particular attention to the economic and sociopolitical causes of inadequate supplies of food in the household. This kind of analysis also involves identifying the causes and manifestations of vulnerability to insufficient food in a household (Baro and Deubel, 2006; Lovendal and Knowles, 2007). Household vulnerability and entitlement are thus directly linked to access to food and food availability in a household. This is because vulnerability is determined by a cumulative chain of events and circumstances, and these subsequently affect entitlement to food, be it through own production or market acquisition. One of the issues that constitute a key aspect of chain of events that make smallholder farmers vulnerable to food insecurity is declining agriculture productivity. We turn to the question of low agriculture productivity in the next section.

Declining Agricultural Productivity and Food Availability

Unlike other regions such as Asia and Latin America, a decline in the overall per capita food production has been observed to be occurring in the sub-Saharan Africa (Sanchez and Swaminathan, 2005; Myres and Kent, 2001). The lagging behind of food yields in Africa can be accounted for by a number of interrelated factors. Forging the argument in the context of the fact that, unlike Asia, sub-Saharan Africa did not undergo a Green Revolution, Sanchez and Swaminathan (2005) argue that declining soil fertility is responsible for reduced food production and that there is need for better soil nutrient restoration and water management techniques. Increasing the use of fertilizers and decreasing overdependence on rain-fed system of farm water supply are critical to increasing per capita food yields in the region. The region does not only experience insufficient rainfall, but also that rainfall is highly variable (Adams, 2009). Therefore, irrigation provides a more reliable alternative means of ensuring steady supply of water for growth of food crops. Cases of crop failure due

to drought are commonplace in the region. For example, drought is in part to blame for famines that southern African region has been experiencing over the past few decades (de Waal and Whitehead, 2003).

Land scarcity is also at the centre of food insecurity problem in the sub-Saharan region. While a more thorough historic account of uneven land distribution is provided later, it suffices to highlight here that it has been widely observed that high population growth rate in Africa is one of critical factors fuelling the problem of land shortage (Mwangi, 1997; Matlon, 1987). The population of the sub-Saharan region is increasing at an annual growth rate of about 3% (UNFPA, 2008). Traditional strategies of maintaining soil fertility, such as shifting cultivation and fallowing, are in most cases no longer applicable amidst increasing land scarcity. The shortening of fallow cycles – without replenishment of soil nutrients through the use of organic and inorganic inputs – has caused the yields to decline overtime (Mwangi, 1997). Mwangi (1997) argues that the practice of continuous cropping has also contributed to the degradation of soil structure and the depletion of micronutrients resulting in secular decline in crop yields even where relatively large amounts of inorganic fertilizers have been used. In the quest for new and more fertile farmlands, farmers tend to move onto marginal lands which also tend to be ecologically more fragile. Such land spaces tend to be degraded easily, with various negative environmental consequences (Adams, 2009; Binswanger, 1986).

Achieving food security through the market, as will be seen later, is one of the food security strategies most favoured by the World Bank and World Trade Organization. However, this approach does not seem to present a viable and efficient policy for most African countries as it is easily undermined by weak foreign exchange reserve positions of most of the countries in the region. For example, Madebwe et al. (2005) report on how the food insecurity problem Zimbabwe is facing is being exacerbated by the shortage of foreign exchange due to the freezing of aid from rich nations of the north. In addition, poor infrastructure, including poor road network in rural areas, presents challenges to food procurement and distribution. Road density per person and per area in the sub-Saharan region is in the order of magnitude much lower than in the south and east of Asia (Sanchez and Swaminathan, 2005). The question of state underinvestment infrastructure is further explained later in relation to the impact of structural adjustment programs on the agriculture sector in the region. Underdevelopment of rural infrastructure does not only contribute to high farm gate price of inorganic fertilizers and other farm inputs, but is also responsible for low prices of agriculture products as farmers find it difficult to transport their farm products to markets where reasonable prices are offered. This setback in turn discourages farmers from maintaining high levels of both agriculture inputs and farm outputs. In Malawi, for example, the withdrawal of state participation in agriculture marketing led to critical shortage of fertilizer and other farm inputs in many rural areas of the country as private traders found it costly to provide agriculture inputs to poor and largely dispersed peasants (Chilowa, 1998; Harrigan, 2003).

It should be noted that, while increasing fertilizer application and expanding irrigation can obviously improve agricultural productivity, these strategies, nonetheless, do not address other underlying causes of food insecurity in the sub-Saharan region.

Two of these causes are political instability and unaccountable political institutions, to which we turn in the next section.

Political Instability and Malfunctioning Political Systems

A situation of entitlement failure and persistent poverty can cause famine as argued by Sen (1981). However, when food insecurity is defined as any transitory interlude of below-trend food consumption that threatens human health (Paarlberg, 2000), then the entitlement approach to food insecurity does not seem to sufficiently explain different famines taking place in a number of countries in sub-Saharan Africa that are experiencing political instability and governed by unaccountable political institutions. To argue that the entitlement framework does not fully take into account food insecurity arising from political instability and malfunctioning political institutions is not the same as saying the theory is irrelevant. But rather, it implies that non-market situations of food insecurity, especially those arising from political causes rather than poverty per se, existing in many countries in the African region tend to fall outside the entitlement theory. Two of the most important sources of famine and food insecurity in the developing world, especially in sub-Saharan Africa today, are violent internal conflicts and non-accountable political systems that are hostile to operations of the market (Paarlberg, 2000). Paarlberg (2000) argues that much work on the analysis of food insecurity in developing countries tends to give relatively more weight to conventional entitlement framework. As a result, food insecurity that arises as a result of civil conflict and corrupt regimes that are hostile to normal functioning of the market cannot be sufficiently explained by this framework.

The geographic mismatch between post-colonial states and ethic boundaries – the legacy of colonialism – is one of the many key factors responsible for the civil conflict in the region. There are many linkages between civil conflict and food insecurity. For example, the recruitment of young persons as soldiers in conflicts in the region makes an already difficult situation of shortage of agriculture labour worse (severe strains on agriculture labour already exist due to HIV/AIDS and urbanization, see Masanjala, 2007; Kalipeni et al., 2004). Destructive practices of warring factions tend to militate against agriculture production as both militias and regular armies obtain most of their food supplies through raiding of agricultural fields and livestock of ordinary people. In war situations, theft and deliberate destruction of remaining or abandoned food crop fields and domestic animals is an accepted strategy of denying access of enemies to these important food resources in contested regions. For example, there is widespread destruction of civilian food crop fields in the Democratic Republic of the Congo and in Darfur region of western Sudan (Macrae and Zwi, 1991). Violent conflicts also displace large numbers of people. This does not only tend to keep large groups of people in continual state of mobility – hence unable to cultivate food crops and domestic animals – but also that such displace populations are usually difficult to target with important social ser-

vices such as immunizations and education, until they come under diplomatic reach of international relief organizations.

North Korea is a well-known example of an unaccountable regime outside the sub-Saharan region that is widely known to be responsible for starving its own population for political ends. In recent years, the Zimbabwean government provides the best example of a sub-Saharan political regime that is known to manipulate the distribution of food to its population for political gains (Gregory, 2007). Just as land redistribution in Zimbabwe has been primarily aimed at rewarding ZANU-PF supporters and veterans, the regime has a tendency to get popular political support by threatening to deny food and drought relief to opposition supporters. However, such strategies are not limited to Zimbabwe only; they are also practised by other regimes throughout many parts of sub-Saharan Africa. As Gregory (2007) argues, regimes usually seek to consolidate their grip on political power by manipulating the political, economic, social and military opportunities that arise from the potential or occurrence of food crisis. In Malawi, the lousy advice by World Bank to sell the country's strategic grain reserve in 2002 (World Development Movement, 2002) – that resulted in starving to death of 1,200 people – gained traction in top government circles because of the presence of corrupt elements who profiteered from grain disposal. The political power of food rests on its scarcity and governments will seek to control the supply of food, and the extent to which the population is fed. During 2004 election in Malawi, the ruling political party, the United Democratic Front, took advantage of the food crisis to muster political support by distributing relief maize only at the ruling party's political campaigns. Tarkana region in Kenya, like other politically remote regions in the country and continent, has increasingly become marginalized politically and economically, including in relief food distribution (Gregory, 2007). People in the area are largely dependent on international organization food supply in coping with frequent dry weather conditions in the region. Food insecurity in the region is, therefore, also closely linked with corrupt regimes and widespread civil conflict presently existing on the African continent, and that these factors should be taken into consideration when explaining and addressing the food crisis in the region.

While the current unstable political climate prevailing on the sub-Saharan continent and the existence of unaccountable political regimes are in part responsible for growing food insecurity in the region, other past and present global processes are also complicit in undermining food security in the region. In the section that follows, we elaborate these key historic factors.

Historical and Contemporary Global Processes Shaping Food Security in Sub-Saharan Africa

The concept of vulnerability has long and varied roots and is used in a wide range of disciplines including economics, anthropology, geography, psychology and even engineering (Adger, 2005). While there are key differences in the manner in which

the concept of vulnerability is applied, many commonalities, nonetheless, exist in the manner in which the term vulnerability is used, including in the area of food security. Firstly, it is widely noted that the term vulnerability is usually conceptualized (as referred to above) as being constituted by components that include exposure and sensitivity to perturbations, or external stresses and capacity to adapt. A discussion of household exposure of stress and its capacity to adapt or cope, and concomitant ramifications for household food security have already been provided in the preceding sections. The second commonality as argued by Adger (2005) is that vulnerability does not exist in isolation from the wider political economy of resource access, control and use. Clover (2003) states that a robust definition of food security begin with individual entitlement, while recognizing the complex linkages between the individual, the household, the community, the nation and the international community. Drawing on these perspectives, we argue that the question of food security on the sub-continent is linked to the persistence of colonial uneven land distribution, structural adjustment and multilateral trade rules of the World Trade Organization.

Colonial Legacy of Uneven Land Distribution

In this section we argue that the colonial legacy of land inequality has largely persisted across much of the territorial Africa until today, and that imbalances in landholding are closely linked with persistent food insecurity (Moyo and Yeros, 2005). The land question is critical in agriculture and food security; structured by social relations, land and agriculture form the basis of society's food system (Turshen, 1984). European imperialism in the African region was largely characterized by mass alienation of fertile native land. As highlighted by Sihlongonyane (see Moyo and Yeros, 2005), over several centuries, European imperialist agents, including merchants, settlers and Christians, incrementally annexed land from its indigenous inhabitants; the climax of which was in the late nineteenth century "Partition of Africa". Not only was land appropriation largely motivated by the need to establish white settler plantation agriculture, but the eviction of indigenous people from ancestral land was a deliberate strategy for ensuring that abundant and cheap native labour was made available in European agriculture and mining complexes in the region. For example in Malawi, while white settlers occupied the best land, local inhabitants were pushed into the margins of agriculture frontier, drawn to work in mining establishments in Zimbabwe and Zambia (Pachai, 1975). Highly skewed landholding landscape in Malawi has largely persisted as evident from per capita cropland holding of 0.175 hectares in the southern region of the country, 0.257 in the centre and 0.256 in the north (Malawi Government, 2001). About 40% of smallholder farmer has a per capita land ownership of between 0.4 and 1.0 hectare (Ellis et al., 2003). Neoliberal policies advocating land reforms through the market have only served to entrench existing inequalities in land ownership. A highly skewed land ownership structure has been blamed for food insecurity and poverty given that 85% of the population live in rural areas with agriculture as the major occupation (Moyo and Yeros, 2005).

Turshen (1984) discusses a similar scenario; that imperial dispossession (first by Germans and then after World War 1 by British) of fertile agricultural land in Tanzania was brutal and abrupt, and in other cases subtle and insidious. Turshen observes that the introduction of private land ownership regime, commercial agriculture and wage labour in Tanzania by the Europeans is largely responsible for declining agriculture productivity as the natives were forced to occupy marginal infertile land. She argues that imbalances in land distribution are in part to blame for malnutrition and the disease environment in the country. In South Africa, land distribution still bears the imprint of apartheid with the majority of land still in the hands of the rich (Bond, 2006). Land redistribution efforts in the country have been complicated by what is believed to be the African National Congress uncritical and hysterical obsession with neoliberalism as evident from unprecedented speedy transition to the market economy (Bond, 2000). Bond (2000) observes that neoliberal changes that took decades for countries like Zimbabwe to accomplish have been carried out in over a period of less than 5 years; raising questions as to whether any meaningful and equitable land reform can take place under such political and economic climate; raising the spectre of what is widely called land "acquisition from below" often by powerful groups (Weis, 2007). As a result, facts on the ground reveal that 55,000 commercial farmers still own 102 million hectares of land compared with 11 million households who own 17 million hectares in former "homelands" (Moyo and Yeros, 2005). The South African government market-based land reform policy guided by the logic of "willing buyer" and "willing seller" not only has left unequal power relations unscathed, but also privileges rich landowners in land transfer negotiations. As a result, land redistribution has not been an effective strategy for dealing with food insecurity and rural unemployment. Beyond food security uneven land distribution in the country also reconfigures other benefits, as evident in access to water. Commercial farmers, who account for 80% of landholding, also dominate control over water catchment areas and consequently have disproportionate access to water for agriculture in the majority of the population (Woodhouse, 2008).

In addition to exacerbating food insecurity, the persistence and entrenchment of unequal landholding has had the effect of pushing populations into marginal agricultural frontiers, with deleterious consequences for the environment (Adams, 2009). As a growing population is forced to subsist on a largely diminishing per capita landholding, this trend is undermining sustainable use of existing land. Hence, erosion, declining soil fertility and low agriculture productivity, as explained above, are commonplace in the region. Unsustainable use of agricultural land is further encouraged by government conservation policies that often exclude humans from "nature" enclaves without regard to the accompanying loss of livelihoods by local people. National parks and game reserves are integral part of governments' vague strategy of natural resource conservation and account for 16% of land space in Africa (Panitch and Leys, 2006). The rate of expansion of spaces designated as protected areas in Africa has given rise to the suggestion of "Cape to Cairo Green Corridor" stretching from Kruger Park in South Africa into Mozambique and Zimbabwe to the east coast of Africa (Panitch and Leys, 2006) as neoliberal advocates, including international conservation agencies, seek to create islands of nature across

continental Africa. However, because these nature enclaves exist as islands in seas of land injustice, they face a precarious future and are perpetually in defence from encroachment by local inhabitants (Weis, 2007; Adams, 2009).

Agriculture Policy Reconfiguration by Structural Adjustment Programs

Structural Adjustment Programs (SAPs) were introduced by the World Bank and International Monetary Fund in the 1980s following the debt crisis of the late 1970s. Although the debt crises that many developing countries experienced during this period were largely caused by factors external to these economies (such as oil shock, rise in interest rates on loans), the World Bank and International Monetary Fund sought to deal with the resultant poor economic growth in these countries through diversification of these economies. The aim was to make them better equipped to cope with future shock of similar nature. Most of the economies in question actually poorly structured by European imperialists during colonialism as they were designed to produce a narrow range of commodities, mainly agriculture based, to meet consumption and industrial demands of Western Europe (Hoogvelt, 2001). Being the mainstay of most economies of African countries, the agricultural sector became one of the focal points of the restructuring process (Harrigan, 2003). It is for this reason that the current food crisis in the African region cannot be fully understood without examining the manner in which national agricultural policies were reconfigured by the World Bank and the International Monetary Fund from the early 1980s. A set of key policy measures aimed at deregulation of the agriculture sector in the region included, but not limited to, the "downsizing" state owned agricultural development agencies and parastatal organizations, cutbacks in fertilizer and other farm input state subsidies provided, liberalizing credit and the promotion of agriculture export (Bello, 2008). Cutbacks in state spending related to agriculture entailed drastic reduction in government investment in critical areas of the agriculture sector, including in agricultural extension support, training and research. It is estimated that, with the exception of the Republic of South Africa, agricultural research expenditures in sub-Saharan Africa as a percentage of gross domestic product dropped from 0.76% between 1981 and 1985 to 0.58% in 1991 (Kuyek, 2002). Further, reduced government participation in the distribution of agriculture inputs and marketing of farm produce from peasants to facilitate the entry of private traders into the industry, while theoretically sound, was fraught with various practical challenges. One of the most critical problems was that non-price constraints such as poor rural road infrastructure, communication and underdeveloped markets militated against efficient private sector provision of much needed agriculture services (Stiglitz, 2003). Thus, state withdrawal from the agriculture sector had been carried out at much faster rate than the provision of appropriate incentives and infrastructure that provide favourable conditions for viable private sector participation. The inevitable consequences included problems in access to farm inputs and markets,

with negative outcomes in household food production and security. As discussed by Stiglitz (2003), poor policy sequencing and pacing was the characteristic failure of structural adjustment programs by the IMF.

The relative roles of the state and the market in the agriculture sector in the neoliberal economic climate remains a highly contentious issue, as characterized by general lack of consensus between the World Bank and African governments (Harrigan, 2003). One of the key unresolved issues are the relative role of food imports and food self-sufficiency in achieving food security and the contribution of the state to the later, and more generally the role to be played by state marketing boards and input subsidies in semi-liberalized input and output markets. The Bank's inevitable policy preference is one where a country should attain food security through the market rather than food self-sufficiency. In other words, the World Bank encourages developing countries to achieve food security by buying food to feed the population from the international food market using foreign exchange generated from the production of commodities over which they have a comparative advantage (Harrigan, 2003). It is this logic that guided the World Bank advice to the Malawi government to sell its strategic grain reserve culminating into famine in 2002 that killed 1,500 people (Bryceson and Fonseca, 2006; Potts and Bowyer-Bower, 2006).

The World Bank's drive to promote export agriculture has also had a profound negative effect on food security in the region. The rationale behind the policy of export promotion was that developing countries would be able to obtain sufficient amounts of the much needed foreign exchange to finance balance of payments as well as national food deficits (SAPRIN, 2004). Countries were, therefore, implored to put in place economic incentives (such as agriculture credit) aimed at promoting the growth of commercial crops, such as tobacco, cotton, coffee and rubber. It was expected that increased household incomes that would result from the exportation of these products would be used to meet food requirements of families. This is in line with the World Bank and World Trade Organization policy goal of achieving food security through the market. As a result of this drive, increasing amounts of land were re-allocated from subsistence food production to commercial agriculture. For example in Malawi, there was net loss of land from cultivation of maize into production of tobacco (Chilowa, 1998). As will be discussed in subsequent section, agricultural exports from developing countries still face high tariffs in developed countries, and this has the effect of eroding the comparative advantage of poor countries. Further, the indiscriminate policy of export production has led to what is called the "fallacy of composition", (Weis, 2007). The phenomenon of the fallacy of composition is widely used to refer to a situation where most developing countries are involved in the production of similar products leading to the problem of structural overproduction, with the result of further driving down commodity price on the international market. As indicated by Stiglitz (2003), the IMF "one size fits all" approach meant that similar policies were implemented in different countries without regard to differences in context. The worsening terms of trade of agriculture produce from Africa region has had other social consequences that go beyond mere food insecurity.

In Ethiopia, for example, Abebe (2007) found that the growing significance of export-led crops like coffee over the local subsistence economy has changed rural livelihoods. The growing food insecurity resulting from the relative decline in the cultivation of local staple, *enset*, coupled with plummeting price of coffee on the international market has contributed to the acceleration of child labour participation in multiple reproductive and income-generating activities. Thus, the changing dynamics of global agriculture trade has led to participation of children in deeply unequal and exploitative system of international trade (Abebe, 2007). Structural overproduction of cocoa from West Africa is largely responsible for the plummeting of the price of cocoa beans on the world market (SAPRIN, 2004). Emerging evidence from the region suggests that between 60 and 80% of rural household income in Africa derives from off-farm sources, with poorest households being the most heavily dependent on off-farm, informal and piecework labour (Panitch and Leys, 2006). Although the foregoing discussion is not by any means comprehensive, it is nonetheless, evident that poor agricultural policies as advised by the World Bank and International Monetary Fund, including chronic underinvestment in the agriculture sector and inappropriate economic incentives are responsible for the collapse of agriculture production in the sub-Saharan region.

Role of the World Trade Organization Multilateral Agreement on Agriculture

Analysis of food insecurity in Africa should also be understood in the context of the role of the World Trade Organization (WTO), especially the Agreement on Agriculture. WTO is generally understood as a set of shared rules that guide member governments' behaviour pertaining to the protection and subsidy of domestic economic activity, a framework for enforcement of such commitments, and a forum for negotiation and construction of these rules. The aim of the WTO Agreement on Agriculture is to establish a "fair and market-oriented agriculture trading system" (Khor, 2002). The need for a fairer agriculture trading system has rationalized on the basis of declining terms of trade, especially for commodities produced from developing countries, distortions created by rich country agricultural surpluses and farm subsidies, and rising import dependency among third world countries. However, as Weis (2007) argues, the form of regulation that has been adopted by the WTO Agreement on Agriculture is far from fair; instead it acts as an ideological pretext for market-oriented policies consistent with those advanced by the World Bank and the International Monetary Fund. Essentially, the WTO has been hijacked by international capitalists, and has been turned into a forum for advancement of legal rights of Agriculture Transnational Corporations (Agri-TNCs) relative to interests of national states and local governments (Bond, 2006). We discuss how this state of affairs directly bears on the question of food security in Africa by examining two main aspects of WTO Agreement on Agriculture; liberalization of agriculture trade and Trade and Investment Property Rights (TRIPS).

As alluded to earlier, the Agreement on Agriculture of the World Trade Organization generally involves the promotion of liberalization of global agricultural trade through the reduction or elimination of domestic supports, agriculture export subsidies and other forms of market barriers. In practice, this means that governments will have less power and control over what is imported into the domestic economy. However, rules that govern the conduct of WTO are explicitly contradictory in a manner that works against the interest of most developing countries, including sub-Saharan Africa. The hypocrisy that characterizes the general conduct of WTO, and the dubious fashion in which business is conducted at this forum is evident by the double standards that have become part and parcel of accepted business norm. For example, while developing country governments are "encouraged" to remove any form of agriculture supports and tariffs on agriculture commodity imports, high tariffs still persist in many developed countries in sectors such as agriculture and textiles, and for selected manufactured products (Khor, 2002). High tariffs for imports of sugar, peanuts, wheat, beef and butter still exist in the United States and the European Union markets, making it impossible for developing country exports to gain access to these markets. Furthermore, this is in sharp contravention of the neoliberal philosophy that western governments espouse which argues that government interference in the market is largely responsible for market failure. In addition, while agriculture support mechanisms, especially subsidies, still persist in the agriculture sector of developed countries, the same WTO requires that developing countries remove state subsidies on agriculture inputs. As highlighted earlier, the precipitous removal of import controls and scrapping of seed and fertilizer subsidies to poor households have been responsible for the impoverishment of smallholder farmers from the region (SAPRIN, 2004).

Mehdi (2008) provides a compelling account of the deleterious effect of heavily subsidized food imports from the European Union to many countries on the African continent. He shows, for example, that EU's chicken exports to Ghana, and other West African countries, enjoyed Euro 254 subsidies per tonne, and affected domestic supply accounted for 89% of domestic supply of poultry in 2001, as compared with 5% in 1992. In Cameron, reduction of import tariffs to 25% led to imports of poultry by about sixfolds. In Senegal, 70% of local production of poultry was wiped out. In Cote d'avoire, domestic production of poultry dropped by 23% between 2001 and 2003. In Mozambique, local production of vegetable oils dropped from 21,000 tonnes in 1981 to 3,500 tonnes in 2002. Damping of cheap imports of tomatoes from the European Union countries has also been observed to greatly undermine local tomato production in the entire region of West Africa (Panitch and Leys, 2006). Declining viability of the rural agriculture in Africa – as a result of cheap products from rich countries – is not only facilitating increased dependency on imports, but is also undermining foreign exchange positions of African countries.

In addition to foregoing negative consequences, the apparent comparative advantage of rich country agriculture products is quickly rendered questionable when the issue of environmental costs is brought into the picture. The grain and livestock complex of the rich country temperate region has largely been built on a treadmill of fossil fuels (Weis, 2007). As Weis (2007) argues, the intersection of the age of

peak oil and high fuel costs with large and rising food miles[2] is one of the greatest contradictions of the global food economy, given how fuels are embedded in extensive transport, processing, integration, refrigeration, farm machinery and agro chemicals and fertilizers. Because the environmental burden emanating from carbon emission and toxic burdens from petro-farming are largely externalized, the comparative advantage is grossly distorted in favour of agriculture products from developed nations. The resulting annihilation of agriculture that is exacted on developing countries by developed countries goes beyond the persistence of food insecurity and increasing dependence on cheap food imports; the dying of agriculture in Africa has also been linked to the rising wave of urbanization in the region. Rapid de-peasantization has been observed throughout much of Africa (Bryceson, 2000).

The rural–urban migration in turn has also been linked to the rapid spread of HIV/AIDS (Kalipeni, 2004) as well as environmental degradation, as migrants occupy fragile parcels of lands on the margins of cities (Weis, 2007). The rising tide of HIV/AIDS in turn also exacerbates the collapse of rural livelihoods and growing food insecurity (Masanjala, 2007). As de Waal and Whitehead (2003) indicate, the character of food crisis that has been observed in recent decades in southern Africa region is distinct from conventional drought-induced food shortages, in the profile of those who are vulnerable to starvation, and the trajectory of impoverishment and recovery. Under the "New Variant Famine" hypothesis, de Waal and Whitehead contend that new groups of deprived households that are emerging across the region include those made more vulnerable to starvation as well as HIV/AIDS as they are increasingly unable to meet their daily subsistence requirements by cultivation. In a study conducted in central region of Malawi, Bryceson and Fonseca (2006) found that food insecurity among peasants militated for sexual exchange practices in women as a means for obtaining food for their families.

The World Trade Organization's definition of property rights under the Trade and Intellectual Property Rights (TRIPS) generally legalizes the corporate practice of collecting and patenting genetic resources such as seeds and traditional medicine, many of them from the developing countries, including sub-Saharan Africa (Weis, 2007; Bond, 2006). TRIPS will severely hinder or prevent local firms, including those involved in the agriculture sector in the African region, from absorbing some of modern technologies over which other corporations (mainly foreign firms) have intellectual property rights (Khor, 2002). The problem of low agriculture productivity in the African region as explained in this chapter will be exacerbated as this treaty will effectively curb the adoption of modern agriculture technology by domestic firms and individuals. Because knowledge about many of the products earmarked for patenting by transnational corporations, including agriculture seed, has been accumulated over a long period of time and has been passed down from one generation to another by local communities, some have characterized the practice of converting these common resources into private commodities for the sake of

[2]Food miles is a conceptual framework for accounting for the distance food has travelled from land to mouth.

securing technological rents as “looting” (Bond, 2006), “bio-piracy” (Shiva, 1997) or “appropriation by dispossession” (Harvey, 2005). Seed is a commodity of critical import to farmers in sub-Saharan Africa, and is widely considered as societal and cultural common property. By patenting indigenous seed, TRIPS will help to secure the ability of transnational agro-input companies to drive poor farmers into the market for commodified seed in a corporate-controlled Web of inputs in agriculture with negative implications for poverty and environment. Intellectual Property Rights, such as patents, plant variety protection, are exclusive monopoly rights over a creation that society provides to the inventor for a period of time. While such monopoly protection obviously restricts the dissemination of knowledge, in the context of patenting existing genetic material, it is not counterbalanced by the incentive that it provides to innovate (Kuyek, 2002). In addition, and equally important for the African region, innovation can take various forms. For example, while a researcher at a pharmaceutical company in the United Kingdom can invent a new drug, a smallholder farmer in Malawi may develop new ways to keep weevils out of maize granary. Both of these people are innovators; but only one of them stands to benefit from an exclusive monopoly on the invention.

Consistent with the Agri-TNC quest to apparently dubious ways of exacting exclusive control over agriculture seed through patenting of indigenous is the threat to African agriculture, and the world natural systems in general presented by genetic engineering of life form, especially seed. Through genetic engineering capital reinforces its attempt to increasingly draw natural resources into a system of expanded reproduction (Panitch and Leys, 2006). Genetically modified seed, as a commercial input, is designed to promote demand for chemical agriculture and enhance profit prospects for Agri-TNCs. Genetically modified crops do not only threaten to replace biodiversity with uniformity, but also that the human health impacts of these products are scientifically inconclusive, and may have potentially harmful health consequences. The current lack of agreement between the United States and the European Union on the safety of genetically modified products provides a testament to scientific uncertainties around potential health impacts (Clapp, 2004). Until recently, the transnational seed industry had little interest in Africa. But with the advent of genetic engineering, these companies are beginning to take a more active interest in the African seed market. Industry analysts estimate that the introduction of genetically modified crops can increase the value of seed markets by 50% (Kuyek, 2002). On the part of its proponents it is argued that the technology could aid the developing world in achieving its developmental and food security goals by increasing output, addressing problems of pest control, disease and crop management, improving nutritional quality, and increasing stress tolerance of new plant varieties (Zerbe, 2008). However, this argument rests on a shaky ground because, as indicated earlier, it is distribution rather than production of food that lies at the root of the current global food crisis.

Strategies for enhancing the expansion of genetically modified material into the region include GMO food relief during disasters, as well as strategic purchasing of local seed companies by Agri-TNCs and increasing production of these transgenic crops. Efforts are also underway to manipulate popular views about these products.

Kushwaha et al. (2004) discuss tactics for expansion of genetically modified cowpeas in northern Nigeria. This study reveals different strategies used to gain the acceptance of local farmers, including the manipulation of perception about risk and socioeconomic impacts through the use of advertisements on international radios. The entire West Africa region has been a target of genetically modified Bt cotton by Monsanto. Moseley (2008) reveals that recent food protests in West Africa can in part be accounted for by the gradual displacement of local grain production with cotton, including six strains of genetically modified cotton introduced by Monsanto. As discussed above, many of the inputs required for higher yielding crops, especially fertilizer, are petroleum based. Dependence on commercial inputs renders poor farmer vulnerable to unstable oil prices, not to mention the environmental burden associated with widespread use of these chemicals. The use of imported seeds (hybrid or GMO) and other inputs only serve to further concentrate the power of Agri-TNCs, and leave smallholder farmers in the region more vulnerable exploitative tendency of these organizations.

Conclusions

The discussion in this chapter has highlighted persistent poverty linked to food insecurity in sub-Saharan Africa. Poverty has undermined food sufficiency at the regional level, and household ability to either produce or purchase sufficient quantities of food to maintain an active, healthy life. Data from the World Bank reveal that the poverty rate in sub-Saharan Africa was over 50% in 2005 – the same as it was in 1981. The Bank also notes that the number of poor households has almost doubled from 200 million in 1981 to 380 million in 2005 (Chen and Ravallion, 2008). If this trend continues, it is estimated that one-third of the world's poor will live in Africa. This large proportion of the population living in poverty also lives with food insecurity. This disturbing picture points to the urgency of addressing food insecurity in Africa.

Beyond a limited perspective of poverty as the cause of food insecurity, we have explored the role of conflict and unaccountable governments in creating and benefiting from situations of food insecurity in the region. Zimbabwe, Malawi and Kenya have only been given as examples, but there are many other countries where food scarcity is either a war or political strategy. These factors are important not only for understanding the determinants of food insecurity, but also for informing strategies for addressing the problem. The chapter has also grappled with historical and contemporary processes that shape the problem of food insecurity on the continent. Uneven land distribution inherited from colonial past hamper food security efforts in the region. Smallholder farmers are concentrated in marginal agriculture frontiers as increasing proportion of land is drawn into natural resource protection and commercial agriculture. Structural adjustment program by the World Bank and International Monetary Fund has had an enduring effect as it reconfigured policies in ways that undermined investment, eroded infrastructure and compromised food

self-sufficiency. Poor farmers throughout most of Africa face problems related to access to agriculture inputs and markets as the state has been rolled back, leaving them at the mercy of private traders. The removal of agriculture subsidies at the behest of World Bank has significantly diminished farm productivity. The World Trade Organization, though founded on the premise of promoting fair trade, has largely served the interest of Agri-TNCs at the expense of smallholder farmers in developing countries. Agri-TNC stranglehold on the WTO is evident from the dubious conceptualization of intellectual property rights, double standards on farming subsidies, and an overly mercantile approach to food security. The resultant displacement of small farmers in the region is contributing to urbanization and HIV/AIDS.

Although structural adjustment programs have nominally been taken out of the picture, following widespread international condemnation, the logic is basically very much present in poverty reduction strategy papers that have been widely adopted by the countries in the African region. These poverty reduction strategy papers embrace the same neoliberal logic of free-market development with minimal government intervention, including the promotion of private sector participation in agriculture. This is in part aimed at creating conditions for strategic access by Agri-TNCs from rich countries into domestic agriculture sector, with the same consequences for food security. Furthermore, the much celebrated debt relief that has been extended to some African countries is also tied to neoliberal conditionalities, including compliance with WTO rules, including agriculture trade liberalization. These policies will further lead to opening up of domestic economies of African countries for damping of cheap products from rich countries. These are the conditions that determine food security in the region.

References

Adams, W. (2009) *Green Development: Environment and Sustainability in a Developing World.* London: Routledge.

Abebe T. (2007) Changing Livelihoods, Changing Childhoods: Patterns of Children's Work in Rural Southern Ethiopia, *Children's Geographies* 5(1): 77–93.

Adger, W.N. (2005) Vulnerability, *Global Environmental Change* 16: 268–281.

Agbola, P.O. (2008) *Effects of Income Diversification Strategies on Food Insecurity Status of Farming Households in Africa: Results of Analysis from Nigeria*. Paper Presented at 12th EAAE Congress 'People, Food and Environments: Global Trends and European Strategies', Gent, Belgium.

Baro, M. and Deubel, T. (2006) Persistent Hunger: Perspectives on Vulnerability, Famine, and Food Security in Sub-Saharan Africa, *Annual Review of Anthropology* 35: 521–538.

Bello, W. (2008) *Manufacturing a Food Crisis*. The Nation, pp. 16–21.

Binswanger, H.P. (1986) Evaluating Research System Performance and Targeting Research in Land Abundant Areas of Sub-Saharan Africa, *World Development* 14(4): 469–476.

Bond, P. (2000) *Elite Transition:From Apartheid to Neoliberalism in South Africa*, London: Pluto Press .

Bond, P. (2006) *Looting Africa: The Economics of Exploitation*. London: Zed Books.

Bryceson, D. (2000) Disappearing Peasantries? Rural Labor Redundancy in the Neo-liberal Era and Beyond. *In* D. Bryceson, C. Kay, and J. Mooij (eds.) *Disappearing Peasantries? Rrural Labour in Africa, Asia and Latin America*, London: Intermediate Technology, pp. 299–326.

Bryceson, D. and Fonseca, J. (2006) Risking Death for Survival: Peasant Responses to Hunger and HIV/AIDS in Malawi, *World Development* 34(8): 1666–2006.

Chen, S. and Ravallion, M. (2008) *The Developing World is Poorer Than We Thought, But No Less Successful in the Fight Against Poverty*. Policy Research Working Paper. Development Research Group, World Bank.

Chilowa, W. (1998) The impact of agricultural liberalisation on food security in Malawi, *Food Policy* 23(6): 553–569.

Clapp, J. (2004) WTO Agricultural Trade Battles and Food Aid, *Third World Quarterly* 25(8): 1439–1452.

Clover, J. (2003) Food Security in Sub-Saharan Africa, *Africa Security Review* 12(1): 145–154.

DeRose, L. and Millman, S. (1998) Introduction. *In* L. DeRose, E. Messer, and S. Millman (eds.) *Who's Hungry? And How Do We Know? Food Shortage, Poverty, and Deprivation*, Tokyo; New York; Paris: United Nations University Press, pp. 1–19.

de Waal, A. and Whitehead, A. (2003) 'New Variant Famine': AIDS and Food Crisis in Southern Africa, *The Lancet* 263: 1234–1237.

Diao, X. and Pritt, A. (2006) Growth Options and Poverty in Ethiopia – An Economy-Wide Analysis, *Food Policy* 32(2): 205–228.

Dréze, J. and Sen, A. (1989) *Hunger and Public Action*. Oxford: Clarendon Press.

Ellis, F., et al. (2003) Livelihoods and Rural Poverty Reduction in Malawi, *World Development* 31(9): 1495–1510.

Food and Agriculture Organization (2006) The State of Food Insecurity in the World Eradicating World Hunger – Taking Stock Ten Years After the World Food Summit.

Gregory, E. (2007) *In Food Policy Report*. Washington, DC: International Food Policy Research Institute.

Harrigan, J. (2003) U-Turns and Full Circles: Tow Decades of Agricultural Reform in Malawi 1981–2000, *World Development* 31: 847–863.

Harvey, D. (2005) *A Brief History of Neoliberalism*. New York: Oxford University Press.

Hoogvelt, A. (2001) *Globalization and the Postcolonial World: The New Political Economy of Development*. Baltimore: Johns Hopkins University Press.

Kalipeni, E. et al. (2004) *HIV and AIDS in Africa: Beyond Epidemiology*. Oxford: Blackwell Publishing.

Khor, M. (2002) *Rethinking Globalization: Critical Issues and Policy Choices* London: Zed.

Kushwaha, S. et al. (2004) Consumer Acceptance of GMO Cowpeas in Sub-Sahara Africa, Long Paper #119265. American Agricultural Economics Association.

Kuyek, D. (2002) *Intellectual Property Rights in African Agriculture: Implications for Small Farmers*. Genetic Resources Action International Report, Barcelona.

Lovendal, C. and Knowles, M. (2007) Tomorrow's Hunger: A Framework for Analysing Vulnerability to Food Security. *In* B. Guha-Khasnobis, S. Acharya, and B. Davis (eds.) *Food Security: Indicators, Measurements, and the Impact of Trade Openness*. UNU-WIDER Studies in Development Studies. Oxford: Oxford University Press. .

Madebwe, C. et al. (2005) Back to Basics: The Role of Indigenous Knowledge Systems in Agro-Diversity and Household Food Security in the Smallholder Agriculture Sector in Zimbabwe: The Case of Chipinge, *Pakistan Journal of Social Sciences* 3(6): 868–872.

Macrae, J. and Zwi, A. (1991) Food as an Instrument of War in Contemporary African Famines: A Review of the Evidence, *Disasters* 16(4): 299–320.

Malawi Government (2001) *Malawi National Land Policy*. Lilongwe: Malawi Government .

Malawi Government (2006) Malawi Growth and Development Strategy Paper, Lilongwe: Malawi Government.

Masanjala, W. (2007) The Poverty-HIV/AIDS Nexus in Africa: A Livelihood Approach, *Social Science and Medicine* 64: 1032–1041.

Matlon, P. (1987) Prospects for Sorghum and Millet Production in West African Semi-arids, Presented at IFPRI/ISRA Conference in Dakar, Senegal.
Maxwell, D., et al. (2000) *Urban Livelihoods and Food and Nutrition Security in Greater Accra, Ghana*. Research Report 112, International Food Policy Research Institute in Collaboration with Noguchi Memorial Institute for Medical Research and Word Health Organization.
Maxwell, S. (2001) The Evolution of Thinking About Food Security. *In* S. Deveroux and S. Maxwell (eds.) *Food Security in Sub-Saharan Africa.* London: ITDG Publishing.
Mehdi, S. (2008) Knocked-down Agriculture after De-industrialization; Another Destructive Influence of Neo-liberalism, Munich Personal RePEc Archive Paper No. 10224: University of Neuchatel.
Moseley, W.G. (2008) *In Search of a Better Revolution*. Minneapolis: StarTribune, pp. 1–2.
Moser, C. (1996) *Confronting Crisis: A Comparative Study of Household Response to Poverty and Vulnerability in Four Poor Urban Communities*. Environmentally Sustainable Development Studies and Monograph Series, No. 20 Washington, DC: World Bank.
Moyo, S. and Yeros, P. (eds.) (2005) *Reclaiming the Land: The Resurgence of Rural Movements in Africa, Asian and Latin America*. London: Zed Books.
Mwangi, W. (1997) Low Fertilizers and Low Productivity in Sub-Saharan Africa, *Recycling Nutrients in Agroecosystems* 47: 135–147.
Myres, N and Kent, J. (2001) Food and Hunger in Sub-Saharan Africa, *The Environmentalist* 21: 41–69.
Paarlberg, R. (2000) The Weak Link Between World Food Markets and World Food Security, *Food Policy* 25: 317–335.
Pachai, B. (1975) *Land and Politics in Malawi*. Ontario: Limestone Press.
Panitch, L. and Leys, C. (eds.) (2006) *Coming Terms with Nature: Socialist Register*. Monmouth: The Merlin Press.
Potts, D. and Bowyer-Bower, T. (2006) *Eastern and Southern Africa: Development Challenge in a Volatile Region.* London: Prentice Hall.
Sanchez, P. and Swaminathan, M. (2005) Hunger in Africa: The Link Between Unhealthy People and Unhealthy Soils, *Lancet* 265: 442–444.
SAPRIN (Structural Adjustment Participatory Review International Network) (2004) Structural Adjustment, Poverty and Inequality (Chapter 9). *Structural Adjustment: The SAPRIN Report.* London: Zed Books, pp. 203–225.
Sen, A. (1981) *Poverty and Famines: An Essay on Entitlement and Deprivation.* Oxford: Blackwell; New York: Oxford University Press.
Sen, A. (1983) Development: Which Way Now, *The Economic Journal* 93: 745–762.
Sen, A. (1989) Food and Freedom, *World Development* 17(6): 769–781.
Sen, A. (1993) The Causation and Prevention of Famines: A Reply, *The Journal of Peasant Studies* 21(1): 29–40.
Shiva, V. (1997) *Biopiracy: The Plunder of Nature and Knowledge*. Boston: South End Press.
Stiglitz, J. (2003) *Globalization and Its Discontents.* New York: WW Norton.
Turshen, M. (1984) *Political Ecology of Disease in Tanzania*. New Jersey: Rutgers University Press.
UNFPA (2008) *UNFPA Population Issues Report*. Washington, DC.
United Nations (2008) *Millennium Development Goals Report*. New York: United Nations.
Watts, M. and Bohle, H.G. (1993) The Space of Vulnerability: The Causal Structure of Hunger and Famine, *Progress in Human Geography* 17: 43–67.
Weis, T. (2007) *The Global Food Economy: The Battle for the Future of Farming*. London and New York: Zed Books.
Woodhouse, P. (2008) *Water Rights in South Africa: Insights from Legislative Reform*. Brookes World Poverty Institute Working Paper.
World Bank (2003) *World Development Report Annual Publication*. Washington, DC: The World Bank.

World Bank (2008) *World Development Report Annual Publication*. Washington, DC: The World Bank.
World Development Movement (2002) *Structural Damage: The Causes and Consequences of Malawi Food Crisis Report*, London.
Zerbe, N. (2008) Sowing the Seeds of Progress: The Agricultural Biotechnology Debate in Africa, *History Compass* 6(2): 404–425.

"*This page left intentionally blank.*"

Environment, Migration and Food Security in the Upper West Region of Ghana

Isaac Luginaah, Tony Weis, Sylvester Galaa, Mathew K. Nkrumah, Rachel Benzer-Kerr, and Daniel Bagah

Abstract Ghana has achieved dramatic improvements in national food security in recent years, but concealed in this overall progress is a considerable measure of regional unevenness, with the population living in the dry savannah regions in the north faring the worst. The Upper West Region (UWR) is the poorest region of Ghana and has long served as a reservoir of migratory labour for the southern parts of the country, but in recent years migration patterns have been both escalating and changing. Increasingly, permanent UWR migration is focusing on the more fertile lands of the Brong-Ahafo Region (BAR), where migrants are able to access farmland in different leasehold relationships. A rapid research appraisal conducted in Techiman (BAR) suggests that UWR migrants view their growing settlement in the BAR to be a long-term phenomenon. It also highlighted how land tenancy issues are central to the challenges migrant farmers face, and are largely perceived as being immutable by the farmers themselves. Nearly all new UWR migrants must begin working in sharecropping relationships for BA landlords, paying out one-third of their harvest as rent, and over time they hope to save sufficient market earnings in order to lease the land outright. Despite these rents and the high cost of transportation, this chapter suggests that evolving migration patterns from the Upper West Region (UWR) of Ghana are connected to an intensifying system of domestic "food aid" (i.e. non-market transfers) back to the region, providing a crucial means of coping with its precarious food insecurity. With environmental conditions in dry regions of Sahelian Africa projected to worsen with climate change, the agricultural capacity of the UWR is likely to deteriorate further in coming years, with migratory pressures therefore continuing to rise. In light of this, this study points towards both future research objectives in the UWR and the BAR, as well as to the implications such research could have for policy interventions and locally grounded regional initiatives.

I. Luginaah (✉)
Department of Geography, The University of Western Ontario, London, ON, Canada N6A 5C2
e-mail: iluginaa@uwo.ca

I.N. Luginaah, E.K. Yanful (eds.), *Environment and Health in Sub-Saharan Africa: Managing an Emerging Crisis*, DOI 10.1007/978-1-4020-9382-1_2,

Keywords Ghana · Upper West Region · Environmental degradation · Migration · Food security

Introduction: The Improving but Uneven Terrain of Food Security in Ghana

In aggregate terms, Ghana's food security situation has improved dramatically in the past decade and a half: the national prevalence of undernourishment declined from 41% in the period of 1989–1991 to 11% in the period of 2002–2004, an improvement that is even more remarkable as Ghana's national population grew by 37% over this same period, from 15.3 to 20.9 million (FAOSTATS). This is largely a reflection of exceptional increases in food production, in particular of Ghana's "core" food staples – cassava, yams, plantains and maize. As reflected in Fig. 1, the growth in productivity of these crops has far outpaced the 37% increase in population since 1990.

Additionally, the production of Ghana's primary agro-export, cocoa beans, has also grown considerably and, as evident in Fig. 2, per unit earnings have largely kept pace with this productivity growth, which is unlike many tropical commodities where terms of trade have worsened (Robbins, 2003). These agro-export earnings have helped pay for rising food imports into Ghana, which are highlighted in Fig. 3. Yet while food imports have risen, these are as yet a modest part of the total food supply, and Ghana does not receive external food aid. Thus, in short, Ghana has done much better than most of sub-Saharan Africa in containing its food import dependence.

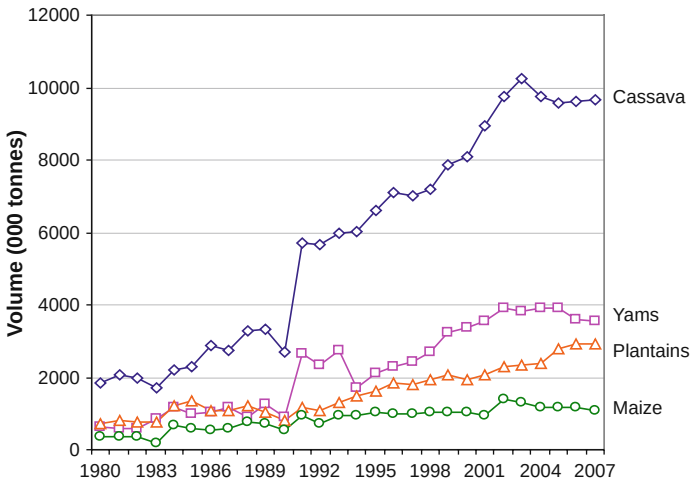

Fig. 1 Ghana's food crop production – core food staples 1980–2007. Data derived from FAOSTAT-Agriculture (http://faostat.fao.org/site/567/DesktopDefault.aspx? PageID=567)

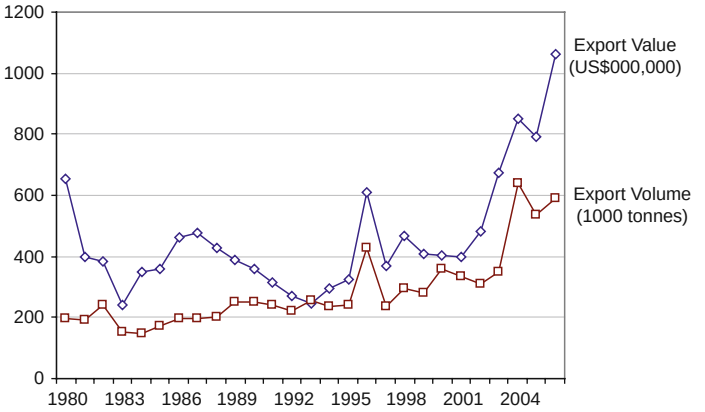

Fig. 2 Ghana's cocoa export performance (by volume and value) – 1980–2006. Data derived from FAOSTAT-Agriculture (http://faostat.fao.org/site/535/DesktopDefault.aspx? PageID=535#ancor)

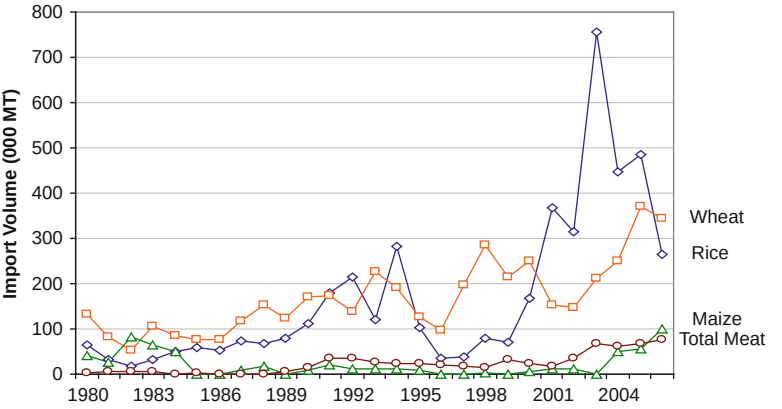

Fig. 3 Selected key food imports to Ghana by volume – 1980–2009. Data derived from FAOSTAT-Agriculture (http://faostat.fao.org/site/535/DesktopDefault.aspx? PageID=535#ancor)

Overall, this brief snapshot of Ghana's agro-production and trade patterns since 1990 reflects a positive picture, in which both production volumes and food security have improved considerably. However, the national scale obscures the regional unevenness within Ghana, and in particular the precarious food security of the dry savannah regions in the north, the Upper West and the Upper East.

The Study Context

The Upper West Region (UWR) is the poorest region in Ghana and covers a geographical area of approximately 18,478 km^2, which constitutes about 12.7% of the total land area of the country. Whereas 39.5% of Ghanaians live below the official poverty line, in the UWR this is much higher, ranging from 79 to 96% across the

region, including 96 to 99% in rural areas. In comparison, the poverty incidence is only 8% in the Accra Metropolitan Area, 10% in the Kumasi Metropolitan Area, and between 16 and 45% in the Western region (Ghana Poverty Reduction Strategy [GPRS], 2005). Welfare indicators from the Ghana Demographic and Health Survey (2003), show that the UWR is clearly below the national mean for the poor, ranking consistently lowest in all categories particularly among women and children who are frequently malnourished. Compared to the rest of the country, the UWR has considerably poorer levels of educational attainment. The non-literacy rate of 69.8% in the UWR is very high when compared to the national average of 42.1%, and is even higher for females, 73.9% (Ghana Resource Centre, 2007).

Lying within the Guinea savannah belt on the southern fringes of the Sahel region, the UWR is characterized by a single rainy season which falls between May and October (wet season) with an average total of 75–115 cm of rain per annum. The savannah conditions and short rainy season are also associated with rapid runoff (Songsore and Denkabe, 1995; Nsiah-Gyabaah, 1994). Yet despite the aridity and water constraints, the economic base of the region hinges on agriculture with over 80% of the population depending on farming (including poultry and livestock production) for their livelihood (Luginaah, 2008; Songsore and Denkabe, 1995). In recent years, there has been a decreasing level of rainfall in the UWR, which has highlighted the vulnerability of the region to climate change and variability, posing challenges amidst the already high levels of poverty and comparatively low health and nutritional status.

Because of its high levels of poverty and limited growing season, the region has long served as a reservoir of cheap migratory labour for productive sectors to the south, with circular migration patterns going back to the colonial period. Historically, much of this migration has been seasonal, revolving around the lengthy UWR dry season, and concentrated in the mining areas of the south and the agricultural heartland of the Brong-Ahafo Region (BAR), which has more fertile soils and a double rainy season (Abdul-Korah, 2007; Van der Geest, 2005, 2003; Konadu-Agyemang, 2000). The UWR's extreme dependence upon short- and long-term migration is reflected in the recent survey that out of a total population of 980,997 of Upper Westerners, only about half (492,597) live permanently in the region (Ghana Statistical Service, 2002). Environmental pressures are likely to cause this migration to rise still further, particularly among those aged 15–45 years.

Across the Sahel annual rainfall volumes have been in long-term decline (Dai et al., 2004; Hulme, 2001), and the "warmer and drier conditions have led to a reduced length of growing season with detrimental effects on crops" (IPCC, 2007:4). The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007:10) describes Africa in general as being "one of the most vulnerable continents to climate variability", with its savannah regions at the greatest risk. More specifically, it notes that

> By 2020, between 75 and 250 million people are projected to be exposed to an increase of water stress due to climate change. . .Agricultural production, including access to food, in many African countries and regions is projected to be severely compromised by climatic variability and change. The area suitable for agriculture, the length of the growing seasons and yield potential, particularly along the margins of semi-arid and arid areas, are expected

> to decrease. This would further adversely affect food security and exacerbate malnutrition in the continent. In some countries, yields from rain-fed agriculture could be reduced by up to 50% by 2020 (IPCC, 2007:10).

The problems associated with this rising aridity echo loudly in UWR farmers' concerns about soil erosion, declining harvests, and increasing household food insecurity, which are widely expressed,[1] and with few alternative sources of income in the UWR, increasing numbers of young people are being forced to seek greener pastures elsewhere (Abdul-Korah, 2007). While mining once provided a major source of seasonal employment and income for UWR migrants, Ghana's declining mining sector (Hilson, 2004) has led to the loss of remitted income for the region and deepened the economic hardships facing many households, particularly when layered on top of the uneven impacts of Ghana's extensive structural adjustment programs (SAPs) (Songore, 1983; Awanyo, 2001; Konadu-Agyemang, 2000). As a result, UWR migration is becoming increasingly concentrated on urban centres to the south (predominantly to Ghana's two major cities, Accra and Kumasi) and on the fertile farmlands of the BAR (Van der Geest, 2005, 2003), and the previously largely seasonal character of migration patterns appears to be changing towards more permanent settlement.

Most UWR migrants to the BAR engage in farming in order to support both their families who travel with them and those remaining back in their home villages and towns, and this linkage has become a crucial source of remitted food and money – to the point that the BAR is becoming widely conceived as a lifeline for the UWR's survival. This rising dependence raises serious concerns both for the food security and long-term economic viability of the UWR and for the health, living conditions, and general well-being of the migrant population in the BAR who, in addition to struggling under difficult tenancy conditions, often remit significant portions of their harvests and earnings back to their families in the UWR. Concerns about the health of young migrants is heightened by the fact that some people in the UWR are raising fears about infectious diseases and increasing mortality rates among this migratory population (Abdul-Korah, 2007).

In light of these emerging problems, this chapter provides an assessment of the changing patterns of food remittance from migrant farmers to their families in the UWR, and on how migrant farmers perceive their challenges – in particular, with respect to the leasehold system in the BAR, the internal food aid they are effectively providing to the UWR, and what changes they envision improving their own circumstances and the food security concerns of their home region. In exploring these linkages between migration and food security we hope to identify a number of important social, economic and environmental dynamics that warrant future research and policy attention.

---

[1]The University of Development Studies – Wa Campus (UWR) runs an innovative field research program in which every undergraduate student is immersed in villages for extended periods to learn about development problems as understood by local people themselves, and hence faculty members are uniquely positioned to comment on the prevailing concerns of the region's farmers.

Methods

Since there are few existing studies and virtually no statistical data on internal food remittance patterns in northern Ghana,[2] an interpretive methodology was adopted for our assessment, with focus group discussions used instead of individual interviews since they tend to facilitate considerable interaction on given topics in a limited space of time (Kidd and Parshall, 2000). Lunt and Livingstone (1996) characterize the focus group as a microcosm of "the thinking society", capable of revealing the processes whereby social norms are collectively shaped through dialogue, debate and argument, ideally creating a space where group members can generate their own questions and pose them to other group members, exchange anecdotes, weigh a range of behavioural possibilities, and comment on one another's experiences and points of view in their own terminology. Further, Kitzinger (1995) argues that focus groups are particularly appropriate for facilitating the discussion of taboo topics because the less inhibited members of the group can serve to break the ice for shyer participants. These processes can also underpin successful participant education (Kidd and Parshall, 2000).

The capital city of the BAR is Techiman, which also acts as the region's dominant trading centre and draws farmers into the city on a weekly basis. Here, in June 2006 and July 2007, UWR migratory farmers were recruited through a snowball sampling strategy, with initial contacts facilitated through the BA Regional Administrative Officer and other community leaders. Focus group discussions were conducted in year. They were led and translated by a researcher fluent in Dagaare, the language of the participants, with a checklist of key topics and semi-structured questions helping to ensure that the study objectives were covered through a process that was flexible enough to allow new questions to be added during the data collection process. All focus group discussions were conducted outdoors in the Techiman market and averaged approximately 1 h in length, with lunch provided as a small token of gratitude to the participants. In addition to the focus groups, semi-structured interviews were conducted with the BA Regional Administrative Officer and the BA District Health Officer.

The analysis of the transcribed data was guided by the use of both *emic* and *etic* categories; that is, both those emerging from the data and those that had already been brought to the study through related literatures. Focus group transcripts were coded using the same coding scheme, with two investigators independently coding portions of the transcripts, and this process helped to identify similarities and differences between groups and ensure a consistent analysis of the data (following Kidd and Parshall, 2000; Patton, 1987). The basic goal was to establish areas of broad consensus and areas of significant differences among focus group participants with respect to the emerging challenges associated with migration and food security in the UWR; the livelihood challenges facing UWR migrants living in the

[2] Van der Geest (2005, 2003) examines migration flows from the UWR, but does not assess the phenomenon of food remittance in much detail beyond noting its significance.

BAR; and how potential improvements are conceptualized. The findings were then organized around the following primary themes: evolving migratory patterns; leasehold arrangements; food remittance to the UWR; health concerns; and social mobilization and perceived policy alternatives, with direct quotations from participants helping to emphasize key points.

Results

The Intensifying Migration–Remittance Lifeline for the UWR

There were many issues of strong consensus among participants. One of the most notable of these was the general view that migration from the UWR to the BAR is a major and growing dynamic, with some participants estimating UW migrants to account for as much as one-third of the Techiman population. Participants indicated that UW migrants meet regularly in groups from their home towns or villages, perpetuating a sense of togetherness, community, and a common Dagaaba identity despite the fact that they typically work in disparate places. The most important space for these gatherings is the Techiman market, with market days serving both an obvious economic role as well as a significant social function for migrants to discuss issues related to their lives in the BAR and to keep abreast of what is happening back in the UWR. In addition to the shared spaces, migrants also described relying on UWR kinship networks in the BAR as a safety net in times of difficulties and as a means to helping new arrivals settle in, principally by helping them to find farmland to lease and in putting up shelters. These kinship networks have both informal and more formal dimensions, such as associations and chiefs who strive to maintain community cohesiveness.

Another area of clear consensus among participants was in explaining the primary motivation for emigration from the UWR, which revolved around different aspects of environmental degradation. Changing climatic conditions and a lack of adequate rainfall were a recurring point of discussion, linked to consequent difficulties coping with life and family responsibilities. As one participant put it, “inadequate rainfall [and] bush fires have destroyed the entire landscape, resulting in people’s inability to cultivate the land to feed their families”. The declining quality of land in the UWR was repeatedly expressed in stark terms:

- “the lands are all dead”;
- “all the trees are gone”;
- “clearing the land and bush burning has destroyed the land”;
- [its like] “a desert now”;
- “land is not fertile, the land is gone. . .it is exhausted, and this has been going down for roughly 15 years now”.

Though changing climatic conditions were identified as a big part of this declining farmland quality in the UWR, a number of participants commented on how

family members at home were being driven into unsustainable farming practices such as a lack of fallowing, reflected in comments such as

- "I told my brother to farm less and rotate land, unfortunately not everyone can do that, they can't do it";
- "Yeah yeah, definitely . . . too much clearance, too many trees cut. . . most young people have come here [the BAR] – no alternative. . .there is no alternative, no choice. . .they either land here or struggle within the land at home";
- "we don't have enough land there and people always work the same spot for many years without fallow".

There was little optimism expressed that the conditions for agriculture in the UWR can improve, and though participants acknowledged that there is a need for increased fallow cycles, collaborative reforestation, and an end to the practice of setting bush fires, the lack of economic alternatives in the region were seen to largely preclude this from happening. As one participant put it: "if you say they shouldn't farm for a year it's gonna be a problem – the determination to work the land is there". Given these circumstances and interpretations, it is not surprising that participants described the need "support their parents and families back home" as their primary motivation migration to the BAR. As one participant simply put it: "there is no food back in the UWR, [so] I had to come here to be able to help". The primary things remitted to the UWR are basic dried foodstuffs and money, but on occasion migrants will return back with items like zinc for shelter. The relative proximity of the BAR also helps migrants respond and provide support during family emergencies.

Although participants described the need for migration and remitted food and income to their extended families and communities in the UWR with a strong sense of immediacy, it was also clear that they saw their individual migration to the BAR as a relatively permanent move. When asked to assess the prospect of moving back to the UWR, none of the participants could foresee themselves re-settling in their home region. One participant summed it up plainly: "when you go back home, all you see is misery. . . the people are hungry. There is nothing, no land, so why go home and perish?"

Leasehold Arrangements for UWR Migrants

The BAR was identified as a major destination for UWR migrants in light of the declining opportunities in Ghana's mining sector, where some participants had previously found employment, and the advantages of the BAR's agricultural conditions, especially the more fertile soils and the double rainy seasons (versus one increasingly unreliable rainy season in the UWR) which allow for greater productivity. According to participants, more UWR migrant farmers used to lease land to the east of the UWR, towards the city of Tamale, but the penetration of tough, invasive grass species (*pulong*) in that region was described as having made farming there more difficult and less profitable.

The attraction of the BAR is magnified by the fact that land is generally seen to be available to those who want to work it under leasehold arrangements. For new migrants, leasehold generally begins with sharecropping, which involves splitting farm production between farmer and landowner in the ratio of 2:1 (*abunu*) or 3:1 (*abusa*) (Codjoe, 2006), until sufficient income can be saved to lease land outright (in 2006, the cost of leasing 1 acre of land was generally ¢250,000–300,000 [US$26–31] depending on quality). Participants indicated that for the most part, land clearance and preparation is still done by hand, as they do not have money to hire tractors to plough it, with the cost of ploughing 1 acre by tractor roughly ¢200,000. Fortunately for farmers, the land is seen to be fertile enough that it does not require external inputs.

Though these leasehold terms might make the BAR landlord–UWR tenant relationship appear to be an exploitative one, participants consistently described landlords in favourable terms, emphasizing qualities such as honesty and reciprocity, which they associated with the Bono culture. It was also suggested that such perceptions were held widely by migrants, to an extent that they constituted an important factor why so much migration was concentrating in the BAR. A number of examples highlight this view of landlords:

- "they willingly lease their land to you to farm and they will not cheat you";
- "they give you respect";
- "I have never faced prejudice";
- "I have never had any conflicts, and don't really know of any farmer from the UWR who did".

Yet while participants spoke in positive terms about the Bono people generally as well as landlords specifically, they did express frustration about sharecropping arrangements; as one participant put it, "the sufferer keeps taking two portions until you can build up the money for outright lease payment. . .a beggar has no choice". Compounding this was the fact that agricultural support programs from the government, including extension services, were not seen to reach them but rather to be concentrated with the landlords, with one participant describing UWR migrants as a "silent workforce". Another participant described his sense of this process: "usually we hear that a particular program has come, and then you never hear of it again, before you know it, its gone".

In short, the views of landlords as decent, honest people and the views of the sharecropping system as inequitable appear to be separated conceptually, which is reflected in the fact that tenant–landlord conflicts were said to be very uncommon. From our discussions, it appears highly unlikely that the UWR migrant farmers would mobilize to contest their terms of land tenancy in the BAR in the near future. Rather, the typical response is for the migrant farmers to endure the *abunu* or *abusa* terms[3] upon arrival in the BAR, starting with limited capital, and work hard to save

[3]Participants indicated that *abunu* (2:1) sharecropping was most common in their experience.

the money that is needed to lease land outright, which participants indicated allows for a greater return on one's labour. In general, it was seen to take between 3 and 5 years to accumulate enough money to initiate this leasehold relationship.[4] In rare cases, migrants have been able to buy land in the BAR, but the prevailing sense among participants was that "they had no prospect of ever buying land", as one put it, and at best could hope for a small lot to build a house upon.

A new leasing arrangement is emerging where some migrant farmers can gain access to government-owned in the early stages of reforestation, which entails regulated techniques and a relatively short duration on the land while the trees grow in. The basic conditions are that, as one participant described it, farmers have to "plant trees, and then farm till trees grow, then you move to new land . . . but you can't plant too much, otherwise you can't farm it!" The scale of this program is unclear but appears to be a subject of future interest in the BAR, especially in light of the environmental pressures discussed below.

Domestic "Food Aid" and the Migrant Farmer

While the participants do not envision themselves moving back to the UWR, as has been discussed, it was recognized that some family members need to remain there, especially for the care of elders. One participant described how his eldest brother stays at home in the UWR to care for their parents, while his responsibility has been to move to the BAR and send food back to help maintain the household; as he put it, "We can't all leave the home, because if we are all here, our homes collapse." Most participants described sending food back to their families several times every year, and the general sense from the discussions was that this regular remittance of food back to the UWR was the norm for migrant farmers in the BAR. One participant described how this scale of food movement to households in the UWR could not occur in the absence of these non-market networks, as "the market power in the Upper West is weak, the people don't have anything to sell, and no money to buy food stuff that is transported to the region".

One participant pointed out that a stark indication of the rising food remittance was that every market day in Techiman "you see the trucks loading [food] on their way to the UWR". One participant noted that "for the 8 years I have been here [in the BAR], I have been sending maize and yam home every year. . .at least three times a year", estimating that he produces roughly 50 large bags of ground maize in a good year and sends about nine of these to his family in the UWR, in addition to sending some of the cash income he generates from selling in the market. Another observed that "anything at all [that is generated beyond his own immediate needs] I send it home to feed my [elderly] mother". This compulsion, it was pointed out, remains for migrants even though "the harvest is not always good", and though

[4] ₵1 M [US$104] was given as a rough target for being able to acquire enough land to generate a viable farm income.

they also have the needs of their immediate families in the BAR to attend to; as one participant put it, "people at home [in the UWR] know when its harvesting season here so when their food is finished, they send a message for me to send more food". Another indication of how the UWR's food security is increasingly tied to its migrant farmers came as participants noted how they are starting to hear appeals for remitted food made by more distant members of extended families and home communities than had previously been the case.

In addition to the aforementioned challenges facing migrant farmers, the process of food remittance is augmented by the typically poor storage facilities farmers have access to, which frequently results in the loss of sizable portions of their harvests, and by the steep shipping costs. At the time this appraisal was conducted a large bag of maize was estimated to sell in the Techiman market for ¢250,000–280,000 (US$26–29), while the average cost for sending this bag to a central part of the UWR was estimated at ¢90,000 (US$9). One participant noted with frustration that it "costs more to send a bag of maize to the UWR than a human being", even though vastly more bags are packed on a lorry than people get moved on a bus. Some participants described this cost of shipping food as a significant deterrent, and the primary reason they were not able to send more.

What Can Be Done? Migrant Perspectives

When asked what could be done to improve conditions in the UWR, most framed this terms of augmenting the role that migrants play in "sending money and food stuff home to help the people". Related to this immediate conception was a focus on ways of improving the flow of goods through these networks, with the cost of transportation and the problems of infrastructure often highlighted and linked as in the following quotes:

- "roads are so bad that transportation is not easy and very expensive";
- "[transportation owners] charge a lot for food stuff, that is the only thing preventing many of the farmers from sending home enough food to the UWR";
- "if the transportation was reasonable, many people will send food home, even to the markets there, and make it a bit cheaper for the people".

In addition to improving the Techiman-to-Wa highway, which for large stretches deteriorates into little more than a bumpy trail, one participant also identified the need for an improved storage system to prevent the significant volume of spoilage that occurs. In terms of productive changes, the focus was not on land access and tenancy issues but on gaining access to supports for farming (recalling how government assistance is seen to elude migrants). Participants suggested that one way of improving access to agro-inputs and hired labour was through making some form of micro-financing available to migrant farmers.

However, despite some ideas for improvement, as yet, there appears to be limited political mobilization of migrant farmers or expectation that they could be a force in advocating for changes. Migrant farmers tend to congregate in groups or unions according to their various village origins, which are primarily social networks, rather than in pan-UWR groups organizing around shared political or economic concerns.[5] Some participants did suggest that if migrant farmers from the UWR were able to organize into a broader representative grouping they would be more effective in their advocacy, but it was also noted how difficult it is in practice to bring together a dispersed population of farmers which is, for the most part, heavily encumbered with long work days and pressing day-to-day matters.

Conclusions and Future Directions

Evolving migration patterns are becoming increasingly entwined with the food security of the UWR, intimately connecting it with the BAR to the south. An informal system of domestic food aid is emerging whereby surpluses produced in Ghana's agricultural heartland are sent northwards through non-market networks from migrant farmers to their families and communities in the UWR, where they have become a major means to survival. The findings reported here point in two major directions that require further exploration.

The first direction is to the food insecurity situation of the UWR, which has broader implications for the Sahelian region that is already one of the poorest in the world. Most participants described how pressures help sustain their families were a primary reason for relocating, and it was clear they perceive this as an indefinite arrangement rather than a temporary phenomenon. Immediately related to this dependence is a need to assess whether programs could be developed to help support UWR migrants with more information, skills and material resources to make their provision of this food aid more efficient than it currently is (e.g. Is it possible to have collectively organized food storage and transportation systems?; How might political pressure for infrastructure improvements be exerted?).

A broader intervention relates to the development challenges associated with climate change, agricultural resilience and other employment opportunities for the people in the UWR, as the persistent out-migration of working age and young migrants and the rising dependence upon food and other remittances also obviously raises profound questions about the future viability of the region. These issues are especially momentous as they are set within a context of protracted environmental deterioration, particularly inadequate rainfalls, which threaten to worsen with climate change, and the lack of alternative sources of income in the UWR. As one

[5]There are more than 50 UWR village associations in Techiman which meet regularly, and these typically embrace both Catholics and Muslims, the two dominant religions in the region. The only pan-UWR migrant group is a Catholic Association (DACA), which has about 200 members and meets every month. Although this group is dominated by farmers it also includes others such as doctors, nurses and teachers.

participant put it: "things aren't likely to improve [in the UWR], it is getting tougher all the time". UWR migrants could well be seen as environmental refugees, and this will only worsen if climate change plays out in dry savannah zone as projected by the IPCC (2007).

The second major direction for future research stemming from these findings relates to the challenges faced by this near-permanent yet virtually silent workforce in the BAR, and the associated environmental impacts in the BAR as agricultural practices become ever more heavily influenced by tenant relations. Socially and economically, migrant farmers from the UWR face multiple challenges – affording leasehold access, struggling to accumulate small amounts of capital while sending a significant volume of surplus production to relatives in the UWR, and providing for the needs of their immediate families in the BAR – and they appear to be largely overlooked in terms of government programs and policies. Furthermore, there is a need to examine the changing gender roles and dynamics in the context of environmental distress migration at both origin and destination.

Environmentally, sharecropping in Ghana has been found to put great pressure on soil fertility as tenant farmers' foremost priority is to secure high yields in the short term in order to pay land rents (Gruhn et al., 2000), and the presence of rising numbers of insecure migrants in the BAR's agricultural landscape could be leading to more land being put under cultivation (Codjoe, 2006), especially in the regions surrounding the cities of Techiman and Atebubu where there are major concentrations of migrant farmers from the UWR. Thus, while we do not intend to imply that there is a simple relationship between rising population and land degradation, there is a danger that the surge of migrant farmers coupled with the land tenancy situation in the BAR could lead to unsustainable practices. This, in turn, points to the need for research on how policy interventions could be established to create incentives for migrant farmers in the BAR to make long-term investments in improved soil fertility.

References

Abdul-Korah, G. B. (2007). "'Where is not home?': Dagaaba Migrants in the Brong Ahafo Region, 1980 to the Present." *African Affairs* 106(422), 71–94.

Awanyo, L. (2001). "Labor, Ecology, and a Failed Agenda of Market Incentives: The Political Ecology of Agrarian Reforms in Ghana." *Annals of the Association of American Geographers* 91(1), 92–121.

Codjoe, S. N. A. (2006). "Population growth and agricultural land use in two agro-ecological zones of Ghana, 1960–2010." *International Journal of Environmental Studies* 63(5), 645–661.

Dai, A., P. J. Lamb, K. E. Trenberth, M. Hulme, P. D. Jones, and P. Xie (2004). "The Recent Sahel Drought is Real." *International Journal of Climatology* 24, 1323–1331.

Ghana Demographic and Health Survey Report (2003). *Ghana Statistical Service*. Accra, Ghana

Ghana Statistical Service (2002). *Ghana 2000 Population and Housing Census, Summary Report of Final Results.* Accra, Government of Ghana.

GPRS II (2005). *Growth and Poverty Reduction Strategy (2006–2009)*, Republic of Ghana, National Development Planning Commission. November 2005.

Gruhn, P., F. Goletti, and M. Yudelman (2000). "Integrated nutrient management, soil fertility, and sustainable agriculture: Current issues and future challenges." *Food, Agriculture, and*

the Environment Discussion Paper #32. International Food Policy Research Institute, 2033 K Street, N.W., Washington, DC, 2006. http://www.ifpri.org/2020/dp/2020dp32.pdf

Hilson, G. M. (2004). "Structural Adjustment in Ghana: Assessing the Impacts of Mining-Sector Reform." *Africa Today* 51(2), 53–77.

Hulme, M. (2001). "Climatic perspectives on Sahelian desiccation: 1973–1998." *Global Environmental Change* 11(1), 19–29.

Intergovernmental Panel on Climate Change (IPCC) (2007). *Climate Change 2007: Climate Change Impacts, Adaptation and Vulnerability, Summary for Policymakers*. IPCC Working Group II Fourth Assessment Report.

Kidd, S. P. and B. M. Parshall (2000). "Getting the focus and the group: Enthancing Analytical Rigor in Focus Group Research." *Qualitative Health Research* 10(3), 293–308.

Kitzinger, J. (1995). Qualitative research: Introducing focus groups. *British Medical Journal* 311, 299–302.

Konadu-Agyemang, K. (2000). "The Best of Times and the Worst of Times: Structural adjustment programs and uneven development in Africa: The case of Ghana." *The Professional Geographer* 52(3), 469–483.

Luginaah, I. N. (2008). "Local Gin (*Akpeteshie*) and HIV/AIDS in the Upper West Region of Ghana: The need for preventive health policy." *Health & Place* 14, 804–814.

Lunt, P. and S. Livingston (1996). "Rethinking the focus group in media and communications research." *Journal of Communication* 46, 79–98.

Nsiah-Gyabaah, K. (1994). *Environmental Degradation and Desertification in Ghana: A Study of the Upper West Region*. Aldershot, UK: Avebury Publishers.

Patton, M. (1987). *How to Use Qualitative Methods in Evaluation.* Thousand Oaks, CA: Sage.

Robbins, P. (2003). *Stolen Fruit: The Tropical Commodities Disaster*. London and New York: Zed Books.

Songsore, J. (1983). *Intraregional and Interregional Labour Migration in Historical Perspectives: The Case of Northwestern Ghana.* Port Harcourt, Nigeria: University of Port Harcourt Press.

Songsore, J. and A. Denkabe (1995). *Challenging Rural Poverty in Northern Ghana: The Case of the Upper West Region.* Trondheim: Universitetet I Trondheim.

Van der Geest, K. (2003). "Rural migration and livelihood security in Ghana." Paper presented at the International Workshop on Migration and Poverty in West Africa, University of Sussex, March 13–14.

Van der Geest, K. (2005). "Local perceptions of migration and livelihood in Northwest Ghana: the home community's perspective." Paper presented at the Institute of Social Studies, The Hague (Netherlands), June 27–30.

Integrating Food Security and Agri-environmental Quality in Southern Africa: Implications for Policy

Oluyede Clifford Ajayi, Festus K. Akinnifesi, Gudeta Sileshi, Sebastian Chakeredza, and Simon Mng'omba

Abstract In many sub-Saharan African countries that experience seasonal food deficits, one of the greatest challenges is how best to integrate environmental quality into food security initiatives. However, a number of agricultural production technologies exist that offer opportunities for achieving the two seemingly divergent goals because they simultaneously contribute to food production and generate environmental services. The field level uptake of such technologies is generally low due to policy and institutional constraints, among other reasons. This chapter draws upon natural resource economics and externality theories to conceptualize an environmental economic logic for enhancing the adoption of multi-output technologies through conditional incentive systems that reward farmers for the environmental services generated by their investments in such technologies. Using agroforestry-based soil fertility technology ("improved tree fallows") as a case study of multi-output technologies, this chapter synthesizes studies that were carried out in southern Africa for over a decade. It then discusses how the potential impacts of technological advances attained in multi-output technologies are affected by policy and institutional constraints. The chapter concludes by identifying different options to address these constraints and facilitate uptake by farmers with a view to unlock their potential in order to satisfy both food production and global environmental services. These policy options at both national and regional levels are required to align smallholder farmers' incentives with those of the society and encourage them to pay cognizance to environmental quality when making agricultural production decisions.

Keywords Adoption · Agri-environmental quality · Agroforestry · Environmental services · Livelihood, Science–policy linkage

O.C. Ajayi (✉)
ICRAF Agroforestry Programme, P.O. Box 30798, Lilongwe 03, Malawi
e-mail: ajayi@gmx.net or o.c.ajayi@cgiar.org

I.N. Luginaah, E.K. Yanful (eds.), *Environment and Health in Sub-Saharan Africa: Managing an Emerging Crisis*, DOI 10.1007/978-1-4020-9382-1_3,

Introduction

In low-income countries including many in sub-Saharan African countries where seasonal food deficits occur, one of the greatest challenges is how best to integrate environmental resource conservation into food security strategies. In the quest to reconcile the environmental debt of tomorrow with the food deficit of today, the trade-off between livelihood (food security) and environmental quality is high. Despite this challenge, there are agricultural land use practices (LUPs) that produce multi-outputs and thus offer potential opportunity to achieving the two seemingly polarized objectives and minimize the trade-offs. However, adoption of such technologies among smallholder farmers has lagged behind scientific advances thereby reducing the potential impacts of the technologies on rural households (Ayuk, 2001; Mercer, 2004). The objectives of this chapter are to (1) highlight agroforestry as an example of a multi-output land use practice for achieving food security and environmental quality, (2) present a conceptual framework to highlight how private benefits diverge from social benefits of multi-output technologies and the insights that the divergence provides for understanding the social sub-optimal level of adoption of such technologies, and (3) identify conditional reward systems and policy options to bridge the divergence and, promote the adoption of the technologies with a view to unlock their potential to satisfy both food production and global environmental services.

Overview of Agroforestry Land Use Practice

Agroforestry Land Use Technology

Low soil fertility is one of the greatest biophysical constraints to agricultural production in sub-Saharan Africa. The use of mineral fertilizers is less affordable for many smallholder farmers, especially after the collapse of government support for mineral fertilizer distribution (e.g., removal of subsidies and dissolution of parastate agricultural inputs marketing agencies) following structural adjustments of the economies in 1980s and 1990s. An agroforestry-based soil fertility replenishment practice, known as “improved fallow” (*sensu* Sanchez, 1999) was developed in southern Africa region in the late 1980s in response to the challenges that smallholder farmers encounter due to continuous depletion of soil fertility. The practice involves planting fast growing and nitrogen-fixing leguminous shrubs and trees to produce large quantities of leaf biomass that easily decomposes to release nitrogen for crop (maize) growth (Kwesiga and Coe, 1994). The practice builds on the principles of biological nitrogen fixation (BNF). While nitrogen is the most limiting macro nutrient in the soil, it constitutes 78% of the atmosphere. Leguminous trees capture atmospheric nitrogen through BNF and make it available to crop plants, thus increasing crop productivity and food security. A typical improved fallow begins with planting a leguminous tree or shrub as a pure stand or intercropped with food

crops, and allowing it to grow for 2 or more years as fallow. Thereafter, the fallow is cleared and the legume biomass is incorporated into the soil during land preparation (Kwesiga et al., 2003). The tree biomass easily decomposes and releases nutrients for crops (usually cereals such as maize) cultivated in the soil for the next 2–3 years. Improved fallows generate positive impacts on farmers' households and the environment. It increases maize yield (the staple food crop in southern Africa) by close to two times compared with fields where maize was cultivated without external inputs (Kwesiga et al., 2003; Akinnifesi et al., 2006, 2008). A recent meta-analysis has demonstrated that the positive effects of fallows on maize yield are consistent across most of sub-Saharan Africa (Sileshi et al., 2008). Detailed impact assessment studies conducted in Zambia showed that based on an average of 0.20 ha of land devoted to the technology by farmers in 2007, and using per capita maize consumption, the technology increased food security for households by generating between 57 and 114 extra person days of maize consumption per year (Ajayi et al., 2007). This translates to reduction of the seasonal hunger period in households by about 2–4 months depending on the type of tree species used and length of the fallow period.

Environmental Services Generated by Agroforestry Land Use Technology

Agroecosystems are ecological systems that are modified by human beings in order to produce food, fibre or other agricultural products (Conway, 1987). It is generally recognized that humans are at the centre of agroecosystems and their well-being is a key issue for its sustainability. In addition to enhancing food production through improved soil fertility, improved fallows also generate ecosystem services that contribute to improving environmental quality in several ways (Sileshi et al., 2007). In the following section, we will briefly describe the most important environmental services provided by improved fallows in southern Africa.

(i) *Carbon sequestration:* Carbon storage in tree biomass and in soil sink is one of the most important strategies to mitigate the global greenhouse gas effect. Studies in southern Africa have shown that improved fallows can store large quantities of carbon stocks in plant biomass and in the soil (Makumba, 2003; Kaonga, 2005; Makumba et al., 2007), and thus provide opportunity to potentially mitigate global greenhouse effect (Sileshi et al., 2007). Agroforestry supports productivity by contributing to climate change mitigation through enhanced carbon sequestration, and that can also boost the production system's ability to cope with adverse impacts of changing climate conditions (Verchot et al., 2007). Although pure forests generally sequester higher amounts of carbon and contribute more to reduction of carbon dioxide emissions, taking landout completely for forestation for many years may not be attractive

to smallholder farmers in food deficit situations because of the high opportunity cost (food production that will be forgone).

(ii) *Reduction of insect pests and weeds:* Some of the improved fallow species reduce pests such as termites (Sileshi and Mafongoya, 2003; Sileshi et al., 2005) and noxious weeds including *Striga* species which limit cereal crop production (Sileshi and Mafongoya, 2003).

(iii) *Biodiversity conservation:* Agroforestry "improved fallow" technology has been shown to create a micro-climate which maintains soil biodiversity thereby further improving soil quality (Sileshi et al., 2007). Studies conducted in Zambia revealed that improved fallows accommodate more soil invertebrates than monoculture maize (Sileshi and Mafongoya, 2006). Improved fallows also accommodates about the same diversity and abundance of soil invertebrates as the *miombo* woodland (Sileshi et al., 2007). This diversity can, in time, provide ecological resilience and contribute to the maintenance of beneficial ecological functions such as pest suppression. The positive impact of agroforestry on the biodiversity conservation of nature reserves has mostly been attributed to

Table 1 Multiple effects of agroforestry-based soil fertility land use practices

	Private	Social
Cost	• Land • Labor • Tree seeds and nursery establishment • Increased pest control (e.g., in *Sesbania sesban* plant) • Working equipments • Risk of fire outbreak	• Incidence of pests, e.g., Mesoplatys beetle and root-knot nematodes (in *Sesbania* species) • Reduction of free grazing area during dry season • Risk of uncontrolled fire outbreak
Benefit	• Yield increase of subsequent crops • Increase in fodder and maize stubble (for livestock) • Fuel wood- available in field, and so reduces time spent searching for wood • Leaves of *Tephrosia vogelii* used as "pesticides" in crop and livestock production. • Suppresses the growth of weeds • Potential to mitigate the effects of drought during maize season • Stakes for curing tobacco leaves • Opportunity for farm diversification (e.g., compatible with fish farming and growing of high-value vegetables)	• Carbon sequestration • Suppression of weeds • Improved soil infiltration and reduced runoff • Enhanced biodiversity • Serves as wind breaks • More fuel wood available to reduce deforestation

Source: Adapted from Ajayi and Matakala (2006).

the reduced pressure on the natural forest due to the ability of agroforestry to sustain their daily livelihood (Chirwa et al., 2008).

(iv) *Runoff and soil erosion:* Soil aggregation is higher in tree fallows, and this enhances water infiltration and water holding capacity which reduce water runoff and soil erosion (Phiri et al., 2003). Improved fallows can potentially contribute to the reduction of the effects of droughts.

(v) *Fuelwood:* Field experiments have revealed that improved fallows can produce up to 10 t of wood per hectare within 2 years to meet household demand for fuel energy (Kwesiga and Coe, 1994), and thus offer the potential to reduce the demand on community forests for fuel wood, especially where human population density is high.

The benefits of agroforestry-based land use practices to households and the environment are well documented (Mafongoya et al., 2003, 2006; Ajayi et al., 2007; Akinnifesi et al., 2008) and have been summarized (Table 1). Often, several of the items listed as costs and benefits occur on the same fallow depending on the type of tree planted. For some of these items, a more rigorous study will be needed to quantify their economic value. While there are some negative spill over effects from improved fallows (see, for example, Ajayi and Kwesiga, 2003), studies in southern Africa show that the majority of the effects are positive.

Financial Profitability and Potential Adoptability of Multi-Output LUPs Under Different Reward Systems

A recent study to evaluate the financial profitability of different land use practices in Zambia reveals that when food production (for example, maize yield) is accounted for only, improved fallows yield a net profit (net present value) ranging from $233 to $309 per hectare (Ajayi et al., 2007). This compares with a net benefit of $499 per hectare for mineral fertilizer (subsidized at the rate of 50% by the government) and $349 for non-subsidized fertilizer. The results show that when maize yield (food security) alone is used as the exclusive criterion for assessment, the estimates of profitability and potential adoptability of land use practices that have multiple positive outputs (e.g., agroforestry) will be biased downward. When environmental services of the technologies are taken into consideration, the profitability and/or adoptability of multi-output technologies increases. The reason is when a given technology generates a positive externality (that largely accrue to the public) and if this externality is excluded from total benefits, there is a tendency of understating the productivity gains from such technologies as some benefits are not counted. The opposite is also true for technologies that generate negative externalities. This implies that when environmental "outputs" of the land use practices are considered, two classes of land use can be recognized: the one that offers direct benefit primarily to farmers (private investors) and another which offers benefit to *both* farmers and the larger society. For the latter type of technologies, the optimum level

of adoption is lower from the private investor's perspective (i.e., private optimum) is lower than the desirable optimum from the public perspective (i.e., social optimum). Explanation for the divergence between private and social optimum for multi-output technologies and the implication on adoptability of such technologies are presented below.

In Fig. 1, the cost of adoption of a LUP that produces a single product (e.g., maize yield only) is represented by the "cost" curve and it follows the normal production cost curve. The benefits of the LUP (i.e., value of crop produced) are represented by the "private benefit" line. It has a constant slope because the value of crop output increases commensurately with the physical quantity of crop production assuming a perfect competition market scenario. The optimum level of adoption is obtained at point "A" where the marginal increase in cost and benefit is the same (i.e., where the slope of cost and benefit lines are parallel). Below point "A", a farmer gets higher net incremental benefit than cost from the use of the technology. It thus pays to adopt more of that LUP. The opposite occurs when adoption level is beyond "A". Thus for LUPs that produce only single product, the rationale domain of adoptability for a private investor (individual farmer) lies between O and A only.

For multi-output LUPs, however, when the additional environmental services that they generate are considered, the benefits of the technology shifts from the "private benefit" line to the "social benefit" line. With the addition of the environmental benefits, marginal benefit equals marginal cost at a higher level and as a result, the social optimum of adoption increases to "B". It is shown in Fig. 1 that the optimum level of adoption of multi-output LUPs from individual's perspectives is always higher than that of the social perspectives. The reason is private discount rates are higher than

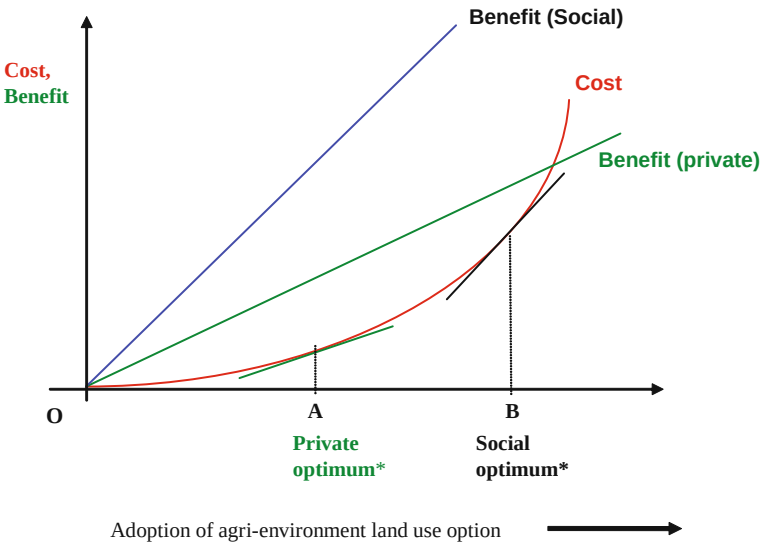

Fig. 1 Potential profitability and adoptability of multi-output LUPs under different reward systems (Adapted from Ajayi and Matakala, 2006)

social discount rates. Hence, immediate objectives that are geared toward satisfying basic household needs in the short term may not coincide with long-term (environmental) goals of the society (Izac, 1997; Ayuk, 2001; Izac, 2003). As a result, efforts to effect a shift in the rationale domain of adoption of multi-output LUPs from "A" to "B", may require some facilitation and incentive supports through public investment. Such supports should be commensurate to the value of the extra social benefits generated by the multi-output land use practice while contributing to the attainment of food security and environmental quality.

Policy Options for Increasing the Adoptability of Multi-Output Land Use Practices

The support for multi-output LUPs from the wider society is justified on several grounds. First, farmers make decisions on alternative land use practices based on the incentives that they perceive as individuals, and not necessarily on the environmental benefits that the various LUPs offer to the wider community (Pagiola et al., 2004). Second, there are differences in the discount rate and time preference between individuals and the society. Third, there is failure of the market system to aggregate individual preferences and occurrence of externalities that extend beyond farm households that are associated with different land use practices (Izac, 1997; Ayuk, 2001; Izac, 2003). The following options outlined below are strategies that will help to align smallholder farmers' food security decisions with agri-environmental quality.

Review of Existing Policies on Land Use Practices

In many countries, some LUPs are often subsidized by the government through various price and institutional supports. Over several years, these government policies have created structural shifts and path dependencies that make multi-output LUPs less financially attractive to smallholder farmers. For example, alley farming was considered impractical as a soil fertility technology in some parts of West Africa some years back because the prices of mineral fertilizer were artificially low and this made fertilizers a cheaper and more rationale option from the perspective of individual farmers (Sanchez, 1999). The situation has changed in recent years with global rise in the cost of fossil fuels, and consequently on chemical fertilizers. Institutional arrangements such as land tenure will become important and need to be improved upon to ensure greater security of tenure over land and wider uptake of multi-output LUPs. Given that the financial returns to some multi-output LUPs are obtained in the medium and long run, it is most likely that farmers will be cautious to invest their scarce resources in such practices if they are not certain how long they would stay on the land. Other national and regional policies need be reviewed to assess and quantify their direct and indirect (dis)incentives to the adoption of multi-output LUPs.

Conditional Reward Mechanism of Farmers for Environmental Services

There is a need for targeted and time-bound incentives to reward smallholder farmers for the environmental services generated by multi-output LUPs. A recent study in Zambia shows that carbon stored in improved fallow LUP varied between 2.5 and 3.6 t ha^{-1} $year^{-1}$ (Paramu Mafongoya, personal communications, 2005). At estimated carbon prices of about $5 per ton, there is potential for improved fallows to increase smallholder farmers' incomes by $12.5–$17.5 per hectare (or $6–$8 per hectare assuming transaction cost of 50%). In addition, the amount of carbon stored in the soil is greater than in biomass by several folds (Makumba et al., 2007). In low-income countries of southern Africa, this figure represents an important income for smallholder farmers as it is equivalent to a wage rate of between 20 and 30 man-days (or 10–15 man-days assuming 50% transaction cost for the carbon marketing). This represents a big boost in smallholder farmers' income and provides incentives for them to make land use decisions in favor of multi-output LUPs that generate more environmental services. In a continental-wide survey to identify cases of successes in African agriculture, incentives were cited as the second most important trigger for inducing change toward success in the continent, surpassed only by expansion of production possibilities (Gabre-Madhin and Haggblade, 2004).

Bridging the Time Gap Between Investment in and Accrual of Benefits from LUPs

Several multi-output LUPs are profitable over time (i.e., positive net present values), but farmers often have to wait for about 2–3 years before they begin to realize these benefits. In few cases, the break-even point is even longer. This implies that smallholder farmers must absorb net losses for 2 or more years before receiving profits from their investment on LUPs. This poses a challenge for farmers especially in a subregion where the cost of capital and discounting factor is high. During the "waiting" period, smallholder farmers are at their most financially vulnerable state and may need some support. A targeted and time-bound conditional reward system for assistance of farmers in the early years of adoption of LUPs is important to assist farmers to cushion the time lag between investment and accrual of benefits.

Innovative Information System to Support Incipient Technologies

Many multi-output LUPs are incipient technologies compared with conventional practices which farmers are more familiar with due to the trainings over a long period. Given the "new" status of multi-output LUPs in southern Africa, human capacity, infrastructure, and institutional supports for such technologies are low in most national extension programs and thus the need for increased support to reach many more farmers to adopt the technologies. Such supports may include improving input and output market to enhance access of smallholder farmers to ensure that

they get the price premium for their crop produce. In addition, unlike annual crop production technologies and conventional LUPs, most multi-output LUPs are relatively more knowledge intensive, requiring skills in terms of management of the technology. The costs of providing information greatly decrease over time, but they are critical when helping farmers get started with the practice.

Bridging the Gap Between Science and Policy Making on Land Use

There is a need to initiate new institutional forms to bring science (technology development) and policy making together to examine food security through a sustainable multi-faceted development lens. The forums should provide a knowledge base and form the basis for dialogue among representatives from broader public viewpoints including policymakers, researchers, and other stakeholders. The need for the participation of broader public stakeholders is important because policies emerge from policy processes that are themselves embedded in political processes, and the political feasibility of expected institutional changes.

Conclusion

Southern African countries face the challenge to implement policies for achieving food security while ensuring environmental quality and protection of the natural resources base. The potential of multi-output LUPs to meet this challenge has not been fully exploited, because of low farmer adoption and hence their potential impacts to improve livelihood and the environment is low, lagging far behind biophysical technological progress. Given that land users generally receive no incentive for the environmental services generated by the agricultural production systems that they choose, there is little or no incentive for farmers to consider environmental services when making decisions about land use. A mix of several policies and strategies (both nationally and regionally) are required to align smallholder farmers' incentives with those of the society, and encourage them to pay attention to environmental quality issues when they are making agricultural production decisions.

Acknowledgements The authors gratefully acknowledge the Canadian International Development Agency (CIDA), Rockefeller Foundation, and Irish Aid for the financial assistance provided to support the preparation of this synthesis. The usual disclaimer applies.

References

Ajayi OC, Kwesiga F (2003) Implications of local policies and institutions on the adoption of improved fallows in eastern Zambia. Agroforest Syst 59: 327–336.

Ajayi OC, Matakala P (2006) Environmental Conservation and Food Security in Developing Countries: Bridging the Disconnect. Plenary paper presented at the 26th triennial Conference of the International Association of Agricultural Economists (IAAE), Queensland, Australia.

Ajayi OC, Place F, Kwesiga F, Mafongoya P (2007) Impacts of improved tree fallow technology in Zambia. In: Waibel H, Zilberman D (eds) International Research on Natural Resource Management: Advances in Impact Assessment, CABI Wallingford, UK and Science Council/CGIAR, Rome, pp. 147–168.

Akinnifesi FK, Chirwa P, Ajayi OC, Sileshi G, Matakala P, Kwesiga F, Harawa R, Makumba W (2008) Contributions of agroforestry research to livelihood of smallholder farmers in southern Africa: Part 1. Taking stock of the adaptation, adoption and impacts of fertilizer tree options. Agric J 3(1): 58–75.

Akinnifesi FK, Makumba W, Kwesiga F (2006) Sustainable maize production using Gliricidia/maize intercropping in Southern Malawi. Exp Agr 42: 441–457.

Ayuk ET (2001) Social, economic and policy dimension of soil organic matter management in Sub-Saharan Africa: Challenges and opportunities. Nutr Cycl Agroecosys 61: 183–195.

Chirwa PW, Akinnifesi FK, Sileshi G, Syampungani S, Kalaba FK, Ajayi OC (2008) Opportunity for conserving and utilizing agro-biodiversity through agroforestry in southern Africa. Biodiversity 9(182): 45–48.

Conway GR (1987) The properties of agroecosystems. Agri Syst 24: 95–117.

Gabre-Madhin EZ, Haggblade S (2004) Successes in African agriculture: results of an expert survey. World Dev 32: 745–766.

Izac AN (1997) Developing policies for soil carbon management in tropical regions. Geoderma 79: 261–276.

Izac AN (2003) Economic aspects of soil fertility management and agroforestry practices. In: Schroth G, Sinclair FL (eds.) Trees, Crops and Soil Fertility, CAB International, Wallingford, UK.

Kaonga ML (2005) Understanding carbon dynamics in agroforestry systems in Eastern Zambia. PhD Thesis, Fitzwilliam College, University of Cambridge, UK.

Kwesiga F, Akinnifesi FK, Mafongoya PL, McDermott MH, Agumya A (2003) Agroforestry research and development in southern Africa during the 1990s: Review and challenges ahead. Agroforest Syst 59: 173–186.

Kwesiga F, Coe R (1994) The effect of short rotation *Sesbania sesban* planted fallows on maize yield. Forest Ecol Manag 64: 199–208.

Mafongoya PL, Chintu R, Chirwa TS, Matibini J, Chikale S (2003) *Tephrosia* species and provenances for improved fallows in southern Africa. Agroforest Syst 59: 279–288.

Mafongoya PL, Kuntashula E, Sileshi G (2006) Managing soil fertility and nutrient cycles through fertilizer trees in southern Africa. In: Uphoff N, et al. (eds.) Biological Approaches to Sustainable Soil Systems, Taylor & Francis, Boca Raton, FL, pp. 273–289.

Makumba WIH (2003) Nitrogen use efficiency and carbon sequestration in legume tree-based agroforestry systems. A case study in Malawi. PhD Thesis. Wagenigen University and Research Centre, Wagenigen, The Netherlands.

Makumba W, Akinnifesi FK, Janssen B, Oonema O (2007) Long-term impact of gliricidia-maize simultaneous intercropping systems on carbon sequestration and soil properties. Agr Ecosyst Environ 118: 237–243.

Mercer DE (2004) Adoption of agroforestry innovations in the tropics: A review. Agroforest Syst 61: 311–328.

Pagiola S, Agostini P, Gobbi J, de Haan C, Ibrahim M, Murgueitio E, Ramírez E, Rosales M, Ruíz J (2004) Paying for biodiversity conservation services in agricultural landscapes. Environment Department Paper No. 96, The World Bank, Washington, DC.

Phiri E, Verplancke H, Kwesiga F, Mafongoya P (2003) Water balance and maize yield following improved *Sesbania* fallow in eastern Zambia. Agroforest Syst 59: 197–205.

Sanchez PA (1999) Improved fallows come of age in the tropics. Agroforest Syst 47: 3–12.

Sileshi G, Akinnifesi FK, Ajayi OC, Chakeredza S, Kaonga M, Matakala P (2007) Contribution of agroforestry to ecosystem services in the miombo eco-region of eastern and southern African. African J Environ Science Tech 1(4): 068–080.

Sileshi G, Akinnifesi FK, Ajayi OC, Place F (2008) Meta-analysis of maize yield response to planted fallow and green manure legumes in sub-Saharan Africa. Plant Soil 307: 1–19.

Sileshi G, Mafongoya PL (2003) Effect of rotational fallows on abundance of soil insects and weeds in maize crops in eastern Zambia. Appl Soil Ecol 23: 211–222.

Sileshi G, Mafongoya PL (2006) Long-term effects of improved legume fallows on soil invertebrate macrofauna and maize yield in eastern Zambia. Agr Ecosyst Environ 115: 69–78.

Sileshi G, Mafongoya PL, Kwesiga F, Nkunika P (2005) Termite damage to maize grown in agroforestry systems, traditional fallows and monoculture on Nitrogen-limited soils in eastern Zambia. Agr Forest Entomolog 7: 61–69.

Verchot L, Van Noordwijk M, Kandji S, Tomich T, Ong C, Albrecht A, Mackensen J, Bantilan C (2007) Climate change: linking adaptation and mitigation through agroforestry. Mitigation Adaptation Strategies and Global Change. doi: 10.1007/s11027-007-9105-6.

"*This page left intentionally blank.*"

Part II
Mining and Environment

"*This page left intentionally blank.*"

Environmental Impact of Mining and Ore Processing – A Case Study at Satellite Goldfields Limited

Albert O. Ainoo, Newton Amegbey, and Raymond S. Suglo

Abstract The increasing number of surface mines in Ghana and the consequent adverse effects of mining operations on the environment have been of great concern to the local communities, government and non-governmental organisations in Ghana over the last decade. Satellite Goldfields Limited (SGL) is an open pit gold mine in the Mporhor Wassa East District which produces about 10,000 tpd of ore at an average stripping ratio of 2.1:1. Ore is processed by crushing, treatment by agglomeration, stacking, heap leaching, electro-winning and smelting.

This chapter identifies the potential environmental impacts of mining and ore processing at SGL on the environment. The results show that fugitive dust levels were generally high during the dry seasons and that the fugitive dust levels far exceeded the Australian and New Zealand maximum guideline value of 4.0 g/m^2/month in 1998 when the project was under construction. The levels reduced markedly over the years. Total suspended solids and iron levels exceeded the Environmental Protection Agency guideline values in streams that received direct discharge from the mining and ore processing areas. Ground vibration and airblast levels were predominantly below the set trigger limit of the seismograph. Waste management practices at the mine, especially segregation of contaminated and uncontaminated waste at disposal sites, were found to be inadequate and require some attention.

Keywords Mining · Environmental · Waste · Dumps · Monitoring

Introduction

There has been a proliferation of surface mines in Ghana within the last decade. The number of large-scale mines increased from 6 in 1986 to 15 by December 2002, while there were over 600 licensed small-scale mining operators in Ghana. These

R.S. Suglo (✉)
University of Mines and Technology P. O. Box 237, Tarkwa, Ghana
e-mail: rsuglo@yahoo.ca

I.N. Luginaah, E.K. Yanful (eds.), *Environment and Health in Sub-Saharan Africa: Managing an Emerging Crisis*, DOI 10.1007/978-1-4020-9382-1_4,

mines employ various exploitation methods to extract the mineral(s) of interest. The escalating rate of environmental degradation and the potential ecological disasters from some of the operations have attracted concern from the local communities, government and non-governmental organisations.

Surface mining involves overburden stripping, drilling and blasting to fragment the rock, loading and hauling of materials to the crusher, stockpiles or waste dumps. Ore processing involves the use of chemicals to extract the mineral(s) of interest and the disposal of the solid and liquid waste generated. SGL is an open pit gold mine in Ghana. The impact of its mining and ore processing operations on the environment has attracted public concern in recent times. Attempts to address the environmental problems caused by mining and ore processing operations at SGL appear to be ad hoc. This chapter attempts to identify and assess the potential environmental impacts associated with mining and ore processing activities of SGL and to make recommendations to effectively manage the environmental issues at the mine.

Mining Operations

SGL is an open pit mine that employs the shovel–truck system of mining. Ore is mined at about 10,000 tpd at an average stripping ratio of 2.1:1. Generally, the material down to a depth of 30 m is free-digging after which drilling and blasting is required to fragment the rock for loading. Blast patterns are predominantly 3.5 m $\times$ 3.5 m. Blastholes are 6-m deep and an emulsion/ANFO explosive mixture is used for blasting. Blastholes are sampled and assayed to establish the grade of the materials. The assay and survey data are integrated into the grade control database in the Gemcom software package for mine planning and design purposes.

The mining operations have been contracted out to PW Ghana Ltd. Loading of ore is done by an O&K RH 120 shovel and hauled to the crusher by a fleet of four CAT 777D (95-t) rear-dump trucks. An O&K RH 40 excavator is employed to dress the pit walls and as a backup to the larger excavator. Ore is dumped directly into the primary crusher. However, a large stockpile of ore is maintained to ensure uninterrupted supply of feed to the crusher and to provide a dumping location during periods when the crusher is not operational. A CAT 988F loader is used to feed the stockpiled ore to the crusher. Mining takes place in 12 pits located at several places on the concession.

Waste Dumps

SGL has three waste dumps. Waste Dump No. 1 is designed with a number of benches to provide a series of terraces to give an overall angle of repose of 24°. The terraces allow runoff from each interlift face to drain back into the dump rather than over the face and cascading down and eroding the lift faces. By minimising the flow over the face, erosion of the face is minimised. The total land area of the

Waste Dump No. 1 is about 580,000 m^2. However, the other waste dumps have been planned to be contoured with round corners and uniform edges to blend with the natural topography.

Ore processing activities at SGL is undertaken with minimum environmental problems. The processing circuit comprises crushing, agglomeration, stacking, heap leaching, treatment by carbon-in-leach, electro-winning and smelting. The run-off-mine ore (ROM) is either dumped directly into a 250-t capacity bin or reclaimed from the ROM stockpile. The crushing plant has a throughput of 700 t/h. The crushed ore is agglomerated using cement and barren cyanide solution to bind the fines and overcome the problem of clay particles which may form impermeable layers and impede the leaching of the ore and also provide the alkalinity needed to leach the gold. The near-surface oxide ore generally contains significant fines and clays, requiring substantially higher cement additions. However, little crushing of this material is required. The fresh ore, which underlies the oxide material, has low fines content and can be stacked to design levels with minimal percolation problems. Substantial crushing is required to break the rock into fine particles to improve recovery. Due to its competent nature, this type of material generates a lot of noise and dust during comminution.

The total designed leach pad capacity is approximately 18 million tonnes based on two phases of pad development. The liner system comprises a network of high-density polyethylene plastic (HPDE) liners laid on top of a compacted, low permeability laterite soil. A leak detection system has been installed under both pads. Cyanide bearing solution is sprayed at a rate of 10–20 l/h/m^2 depending on the ore type for up to 120 days. There are three solution collection ponds in the leaching circuit – the pregnant, intermediate and barren ponds. A fourth pond is available as a buffer against any storm surges. The system has been designed to handle all routine flows plus precipitation up to a 2-year storm event within the enclosed system. Excess runoff from the storm larger than a 2-year event will spill into the storm ditch and be routed to the surge pond.

Ancillary Facilities

Ancillary facilities, which are mostly run by contractors on the SGL concession, include a fuel storage depot and an explosives magazine. The supply of bulk fuel and lubricants has been subcontracted to Mobil Oil Ghana Limited which has provided a fuel depot on site. Four surface tanks have been installed to supply light and heavy mining equipment with fuel and a separate tank for the power generation stations. A magazine for explosives is located 450 m northwest of the mine adjacent to Phase Two Leach Pad and away from inhabited areas. The site has been fenced off, bunded with laterite, lighted and provided with 24-h security and operated in accordance with the Explosives Regulations of 1970 (LI 666).

Waste generated from mining activities at SGL is mainly the oxide type and consists of topsoil, laterite and ‘fresh rock’. Waste is disposed at suitable dump sites based on economics and topography. Three dump sites have been used since 1999.

The most active dump site is Waste Dump No. 1. Solid waste from domestic sources is safely disposed off at a landfill site provided within the mine waste dump areas. Sewage disposal at SGL is by means of septic tanks. The septic tanks are emptied from time to time on contract by the Wassa West District Assembly.

Even though the leaching systems have been designed to have a zero discharge or 100% recycle operation, it is recognised that the discharge of effluents from the processing activities is inevitable (Rau and Wooten, 1980). Consequently, in April 2000, a cyanide detoxification plant was incorporated into the adsorption desorption recovery plant and pond system to treat effluent containing levels of cyanide exceeding the EPA guidelines prior to releasing it into the natural drainage system. The facility uses hydrogen peroxide as the cyanide destruction agent while copper sulphate acts as catalyst in the reaction process. The hydrogen peroxide system from Degussa was adopted because the by-products are environment friendly (Anon, 1998; 2001). The detoxification pond system comprises five ponds. All ponds have been lined with HPDE plastics, provided with drainage channels to link the surge pond underdrain and fitted with suction pumps to facilitate thorough mixing of the effluents. The approval of EPA is sought prior to any effluent release exercise by the mine.

Data Collection and Analysis of Results

This section presents the data collection activities and analyses of the results from the field studies. Data collection was done from September 2000 to October 2001.

Environmental Monitoring

SGL has established a monitoring programme that has gone through many changes based upon recommendations made by consultants and in line with the commitments made in the company's Environmental Impact Assessment and Environmental Management Plan (Anon, 1996). SGL conducts weekly and monthly monitoring of surface water for physicochemical analysis. Dust, airblast and ground vibration monitoring are conducted regularly on the mine. Occupational Health and Safety training and monitoring programmes are undertaken to create employee awareness on the need for high safety and health standards to be maintained on the mine. Reclamation programmes are also undertaken concurrently with mining and ore processing activities where practicable.

Surface water monitoring on the mine comprises seasonal water level monitoring, flow gauging using weir and impeller flowmeter, and water sampling for physicochemical analysis. Understanding the sources, interactions and effects of water pollutants is essential for controlling pollutants in an environmentally safe manner (Down and Stocks, 1977; Manahan, 1991). Groundwater level monitoring of boreholes were selected to provide a suitable area spacing determined by the groundwater gradient. This resulted in an approximate monitoring borehole density

of $1/10^4$ m^2 across the site. Groundwater levels were conducted at the Main Zone, Condemnation and Deadman's Hill areas. Groundwater from wells and boreholes is extensively used within the project area for domestic purposes. Groundwater samples were obtained from stationary hand pumps installed in the neighbouring communities and mine residential sites, while other samples were obtained from underdrains installed at the leach pads and the rest by bailing out of water using syringe (artesian conditions).

Ambient Air Quality

Monitoring of fugitive dust levels was done by locating dust deposit gauges at Deadman's Hill (DG1), Akyempim (DG3) and Kubekro (DG4). Samples were collected at the end of each month and analysed at the environmental laboratories of SGL and SGS to determine the total solids using gravimetric methods. Figures 1, 2, and 3 show the trend in dust fallout recorded by the three gauges from January 1999 to December 2001. In the absence of any recommended threshold values for dust fallout in Ghana, the Australian and New Zealand Environmental Council (ANZEC) guideline was adopted in assessing dust fallout levels (Anon, 1998; Amegbey, 2001a). The ANZEC maximum allowable guideline value of 4.0 g/m^2/month has been superimposed on all the graphs.

From Figs. 1, 2, and 3, apart from June, July and October for the Deadman's Hill (DG1) and Akyempim (DG3) gauges, all the values recorded exceeded the ANZEC guideline value of 4.0 g/m^2/month in 1998. Significantly higher values were recorded in 1998 than the other years due to construction of the project

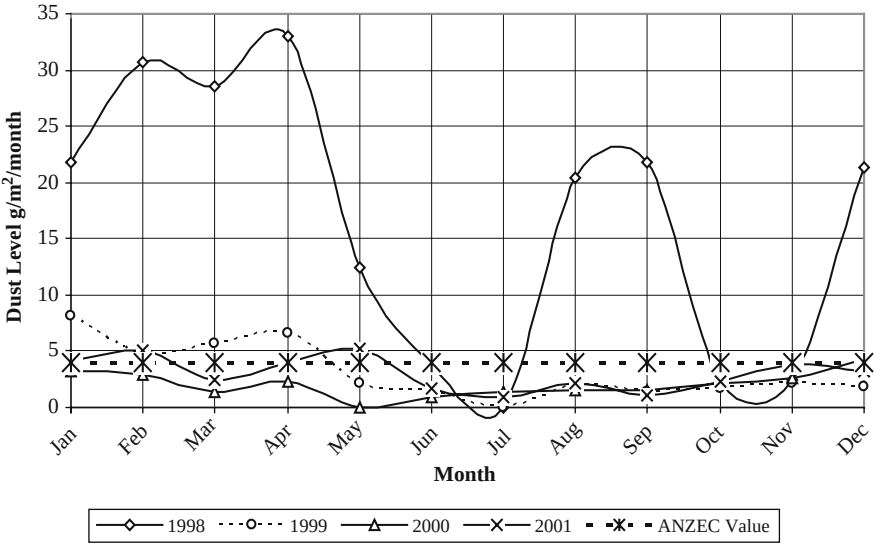

Fig. 1 Trend in dust fallout from January 1998 to December 2001 at the Deadman's Hill (DG1)

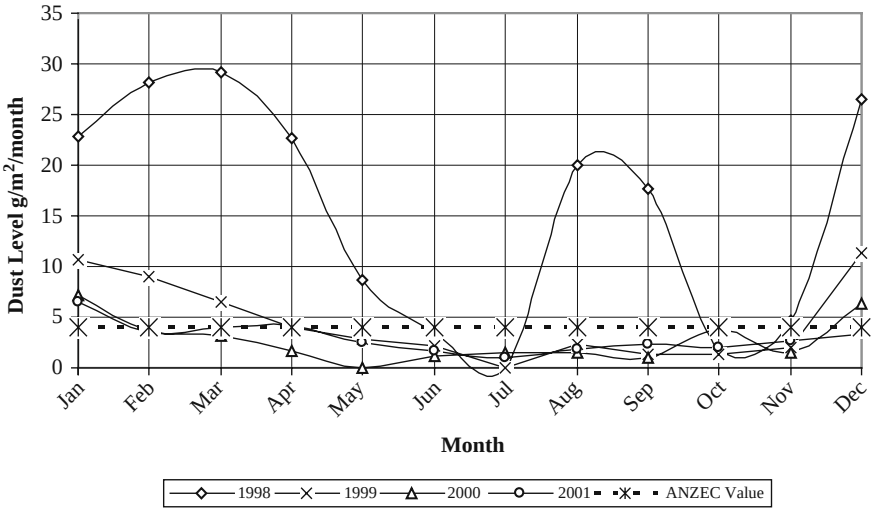

Fig. 2 Trend in dust fallout from January 1998 to December 2001 at Akyempim (DG3)

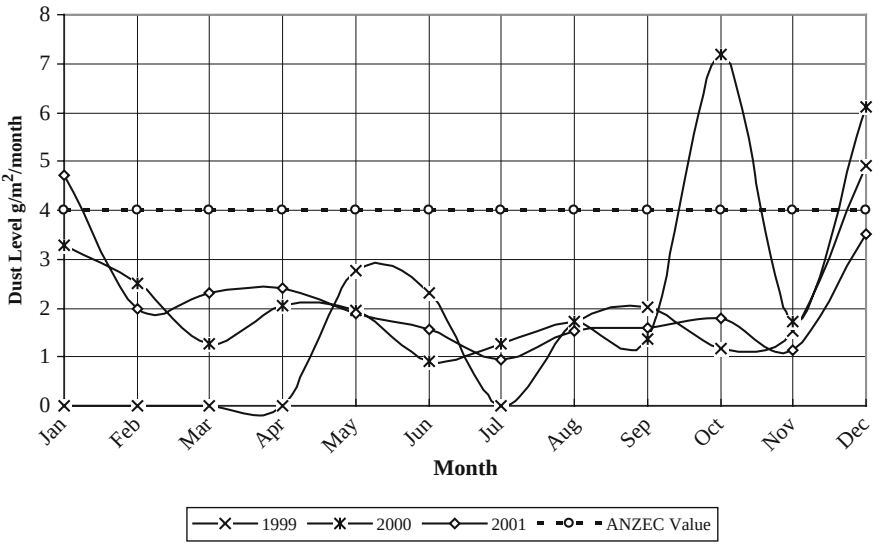

Fig. 3 Trend in dust fallout from January 1998 to December 2001 at Kubekro (DG4)

facilities. There were no values recorded by the Kubekro gauge (DG4) in 1998 because it had not been installed by then. In 1999, DG1 recorded values from January to April that exceeded the ANZEC guideline value. In 1999, the values recorded by DG3 exceeded the ANZEC guideline value from January to March and December, while the DG4 values only exceeded the guideline value in December. The rest of the values were below the ANZEC guideline value for all the gauges. In

December 2000, the recorded values of all the three gauges exceeded the guideline value of 4.0 g/m^2/month. In January 2001, all the three gauges recorded values that exceeded the guideline value of 4.0 g/m^2/month. Furthermore, DG1 readings in February and May, and the April readings of DG3 exceeded the ANZEC guideline limit. The results generally show that there were high dust fallouts mainly in the dry (hamattan) season.

Water Quality

Water samples were collected from 19 sampling sites and analysed in the first week of every month over a 12-month period. Physical parameters such as pH, conductivity, total suspended solids (TSS), total dissolved solids (TDS), temperature, total and free cyanide were analysed on site while the remaining parameters were sent to SGS Laboratory for analysis. Cyanide is lethal to many species of fish at concentrations as low as 0.04 mg/l CN. Monitoring activities were centred on surface water sources.

The maximum values of TSS exceeded the EPA guideline value of 50.0 mg/l at Subri and Kubekro streams, Kumwe Creek, Adehesu, Toe River and the leach pad underdrains. Almost all of these sampling locations received direct discharge of surface runoffs from active mining and ore processing activities at SGL. This probably accounted for the resultant high values of TSS recorded in those streams. The maximum values of iron for Kubekro, Adehesu and Nkaasu streams, and the leach pad underdrains also exceeded the EPA guideline value of 10.0 mg/l. The results also show that traces of nickel, arsenic and cadmium were recorded in some samples. On one occasion, some water samples taken along the Nkaasu stream recorded mercury levels of 0.023 mg/l which exceeded the EPA guideline value of 0.005 mg/l (Anon, 1995). This could be attributed to the illegal small-scale mining (‘galamsey’) operators who use mercury near this sampling location.

Ground Vibration and Airblast

Ground vibration and airblast monitoring was undertaken to assess the resultant peak particle velocity (ppv) and overpressure as well as the direct effects of blasting operations on the nearby communities (Wiss and Linehan, 1978; Siskind et al., 1980). The monitoring locations were selected at the outskirts of the Kubekro and Akyempim villages, respectively (Anon, 2000a). The Kubekro monitoring point was sited at the entrance of the village while that of Akyempim was about 30 m northwest of Waste Dump No. 1. A Vibrock 401 seismograph was used to monitor the ground vibration and airblast. A total of 64 blasts were monitored over the period. The blasting times were mostly between 2 and 5 p.m. from Monday to Saturday. The Kubekro and Akyempim communities were given 24 h notice prior to every blast at the mine.

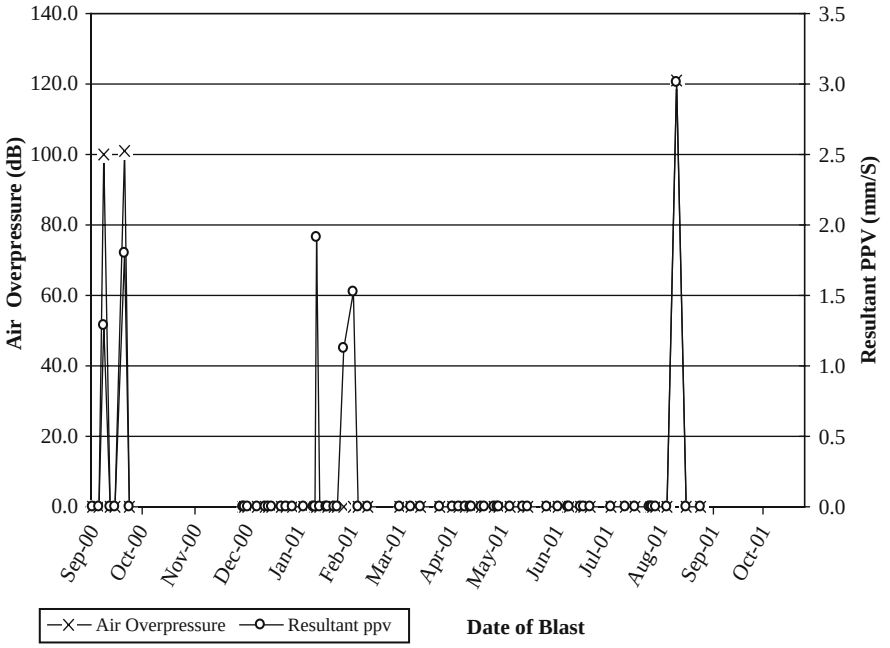

Fig. 4 Peak particle velocity and air overpressure from September 2000 to September 2001

Figure 4 shows the resultant peak particle velocity and air overpressure levels recorded in the study from September 2000 to September 2001. It is noted that in most cases the recorded ppv and overpressure levels did not exceed the set trigger limit of 0.5 mm/s of the transducer except on a few occasions in September to October 2000 and from February to March and September of 2001. At present, the EPA guidelines for Ghana's mining industry fail to make adequate provisions for airblast and ground vibration. Accordingly, the recommendations made from earlier studies conducted and the ANZEC guidelines were adopted (Sengupta, 1993; Anon, 1998, 2000b).

The maximum recommended air overpressure limit of 105 dBL was exceeded on two occasions in 12 months. The maximum allowable air overpressure value of 115 dBL was exceeded once. The maximum recommended ground vibration level of 2.6 mm/s resultant ppv was also exceeded once during the 12-month period. This recorded value of 3.0 mm/s in ppv produced a corresponding overpressure value of 120 dBL. The recorded high levels of ground vibration and airblast received serious complaints from inhabitants of the Kubekro village. Investigations showed that the holes were overcharged with explosives during the blast.

Noise Monitoring

Noise surveys were undertaken within the Kubekro and Akyempim villages during peak mining operations and ore processing periods. At each village, noise levels

were monitored for 4 h once a week for a period of 3 months using a CEL 234 sound level meter. Monitoring points were selected based on the proximity to the generating source. The results of the noise survey show that the noise levels at Akyempim village varied between 32.9 and 80.3 dBA while those at Kubekro village were from 31.6 to 72.5 dBA. The recommended EPA noise level for heavy industrial areas is 70 dB(A) (Corbitt, 1990; Amegbey, 2001b). Thus the maximum noise level recorded on some occasions at Akyempim (80.3 dBA) far exceeded the recommended EPA noise level of 70 dBA for heavy industrial areas. However, the noise levels recorded at Kubekro were generally within acceptable levels. The high levels of noise registered at Akyempim could be the result of the movement of trucks at the mine, increased traffic and the high population in the village.

Solid Waste Handling, Storage and Disposal

The waste disposal areas were inspected to determine the impacts on their immediate environment. At the time of the research, SGL had three waste dumps (Waste Dump Nos. 1–3). Waste Dump No. 1 is located adjacent the Akyempim village, while Waste Dump Nos. 2 and 3 are located west and east of the Deadman's Hill, respectively. Site inspections were undertaken to ascertain whether adequate environmental factors were considered in selecting the waste dump sites (e.g. the nearby landscape, proximity to surface water sources and local residential areas). The results of the field observations undertaken at waste handling, storage and disposal sites show that Waste Dump No. 1 was about 60% completed. It is close to Akyempim and is located at the source of the Aworaa creek which is the main source of drinking water for the people of Akyempim. It has been constructed in terraces with the benches being 6 m high and 8–12 m wide. The bottom of Waste Dump No. 1 is about 10 m high and the material is dumped at an angle of repose of about 45° making it very steep compared to successive terraces built on it. Signs of serious erosion were observed on the bottom bench. There were no trenches or sediment traps provided at the toe of the waste dump that would trap eroded overburden material during heavy rainfalls. The present dumping practice has exposed boulders at the top and at some portions of the slopes. Some portions at the top of the dump failed to respond to natural vegetative regrowth though the immediate surroundings have responded positively.

Inspections of the SGL sewage disposal facilities in residential areas and offices were also undertaken. A total of 25 sewage collection points comprising 20 from residential sites and 5 from areas around the offices were inspected weekly to establish whether uncontaminated domestic refuse is segregated from contaminated refuse and to ascertain whether the collection and disposal methods conform with the standard environmental practices. The collection sites and landfill area were visited weekly to assess the type and physical conditions of the sewage disposal system. Domestic refuse including solid waste generated at the canteen, senior staff mess and residential sites were collected daily, and these were conveyed to a landfill site provided at Waste Dump No. 1 for safe disposal. However, there was no segregation of contaminated waste from domestic waste and no sorting was undertaken.

The results of site inspections of septic facilities indicate that the soak-away systems provided were not functioning properly due to the build up of sediments. Consequently, regular build up and overflows of the sewage water with the emission of foul odour were detected. These required frequent services of the cesspool emptier. This situation could lead to increased faecal coliform bacteria levels in receiving waters if accidentally washed into streams by rainfall.

Sources of oil and grease generating points at the light vehicle workshop and the powerhouse were inspected weekly. SGL collects all waste oil into drums and empties them into a bulk tank located at the powerhouse, which is subsequently disposed of by the contractor. Oil spills were observed around the bulk oil collection point and the bund wall provided had no valve to control any unplanned spill.

The site visits also revealed that drainage control measures, judicious use of waste by material segregation and existence of surface water sources were not considered adequately in the selection of the waste dump sites. This is because Waste Dump No. 1 is located less than 100 m west of Akyempim village and is located at the source of the Aworaa creek, the main source of water for the inhabitants of Akyempim. Though approximately 60% revegetated on the north portion facing the village, it has some aesthetic and probable fugitive dust problems in the short term. However, these impacts are unlikely to be experienced in the long term when the vegetative cover finally blends with the natural vegetation of the surrounding environment. The exposed boulders will pose problems during reclamation of the area. The other dumps are properly located except that some problems may be encountered by Waste Dump No. 3 which is close to Kubekro village if adequate care is not taken in its construction and revegetation. There were some signs of deposited mud from that waste dump across the main access road to the Kubekro village, rendering it impassable for inhabitants on foot and difficult for vehicular movement during rainy seasons.

The practice of recycling waste oil through the contractor appears to the best option. The oil spill at the collection point needs to be cleaned daily and the bund wall provided with a valve to control any unplanned spill. The spill around the waste oil storage facility, if not cleaned, will lead to soil contamination and pollution of downstream receiving waters. This could result in oxygen deficiency or eutrophication.

Visual Intrusion

A field observation tour was undertaken around all the active working areas of the mine site to assess the extent of aesthetic impact due to mining and ore processing activities of the company. It was observed that exposed areas adjacent to the pregnant pond and the mid-east pit leave an aesthetic impact on people using the road to the Ateiku town and the Kubekro village, respectively. Though efforts were being made by the mine to minimise this problem through revegetation activities, the visible areas have not been tackled in a timely fashion.

Conclusions

From the analysis in this chapter, it is concluded that fugitive dust levels were significantly high during the construction period in 1998 and reduced markedly over the years up to 2001. Most of the fugitive dust levels that exceeded the ANZEC guidelines of 4.0 g/m^2/month were recorded between December and April which is the dry (hammatan) season. Water quality parameters were found to be largely within the EPA guideline values except the value of 0.023 mg/l of Hg that was recorded at one monitoring point along the Nkaasu stream which exceeded the EPA guideline value of 0.005 mg/l. This was probably due to the use of mercury for illegal small miners around the sampling area. The recorded values of TSS at some locations exceeded the EPA guideline value of 50 mg/l, while some iron levels recorded exceeded the EPA value of 10.0 mg/l. These could be attributed to surface runoffs from exposed mined out areas and leach pads.

The mine waste dumps were found to be in stable state due to the competent nature of the dumped material, although Waste Dump No. 3 had signs of overburden erosion affecting the access route to the Kubekro village. The peek particle velocity values recorded from the blasting operations of the mine were generally below the set trigger limit of 0.5 mm/s except on one occasion when the recorded value of 3.0 mm/s exceeded the recommended value of 2.6 mm/s. Maximum noise levels recorded at Akyempim significantly exceeded the recommended EPA value of 70 dBA while those at Kubekro were slightly above the EPA limit. The aesthetic view of the area has changed as a result of SGL's operations but reclamation work undertaken on the mine is rapidly mitigating the situation. It is recommended that SGL embarks on proper rock fragmentation, materials handling and waste disposal methods to quickly mitigate the adverse effects of their mining and processing operations on the environment.

References

Amegbey, N. (2001a). *Proposed Mining at Deadman's Hill and the Effect on Kubekro Community*, Environmental and Social Impact Assessment on the Kubekro Community, pp. 29–32.

Amegbey, N. (2001b). *Mine Environment and Safety*. Unpublished Modular MSc Lecture Notes, 3rd ed., Western University College of KNUST, Tarkwa, pp. 5–40.

Anon (1995). *Best Practice Environmental Management in Mining, Environment Australia*, Environmental Monitoring and Performance, Perth, Australia, pp. 3–12.

Anon (1996). *Environmental Impact of Surface Mining at Billiton Bogoso Gold Limited*, Unpublished MSc. Thesis report by K. M. A. Baku, Western University College, Tarkwa, Ghana, pp. 5–50.

Anon (1998). *Best Practice Environmental Management in Mining*, Environment Australia, Cyanide Management, Perth, Australia, pp. 21–59.

Anon (2000a). *Reclamation Plan of Satellite Goldfields Limited*, Tarkwa, Ghana (Unpublished), pp. 4–18.

Anon (2000b). *Annual Environmental Report – 2000*, Satellite Goldfields Limited, Tarkwa, Ghana, (Unpublished), pp. 2–10.

Anon (2001). *Mining Environmental Management Magazine*, A Mining Journal Publication, Friary Press, London, May 2001 edition, pp. 8–20.

Corbitt, R. A. (1990). *Standard Handbook of Environmental Engineering*, McGraw-Hill Publishing, New York, pp. 4.97–4.104.

Down, C. G. and Stocks, J. (1977). *Environmental Impact of Mining*, Applied Science Publishers, London, pp. 370–375.

Manahan, S. E. (1991). *Environmental Chemistry*, 5th ed., Lewis Publishers, Chelsea, MI, pp. 145–450.

Rau, J. G. and Wooten, D. C. (1980). *Environmental Impact Analysis Handbook*, McGraw-Hill Book Company, New York, pp. 1-50–5-50.

Sengupta, M. (1993). *Environmental Impacts of Mining, Monitoring, Restoration and Control*, Lewis Publishers, New York, pp. 425–427.

Siskind, D. E., Stagg, M. S., Kopp, J. W. and Dowding, C. H. (1980). *Structure Response and Damage Produced by Air Blast from Surface Mining*, US Bureau of Mines Report of Investigations R18507, Washington, DC, pp. 2–8.

Wiss, J. F. and Linehan, P. W. (1978). *Control of Vibration and Blast Noise from Surface Coal Mining*, Research report for the US Bureau of Mines, pp. 3–14.

Contaminated Identities: Understanding Human and Environmental Risks and Livelihood Options Among Small-Scale Gold Miners in Ghana

Petra Tschakert and Nicole Laliberte

Abstract Numerous studies exist on toxic soil and water contamination due to small-scale gold mining activities, as well as exposure prevention and clean technologies. However, few attempts have been made to understand the environmental health situation associated with contamination from a miner's perspective. The aim of this research is to increase awareness of the risks and impacts of mercury and other human–environmental health threats among small-scale miners in Ghana by placing these hazards into the broader livelihood context of the miners themselves. Through participatory approaches, we assess community perceptions of bodily exposure to mining-related toxicants and propose culturally and gender-sensitive risk communication and mitigation tools.

The ultimate goal of this research is to further interdisciplinary studies among African scientists and mining communities to enhance livelihood conditions in a high-risk environment. This chapter outlines the preliminary phase of a partnership project on human and environmental health with small-scale gold miners in Ghana. It includes two components: the understanding of miners' risk perceptions and an evaluation of potential livelihood alternatives. Research was conducted in the summer of 2006 in collaboration with groups of artisanal miners around Dunkwa and Bogoso.

Most of the participants operate without a license and have limited access to educational and health services. Based on the enthusiasm of the miners to participate, we intend to initiate, for a subsequent phase, a peer-educator health program that involves men and women miners more actively in addressing their major human and environmental health concerns.

Keywords Mercury · Artisanal mining · Ecohealth · Collective learning · Rural livelihoods · Ghana

P. Tschakert (✉)
Department of Geography/Alliance for Earth Sciences, Engineering, and Development in Africa (AESEDA), Pennsylvania State University, 315 Walker Building, University Park, PA 16802-5011, USA
e-mail: petra@psu.edu

I.N. Luginaah, E.K. Yanful (eds.), *Environment and Health in Sub-Saharan Africa: Managing an Emerging Crisis*, DOI 10.1007/978-1-4020-9382-1_5,

Introduction

An estimated 80–100 million people worldwide are currently engaged in artisanal and small-scale mining (ASM) and directly or indirectly depend on it for their livelihoods (Veiga and Baker, 2004). ASM is usually defined as a practice that involves rudimentary techniques of mineral extraction, highly manual processes, hazardous working conditions, and low levels of environmental, health, and safety awareness (Hilson, 2002). Hence, it is often criticized for its negative impacts on human and environmental health as well as adverse socioeconomic effects.

In Ghana, ASM, most of it related to gold, has expanded dramatically in recent years. The country is currently Africa's second largest gold producer after South Africa, with gold exports accounting for >40% of total export earnings (Mate, 1999). Over the past 10 decades, Ghanaian gold production from ASM activities has risen tenfold and doubled since 1998 (Table 5.1), accounting for an estimated contribution of $461.1 million to the national economy since 1989 (Carson et al., 2005). In the same study, the authors estimate that 300,000 people are currently involved in small-scale gold extraction, which amounts to over 60% of Ghana's total gold miners. As the precious mineral now provides many poor with higher income than agriculture, the government's official policy is to promote ASM as a catalyst for poverty reduction and sustainable development (Aryee, 2003).

Despite the state's attempts to regularize the sector through a series of laws and enactments, illegal mining in Ghana is widespread. According to Carson et al.

Table 5.1 Small-scale mining, Ghana

Year	Sales ($ millions)	Ounces	% Small-Scale Mining in Total Ghana
1989	3.4	9,272	2.2
1990	6.3	17,233	3.2
1991	5.3	15,601	1.8
1992	6.1	17,297	1.7
1993	11.5	35,144	2.8
1994	34.7	89,520	6.2
1995	48.7	127,025	7.4
1996	36.0	112,347	7.1
1997	28.4	107,094	5.9
1998	36.6	128,334	5.4
1999	35.2	130,833	5.2
2000	40.9	145,662	6.2
2001	39.3	185,596	8.7
2002	48.9	160,879	7.2
2003	79.8	211,414	9.5
TOTAL	461.1	1,593,253	

Sources: Amankwah and Anim-Sackey (2004); Yakubu (2002)

(2005), roughly 250,000 miners (85% of the total labor force) operate without an official license. Locally, these miners are referred to as *galamseyers*, a term that originated from the phrase "gather and sell." In practical terms, there are barely any differences either organizationally or technologically between unregistered illegal miners – here referred to as *galamsey* or artisanal miners – and registered small-scale miners, with the exception that the latter have security of land tenure (Carson et al., 2005). Hilson and Potter (2003) estimate that half of those employed in the artisanal gold mining sector in Ghana are women, one of the highest rates in Africa. Women typically work as panners, carriers, and processors as well as jewelery makers, cooks, shopkeepers, and other service providers (mainly prostitutes) in and around mining sites.

The vital livelihood opportunities in ASM notwithstanding *galamsey* mining has become increasingly contested. In their study on conflict mitigation in Ghanaian gold mining, Carson et al. (2005) outline the conflictual dimensions of *galamsey* operations around four axes: legal, environmental, social, and armed conflict. Together these axes combine to create an anti-*galamsey* discourse that directly impacts the health and livelihood of the mining communities.

This article is divided into four parts: (1) an overview of the role of mercury in the marginalization of artisanal miners in Ghana; (2) a description of the study area and the research methodology; (3) the discussion of results from participatory risks assessments, body health mapping, mercury measurements from water and soil samples, and alternative livelihood assessments; and (4) a general discussion and recommendations for a peer-educator health program in and around small-scale mining communities.

Mercury and Marginalization in the Artisanal Mining Sector

With the 1989 Small-Scale Gold Mining Law (PNDCL 218), the Mercury Law (PNDCL 217)[1], and the PNDCL Law 219[2] regarding the Precious Minerals Marketing Corporation (PMMC), the government of Ghana has legalized small-scale gold mining and provided a broad regulatory framework for gold processing and marketing. While the law stipulates good mining practices in the use of mercury, the predominant method of gold recovery in Ghana from both alluvial and hard rock mining sites, it does not include any guidelines in terms of handling and disposing of the chemical, which makes compliance and monitoring difficult (Amegbey and Eshun, 2003).

We argue that mercury use and contamination are key elements in the anti-*galamsey* rhetoric of marginalization and criminalization in Ghana. For the *galamseyers*, mercury amalgamation is not only simple and relatively inexpensive, but also the only currently available means of extracting gold. While many are aware of

[1]PNDCL 217 allows small-scale operators to purchase mercury from licensed mercury dealers.

[2]PNDCL 219 regulates purchasing services for small-scale gold (and diamond) miners.

its toxicity, the immediate economic needs that can be satisfied through its use outweigh the risks. We contend that inadequate governmental policies, technological failures, and an appalling lack of research or attention to the community dynamics in the ASM sector have prevented the inclusion of miners themselves into educational activities that explore and promote more environment-friendly techniques (Tschakert and Singha, 2007). Having no other choice than continuing to use mercury for amalgamation, the large majority of miners find themselves trapped in a vicious cycle of lack of access to information and alternative technologies that results in further contamination, and, hence, further criminalization.

Through the ASM amalgamation process, miners release mercury in two forms: metallic mercury and mercury vapor. Hinton et al. (2003) provide an extensive list of critical health risks posed to humans by both mercury vapor and metallic mercury – especially via contaminated food and water sources. These risks range from numbness, to kidney dysfunction, to severe neurological symptoms. Additionally, the effects of mercury have been shown to result in negative effects on biota and ecosystem functions (Hinton et al., 2003; Donkor et al., 2006).

Despite over a decade of donor efforts to increase environmental awareness in mining communities, risk communication campaigns have grossly ignored the socioeconomic and cultural dynamics and educational needs of ASM populations and, hence, have been largely ineffective (Hilson and Pardie, 2006). The authors' recommendations to not discriminate between legal and illegal miners when it comes to mercury risk communication campaigns are critical and deserve more attention. This study was an attempt to contribute to this emerging community-based approach and, ultimately, to facilitate risk appraisals and communication.

Study Area and Research Methodology

This pilot study was conducted in August 2006 and involved a research team of six people, including one geographer, one hydrogeologist, and four masters students from the Regional Institute for Population Studies (RIPS) at the University of Ghana. Two *galamsey* sites were selected with the help of officials from Small-Scale Mining District Offices who were familiar with the artisanal operations at the sites. The first one (Site#1) is a deep alluvial site along the Offin River and next to Dunkwa-on-Offin in the Upper Denkyira District, Central Region. The other study site (Site#2) is a hard rock area next to Bogoso in the Wassa West District, Western Region. In addition to the miners, we interviewed health personnel in the two towns.

The methods used in this study were highly participatory and integrative. First, we used focus group discussions and participatory risk ranking to identify human and environmental risks and other preoccupations as encountered by male and female miners. Through participatory health mapping, we were able to elicit collective experiences of health hazards. This technique involves life-size body sketches and color-coded dots to record individual responses (Keith and Brophy, 2004). Then,

with the help of medical practitioners, solutions to prevailing health problems, as indicated by the health maps, were discussed.

We conducted semi-structured interviews with miners as well as medical doctors and community health volunteers in order to evaluate perceived causes and consequences of mercury and arsenic exposure and other major health threats using mental models – psychological representations of real or hypothesized situations, generally in the form of conceptual maps of ideas (Bostrom et al., 1994; Morgan et al., 2002). Finally, the findings from these interviews were compared to a composite mental model based on the current literature. Points of disagreement, misconceptions, and lack of knowledge were identified to serve as entry points for future risk communication efforts.

We used participatory risk mapping of the sites to identify hazardous spaces and perceived risk. Subsequently, we involved miners in collecting water samples for mercury testing. They collected ground and surface water samples and tested them for arsenic and mercury concentrations using ready-made "hot kits" to evaluate the nature and extent of mining-related pollution and to estimate the occupational health risk of those exposed.

To assess alternative livelihood options, we used semi-structured interviews and a survey to evaluate the attractiveness and feasibility of other income-generating activities for small-scale miners. These options include grasscutter rearing, snail farming, oil palm plantations, batik making, and more, as currently suggested to reduce rural unemployment in Ghana. Miners were asked to compare alternatives with advantages and disadvantages of being in the small-scale mining sector.

Results

Results from Risk Ranking

The participatory risk ranking and scoring revealed a total of 25 major risks and hazards that men and women miners face on a regular basis (Tschakert and Singha, 2007). The most common ones are depicted in Figs. 5.1 and 5.2. Clearly, the most serious hazard on both sites is collapsing sediments, pits, or shafts, with a severity of 5 ('can kill you') and was mentioned by women, younger men, and older men. Additional life-threatening risks were those related to dynamite rock blasting and underground heat at the hard rock site. The latter refers to increased temperature and reduced oxygen that are associated with deep shafts (up to 45 ft in depth). Additional risks, typically non-fatal, can be categorized as health concerns similar to those in section "Results from Health Body Mapping."

Risks related to mercury contamination were explicitly addressed on Site#1 only. This is little surprising as amalgamation and burning occur directly on the site, albeit in a restricted area. Mercury in one's palm and in one's mouth and smoke from mercury burning were raised as concerns by women and young men while older men, most of whom had been on the site for several months and years, felt the

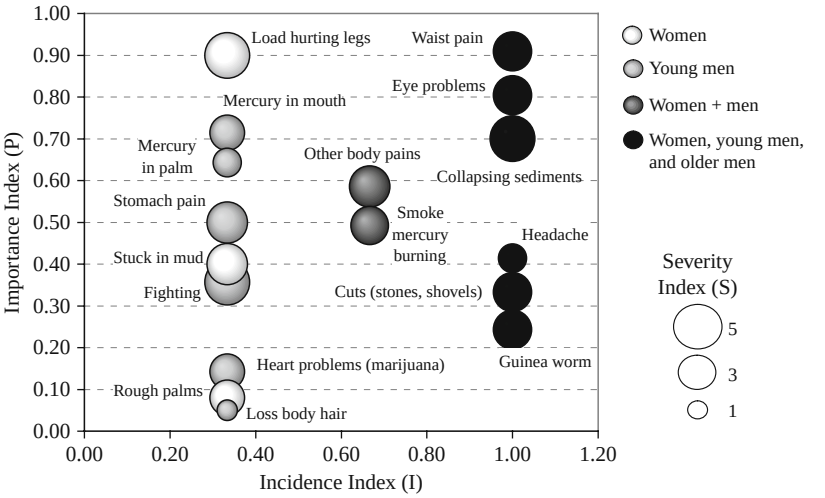

Fig. 5.1 Mining-related risks, Site #1 (deep alluvial mining site);
Source: Tschakert and Singha (2007)

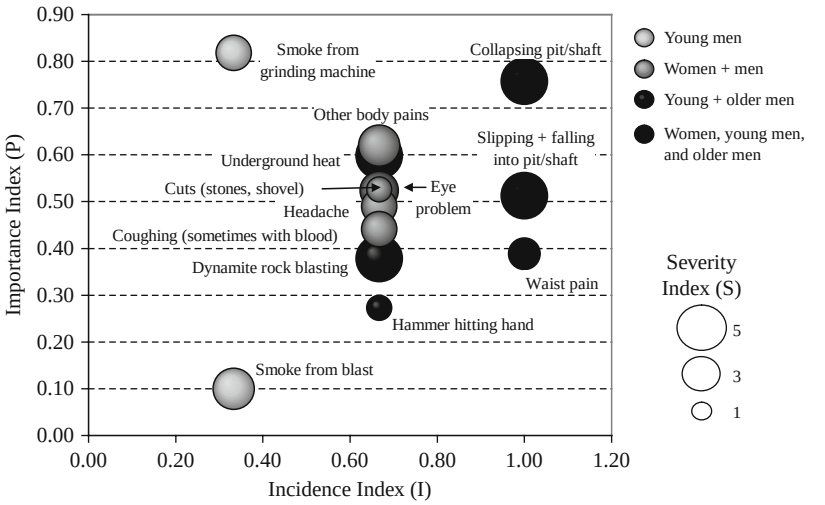

Fig. 5.2 Mining-related risks, Site #2 (hard rock mining sitte)
Source: Tschakert and Singha (2007)

problem was manageable. In fact, responses from the informal interviews suggest that much care is taken when handling mercury. Group leaders argued that mercury was costly and spillage usually minimal as spoons and shovels were used to gather accidentally lost droplets.

Overall, the results suggest that men and women artisanal miners face more numerous and more immediately life-threatening risks than mercury intoxication

on their sites. Several of these risks can result in instantaneous death. Although protective measurements are taken, such as using props for shafts and reducing the distance between pits to avoid collapsing sediments, the environment remains highly risk-prone. First aid is rarely provided on sites. Gloves, helmets, goggles, and boots – the elemental safety wear – are essentially non-existent. While they were deemed efficient, very few miners were able to afford them.

Results from Health Body Mapping

The results from the health body mapping support the results from the previous section. While there were health concerns related directly to mercury (i.e., throat irritation from the inhalation of mercury vapor), the majority were related to other issues (Tschakert, 2009a). All miners, including women, complained about waist pain due to the continuous shoveling, lifting, and carrying of sediments. Also common was a complaint of eye problems resulting from muddy water on the deep alluvial site and rock particles and smoke from the crushing and grinding machines. In addition, miners on the alluvial site reported guinea worm infections and foot-rot as a result of standing in water-filled excavation pits all day long.

Although many reported health concerns were similar between genders, there were a few differences. For example, foot problems were primarily a male concern at Site#1 and a female concern at Site#2. Additionally, there were more reports of head and neck pain by women at Site#2, presumably from carrying heavy loads. Such differences can be attributed to gendered divisions of labor.

The subsequent conversations with medical practitioners allowed the miners to play an active role in finding solutions to their prevailing health problems. Although this research phase was conducted as a pilot study, miners and health personnel alike requested a follow-up. As one professional nurse put it: “I hope you will do the same in all mining communities in the area.”

Results from Conceptual Mapping

The composite mental model in Fig. 5.3 is based on interviews with miners and medical personnel and illustrates how they understand the drivers and consequences of mercury contamination (Tschakert and Singha, 2007).

Miners agreed on three main causes of mercury contamination: the burning of mercury after amalgamation, dispersion of mercury in water bodies after spillage and rain, and contact with the mouth through unwashed hands after amalgamation. Lack of education and awareness aggravate contamination. Importantly, it was made explicit that the illegal status of the miners undermined awareness raising through the Mineral Commission and enforcement of safety regulations. The health personnel reinforced and expanded upon these points (see Fig. 5.3).

On the consequence side, skin irritation, respiratory problems, muscular tremors, numbness of extremities and atrophy, vomiting, gastrointestinal problems, and

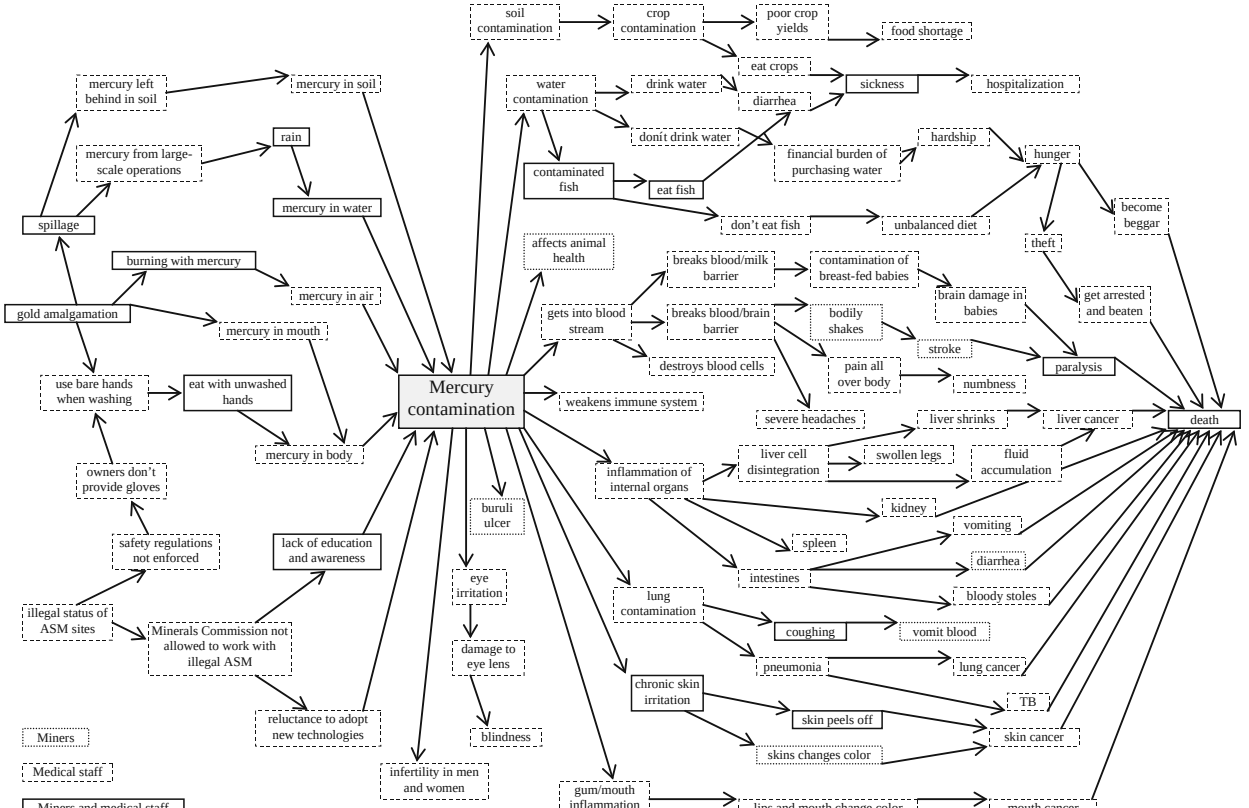

Fig. 5.3 Aggregate mental model of mercury contamination (combined miners and health personnel)
Source: Tschakert and Singha (2007)

finally death were all part of the miners' mental models. As for effects on the environment, there was consensus that mercury can affect animals through contaminated water and enter the food chain, contaminate fish, and eventually also cause sickness among humans.

The concepts elicited by the interviewed health personnel were exhaustive, including many more details than those understood by the miners, especially with respect to neurological symptoms. Additionally, one female health volunteer elaborated on the complex socioeconomic and health ramifications of mercury contamination for people's livelihoods that clearly go beyond the narrow clinical analysis. To avoid contaminated drinking water and fish, people would need to purchase water or forego fish consumption, both of which may lead to hardship and hunger, and potential social marginalization and death.

Results from Indicator Strips and Water Samples

The indicator strips provided a tool to discuss water contamination with the miners which would not have been possible by taking water samples for the laboratory alone. We found the miners to be highly interested in conducting real-time water sampling, and seeing the results. They were also concerned about the impacts of mercury on both the environment and human health. The strips from the alluvial site showed higher mercury values than bottled water, which was used for comparison. While the resolution of the strips is poor (no demarcations between 0 and 50 $\mu g\ L^{-1}$), the strips indicated values on the order of 50–100 $\mu g\ L^{-1}$. Given the lab results which show ng L^{-1} concentrations of Hg, the strips likely registered the impact of iron concentrations, which were as high as 3.3 mg L^{-1}. Consequently, the indicator strips, in this study, are a poor representation of mercury onsite. Better quality mercury indicator strips may be available, and should be tested in this environment, particularly, for educational purposes (Tschakert and Singha, 2007).

Results from Alternative Livelihood Assessments

Economic concerns were pivotal in livelihood decision-making for the individuals surveyed in ASM. Many miners reported dissatisfaction with their current livelihood, citing the risky nature of *galamsey* work, the lack of long-term employment, and the lack of societal respect for *galamseyers* in general. They also viewed the unpredictability of the income negatively while simultaneously valuing its potential for large payouts. Of the 19 respondents, 8 reported the desire to leave ASM within a year, 5 reported that they were there to build up capital for another venture, and 3 said they were waiting for a better job.

Of the alternative livelihood options surveyed, miners were most familiar with snail farming and grasscutter rearing followed by mushroom growing and batik making. Awareness, however, does not indicate a viable livelihood alternative. Results suggest that the majority of alternative livelihood options require substantial

start-up funds and/or minimum educational requirements and fail to provide the fast returns that presently attract men and women to mining (Tschakert, 2009b).

Conclusion

In Ghana, the mercury problem has historically been presented as a technical problem that requires a technical solution while ignoring broader socioeconomic, cultural, and political community issues. At the same time, the *galamsey* miners are portrayed as the anti-thesis of environmental stewards, recklessly degrading ecosystems and endangering their own and other people's health through irresponsible use and handling of mercury during gold amalgamation. Due to their illegal status, these miners are officially excluded from governmental programs that support mercury risk communication and loans to purchase safer technologies such as retorts, as inapt as they may currently be. Also, most measurements and monitoring are undertaken without their active involvement, thus prohibiting a practical learning experience. Being trapped in this vicious cycle of lack of access to information, health care, and alternative technologies, the miners perpetuate the pollution for which they are accused and marginalized. Hence, their identities are as much contaminated by the mercury in their immediate environment as by the ostracizing rhetoric that is perpetuated by the media, governmental officials, and large-scale corporations (Tschakert and Singha, 2007).

As long as *galamseyers* are considered outlaws and used as test subjects for contamination studies, learning, and changes in behavior are unlikely to occur. We witnessed a genuine interest and active participation on the part of the *galamseyers* in in situ mercury measurements and health- and hazard-related discussions at our two study sites. These findings suggest the importance and potential for science and community collaboration. Common concepts and overlaps in knowledge ought to be used as starting points for more in-depth awareness raising. Communication of the more extensive knowledge held by the medical personnel in regards to the human and environmental health risks associated with mercury contamination as well as other common health concerns is crucial to miners. What is lacking is an effective channel to make this information accessible to mining communities.

We propose a peer-educator program to fulfill this role. Such a program, supported by a partnership with local agencies and researchers, will facilitate a community-based approach to the complex concerns of mining communities. This type of partnership and communication will undermine the discourse of marginalization that currently prevents any type of fruitful collaborative and long-term action.

Acknowledgments The authors gratefully acknowledge a Faculty Research Grant from the Africa Research Center and a Wilson Research Initiation Grant from the Pennsylvania State University and invaluable contributions of team members Raymond Tutu, Jones Adjei, Doris Ottie-Boakye, and Iddrisu Mutaru Goro (Regional Institute for Population Studies, University of Ghana). We also want to thank the men and women miners who granted us access to their sites, participated in the study, and shared with us many constructive insights about the artisanal mining sector in Ghana.

Finally, we would like to thank Richard Amankwah and Newton Amegbey (University of Mining and Technology, Tarkwa), Francis Momade (Kwame Nkrumah University of Science and Technology, Kumasi), Seth Danso (Ecological Laboratory, University of Ghana, Legon), and Francis Dodoo and Nii Codjoe (Regional Institute for Population Studies, University of Ghana, Legon) for their institutional support, and Mike Appiah and Clemence Adzormahe from the Minerals Commission for practical guidance.

References

Amankwah, R.K., Amin-Sackey, C., 2004. Promoting cooperation between small- and large-scale mining companies in Ghana. Mining Engineering 56(4), 36–39.

Amegbey, N.A., Eshun, P.A., 2003. Mercury use and occupational exposure in the Ghanaian small-scale gold mining industry. Ghana Mining Journal 7, 54–61.

Aryee, B.N.A., 2003. Small-scale mining in Ghana as a sustainable development activity: its development and a review of the contemporary issues and challenges. In: Hilson, G.M. (ed.) The Socio-Economic Impacts of Artisanal and Small-Scale Mining in Developing Countries. A.A. Balkema Publishers, Lisse, The Netherlands, pp. 379–418.

Bostrom, A., Morgan, M.G., Fischhoff, B., et al., 1994. What do people know about global climate change? 1. Mental Models. Risk Analysis 14(6), 959–970.

Carson, M., Cottrell, S., Dickman, J., Gummerson, E., Lee, T., Miao, Y., Teranishi, N., Tully, C., Uregian, C., 2005. Managing mineral resources through public-private partnerships: mitigating conflict in Ghanaian gold mining. Woodrow Wilson School of Public and International Affairs, Princeton, NJ.

Donkor, A.K., Bonzongo, J.C., Nartey, V.K., Adothey, D.K., 2006. Mercury in different environmental compartments of the Pra River Basin, Ghana. Science of the Total Environment 369, 164–176.

Hilson, G., 2002. Small-scale mining and its socio-economic impact in developing countries. Natural Resources Forum 26, 3–13.

Hilson, G., Potter, C., 2003. Why is illegal gold mining activity so ubiquitous throughout rural Ghana? African Development Revue 15(2), 237–270.

Hilson G., Pardie, S., 2006. Mercury: an agent of poverty in Ghana's small-scale gold-mining sector? Resources Policy 31, 106–116.

Hinton, J.J., Veiga, M.M., Beinhoff, C., 2003. Women, mercury and artisanal gold mining: risk communication and mitigation. Journal of de Physique IV France 107, 617–620.

Keith, M.M., Brophy, J.T., 2004. Participatory mapping of occupational hazards and disease among asbestos-exposed workers from a foundry and insulation complex in Canada. International Journal of Occupational and Environmental Health 10(2), 144–153.

Mate, K., 1999. Boom in Ghana's golden enclave. UN office of Communications and Public Information. <http://www.un.org/eco-socdev/geninfo/afrec/vol11no3/ghanagold.htm>.

Tschakert, P., 2009a. Digging deep for justice: a radical re-imagination of the artisanal gold mining sector in Ghana. Antipode (in press).

Tschakert, P., 2009b. Recognizing and nurturing artisanal mining as a viable livelihood. Resources Policy 34, 24–31.

Tschakert, P., Singha, K., 2007. Contaminated identities: mercury and marginalization in the artisanal mining sector of Ghana. Geoforum 38, 1304–1321.

Veiga, M.M., Baker, R., 2004. Protocols for Environmental and Health Assessment of Mercury Released by Artisanal and Small Scale Miners, report to the Global Mercury project: removal of barriers to introduction of cleaner artisanal gold mining and extraction technologies, GEF/UNDP/UNIDO, 170p. Available: http://www.globalmercury.org

Yakubu, H., 2002. Water quality analysis of some commercial mineral waters in Kumasi, Ghana. Abstracts of papers of the American Chemical Society 223: 490-CHED.

"*This page left intentionally blank.*"

Part III
Environmental Management and Policy Development

"*This page left intentionally blank.*"

Environmental Degradation in Sub-Saharan Africa

Abel Chikanda

Abstract The chapter draws linkages on environmental management, development and human health. It is argued that poverty in Africa is a leading factor contributing to environmental degradation. Overexploitation of the natural environment has led to widespread deforestation and serious land degradation. In other regions, urban growth, industrialisation and mining activities have put the environment under stress, and have also led to the outbreak of diseases posing significant threats to human health. Slow and uneven progress has been made towards sustainable environmental management in Africa. Several countries have adopted environmental management tools, while some have sought ways of reclaiming degraded environments.

Keywords Environmental degradation · Africa · Uneven progress

Introduction: Linking Environment, Development and Human Health

Considerable interest has been displayed in recent years in the link between environmental management, development and human health (Colby, 1990; Donohoe, 2003). On the African continent, in particular, rapid population growth coupled with limited economic opportunities has led to rapid exploitation and deterioration of the available natural resources. For instance, while Africa's population grew by 2.5% between 1990 and 2004, consumption of traditional biomass energy rose by 42% over the same time period (Ejigu, 2008). On the other hand, agricultural output in most sub-Saharan states has stagnated over the past 25 years. As a result, the growth of food production in most African states lags behind demographic growth (Schweigman, 2008), leaving the majority of the continent's population depending

A. Chikanda. (✉)
Department of Geography, Social Science Centre, The University of Western Ontario, London, ON, Canada N6A 5C2
e-mail: achikand@gmail.com

I.N. Luginaah, E.K. Yanful (eds.), *Environment and Health in Sub-Saharan Africa: Managing an Emerging Crisis*, DOI 10.1007/978-1-4020-9382-1_6,

on environmental resources for survival (Economic Commission for Africa, 2002). The unsustainable exploitation of natural resources in the quest to achieve economic growth and alleviate poverty has impacted negatively on the quality of land, water availability and quality, soil resources availability, increasing pollution and desertification.

While human activities have primarily been responsible for triggering environmental change, it is also noteworthy that human activities on the continent have been affected and constrained by environmental change. Climate change is arguably one of the worst human-induced environmental challenges facing sub-Saharan African states, and has been blamed for an increase in occurrence of droughts. The Stern Review noted that although Africa is the continent least responsible for climate change, it is acutely vulnerable to its adverse effects – on economic growth and sustainable development, on poverty reduction, on human security, and on the prospects for achieving the Millennium Development Goals (MDGs) (Stern et al., 2006). The impacts range from reduced agricultural production, worsening food security and growing malnutrition, to spreading disease, more humanitarian emergencies, growing migratory pressures and increased risk of conflict over scarce land and water resources. Ironically, Africa is the continent least able to meet the costs of adapting to these impacts, with the greatest need to develop its energy sources, and also with the potential to contribute to global efforts to reduce emissions through its forest resources. Thus, African countries find themselves entangled in a web of poverty as the impacts of climate change further reduces their capacities to manage natural resources in a sustainable manner.

This section/chapter examines some of the common environmental problems faced by countries in Africa and describe the extent of the problem. The environmental problems discussed in this section are occurring largely as a result of human activity, but may also occur naturally. Human-induced environmental degradation occurs as a result of human activity ranging from agricultural and industrial development to mining activities and rural settlement or urban development. It is the most common and has far and wide-reaching impacts on the environment. On the other hand, natural environmental degradation includes situations that arise from local influences such as extremes of weather, local infectious agents and physical disasters. Floods, for instance, may result in human and animal deaths and may also lead to pollution of water sources.

Poverty and Environmental Degradation

As a starting point, it is necessary to examine the relationship between poverty and environmental degradation. Both poverty and environmental degradation are on the rise on the African continent. However, the link between poverty and environmental degradation continue to generate considerable scholarly debate. One school of thought argues that poverty is a major cause of environmental degradation and if policy makers want to address environmental issues, then they must first address the poverty problem (World Bank, 1992). Poor families, in their quest to meet

their short-term needs, mine the natural resources by excessive cutting of trees for firewood and failure to replace soil nutrients. Their impoverishment of their environment further impoverishes them, making their survival ever more uncertain and difficult (WCED, 1987). Emerging evidence suggest that the poor do not initially or directly degrade the environment, and their actions are contingent upon the activities of other groups not degrading the environment, and an absence of market or institutional failures (Duraiappah, 1998). He notes that the activities by the rich and powerful are the primary contributing factors forcing groups living at the margins into poverty. Consequently, the poor are left with few options other than to adopt resource mining activities, which will in turn affect the environment.

Be that as it may, it can be noted that the impacts of poverty on the environment are largely negative. For instance, poverty makes people rely on fuel wood for energy, which may result in deforestation and land degradation if there are no afforestation programmes put in place to mitigate overexploitation. In most cases, the poor are arguably both the agents and victims of environmental change (Economic Commission for Africa, 2002). Most of the poor in Africa live in rural areas where they lack resources and technology and do not have access to the infrastructure that provides economic opportunities and that safeguards health. The urgent short-term needs of the poor lead them into activities that have negative effects on the environment, such as cultivating erosion-prone hillsides, clearing natural vegetation and trees to make space for houses and crops, and exploiting the soil without replacing nutrients.

Land Degradation

Land degradation is a process which results in the land losing its productive capacity to sustain life and poses a serious threat to both agricultural productivity and biodiversity. Since most societies in Africa rely on agriculture for survival, land degradation presents a major threat to livelihoods on the continent. Consequently, with continued land degradation, more people on the continent are likely to sink deeper into poverty. Muchena et al. (2005) have noted that land degradation continues unabated in sub-Saharan Africa, with 65% of agricultural land, 31% of permanent pasture land, and 19% of forest and woodland degraded. Human factors are largely to blame for this state of affairs, with the major causes being overgrazing (49%), agricultural mismanagement (28%), deforestation (14%), and overexploitation of vegetation for domestic and industrial use (13%). Factors promoting land degradation in Africa include poverty and economic pressure, high rates of population growth, agricultural mismanagement of soil and water resources, lack of agricultural intensification, deforestation, overgrazing and insecure land tenure.

Several scholars have sought to establish the impact of security of land tenure on management practices (see, for example, Duraiappah, 1998; Muchena et al., 2005; Bugri, 2008). Theoretically, it can be argued that there is a positive correlation among land tenure security, enhanced agricultural production and sound environmental management practices. If people do not have title to land, they have no

incentive to invest in long-term improvements. Overexploitation and degradation of natural resources are likely to occur as the costs of degradation are borne by society as a whole, whereas benefits accrue to individuals. This is supported by the decline in the effectiveness of traditional grazing management methods in rangeland, owing partly to an increase in both human and animal populations. Across the African continent, free-range grazing has led to overgrazing, especially in arid and semi-arid areas, resulting in deteriorated land cover. A study by Bugri (2008) demonstrated that even though most stakeholders in north-east Ghana perceived their tenure security to be high, poor agricultural production and environmental degradation were evident in the region. The study concludes that the failure of stakeholders' high perceptions of their security of tenure to translate into enhanced agricultural production and sustainable land use practices implies the existence of other non-tenurial factors with negative consequences for agricultural production and environmental management. This demonstrates the need to adopt a holistic approach in the study of environmental management practices as land degradation is frequently a result of an interplay of a combination of variable factors.

Land degradation has also been associated with soil erosion, which washes away the productive layer of the soil. In South Africa, it is estimated that water erosion affects 6.1 million hectares of cultivated soil, while wind erosion affects an estimated 10.9 million hectares of cultivated soil, resulting in a mean annual loss of 2.5 t/ha/year (Economic Commission for Africa, 2002). The ECA report also estimates that 30% of smallholder farmland in Zimbabwe is now totally degraded. A similar situation can also be observed in Malawi (Table 1) where soil erosion had major impacts on crop yields. In 1999, an average of 20 t/ha of soil was lost through erosion, resulting in crop yield losses of between 4.0 and 11.3%. In this case, poor

Table 1 Soil and yield loss in gross arable land by districts in Malawi

Agricultural development districts	Arable land (ha)	Soil loss (t/ha/year)	Weighted average yield loss low impact (%)	Weighted average yield loss high impact (%)
North:				
1. Karonga	28,100	29	5.5	15.6
2. Mzuzu	42,500	22	4.3	12.2
Central:				
1. Kasungu	235,050	20	3.9	11.1
2. Lilongwe	231,150	22	4.2	12.1
3. Salima	46,400	16	3.1	8.8
South:				
1. Machinga	47,200	13	2.6	7.4
2. Blantyre	88,200	29	5.6	15.7
3. Shire Valley	0	17	3.2	9.3
Total	718,600	20	4.0	11.3

Government of Malawi (1999) (cited in Economic Commission for Africa, 2002).

agricultural practices are seen as having a direct negative impact on yields per unit area of land.

Similarly, in Nigeria land degradation represents one of the most crucial challenges facing the country. It affected an estimated 50 million people in 1990, at an annual cost of US$3 billion, including costs of food importation (Economic Commission for Africa, 2001). Generally the impact of soil erosion on farm-level productivity is often severe, with crop yield losses averaging between 2 and 4% across Africa. Serious effort, therefore, needs to be made to combat land degradation if the continent is to become self-sufficient in food production and end its reliance on food importation.

Deforestation

Africa is well endowed with forest resources and is home to almost a third of world's tropical forest cover (Economic Commission for Africa, 2001). However, the forests are increasingly coming under strain as many households, particularly those in the rural areas increasingly rely on fuel wood as the main source of energy. Consequently, the indiscriminate harvesting of fuel wood and forest products has resulted in deforestation and loss of plant and animal biodiversity (see Table 2). The problem is worsened by the fact that demand for fuel wood exceeds the natural regeneration ability of the forests.

FAO (2007) estimated the forest area for Africa in 2005 to be 635 million hectares, which represents about 16% of global forest area. However, net annual forest loss of about 4 million hectares was recorded for the period 2000–2005, a figure which amounts to almost 55% of the global reduction in forest area. The loss of forests is not uniformly distributed among the different countries and subregions. For instance, Zimbabwe's forest loss of 1.7% per year for the period 2000–2005 is far above the average of 0.7% for all southern Africa, while in northern Africa,

Table 2 Extent and change in forest area in Africa: 1990–2005

	Area (1,000 ha)			Annual change (1,000 ha)		Annual change rate (%)	
Subregion	1990	2000	2005	1990–2000	2000–2005	1990–2000	2000–2005
Central Africa	248,538	239,433	236,070	–910	–673	–0.37	–0.28
East Africa	88,974	80,965	77,109	–801	–771	–0.94	–0.97
Northern Africa	84,790	79,526	76,805	–526	–544	–0.64	–0.69
Southern Africa	188,402	176,884	171,116	–1,152	–1,154	–0.63	–0.66
West Africa	88,656	78,805	74,312	–985	–899	–1.17	–1.17
Total Africa	699,361	655,613	635,412	–4,375	–4,040	–0.64	–0.62
World	4,077,291	3,988,610	3,952,025	–8,868	–7,317	–0.22	–0.18

Source: FAO (2007).

the Sudan alone accounts for most of the forest cover and for 60% of the forest reduction (FAO, 2007).

Fuel wood extraction is a major cause of deforestation in the Sahel, semi-arid areas of eastern and southern Africa, densely populated areas of East African Highlands and the densely populated savanna zones of West Africa. The majority of urban people as well as the rural poor use fuel wood and charcoal as energy sources. In Central Africa, it was estimated that the annual gross deforestation rate of the tropical forest is 0.21% per year, with an additional gross forest degradation of 0.15% per year (Duveiller et al., 2008). The Congo Basin is the worst affected with mean annual deforestation rates ranging between 0.15 and 0.27%. This clearly should be cause for alarm. On the other hand, agricultural expansion poses a serious threat to both natural and biological resources. Across Africa, between 1990 and 1997, 310,000 ha of forests were transformed to agriculture per year, with a further 280,000 ha into mosaics and 200,000 ha/year into savannas or woodlands (Archard et al., 2002).

In Zimbabwe, studies by Elliot et al. (2006) revealed that the fast track land reform programme implemented by the government since 2000 resulted in a 9% expansion of cultivation, the loss of approximately 20% of woodland, a small loss of grassland and an 11% expansion of bushland within the resettlement schemes studied. Practices such as shifting cultivation have also been blamed for fuelling deforestation. In Central Africa, Zhang et al. (2002) estimate that by 2050, with current technology level and consumptive habits shifting cultivation will have converted 94% of the primary forests into cropland, fallow and secondary forest. Logging accounts for 79% of forest loss in Africa, while agriculture, energy and other infrastructural development account for 17 and 12% of biodiversity loss, respectively (Economic Commission for Africa, 2001).

The destruction of trees accelerates the rate of soil erosion and landscape degradation. Forests play an important role in the hydrological system as well as in nutrient recycling. The destruction of forests also threatens habitat for wildlife and non-food forest products such as medicinal plants. Besides these impacts, forest destruction has direct implications on climate change as forest reserves serve as major sinks of atmospheric carbon dioxide. Recognising these valuable properties of forests, there is need therefore for countries to enact measures for sustainable use of forests and forest products. Such efforts are underway in countries like South Africa, Zimbabwe, Zambia and Namibia, which have developed nature conservancies and community development projects. These have helped in the quest to achieve the twin aims of conservation of wildlife and forest resources, with the local communities also deriving additional benefits of natural resource conservation through ecotourism.

Urban Growth and Industrialisation

Pollution of air, water and land has been accompanied by urban and industrial growth. Air pollution, in particular, has resulted from emissions emanating from

a multiplicity of sources, mainly stationary, industrial and domestic fossil fuel combustion, and petrol and diesel vehicle emission. Studies have shown the associations between exposure to the classical pollutants and ill-health endpoints such as increased hospital admissions for respiratory, cardiovascular disease and congestive heart failure, increases in asthma attacks, increases in acute bronchitis and decreased lung function (Cairncross et al., 2007).

Fossil fuel carbon emissions from Africa are low in both absolute and per capita terms compared to the industrialised countries of Europe and North America. Only five countries are largely responsible for the majority of Africa's fossil fuel regional emissions. South Africa is by far the largest emitter, responsible for 39% of the continental total (Economic Commission for Africa, 2001). Another 42% of carbon comes from Algeria, Egypt, Libya and Nigeria combined. Only Libya (1.98 t) and South Africa (1.88 t) have per capita emissions higher than the global average of 1.13 t of carbon per year.

The use of motor vehicles in Africa is growing as cities continue to expand and incomes continue to grow in some countries. Even though Africa's average urbanisation rate of about 38% is well below the rates in developed countries, the negative impacts of rapid urbanisation and industrialisation on the environment are quite staggering on the continent. For instance, El Araby (2002) notes that in the Greater Cairo Metropolitan Region, the 10th largest mega city in the world, as many as 900,000 residents or almost 10% of the total population, suffered from respiratory illnesses due to air pollution. Motor vehicles were said to account for between 60 and 70% of all air pollution in the region. As a result, Cairo's children now have the highest blood lead levels in the world, even exceeding the levels found among children in the worst polluted cities such as Mexico City. Besides vehicular emissions, industrial emissions are the other major source of air pollution in Cairo. This is largely a result of many factories using lignite, a soft coal which is available cheaply in Cairo. This problem shows the need for African countries to ensure that cleaner fuels are made affordable so as to reduce the high levels of industrial air pollution in the cities and all the major industrial regions.

Environmental Degradation and Migration

Several studies have attempted to draw the link between environmental change and migration (see, for example, Babu and Hassan, 1995; McDonald, 1999; Braimoh, 2004). However, migration is often a result of a complex interplay of several factors, which makes it difficult to distinguish between economic and environmental migrants. In many cases, environmental reasons are generally intertwined with economic ones and in this sense environmental migrants are also economic migrants. What is clear though is that environmental factors sometimes have economic implications, making it difficult to separate the two. An environmental factor such as drought or floods may affect the economic standing of a household, and may be a motivation for migration. The movements often involve a transfer of negative factors

from the areas of origin into the receiving areas. For instance, rural–urban migration may help reduce pressure on the rural environment although it brings a new set of pressures on the urban environment associated with the demand for land and services. It has been found, for instance, that urbanisation and, particularly, unplanned informal settlement negatively impacts on runoff from storm water, concentrating flows and causing land degradation and erosion (Economic Commission for Africa, 2002).

Migration is a significant factor in population change and distribution. Large-scale movements are likely to affect the population – ecological balance of the receiving area. For example, between 1930 and 1990, the population of what is now Burkina Faso trebled from 2.8 to 8.7 million inhabitants, whereas the population of the Ivory Coast multiplied by eight, rising from 1.4 to 11.4 million inhabitants (McDonald, 1999). As a result of rural–urban migration and population growth, African cities have often become overcrowded, with inadequate water and sanitation facilities, poor housing and lack of access to health services.

The Sahelian droughts of 1973 and 1984 caused massive population displacements (Akokpari, 1998). For instance, drought-displaced persons in the affected countries of Burkina Faso, Niger and Mali moved south to Ghana, while nomads in the north of the country moved into Algeria and Libya (Fair, 1996; Akokpari, 1998). In some cases, environmental degradation has generated conflicts which have in turn induced refugees and migration (Akokpari, 1998). Such conflicts are the inevitable result of competition for resources owing to resource scarcity. These conflicts, sometimes called ‘eco-conflicts’ have pitted groups such as pastoralists against farmers, and eco-refugees and host communities. It is commonly believed that the current crisis in Sudan is partly a result of competition for resources. Commenting on the Sudanese conflict, Suliman (2005:12) observed that ‘many of the current disputes are not being fought along traditional political borders, but along the ecological borders that divide the richer and the poorer eco-zones’. This illustrates the role that resources play in the livelihoods of people and competition for them has the potential for generating conflicts.

A number of African countries continue to experience conflict and high levels of political instability. This has resulted in several thousands of people displaced from their homes and fleeing to neighbouring countries as refugees. The impact of refugees on the land pressure, soil fertility and environmental degradation is immediately felt and has serious implications for the survival of the local population (Babu and Hassan, 1995). Forest tree resources are a major component of the ecosystem that suffers from overexploitation resulting in deforestation. Biswas and Tortajada-Quiroz (1996) noted that the influx of 1.5–2.0 million Rwanda refugees into the then Zaire in 1994 resulted in widespread deforestation, soil erosion, landslides, poaching and changes in land use. Establishing the refugee camps requires clearing vegetation and trees, while firewood is often the main source of energy in the camps. Akokpari (1998) also reported that the Rwandan refugees in eastern Zaire were known to have poached every ‘edible’ creature in the area, including rats, antelopes and monkeys.

Mining and the Environment

Mining is an important driver of economic development in a number of African states. However, the benefits associated with mining activities often come at a huge cost to the environment. The impacts of mining on the environment have widely been reviewed in the literature (see, for example, Hilson, 2002; World Rainforest Movement, 2004; Van Niekerk and Viljoen, 2005). It has been shown that mining has negative impacts on the environment (Van Straaten, 2000), which may in turn have adverse effects on human health (Kuma and Younger, 2004). This section reviews evidence of the impacts of mining on the environment and discusses the associated health impacts using selected case studies from African countries.

An examination of the stages involved in mining may help uncover the impacts associated with each of these phases. The first stage in mining is surveying and mineral exploration. Mineral exploration is the process undertaken by prospective mining companies in the endeavour of finding commercially viable concentrations of minerals to exploit. While mineral exploration takes place at a smaller scale, the cumulative effects of exploration activities at multiple sites within an area have the potential to drive environmental change. According to the Economic Commission for Africa (2002), the general environmental impact of mining exploration includes the removal of vegetation for survey lines, vegetation damage and soil erosion from vehicle tracks, abandoned equipment and supplies, soil, vegetation and water resource pollution and contamination.

The range of impacts of mining on the environment depends to some extent on the method of extraction used. Two main methods used to extract minerals are open cast and underground mining. Presently, over 60% of the materials mined in the world are extracted by the open cast method, causing devastation of the ecosystem where they are operating (deforestation, contamination and alteration of the water, destruction of habitats). It is estimated that mining is threatening 38% of the last stretches of the world's primary forests (World Rainforest Movement, 2004).

In Africa, Ghana probably exhibits the worst effects of mining on the environment, human livelihoods and health. Perhaps no region in Ghana has been touched by mining operations, both positively and negatively as Wassa West District. Over 60% of the district is now under concession to large-scale mining companies. As a result, subsistence farmers and artisanal miners have been displaced from the district. Hilson and Nyame (2006) note that as many as 30,000 people in 14 communities in Tarkwa area were relocated so as to pave way for the expansion of mining operations.

Surface mining also presents a serious threat to the last vestiges of Ghana's forest resources and threatens the rich biodiversity of the country's tropical rainforest (World Rainforest Movement, 2004). There is a growing conflict between sustainable forest management and mining activities. Tockman (2001) has noted that by 2001, over 60% of the rainforest in Wassa West District was lost to gold mining activities. Tarkwa area lies in a prime timber-producing region with a good overlay of forest reserves. The area is said to contain 44% of the country's closed forest,

with trees reaching heights of up to 45 m. Ironically, it has the highest concentration of surface mines and exploration companies. Eight of the country's 14 large-scale mines are located in Tarkwa, and some even have licenses to operate in forest reserves. The removal of the forest cover is rapidly drying up rivers and streams, leading to the extinction of river-hosted animal and plant species. At the community level, the threat to ecological biodiversity has economic implications: increased mining activities in the area have partly led to the reduction or extinction of certain flora and fauna species that the communities depend on. Many communities complain that snails, mushrooms and medicinal plants are no longer available in the area due partly to mining activities.

Mining has also been responsible for polluting open sources of water which provides sustenance to the impoverished rural population. In 2001, thousands of cubic metres of toxic mine waste were spilled in Wassa West, severely polluting the Assaman River, a water source for five villages and more than 1,000 people. There are also fears that even underground water could be polluted even though the latest studies have been not yielded conclusive results (see, for example, Kuma and Younger, 2004). The affected communities have voiced their concern at the negative impacts of mining both on the environment as well as on their livelihoods. For instance, an advocacy group was created in 1998 called Wassa Association of Communities Affected by Mining (WACAM). The group enjoys heavy support of Oxfam America and seeks to pressure mining companies and the government for justice. The group documents human rights violations, develop media campaigns to promote balanced news coverage of the conflicts between villages and mines, and train citizens to understand and defend their rights.

The majority of the environmental impacts of mining can be attributed to mining waste disposal. Van Niekerk and Viljoen (2005) have noted that mine discard and tailings dams are not a revenue-producing aspect of the mining industry. Hence many mining companies have been reluctant to spend money on their tailings deposition. Not surprisingly, a number of disasters have been recorded involving tailing spillages. Van Niekerk and Viljoen (2005) have described three cases of tailing spillages that have occurred in southern Africa, often with dire consequences on the environment and even resulted in human deaths. First, on 11 November 1974, a major failure of the number four tailings dam of Impala Platinum Mines near Rustenburg, South Africa (also known as the Bafokeng disaster), took place. More than 3,000,000 t of tailings escaped through the breach and engulfed the number four mineshaft, killing 12 men underground, and flowed on the surface for 25 km down the Elands River. The Bafokeng tailings dam failure produced a tailings flood that was up to 800 m wide and 10 m deep, 4 km away from the breached dam wall. Second, on 31 January 1978 at Arcturus mine in Zimbabwe, a tailings dam overflowed. A 55 m wide breach released more than 30,000 t of liquefied gold tailings that blocked and contaminated a public waterway and adjoining rough pasture through extensive siltation. A nearby village was damaged, one child was killed, and another injured. Third, on the night of 22 February 1994, the 31 m high northern wall of the number 4 tailings dam of the Harmony Gold mine in the Free State Goldfields of South Africa collapsed. More than 2.5 million tonnes of liquefied tailings

ripped through the sleeping mining village, killing 17 people and sweeping away 80 houses and damaged 200 others. The above incidences show that failure to comply with safe standards of mineral waste disposal not only affects the environment but can also affect human health or lead to deaths.

Mining is also associated with the destruction of vegetation, often leading to land degradation. Maponga and Ruzive (2002) have noted that the principal environmental problems resulting from chromite mining in the Great Dyke area in Zimbabwe include removal of vegetation (deforestation), which exposes the soil to erosion by both fluvial and wind agents. Furthermore, the miners systematically abandon trenches, some of which are very deep and move to new mining sites in search of easier ore bodies to mine. Some of the trenches have become overgrown with grass and pose a serious hazard to other miners and animals in the area. In addition, the growth of settlements around mining sites exerts additional pressure on the environmental resources in the area, as the settlers harvest timber for wood fuel and construction of dwellings.

While large-scale mining activities have considerable impacts on the environment, even worse impacts can be observed from the activities of small-scale miners. Most of them operate outside the legal framework of their country's mining laws and they aim to maximise their benefits from mining, often at the expense of the environment. They mine various minerals but alluvial gold mining is the most common activity. The environmental impacts of alluvial gold panning include the digging up of river channels, banks and their flood plains as well as surface trenching using picks and shovels, resulting in hazards for humans, domestic and wild animals as well as reducing river frontage (Zwane et al. 2006).

Mercury contamination associated with small-scale gold mining and processing represents a major environmental and human health concern in the affected areas in Africa. If the population involved in gold panning activities is taken into consideration, the environmental impacts become more apparent. Van Straaten (2000) has noted that as many as 200,000–300,000 persons are involved in small-scale gold mining activities in Tanzania and more than 200,000 persons in Zimbabwe. Mercury is used mainly for the processing of primary gold quartz veins and supergene gold mineralisations. Van Straaten (2000) demonstrated that between 70 and 80% of the mercury that is used in processing the gold is lost to the atmosphere, while 20–30% is lost to tailings, soils, stream sediments and water. In all, mercury released into the atmosphere due to gold panning activities is approximately 3–4 t in the whole Lake Victoria Goldfields of Tanzania and about 3 t in Zimbabwe.

It is therefore imperative for African states to adopt measures that mitigate the negative impacts of small-scale mining on the environment. It is important to recognise the contribution of small-scale mining to the national economy. In most of the cases, the relative contribution of the small-scale miners is unknown since most of them operate without formal licences. However, in Tanzania, gold production from the small-scale mining sector provided some 76% of Tanzania's total mineral export in 1992, contributing 4,525 kg gold worth US$40.4 million to the Bank of Tanzania (Van Straaten, 2000). Extractive methods that do not have adverse impacts on the

environment need to be introduced and adopted by the small-scale miners so that they can contribute positively to economic growth without posing negative impacts on the environment.

Environmental Management

The scale of environmental degradation in Africa has necessitated the implementation of various measures to ensure the sustainable use of existing resources and rehabilitate the degraded ones.

Agroforestry

Slow and uneven progress has been made towards sustainable forest management in Africa. Afforestation programmes with various aims have been established and Africa currently boasts of some 13 million hectares of forest plantations (FAO, 2007). It is important to note that approximately 2.4 million hectares (18%) of forest plantations are planted for protective purposes; the remainder are planted to produce wood, particularly industrial roundwood and fuelwood. As shown in Table 3, more than half of Africa's forest plantations are located in North Africa because of scarcity of natural forests. Southern Africa has developed a globally competitive forest industry almost entirely based on planted forests. In the period 1990–2005, there was an increase in the extent of protective forest plantations of nearly 400,000 ha.

Some attempts to reforest areas affected by deforestation have gone beyond solving the immediate problem of deforestation. Such programmes with the primary objective of environmental protection include afforestation of degraded areas for soil conservation, and establishment of windbreaks and shelterbelts to protect agriculture areas. However, lately the total area of forest designated for protective purposes has been on the decline throughout the continent, save for northern Africa which

Table 3 Area of forest plantations

	Area (1,000 ha)			Annual change (1,000 ha)	
Sub region	1990	2000	2005	1990–2000	2000–2005
Central Africa	348	388	526	4	28
East Africa	1,246	1,233	1,230	–1	–1
Northern Africa	7,696	7,513	7,503	–18	–2
Southern Africa	1,867	2,060	2,150	19	18
West Africa	900	1,337	1,677	44	68
Total Africa	12,057	12,532	13,085	48	111
World	101,234	125,525	139,466	2,424	2,788

Source: FAO (2007).

Table 4 Area of forest designated primarily for protection

	Area (1,000 ha)			Annual change (1,000 ha)	
Sub region	1990	2000	2005	1990–2000	2000–2005
Central Africa	368	746	651	38	–19
East Africa	3,748	3,633	3,574	–12	–12
Northern Africa	3,645	3,819	3,861	17	8
Southern Africa	2,692	2,480	2,279	–21	–40
West Africa	10,939	10,610	10,247	–33	–72
Total Africa	21,392	21,287	20,613	–10	–135
World	296,598	335,541	347,217	3,894	2,335

Note: Fewer than 50% of the countries in Central Africa were able to report on this parameter.
Source: FAO (2007).

showed a slight increase (see Table 4). Examples of forestry programmes that have been implemented in Africa include the soil conservation and agroforestry in Zambia, the Gitusa Forest Project in Rwanda and the Projet Agroforestrier in Burkina Faso.

A considerable proportion of smallholder farmers in Africa rely on livestock production. This has put a strain on the land available for grazing, often leading to overgrazing and land degradation. Various efforts have been implemented to ensure that the livestock production does not affect the environment. In Tanzania, Malawi and Zimbabwe, agroforestry involving the use of the so-called ‘fodder trees’ has helped restore vegetation in areas affected by deforestation but has also provided vital food supplements to livestock, particularly cattle (Chakeredza et al., 2007). This may go a long way in reducing the impacts of overgrazing particularly in the overcrowded native communal farming areas. Hamer et al.(2007) showed that in northern Mali where trees had become scarce, farmers are now dependent on planted fodder shrubs to feed their animals adequately in the dry season.

Besides providing food supplements to livestock, agroforestry has also been used for improving soil fertility. Called ‘alley cropping’, food crops and woody species are intercropped, food crops are grown in the alleys formed by hedgerows of planted trees and shrubs, preferably legumes (FAO, 1993). The hedgerows are cut back at planting and periodically pruned during cropping to prevent shading and to reduce competition with the food crops. The prunings are used as green manure or mulch. However, the success of such programmes hinges to a large extent, on the ability of the farmers to grow the trees, and the availability of land suited to the growth of the trees.

Pollution Reduction Strategies

The growth in industries all over the world has been blamed for increasing atmospheric pollution and altering natural processes resulting in global climate change.

While Africa's industrial base is small as compared to other developed regions, the amount of pollutants generated by industries in Africa is becoming a cause for concern. Not surprisingly, a number of African countries have adopted a variety of strategies to reduce industrial emissions and limit atmospheric pollution.

The implementation of atmospheric reduction strategies in Africa have been met with varying levels of success. In Tanzania, for instance, Yhdego (1995) noted that the reliance on regulatory approaches, which rely heavily on monitoring and enforcement have failed to yield the required results. The author advocates for a move away from the polluter pays principle which is not only prevalent in Tanzania, but in most developing countries, to a pollution-prevention approach. Such an approach seeks to restructure the industrial economy according to eco-development principles in order to prevent waste through input management and an increased emphasis on reduction and internal material recycling. Cleaner production can therefore be implemented as it is a pollution prevention strategy that addresses all aspects of the product life cycle.

Environmental Monitoring Tools

The foregoing discussion has shown that an integrated approach to pollution management often yields the best goals. An essential component of environmental management involves the introduction and use of proper monitoring tools. Advances in geo-information science, particularly in the fields of remote sensing and geographic information system (GIS) have increased the number of tools that are available for environmental monitoring. Rates of deforestation over time, for instance, may be calculated using remote sensing. Trends can therefore be established and this provides vital information that can guide in the adoption and implementation of appropriate policy frameworks.

Sustainability

The concept of sustainable development was popularised by the Brundtland report which emphasised the need to conserve present resources for future generations. While the concept has gained ground globally, there has also been recognition that the concept also need to factor gender as it determines to some extent the exploitation of natural resources. Since gender relations may play a role in structuring the day-to-day activities of men and women, there is increasing need to include both men and women in the management of natural resources. Women, in particular, are the primary utilisers of natural resources and therefore have unique opportunities, responsibilities and constraints in the management of natural resources (Armitage and Hyma, 1997). Women who are poor, illiterate and oppressed cannot take on a meaningful, effective role as agents of environmental and human health. Hence, uplifting the status of women is one major step towards achieving the goal of sustainability.

The state of the environment in Africa continues to be influenced mainly by rapid population growth, worsening poverty and inappropriate development strategies, particularly agricultural and industrial production methods (Economic Commission for Africa, 2001). This has resulted in extensive degradation of both land and natural resources.

References

Akokpari, J. K. (1998) The state, refugees and migration in sub-Saharan Africa. *International Migration* 36(2): 211–234.

Archard, F., Eva, H. D., Stibig, H., Mayaux, P., Gallego, J., Richards, R., and Malingreau, J. (2002) Determination of deforestation rates of the world's humid Tropical forests. *Science* 297: 999–1002.

Armitage, D. R. and Hyma, B. (1997) Sustainable community-based forestry development: A policy and programme framework to enhance women's participation. *Singapore Journal of Tropical Geography* 18(1): 1–19.

Babu, S. C. (1995) International migration and environmental degradation – The case of Mozambican refugees and forest resources in Malawi. *Journal of Environmental Management* 43: 233–247.

Biswas, A. K. and Tortajada-Quiroz, H. C. (1996) Environmental impacts of the Rwandan refugees on Zaire. *Ambio* 25: 403–408.

Braimoh, A. K. (2004) Seasonal Migration and Land-Use Change in Ghana. *Land Degradation & Development* 15: 37–47.

Bugri, J. T. (2008) The dynamics of tenure security, agricultural production and environmental degradation in Africa: Evidence from stakeholders in north-east Ghana. *Land Use Policy* 25: 271–285.

Cairncross, E. K; John, J., and Zunckel. M. (2007) A novel air pollution index based on the relative risk of daily mortality associated with short-term exposure to common air pollutants. *Atmospheric Environment* 41: 8442–8454.

Chakeredza, S., Hove, L., Akinnifesi, F. K., Franzel, S., Ajayi, O. C., and Sileshi, G. (2007) Managing fodder trees as a solution to human-livestock food conflicts and their contribution to income generation for smallholder farmers in southern Africa. *Natural Resources Forum* 31: 286–296.

Colby, M. E. (1990) *Environmental Management in Development: The Evolution of Paradigms*. World Bank Discussion Paper 80. The World Bank, Washington, DC.

Donohoe, M. (2003) Causes and health consequences of environmental degradation and social injustice. *Social Science & Medicine* 56: 573–587.

Duraiappah, A. K. (1998) Poverty and environmental degradation: A review and analysis of the Nexus. *World Development* 26(12): 2169–2179.

Duveiller, G., Defourny, P., Desclée, B., and Mayaux, P. (2008) Deforestation in Central Africa: Estimates at regional, national and landscape levels by advanced processing of systematically-distributed Landsat extracts. *Remote Sensing of Environment* 112: 1969–1981.

Economic Commission for Africa (2001) *State of the Environment in Africa*. Economic Commission for Africa, Addis Ababa.

Economic Commission for Africa (2002) *Economic and Social Conditions in Southern Africa 2002: Economic Impact of Environmental Degradation in Southern Africa*. ECA Subregional Office for Southern Africa (SRO-SA), Addis Ababa.

Ejigu, M. (2008) Toward energy and livelihoods security in Africa: Smallholder production and processing of bioenergy as a strategy. *Natural Resources Forum* 32: 152–162.

El Araby, M. (2002) Urban growth and environmental degradation: The case of Cairo, Egypt. *Cities* 19(6): 389–400.

Elliott, J. A., Burnside, N. G, Broomhead, T; Kinsey, B. H., and Kwesha, D. (2006) The nature and extent of landscape change under land resettlement programmes in Zimbabwe. *Land Degradation & Development* 17: 495–508.

Fair, D. (1996) Refugees in sub-Saharan Africa: From cause to solution. *Africa Insight* 26(1): 36–42.

FAO (1993) Soil tillage in Africa: Needs and challenges. *FAO Soil Bulletin No. 69*, Rome.

FAO (2007) *State of the World's Forests 2007*. Food and Agriculture Organization of the United Nations, Rome.

Government of Malawi. (1999) *New Environmental Action Plan*. Government of Malawi, Blantyre.

Hamer, A. G, Franzel, S., and Mounkoro, B. (2007) Using farmers' criteria to assess profitability of fodder shrubs in the desert margins of West Africa. *Land Degradation & Development* 18: 670–679.

Hilson, G. (2002) The environmental impact of small-scale gold mining in Ghana: Identifying problems and possible solutions. *The Geographical Journal* 168(1): 57–72.

Hilson, G. and Nyame, F. (2006) Gold mining in Ghana's forest reserves: A report on the current debate. *Area* 38(2): 175–185.

Kuma, J. S. and Younger, P. L. (2004) Water quality trends in the Tarkwa gold-mining district, Ghana. *Bulletin of Engineering Geology and the Environment* 6: 119–132.

Maponga, O. and Ruzive, B. (2002) Tribute chromite mining and environmental management in the northern Great Dyke of Zimbabwe. *Natural Resources Forum* 26: 113–126.

McDonald, D. A. (1999) Lest the rhetoric begin: Migration, population and the environment in Southern Africa. *Geoforum* 30: 13–25.

Muchena, F. N., Onduru, D. D., Gachini, G. N., and de Jager, A. (2005) Turning the tides of soil degradation in Africa: Capturing the reality and exploring opportunities. *Land Use Policy* 22: 23–31.

Schweigman, C. (2008) Food security problems in sub-Saharan Africa: Operations research as a tool of analysis. *International Transactions in Operational Research* 15: 173–193.

Stern, N., Peters, S., Bakhshi, V., Bowen, A., Cameron, C., Catovsky, S., Crane, D., Cruickshank, S., Dietz, S., Edmonson, N., Garbett, S.-L., Hamid, L., G. Hoffman, G., Ingram, D., Jones, B., Patmore, N., Radcliffe, H., Sathiyarajah, R., Stock, M., Taylor, C., Vernon, T., Wanjie, H., and Zenghelis, D. (2006) *Stern Review: The Economics of Climate Change.* HM Treasury, London.

Suliman, M. (2005) Ecology, politics and violent conflict. *Respect, Sudanese Journal for Human Rights' Culture and Issues of Culture Identity* 1: 1–25.

Tockman, J. (2001) *The IMF-Funding Deforestation: How International Monetary Fund Loans and Policies Are Responsible for Global Forest Loss*. American Lands Alliance, Washington, DC.

Van Niekerk, H. J. and Viljoen, M. J. (2005) Causes and consequences of the Merriespruit and other tailings-dam failures. *Land Degradation & Development* 16: 201–212.

Van Straaten, P. (2000) Mercury contamination associated with small-scale gold mining in Tanzania and Zimbabwe. *The Science of the Total Environment* 259: 105–113.

WCED (1987) *Our Common Future*. Oxford University Press, Oxford.

World Bank (1992) *World Development Report*. Oxford University Press, Oxford.

World Rainforest Movement (2004) *Mining: Social and Environmental Impacts*. World Rainforest Movement, Montevideo.

Yhdego, M. (1995) Environmental pollution management for Tanzania: Towards pollution prevention. *Journal of Cleaner Production* 3(3): 143–151.

Zhang, Q; Justice, C. O., and Desanker, P. V. (2002) Impacts of simulated shifting cultivation on deforestation and the carbon stocks of the forests of central Africa. *Agriculture, Ecosystems and Environment* 90: 203–209.

Zwane, N., Love, D., Hoko, Z.., and Shoko, D. (2006) Managing the impact of gold panning activities within the context of integrated water resources management planning in the Lower Manyame Sub-Catchment, Zambezi Basin, Zimbabwe. *Physics and Chemistry of the Earth* 31: 848–856.

Environmental Legislation and Regulation in Sub-Saharan Africa: 'Green Development' or 'Green Imperialism'?

Paul Mkandawire and Godwin Arku

Abstract This chapter examines the availability and effectiveness of environmental legislation in sub-Saharan Africa. It is observed that while governments in the region have moved rapidly in putting together policies and legislations to deal with the environmental crisis, practical action on the ground continues to lag behind. Some of the reasons for this include lack of financial and human resources and lack of appropriate legal frameworks. Further, it is argued that key environmental policies adopted by sub-Saharan countries do not only amplify environmental discourses from rich countries, but also that they in many ways serve strategic interests of rich nations. Environmental policies of countries in Africa are largely dictated by developed nations, through various mechanisms including international conservation organisations, and tend to militate against the livelihoods of poor communities in developing countries. The chapter also points to potential pitfalls that may arise due to the wholesale adoption of these environmental policies. The chapter concludes proposing that sustainable solution to the current environmental crisis lies in beyond tinkering with bureaucratic details of developing countries and criminalising livelihoods of the poor. The root of the problem lies at the current pattern of production and consumption.

Keywords Sub-Saharan Africa · Environmental legislation · Green development · Green imperialism

Introduction

Sub-Saharan Africa seems to epitomise a region where all that can go wrong with humanity is converging. It combines conditions of both 'worst nature' and 'worst poverty'. While the former is represented in images of overgrazing and

P. Mkandawire (✉)
Department of Geography, Social Science Centre, The University of Western Ontario, London, ON, Canada N6A 5C2
e-mail: pmkandaw@uwo.ca

I.N. Luginaah, E.K. Yanful (eds.), *Environment and Health in Sub-Saharan Africa: Managing an Emerging Crisis*, DOI 10.1007/978-1-4020-9382-1_7,

desertification of dry lands, the latter is propagated in notions of social disintegration, desperation and ravages of HIV/AIDS (Panitch and Leys, 2006). This received wisdom has affinities with sensational representations of African governments as corrupt, collapsing and dysfunctional (Tandon, 2000; Reno, 1999), conveying a sense of place where misery is self-inflicted. While it is appropriate to maintain some degree of scepticism for discourses of African failure, would be misleading to deny or refute these allegations altogether. Evidence in support of these views is, unfortunately, abundant; yet in this chapter, dominant narratives that frame underlying causes of these problems as natural and internal to the region is replaced by a conception which considers that the socioeconomic and ecological landscape of sub-Saharan region cannot be accounted for independently of its place in the global political order. Historical analysis of development on the continent has revealed that the region's current state has not been arrived at entirely through separate evolution, but also because it has had prolonged and extended contact with outside societies (Rodney, 1972).

This chapter is not especially aimed at examining the validity of these negative narratives, although in some ways the discussion inevitably casts light on the realities hidden behind such populist generalisations. The chapter mainly concerns the existence and effectiveness of legislation and regulations relating to environmental management in the sub-Saharan region. However, the plethora of environmental laws and policies currently existing in the sub-Saharan region precludes the kind of analysis we attempt here. Consequently, what we seek to present relates to a selection of broad environmental themes and policies that generally shape the overall direction and content of environmental protection efforts in Africa. We attempt to use these policies as a lens for gaining insight into the effectiveness of environmental management efforts in the region.

However, merely narrating the efficacy of environmental policies in the region, or the extent to which governments have so far succeeded in pursuing these commitments would be analytically short of the mark. It reduces the analysis to a mechanical exercise of gauging progress against predetermined policy targets, while tacitly acknowledging that the policies in questions are socially and politically neutral. This chapter contests this assumption and seeks to perceive environmental policy as a terrain on which social and political power of various interest groups is played out. Human beings exist in a relationship with the environment; while human activity has an impress on nature, the environment also shapes human welfare (Forsyth, 2003). This implies that any deliberate policy intervention by the government that seeks to mediate the relationship between human beings and the environment cannot be politically neutral both in its intentions and outcomes. Consistent with this position, this chapter seeks to demonstrate that certain government efforts to regulate the environment may not only give rise to complex bureaucratic challenges, but also that such actions have a tendency to configure new regimes of rights, access and control over the natural resources that are often hostile to the poor. Using examples from selected countries, we seek to show how environmental management practices in the region reconfigure regimes of access and exclusion and how benefits flow relative to such entitlement shifts.

Historical Continuities in Environmental Policies in Sub-Sahara

The aim of this section is not to provide a comprehensive analysis of the history of environmentalism in the region. Concerns about human relationships with the environment have roots that run deep into medieval Europe, and have subsequently been shaped by global mercantile trade experiences and European imperial conquests of the last couple of centuries (Grove, 1990). As such analysis is complex and beyond the remit of this discussion, it would suffice to say that environmental regulation in the sub-Saharan region largely bears the imprint of colonialism. As it will be shown later, many key policies relating to environmental protection have largely been shaped by views which trace back to European imperialism in the region. But this is not incidental or only limited to this particular policy sector. Colonial imprints have also been manifest in other related social and economic sectors. For example, the current structure of land ownership in many countries in sub-Sahara tends to exhibit a pattern of inequality that has largely been in place since the colonial period (Moyo and Yeros, 2005).

Colonial interest in the conservation of African natural resources assumed material effect with the inception of the Society for Wild Life Preservation of the Wild and Fauna of the Empire (SPWFE) in London in 1903. One of the most critical and durable outcomes of this development was the enactment of strong hunting regulations, culminating into the establishment of game reserves across much of colonial Africa (MacKenzie, 1988). The dominant ideology informing this policy position was that Africans' hunting and gathering practices were largely destructive and presented a grave threat to the preservation of nature. While Europeans also engaged in hunting as a sport, it was widely understood that the visiting sportsman only killed discriminately, almost invariably a male trophy and only getting what satisfied him. On the other hand, the Europeans largely viewed the native hunter as a poacher who cared nothing about species and wanted as many animals as possible for meat and for barter (Hingston, 1931). These narratives were persuasive, and greatly helped to galvanise international support for conservation measures that largely supported the alienation of the natural resources from natives.

As prospects for decolonisation loomed soon after the Second World War, a number of national parks were established in colonial territories. The main aim was to ensure future protection of natural resources from exploitative tendencies of natives (Fitter and Scott, 1978). But as the poachers turned into gamekeepers, Europeans were nonetheless still concerned about the future of wildlife in the region. As a result the Europeans founded the 'Africa Special Project' in 1961 to ensure that the shift in locus of power ushered by the independence movement in Africa would not undermine the preservation of nature. The project was designed to persuade the new African leaders to embrace the utilitarian views of nature and stay the course of the colonial conservation policy (Holdgate, 1999). Educated by the very same imperial masters, and with their dreams of a 'developed Africa' embedded in visions of modernity (Weis, 2007), many of the African leaders had little difficulty inheriting these views and policies.

That conservation policy in the region would continue to bear the lasting signature of colonialism was evident in the 1968 Convention on Conservation of Nature and Natural Resources by the Organization of African Unity. Not only did the treaty ratify the colonial style of nature conservation, but it also served to bring new areas of the natural environment previously existing outside the control of the state under the forbearance of government. These other sectors included 'economic resources' of soil and water; the rationale was that these resources needed to be managed in accordance with 'scientific principles' and with 'due regard for the best interest of the people' (Adams, 2009). The catch here relates to whose environmental knowledge is considered 'scientific' and what happens of the rights, access and livelihoods of those whose practices are deemed unscientific and illegitimate. By embracing this approach, European views of nature and appropriate ways of conservation were securely encoded.

Notwithstanding the exclusive and racial character of colonial conservations policies, it is critical to understand that these efforts and views constituted an important factor in the development of the idea of sustainable development (Adams, 2009). International organisations such as International Congress for Preservation of Nature, the International Committee on Birds Protection and the American Committee for International Wildlife played a central role. After the Second World War, these efforts were augmented by the activities of the Swiss League for Protection of Nature, UNESCO's expansion of its remit to include conservation issues and the establishment of World Wildlife Fund in 1961 in London.

Although the idea of sustainable development was initially encoded in the *World Conservation Strategy (WCS)* in the early 1970 s, and later fed into the Brundt Report in 1987, and then in *Caring for the Earth* in 1991, it was at the 1992 Earth's Summit in Rio de Janeiro that the concept was theoretically more fully developed and articulated. This did not only help to move the question of sustainable development further up the policy agendas in sub-Saharan governments, but also served to provide a theoretically more coherent framework for packaging poverty and environment objectives in national development efforts. While the African Ministers Meeting on the Environment that was held in Durban in 1995 was a direct outcome of the Rio Summit, the Sustainable Development Summit of 2002 in Johannesburg symbolically brought sustainable development at the doorsteps of sub-Saharan Africa, and served to draw countries in the region further into the environmental movement (Adams, 2009). Strategically, this move ensured that environmental crisis also remains at the forefront of policy debates in a region largely preoccupied with the HIV/AIDS epidemic. The subsequent proliferation of environmental legislation and policies in many countries in the region can be seen as a testament of these efforts (Kakonge, 2006). Some of the key institutional changes in many African governments attributed to these efforts include establishment of environmental protection agencies, enactment of acts and laws, and the adoption of Environmental Impact Assessments (EIA). Generally, the adoption of EIA entailed a commitment to explicit and systematic analysis of environmental implications in activities, decisions, programmes and policies at different scales of social and economic development in the region.

Overview of Recent Legislation

The widespread enactment of environmental acts and laws that followed the Rio summit was aimed at providing a framework for implementation of national policies and programmes to deal with environmental challenges in sub-Saharan countries. For instance, Mozambique passed the Environmental Law in 1997 aimed at achieving rational use and management of environmental elements in order to promote the improvement in the quality of life of citizens and to conserve biodiversity and ecosystems. Zambia and Kenya also passed the Environmental Protection and Pollution Control Act, and the Environmental Control and Managements Act, respectively, in 1999. Their main objectives can be summarised as to regulate discharge of effluents, provide standards for disposal of industrial wastes and preserve natural resources and their misuse. Several other countries in the region made similar institutional provisions. This includes, but not limited to, Nigeria's enactment of the Environmental Impact Assessment Act in 1992, Ghana's Environmental Protection Act of 1994 and Republic of South Africa's publication of the White Paper in 1997. The White Paper in South Africa is tied to the country's Bill of Rights. It espouses that everyone has the right to an environment that is not harmful to their health or well-being, to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures. It also provides details on measures for preventing pollution and ecological degradation, promote conservation, and secure ecologically sustainable development and use of natural resources while promoting equitable economic and social development.

Tanzania, though somewhat a latecomer, had an environmental act in place in 2005. Other countries also incorporated environmental concerns in Bills of Rights of their respective constitutions. For example, Malawi included environmental issues in the constitutional amendment of 1994 in order to reflect the value that everyone has a right to healthy living and working environment with full recognition of the rights of future generations. Emphasis is on degradation of natural resources and the environment. In Ethiopia, the Environmental Protection Agency has also been formulated in order to provide standards, guidelines and monitoring mechanisms for the sustainable use and management of the country's ecosystems. It was also entrusted with the promotion of community based and ecosystem approach for improved livelihood and environmental protection. Virtually every country in the region has laid down a framework of some kind for guiding the policy and management of the environment, although the degree of thoroughness and emphasis may actually vary from one country to another.

Pattern of Convergence of Environmental Policy in the Region

The range of environmental issues, as covered by the above listing of legislations, is evidently quite broad. However, in general they include land degradation, access to good quality water and sanitation, environmental pollution, wildlife and biodiversity

loss, deteriorating aquatic systems, and deforestation and woodland loss, although emphasis varies between countries.

Environmental laws, especially those concerning environmental exposure and pollution, are relatively new and the majority of them have been developed over the past two decades. The proliferation of various legislations within a short span of time raises the question of whether sufficient time was allowed to conduct country-specific analyses to inform these laws and policies. It appears that to a great extent, these policies and strategies evolved in the context of theoretically rather than data-driven environmental analyses (Niemeijer, 2002; Kakonge, 2006). It is important to note, nonetheless, that even if ample time was allowed, many countries in the region do not have the requisite capacity to conduct such complex epidemiologic studies (such as environmental exposure investigations to determine carcinogenic or toxicity of substances) that form the basis of these environmental exposure policies. It is less surprising, therefore, that environmental regulations adopted largely amplify particular environmental discourses earlier generated by the rich nations of the North (Jasanoff, 1991).

Current legislation on environmental exposure in the region largely exhibits a particular pattern of convergence. For example, almost all countries have passed legislation to minimise or eliminate altogether both industrial and domestic use of a wide range of substances including dioxins, polychlorinated biphenyls (PCBs), hexachlorobenzene (HCBs) and persistent organic pollutants (DiGangi et al., 2005). Regulation of these substances followed the IPEN Arusha Declaration on the elimination of (POPs) in African in 2002. Outlawing use of these products is premised on their alleged potency for human toxicity and carcinogenicity.

The tendency for international convergence of environmental policy is not unique to the region. Jasanoff (1991) argues that the convergence can be explained by the fact that scientific findings tend to trigger similar political demands across international boundaries. Similarly, economic reasons related to expediency and economies of scale tend to result in similar product specifications. Further, bureaucratic (especially limitations in financial and human resources) as well as political factors (mass communication facilitate similar expectations) tend to push environmental risk management decisions towards convergence across national boundaries (Jasanoff, 1991). Therefore, while we observe that countries in sub-Saharan Africa prefer natural resource management regimes that favour enclosing natural resources, we also observe a tendency for national states in the region to adopt environmental exposure mitigation measures that simply amplify views of rich countries.

Perceived Efficacy of Current Legislation and Policy

Although a more thorough examination of the effectiveness of environmental legislations and policies in the region is beyond the scope of this chapter, even cursory skimming is rendered problematic largely because of lack of coherent data. But more importantly, it is because environmental issues are subjective, laden with

values and open contention. This means that a purely objective analysis may be not only difficult but also less desirable. Nonetheless, in the sub-Saharan region, evidence from existing literature seems to point to serious policy limitations. It is widely believed that there seems to be a general lack of political will largely because of competing demands and priorities in the region, especially in relation to HIV/AIDS and poverty. Shortage of resources to finance environmental assessments, to hire, retain and train qualified staff to implement environmental programmes, has resulted in dependence on short-term consultancy and expatriate support. Continued lack of public participation in critical stages of the process of formulating environmental legislation, and in the conduct of EIAs has served to erode trust, credibility and perceived fairness in environmental policy (Kakonge, 2006). Inadequate environmental monitoring and data have also been cited as a significant challenge in as far as it undermines credible execution of EIA and monitoring of the environmental outcomes.

Various studies conducted so far in the region seem to suggest that environmental policy and legislation has not delivered expected dividends. A study conducted on Msimbazi River in Dar es Salaam revealed an unacceptably high organic and nutrient concentration and indicator organisms (Mbuligwe, 2005), suggesting persistent human and aquatic exposure to adverse environment. Another study conducted in Ghana revealed that institutional constraints prevented community from active participation in environmental impact assessment processes (Appiah-Opoku, 2001), despite availability of legal provisions in the country's Environmental Protection Act. In Namibia, a study revealed that fiscal challenges were largely to blame for delayed formulation of the 1994 Water Resources Management Act and its legal framework (Bethune et al., 2005). In Kenya, municipal waste management challenges have been reported. These are mainly due to collapsed state of infrastructures. Accelerated urbanisation taking place in the country confounds the ability of the municipal council to provide safe and clean urban environment and present negative health consequences (Henry et al., 2006). Declining access to clean water, increased ownership of automobiles and unchecked industrial pollution in South Africa remain an important challenge for millions of metropolitan dwellers, despite the fact that the White Paper frames 'access to healthy environment' as a basic human right (Thomas et al., 2002). In West Africa, widespread noncompliance with existing legislation and regulation has led to the decay of the built environment in Nigeria, and is seriously undermining the health of urban dwellers (Ahianba et al., 2008). Similarly, rural communities in Malawi continue to 'encroach' into 'protected areas', and occupy land designated for game reserves and national parks (Moyo and Yeros, 2005). Likewise, Ghanaian rural communities are largely blamed for illegal logging and deforestation despite government efforts to preserve forests.

The foregoing selected cases suggest that while the existence of legislation and policies are necessary factors for promotion of healthy environment on the sub-Saharan region, they are not sufficient in themselves in checking and arresting environmental degradation. There is need to direct efforts towards addressing challenges that undermine implementation of environmental policies.

Two further areas deserve more serious consideration in the sub-Saharan region. Firstly, international environmental legislation and action on transboundary environmental pollution seems relatively weak and in some cases non-existent. With the exception of few cases such as the Okavango basin agreement among Namibia, Angola and Botswana and certain large-scale industrial and economic projects that cross national boundaries such as the 220 kV Mozambique–Malawi Hydro-Electric Project, much less attention seems to have been paid to rivers and lakes which span national boundaries. Secondly, the question of indoor ambient air pollution seems to have been given relatively low priority in environmental policy regulation in many countries in the region. Ambient air pollution has been linked to acute respiratory infections in a number of studies conducted around the world (WHO, 1992; Luginaah et al., 2005; Smith et al., 2000). Indoor exposure to particulate matter from combustion of bio-fuels such as wood, charcoal, agriculture residues, and dung pose persistent health risk and is particularly urgent matter given that 2 billion people in the developing countries rely on biomass as main source of fuel (WHO,1991; Ezzati and Kammen, 2002). Indoor air pollution needs be at the centre of environmental health legislation and policy, and the region should continue to explore avenues for clean and affordable sources of energy.

The Political Economy of Environmental Policy in the Region

In the preceding sections, we made an observation that environmental protection efforts in Africa are undermined by various challenges ranging from insufficient financing to human resource shortage and lack of public participation. We also noted that while natural resource conservation approaches in the region bear the legacy of colonialism, recent strategies on pollution and climate change generally seem like caricatures of western policies. It is evident, therefore, that Africa has been on the receiving end of global environmental policy and legislation. In essence, this trend is consistent with growing concerns that the sub-Saharan region has been turned into a preferred geographic region for global environmental mitigation efforts (Panitch and Leys, 2006). This begs the question of what accounts for this state of affairs. The question gains even more validity when examined in light of the fact that despite populist narratives that Africa is excessively degraded and overgrazed, the region still accounts for the highest proportion of land that is formally designated as ‘protected areas’ in the world. About 16% of land in the region is enclosed, followed by North America at 15% (Panitch and Leys, 2006). In some countries, including Malawi and Ghana, the percentage is even higher, estimated to be over 20% (Malawi Government, 2001; Moyo and Yeros, 2005). Coupled with this is that the region currently accounts for only a minute proportion of global carbon emissions compared to developed nations and industrialising countries such as India and China (Bond, 2005). It would seem therefore that with such an environmental record, sub-Saharan Africa would be able to secure a key place in the global environmental debate; as opposed to suffering a concatenation of negative environmental stereotypes.

However, this paradox gains coherence when the push for ecological legislation in the region is viewed in light of the existing global economic, social production and consumption order. Alongside examining the implications of some of the existing environmental policies, the following section also attempts to explore how these legislations sit with existing social and economic order.

The Legal Spectre

A close look at legislations and policies adopted by many countries in the region reveals preponderance of legal approach to environmental regulation and management. The legal hint is especially pervasive in policies related to environmental exposure. References have been made to reasons such as inappropriate legal frameworks and unavailability of environmental lawyers as some of the most critical issues that undermine successful environmental policy formulation and implementation in the sub-Saharan region (Kakonge, 2006). Legalistic and rational approaches to environmental management have great appeal in the region, and tend to resonate with notions of accountability and principles of democracy. However, countries should be cautious, and need also endeavour to give due consideration to potential ramifications of an overly legalistic approach to environmental management and protection. This is not only because environmental issues are value-laden, and therefore open to contention. But equally important is because there is still considerable degree of scientific uncertainty about the relationship between human environmental exposure and associate potential health outcomes (Burger, 1990; Coyle, 2004). For example, while conversion of wildlife habitat to farmland may be considered as environmental degradation, this action may represent better livelihood for a rural poor community such that the distinction between productive use and unsustainable exploitation may not be clear (Panitch and Leys, 2006). Environmental exposure presents particularly complex challenges. For example, scientific evidence linking exposure to many substances such as PCBs and cancer is still equivocal and inconclusive (Burger, 1990; Garvin and Eyles, 1997). Exposure outcomes are likely to be mediated by various cofactors such as latency and biologic determinants. Even if causal links were precisely discernible scientifically, widespread poor socioeconomic status in the region is likely to have a confounding effect on the findings, thereby rendering the evidence more open to dispute.

Negotiation and persuasion should also be considered an important part of the overall strategy for environmental regulations enforcement in the region. This is because even in science, consensus is rarely achieved through objective and empirical verification of facts, but largely by persuasion (Kuhn, 1986; Aronson, 1984; Jasanoff, 1987). It has been shown that regulatory science which provides the basis for policy formulation is more open to contestation than science conducted in academic settings (Jasanoff, 1995). This is not only because disciplinary norms that facilitate consensus are largely absent in public policy fraternity, but also that policy outcomes of regulatory science are often politically salient (Rushefsky, 1986).

Therefore, environmental regulation through adversarial confrontation, using the court of law, is likely to polarise differences between scientists in a dispute and harden positions thereby undermining negotiation and compromise. Lack of scientific certainty and consensus on specific pathways and mechanisms that link environmental exposure with specific health outcome provides and value-laden nature of environmental issues provide for subjective interpretation of scientific evidence, especially in a context where political and economic stakes are high. Protracted legal battles that followed the Love Canal toxic exposure should serve as reminder that scientific studies are not invulnerable to being infused with values and special interests (Brown, 1992; Ozonoff, 1994). Therefore, sub-Saharan countries need to endeavour to strike a balance between formal and combative legal approaches with informal and more reconciliatory strategies based on negotiation and cooperation to environmental regulation and management.

Enclosures and the Reconfiguration of Access and Control

Enclosure of natural resource spaces, including forests and wildlife enclaves, is arguably the most pervasive environmental policy in the sub-Saharan region (Adams, 2009). Under this policy, entire ecosystems are closed off and access of local people into the areas is either restricted or curtailed altogether. It has been observed that the World Bank (WB) and International Monetary Fund (IMF) Structural Adjustment Programmes (SAP) have largely contributed to the increase in the proportion of land that has been drawn into the category of 'protected areas' by an additional 63% (Panitch and Leys, 2006). Expansion of 'protected areas' has given rise to a spectre of the 'green corridor' from Cape to Cairo, that stretches from Kruger National Park in South Africa to East and North Africa. The enclosure of areas is increasingly becoming a desirable strategy for global environmental well-being. However, this policy also has the effect of reconstituting regimes of rights, access and control over natural resources in sub-Saharan Africa, producing new regimes of privilege and exclusion.

Most of the countries with the highest per capita carbon emissions are in the North. In order to regulate carbon effluence into the atmosphere the concept of carbon trading was mooted. In carbon trade, countries get certificates that assign a ceiling on the volume of carbon that they (or firms) can emit into the atmosphere. These coupons can also be sold to other countries which have a deficit or have overshot their carbon emission limit. While the strategy is obviously ingenious, the concept has fundamental problems. Firstly, it sidesteps the question of unsustainable production and excess consumption which are seen to be at the centre of the global climate change. Secondly, and more directly related to the sub-Saharan region, carbon trade is in large measure possible because of the existence of forest reserves in the South which act as carbon sinks. Sinks refer to forests, seas and plants that absorb carbon from the atmosphere. Essentially, the carbon trade implies the transformation of nature reserves, most of them located in the South, into commodities tradable in

stock markets in the North. The push for reforestation and the enclosure of more areas into 'protected areas' in the region gain logic when examined in this light. But enclosures often result in resettlement of entire villages and communities. The livelihood activities of local inhabitants such as fuel-wood, hunting, farming and gathering in these nature reserves are criminalised and disrupted (Moyo and Yeros, 2005). In Malawi, for example, the establishment national parks has uprooted communities and annihilated livelihoods of many poor families. In addition to loss of livelihoods, the policy has also led to growing hostility between the armed game rangers who guard these reserves and local inhabitants, exposing poor Malawians to the risk of injury, death and sometimes corruption.

Even where efforts have been made to incorporate communities in the management of these natural resources the results have been at best dismal. But in many cases these new natural resource management regimes and initiatives have created more confusion. In southern Malawi, for example, concept of community-based natural resource management has not only led to accelerated degradation of the environmental, but has also created new class of elites (forest committees) who largely operated as corrupt and unaccountable bureaucrats who have succeeded in alienating local communities from these resources (Zulu, 2008). In Mali, decentralisation of natural resource management has superimposed modern legal institutions on preexisting community institutions resulting in ambiguous relationships that seem to undermine both the authority of nascent local governments and the performance of customary institutions (Benjamin, 2008). South Africa provides an extreme example of how environmental protection reconfigures regimes of access and exclusion. Inequality of access to water resources in South Africa is more profound than inequality of access to land. Water use in Inkomati catchment area, for example, is largely dominated by established commercial agriculture and forestry, and by important environmental interests, including the Kruger National Park. In a country with national water Gini coefficient of 0.96, irrigated commercial agriculture in this region accounts for 57% of all water use, forestry plantations 11%, industrial use 10%, international treaty obligations (cross-frontier flows to Mozambique) 11%, urban water supply 6% and rural supply 2%. More recent estimates claim that the demand for water for irrigation may be as high as 83% (Woodhouse, 2008).

Kyoto's Clean Development Mechanism (CDM) in the Sub-Saharan Region

As earlier indicated, the sub-Saharan region suffers from widespread indoor air pollution from extensive use of biomass to meet energy needs of the majority of the poor. For example, less than 10% of households in Malawi are connected to electricity. Only 8% of households use electricity in Uganda, and about 10% of rural households use electricity in Nigeria. It appears, therefore, that the implementation of certain elements of the Clean Development Mechanism (CDM) of the

Kyoto protocol would serve to make countries in the region successfully switch from biomass to cleaner energy sources and reduce indoor air pollution. The Clean Development Initiative refers to projects involving investment in a developing country from a developed country in clean energy sectors such as power stations, wind power and forests (Panitch and Leys, 2006). The amount of resources invested under this initiative is subtracted from the country's carbon reduction obligation. Therefore the initiative acts as an incentive for countries to commit resources to the development of cleaner energy sources. Investments in power stations would enhance access to reliable and hygienic energy sources to the majority of the people on the continent. The irony though is that while sub-Saharan region remains attractive for reforestation projects, it is apparently not viable for these other types of CDM investment such as power stations and wind power. Industrialising countries such as India, Mexico and Brazil are preferred instead.

Balance of Power Between International Capital and Sub-Saharan Governments

The issue of environmental regulation in the sub-Saharan region is also closely related to international capital. The volume of economic activities related to international capital in the region remains substantial, despite claims that the region has been bypassed by globalisation. For example, the continent continues to attract significant international capital into oil and mineral-rich sectors in countries such as Nigeria, Sudan, Angola, and the Democratic Republic of the Congo – many of them conflict riddled (Ferguson, 2005; Bond, 2005). Further, the global economy sources over half of its supply of diamonds, platinum, cobalt and chromium and more than a third of its requirements of other minerals from Africa (Taylor et al., 2006). The region also remains a major supply line for timber for other regions.

The relative strength of international capital vis-à-vis governments in the region has come under spotlight. A relatively more detailed account of how corporate–government nexus bears on the environment is provided in the chapter 'The Future of Environmental Degradation in the Region'. Such concerns have greatly increased in the face practices which favour the relocation of production activities with serious negative social and environmental effects to offshore territories mostly located in the South (Adams, 2009). The existence of weak regulatory framework in many countries in the South serves as an important factor in spatial location decisions of these toxic facilities. As rights to exploit natural resources in the region are granted to corporations, local communities suffer multiple effects. These communities tend to lose access and use of resources often without provisions for alternative livelihoods; promises of jobs and social amenities are rarely honoured. While the benefits from exploitation of these resources tend to accrue globally environmental costs are largely borne by local inhabitants. These negative externalities take many forms and shapes including polluted water sources, air pollution, loss of access to water sources due to rechannelling of rivers, diseases, disfigured landscapes and

loss of farmland. In Ghana, for example, connivance between chiefs and government to expropriate land for corporate plantation agriculture is often framed as in the 'national interest' and poor farmers are promised jobs, roads, electricity and houses (Moyo and Yeros, 2005). While compensation for loss of livelihoods is often out of question, resistance to eviction by poor communities is usually met with draconian response from the government. Corporations themselves inflict violence on native populations who contest occupation of their lands as many of these companies also tend to be highly militarised (Bond, 2005). The policy of game parks as guarded enclaves is evident in much internationally celebrated Serengeti National Park in Tanzania. The shoot-to-kill policies against poachers, who are often simply the local people who lost their rights to ancestral land when they were forcefully evicted to create game park, saw the shooting to death of some 50 famine-stricken villagers who entered the park in search of small game (Neumann, 2001).

The provisions of the World Trade Organization Trade Related Investment Measures Agreement (TRIMS) only serve to make an already bad situation worse. TRIPS compound environmental regulation efforts in the region by tilting the balance of power in favour of multinational corporations. Basically, TRIMS prohibit WTO member countries from making the approval of investment conditional on compliance with laws, policies or administrative regulations that favoured domestic products (Khor, 2001). Coupled with this is their superior financial prowess. In reality these international companies function beyond the control of weak governments in the region and tend to conduct their corporate operations outside national environmental regulatory framework. The increasing subservience of governments to these corporations is evident from tax breaks and rebates that are often granted to these business interests. The ability of international corporations to extort tax holidays and evade tax obligations in host countries through mechanisms such as transfer pricing constitute new forms of accumulation (Bond, 2005). Corruption and influence peddling have become essential levers in business contracts negotiations. Motivated by the need to maximise profits, their activities tend to have little regard for the environment. The overall economic and social benefits to host countries are usually tenuous (SAPRIN, 2004).

Conclusions

In this chapter, the question that runs through the entire discussion is whether durable solutions to the current environmental crisis lie in fiddling with technologies and tinkering with bureaucratic details in the sub-Saharan region. We have attempted to survey broad areas of environmental policy in the sub-Saharan region and sought to technically examine their efficacy. A quick survey reveals that financial and human resources are some of the key challenges that present major constraints in meeting environmental protection commitments. But more importantly, we have attempted to demonstrate that many key environmental policies pursued by governments in the Sub-Saharan region are infused with interests of industrialized nations. These objectives are often pursued at the expense of poor

communities. New regimes of access and control that emerge from implementation of environmental policy tend to reward international capital and penalise natives. Thus, while environmentally deleterious practices of corporations remain unchecked, poor communities often face state violence when they attempt to assert their rights to livelihoods. This analysis does not purport to present environmental conservation efforts of governments and non-governmental organisations as deserving of condemnation. Much of the work that is carried out by these actors is valuable. But a close look at environmental conservation practice seems to tell us more about how 'other' interests are forged and encoded in these legislations, and how the sub-Saharan Africa region and the contemporary global world are interconnected. This helps us to understand how new regimes of access and exclusion are configured, and how benefits flow relative to the resulting changes in entitlement patterns.

It is also apparent that the ultimate solution to the ecological crisis lies beyond passing legislation about nature reserves, criminalising livelihoods of the poor and the discursive re-invention of the socioecological landscape of the sub-Saharan Africa. On the contrary, environmental policies that exacerbate poverty serve to undermine the very goal of sustainable development as evident from unsustainable use of natural resources by poverty-stricken peasants in the region. Tinkering with bureaucratic details of African governments only constitutes a strategic detour because lasting solutions to the problem of climate change seem to depend on the global political will to revisit the existing mode of production and patterns of consumption.

References

Adams, W. (2009) *Green Development: Environment and Sustainability in a Developing World*. London: Routledge.

Ahianba, J. et al. (2008) Built Environment Decay and Urban Health in Nigeria. *Journal of Human Ecology* 23(3): 259–265.

Appiah-Opoku, S. (2001) Environmental Impact Assessment in Developing Countries: The Case of Ghana. *Environmental Impact Assessment Review* 21: 59–71.

Aronson, N. (1984) *Studies in the Sociology of Social Problems*. Norwood: Ablex Publishing Corporation.

Benjamin, C. (2008) Legal Pluralism and Decentralization: Natural Resource Management in Mali. *World Development* 36(11): 2255–2276.

Bethune, S. et al. (2005) Review of Namibian Legislation and Policies Pertinent to Environmental Flows, *Physics and Chemistry of the Earth*, 30: 894–902.

Bond, P. (2005) *Looting Africa: The Economics of Exploitation*. London: Zed Books.

Brown, P. (1992) Popular Epidemiology and Toxic Waste Continuation: Lay and Professional Ways of Knowing. *Journal of Health and Social Behaviour* 33(3), 267–281.

Burger, E. J. (1990) Health as a Surrogate for the Environment. *Daedelus* 114(4): 133–153.

Coyle, Y. M. (2004) The Effect of Environment on Breast Cancer Risk. *Breast Cancer Research and Treatment* 84: 273–288.

DiGangi, J. et al. (2005) *The Egg Report: Keep the Promise Eliminate POP*. Working Group of the International POPs Elimination Network (IPEN).

Ezzati, M. and Kammen, D. (2002) The Health Impacts of Exposure to Indoor Air Pollution from Solid Fuels in Developing Countries: Knowledge, Gaps, and Data Needs. *Environmental Health Perspectives* 110: 1057–1068.

Ferguson, J. (2005) Seeing Like an Oil Company: Space, Security, and global Capital in Neoliberal Africa. *American Anthropologist* 107(3): 377–382.
Fitter, R. and Scott, P. (1978) *The Penitent Butchers: The Fauna Preservation Society, 1903–1978*. London: Collins.
Forsyth, T. (2003) *Critical Political Ecology: The Politics of Environmental Science.* New York: Routledge.
Garvin, G. and Eyles, J. (1997) The Sun Safety Metanarrative: Translating Science into Public Health Discourse. *Policy Sciences* 30: 47–70.
Grove, R. (1990) The Origins of Environmentalism. *Nature* 345(6270): 11–14.
Henry, R. et al. (2006) Municipal Solid Waste Management Challenges in Developing Countries: Kenyan Case Study. *Waste Management* 26: 92–100.
Hingston, R. (1931) Proposed British National Parks for Africa. *Geographical Journal* 77: 401–428.
Holdgate, M. (1999) *The Green Web: A Union for World Conservation*. London: Earthscan.
Jasanoff, S. (1987) Contested Boundaries in Policy Relevant Science. *Social Studies of Science* 17: 195–230.
Jasanoff, S. (1991) Cross-National Differences in Policy Implementation. *Evaluation Review* 15: 103–119.
Jasanoff, S. (1995) Procedural Choices in Regulatory Science. *Technology in Society* 17(3): 279–293.
Kakonge, J. (2006) *Environmental Planning in Sub-Saharan Africa: Environmental Impact Assessment at the Crossroads*. Working Paper No. 9.
Khor, M. (2001) *Rethinking Globalization: Critical Issues and Policy Choices*. London: Zed.
Kuhn, T. (1986) *The Structure of Scientific Revolution*. Chicago: University of Chicago Press.
Luginaah, I. N. et al. (2005) Association of Ambient Air Pollution with Respiratory Hospitalization in a Government-Designated "Area of Concern": The Case of Windsor, Ontario. *Environmental Health Perspectives* 113(3): 290–296.
MacKenzie, J. (1988) *The Empire of Nature: Hunting, Conservation and British Imperialism*. Manchester: Manchester University Press.
Malawi Government (2001) *Malawi National Land Policy*. Lilongwe: Malawi Government.
Mbuligwe, S. (2005) Comparative Treatment of Dye-Rich Wastewater in Engineered Wetland Systems (EWSs) Vegetated with Different Plants. *Water Research* 39(3): 271–280.
Moyo, S. and Yeros, P. (eds.) (2005) *Reclaiming the Land: The Resurgence of Rural Movements in Africa, Asian and Latin America*. London: Zed Books.
Neumann, P. (2001) Disciplining Peasants in Tanzania: From State Violence to Self-Surveillance in Wildlife Conservation. In *Violent Environments*, Nancy Peluso and Michael Watts (eds.) Ithaca: Cornell University Press.
Niemeijer, D. (2002) Developing Indicators for Environmental Policy: Data-Driven or Theory-Driven by Example. *Environmental Science and Policy* 5: 91–103.
Ozonoff, D. (1994) Conceptions and Misconceptions About Human Health Impact Analysis. *Environmental Impact Assessment Review* 14: 499–515.
Panitch, L. and Leys, C. (eds.) (2006) *Coming Terms with Nature: Socialist Register*. Monmouth: The Merlin Press.
Reno, W. (1999) *World Politics and African States*. Boulder: Lynne Rienner Publishers.
Rodney, W. (1972) *How Europe Underdeveloped Africa*. London: Bogle-L'Ouverture Publications.
Rushefsky, M. (1986) *Making Cancer Policy*. New York: SUNY Press.
SAPRIN (Structural Adjustment Participatory Review International Network) (2004) Structural Adjustment, Poverty and Inequality (Chapter 9). In: *Structural Adjustment: The SAPRIN Report*. London: Zed Books, pp. 203–225.
Smith, K. et al. (2000) Indoor Air Pollution in Developing Countries and Acute Lower Respiratory Infections in Children. *Thorax* 55: 518–532.
Tandon, Y. (2000) *Globalization and the Post-Colonial African State*. Harare: AAPS Books.
Taylor, L. et al. (2006) *World Mineral Production, 2000–2004*. Nottingham: British Geographical Society.

Thomas, E. et al. (2002) Environmental Health Challenges in South Africa: Policy Lessons from Case Studies. *Health and Place* 8: 251–261.

Weis, T. (2007) *The Global Food Economy: The Battle for the Future of Farming*. London and New York: Zed Books.

Woodhouse, P. (2008) *Water Rights in South Africa: Insights from Legislative Reform*. Brookes World Poverty Institute Working Paper.

World Health Organization (1991) *Epidemiological, Social, and Technical Aspects of Indoor Air Pollution from Biomass Fuel: Report of a WHO Consultation*, WHO/PEP/92.3A. Geneva: World Health Organization.

World Health Organization/United Nations Environment Program (WHO/UNEP) (1992) *Urban Air Pollution in Megacities of the World*. Oxford: Blackwell.

Zulu, C. (2008) Community Forest Management in Southern Malawi: Solution or Part of the Problem? *Society and Natural Resources* 21(8): 687–703.

The Impact of Industrial Clusters in Greening Manufacturing Industry Practices: The Case of the Old Ardbennie Industrial Cluster in Harare, Zimbabwe

Charles Mbohwa and Peter Rwakatiwana

Abstract Industrial clustering can be used to improve the impact of green manufacturing practices in industry by enabling reduced energy and water consumption levels, solid waste and wastewater minimisation strategies and enabling increased participation in corporate social responsibility activities. This chapter assesses the performance of the Old Ardbennie Industrial cluster in Harare, Zimbabwe. Levels of water and energy savings, solid waste minimisation, wastewater reduction and corporate social responsibility achievements by members of the cluster are determined through both questionnaire surveys and interviews, in addition to monitored data. An inference was also carried out using cross-tabulations to determine whether there is relationship between participating in cluster activities and achievement of targets. The results show that the cluster had 15.76% savings in water consumption. However, effluent management by cluster members was still poor with most companies using the municipality pipes for untreated effluent disposal. Potential for trading in waste was identified. Reduction in solid waste was 2.71% and no effective reduction in energy consumption was observed. In general, cross-tabulation results showed that a positive relationship existed between participation in cluster activities and achievement of green manufacturing.

Keywords Industrial clusters · Harare · Zimbabwe · Green manufacturing

Introduction

The industrial clustering concept has gained worldwide recognition as the impetus for the promotion of sustainable development (McCormic, 1998; Ketels, 2003). This is because of its potential to develop environmentally conscious enterprises that result in increased competitiveness on the global market. Industrial clustering encompasses full integration of manufacturing operations through the value chain to

C. Mbohwa (✉)
Fulbright Scholar, The Supply Chain and Logistics Institute, Atlanta, GA 30332-0205, USA

I.N. Luginaah, E.K. Yanful (eds.), *Environment and Health in Sub-Saharan Africa: Managing an Emerging Crisis*, DOI 10.1007/978-1-4020-9382-1_8,

enhance industrial linkages, increase productivity and competitiveness (Helmsing, 2001). There has been an emergence of environmentally focused industrial clusters in Zimbabwe established in the years 2003 and 2004 (Kativu and Matayaunga, 2005; Chenga, 2004). The need to share knowledge, resources and experiences (through networking) as a way of survival in the unpredictable economic environment resulted in industries voluntarily, teaming up to form clusters to tackle the imminent challenges (UNIDO, 2006; Schmitz, 1995; Barton Group, 2005). Clusters emerge as a result of the need for a framework to deal with the increasing complexity of today's competitive and rapidly changing business environment (Mbohwa, 2006). This framework can only be achieved through collaboration that creates value for firms by providing them with the four main drivers i.e. critical mass, sharing and grouping of competencies, integration of learning and social capital (Barton Group, 2005). The study of clusters is therefore important in that they promote institutional approach to corporate learning, which is more sustainable than individual approaches (Fisher and Reuber, 2000; Green et al., 2001; UNIDO, 2006). Among the issues that are of relevance to Zimbabwe's existing clusters is the concept of sustainable development. Environment Africa played a pivotal role in setting up these clusters in Harare with the aim of raising awareness among industries on the importance of protecting the environment in which they operate (Environment Africa, 2005). The industrial clusters in Zimbabwe consist of groupings of industry in a given locality teaming up to voluntary network, pool resources together share best practices in areas like environmental management, energy conservation, water conservation and waste management. Thus the clusters are formed to promote the adoption of clean technologies that both prevent pollution and reduce production costs (Blackman and Kildegaard, 2003). The Old Ardbennie cluster, which is the subject of this study is championed by a company called Cairns Foods and was started in August 2003, with Cairns Foods providing the Secretariat.

The need for manufacturing industries to join hands and try to minimise environmental damage has been well documented (Blackman and Kildegaard, 2003). This is so because the management of waste and the reduction of its generation are gaining momentum worldwide as a result of the continued decrease in availability of landfill sites and the challenging desire for a pollution-free environment (Ball and Blight, 1986; Otieno, 1992). According to Kouts (1984) landfilling has become both very costly and environmentally unacceptable and thus there is a need for industries to devise ways of minimising waste. The increased environmental awareness during the last few years coupled with the realisation that a cleaner and a better protected environment supports a higher standard of living has coerced many governments and municipalities to draft more stringent environmental laws, some of which have a direct impact on industries (Otieno, 1992). Although these regulatory policies were put in place to prevent careless and uncontrolled dumping of waste, they have not yielded positive results and many municipalities in developing countries still face the problem of indiscriminate dumping of waste (Mbohwa, 2006; Blackman and Kildegaard, 2003; Otieno, 1992). Clusters promote accelerated adoption of cleaner technologies and voluntary participation and self-regulation. Although the cluster concept seems to offer positive results for the environment, controversial debates

on its capability are still raging on. Ketels (2003) mentions that some critics of this concept say it cannot be applied to situations that have little resemblance to the original framework.

The major obstacle cited for the persistence of environmental problems is the lack of finance. Clusters have been proven to be effective in disseminating information and encouraging voluntary adoption of clean technologies (Blackman and Kildegaard, 2003). They can overcome the problem of funding through pooling of resources. They also provide an 'information-rich' environment with specialised labour pools that help in knowledge diffusion and capacity building (Barton Group, 2005; Fisher and Reuber, 2000; Helmsing, 2001; Kim et al., 2000). There is a need to see if there is any positive contribution that industrial clustering poses to crucial development issues apart from its well-known potential to provide a sound economic growth for both the industry and the nation at large (Kim et al., 2000; Green et al., 2001). The performance of industrial clustering in improving green manufacturing practices in addition to the competitive advantages that it comes with has to be examined for the existing cluster. Industrial clusters are gaining widespread recognition as an important tool for waste minimisation, especially under the concept of industrial ecosystems, where one enterprise's waste becomes another's raw material, generating the most important waste trade links (Yap, 1999). The assessment becomes more important when one considers arguments by Blackman and Kildegaard (2003) that geographically clustered industries create severe environmental problems, citing the example of emissions of particulate matter from a cluster of 350 small-scale brick kilns in Mexico that is said to be causing premature mortality through respiratory illness.

In Zimbabwe no study has been carried out to see whether the cluster concept is impacting positively or negatively to both the environment and the companies involved, even though the concept had already been adopted by some industries. In addition, information on how best to implement the environmental cluster concept under an unfavourable economic environment such as the one prevailing in Zimbabwe is inadequate. There might be a need to develop a focused cluster-based model and avoid the pitfalls of enormous publicity that befell the woodworking industrial cluster in Brazil, when most industries adopted it before grasping the real concepts (Fisher and Reuber, 2000). The City of Harare and many other towns of Zimbabwe have been facing many economic and health problems that can be traced back to the environment with little or no doubt at all (Chenga, 2004; Nhapi and Hoko, 2002). The City of Harare, Ministry of Environment and Tourism and other regulatory bodies have also been facing serious inadequacies as to how to enforce their regulations. This study therefore is a first attempt in scientifically reviewing the performance of the existing clusters before wide-scale adoption in Africa. Furthermore, the study becomes more important when one considers concerns raised by Ahern (1993) that clusters may result in firms losing proprietary information, ability to compete effectively due to dependence on partner for certain funds and that small firms may become targets for takeover by their large partners. It is, therefore, important to assess how clustering can be used to find collective solutions to the adverse effects of industrial development on the environment. The more specific objectives of this study are

- To determine the level of water and energy savings achieved as a result of industrial clustering.
- To determine any improvement in performance achieved on environmental impact due to the implementation of industrial cluster initiatives.
- To determine the levels of waste minimisation attained as a result of advocating for good waste management from cluster participation.
- To determine the level of corporate social responsibility achieved as a result of networking in industrial clusters.

Research Methods

The geographical location of the Ardbennie cluster is shown in Fig. 1 showing the location of the clusters relative to the water bodies, Lake Chivero and Lake Manyame, which supply the cities of Harare and Chitungwiza with water. The study population consisted of all 16 companies that are members of the cluster. Allowing all willing members of the cluster to participate in the survey minimised the element of bias. The study looked at the collective effort of the companies involved in the cluster and how far they have gone in achieving their objectives in terms of protecting the environment and other sustainability performance areas. A questionnaire with both open-ended and closed-ended questions was used in this study. The performance study also depended on collecting monitored data that was gathered over a period of 2 years by some of the companies since their inclusion in the cluster. Information gathering involved visiting and holding conducting interviews at secondary sources such as Environment Africa, Scientific and Industrial Research and Development Centre (SIRDC), Harare City Council and the Zimbabwe National Water Authority (ZINWA), Zimbabwe Institution of Engineers (ZIE) and Institute of Environmental Studies (IES). To familiarise with the members of the cluster and their activities, attendance to cluster meetings, seminars and special occasions was done. This had the advantage of acting as the basis of establishing the cluster's common ground information and its objectives (Pratt and Loizos, 1992). Such information usually related to organisational structure of the cluster, solid waste management, air pollution and effluent disposal methods. Participant observations were also used to obtain information on the cluster's activities and in identifying areas for improvement. This was a very useful method of checking information from the surveys, especially on those aspects of the environment, which both the workforce and the management would avoid discussing openly in an interview. An attempt was made during the entire fieldwork to have frequent interactions with cluster members for informal and formal information collection.

Pratt and Loizos (1992) as well as Oppenheim (1996) contend that detailed surveys are an essential part in order to sharpen the research focus; hence, they are the main tool used in this study. A questionnaire with both open-ended and closed-ended questions was designed, as distinct from a more structured one, to give as much room as possible to accommodate the respondent's ideas. Open-ended questions serve the purpose of disclosing the system of knowledge and structuring of

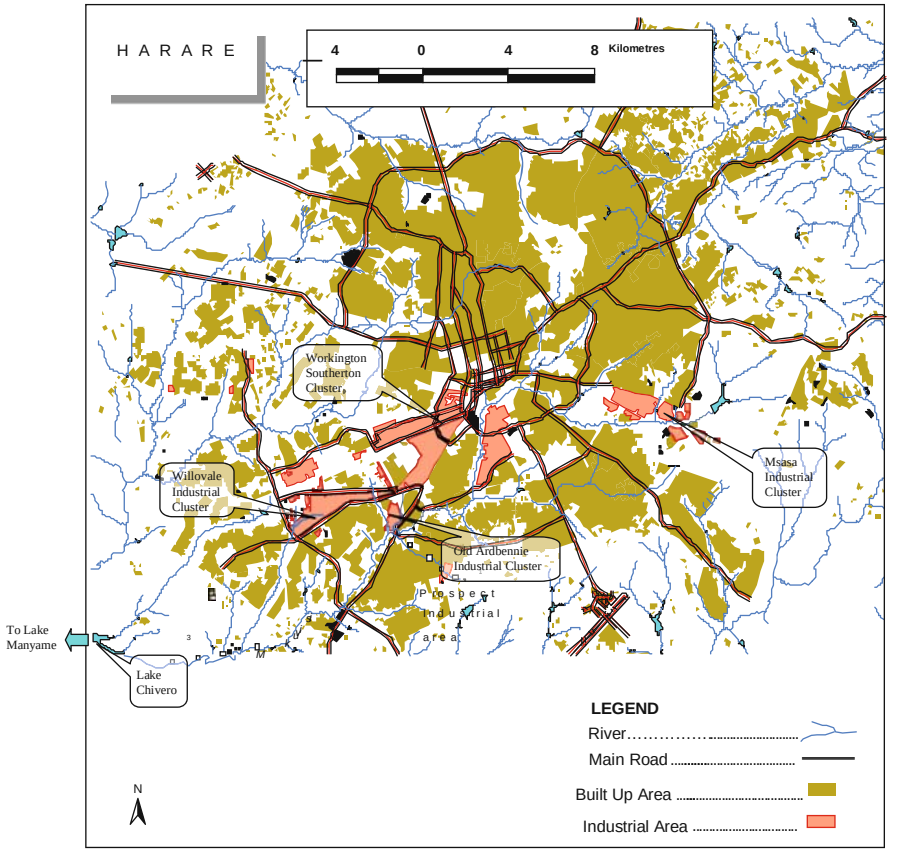

Fig. 1 A GIS map of the study area

ideas central to the respondent's own views of the world. Prior to the actual survey, the questionnaire was pre-tested using two members, in order to refine the questions. The design of the questionnaire was such that it enables the researcher to capture information on following key areas: reduction in energy consumption; water savings achieved; waste treatment and management practices (achievements in waste reduction); pollution prevention activities currently in place; corporate social responsibility activities; monitoring activities in place; and compliance to regulation before and after carrying out the cluster initiatives. Highly flexible interviews involving key informants in the companies were carried out. Flexible interviews were used because questionnaires alone are not the best method for gathering information about private or otherwise sensitive matters. Flexible interviews were also used in combination with the questionnaires in a bid to improve response rates. A key informant in this study was someone who had in-depth knowledge on environment, cleaner production and industrial clustering. Observational data including notes on non-verbal communication were recorded during the interviews.

The SPSS 10.0 statistical package for Windows was used to analyse the data. Data were entered in the narrative form and figures as well as tabulations and cross-tabulations to establish emerging relationships were produced. To aid in summarising, describing and interpreting the findings, the data were subjected to various statistical computations. For quick manipulation of the data, frequency tables were drawn. Then the bar charts and pie charts were chosen as distribution pattern graphs. The bar chart was chosen since it is the best form of diagram for discrete variates such as those that were obtained from the survey responses (Clarke, 1982). First, the data was tested for normality using the One-Sample Kolmogorov–Smirnov test.

The One-Sample Kolmogorov–Smirnov test was chosen because it is appropriate for independent observations constituting a random sample from some unknown distribution function $F(x)$ such as the one presented in this study (Daniel, 1990). In addition, the One-Sample Kolmogorov–Smirnov test with discrete distribution was used because it is said to be applicable for sample sizes less than 30, although it is said to be more conservative for sample sizes greater than 30. The value of the Kolmogorov–Smirnov (Z) is based on the largest absolute difference between the observed and the theoretical cumulative distributions.

The test statistic that was used in this study is given by

$$Z = \underset{x}{Sup} \left| S\left(x\right) - F_0\left(x\right) \right|$$

where $S(x) =$ the proportion of sample observations less than or equal to x; $F_0(x) =$ the probability that the value of the random variable X is less than or equal to x, that is, $F(x) = P(X \leq x)$.

Nonparametric statistical procedures were then used to analyse the data based on the fact that the observed response data showed mixed distribution (both normal and not normal). The nonparametric methods were chosen because they do not depend on the validity of rigid assumptions as in the case of parametric procedures (Daniel, 1990; Clarke, 1982). Furthermore, nonparametric procedures were chosen on the basis that they depend on minimum assumptions and their applicability on count data. The chi-square test was also chosen to test the hypothesis based on medians rather than means because the study sample was not large. To test for independence of achievement of targets and other variables to participation in cluster activities, cross-tabulations with chi-square test were done for a number of variables. The chi-square test was used to test for association of variables. The chi-square test for independence was chosen on the basis that data consisted of a random sample since it depended on the willingness of cluster members to respond and that the observations can be cross-classified. In addition, the chi-square was chosen because the variables were assumed to be inherently categorical. The test statistic used expected cell frequency obtained by multiplying appropriate row and column totals and dividing the product by the total sample size. The test statistic that was used is

$$\chi^2 = \sum_{i=1}^{r} \sum_{j=1}^{c} \left[\frac{\left(O_{ij} - E_{ij}\right)^2}{E_{ij}} \right]$$

where X^2 = chi-square; r = number of rows in the contingency table; c = number of columns in the contingency table; O_{ij} = observed cell frequency; E_{ij} = expected cell frequency.

To investigate the presence of an association between cluster activities and achievement of green manufacturing, Cramér's statistic (V) was used because it is appropriate for two categorical variables yielding frequency data that may be displayed in contingency tables of any size (Daniel, 1990). The Cramér's coefficient used in this study is given by

$$V = \sqrt{\frac{\chi^2}{n\,(t-1)}}$$

where: X^2 = chi-square statistic; n = total sample size; t = either the number of rows or the number of columns in the contingency table, whichever is smaller.

Results and Analysis: Old Ardbennie Cluster

Data analysis was mainly hinged on determining the percentage levels of water conservation, energy conservation, minimisation of wastewater, solid waste reduction and participation in corporate social responsibility activities due to clustering.

Water Conservation

The survey results for Old Ardbennie cluster showed that 12.5% of the members were facing critical water shortages and thus the need to conserve the little amount of water that may be available. However, out of those facing critical water shortages, 16.7% said they managed to overcome this problem as a result of their participation in cluster activities as shown in Fig. 2.

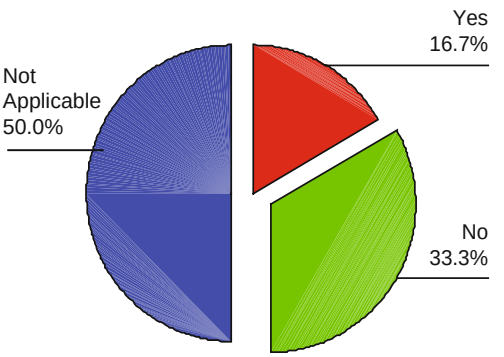

Fig. 2 Percentages of companies overcoming critical water shortages as a result of clustering (Old Ardbennie)

Apart from critical water shortages, 66.7% of the members said they managed to reduce water consumption due to clustering. The cluster as a whole managed to achieve average water saving of 15.8% which when translated to monetary value results in major economic savings. Some companies like Samburn Pressings that do not have any other environmental programmes (such as the ISO 14000 series) in place managed to reduce their water consumption by 20%. It can be concluded that water savings were directly linked to cluster activities. In an effort to reduce Harare City Council's water consumption some Old Ardbennie cluster members installed boreholes at their premises. Although this did not result in direct reduction in water consumption, it helped in relieving the pressure on the Harare City Council's provision of services. Some companies reduced water use through process re-engineering. For example, at Cairns Foods a reduction in flow rate during the slice rinsing process is used in conjunction with good housekeeping as well as timely repair of leaking pipes and taps to conserve water. It reduced its water consumption by 3.8% or about 570 m^3 of water per month. The volume of water savings can be increased by recruiting more members in the local area and encouraging all members to start or improve water conservation efforts.

Wastewater and Effluent Management

The results as illustrated by the graph in Fig. 3 show that most of the members dispose their effluent through municipality effluent pipes, a dangerous practice since the pH of the effluent is rarely checked and very few companies do effluent treatment before discharge.

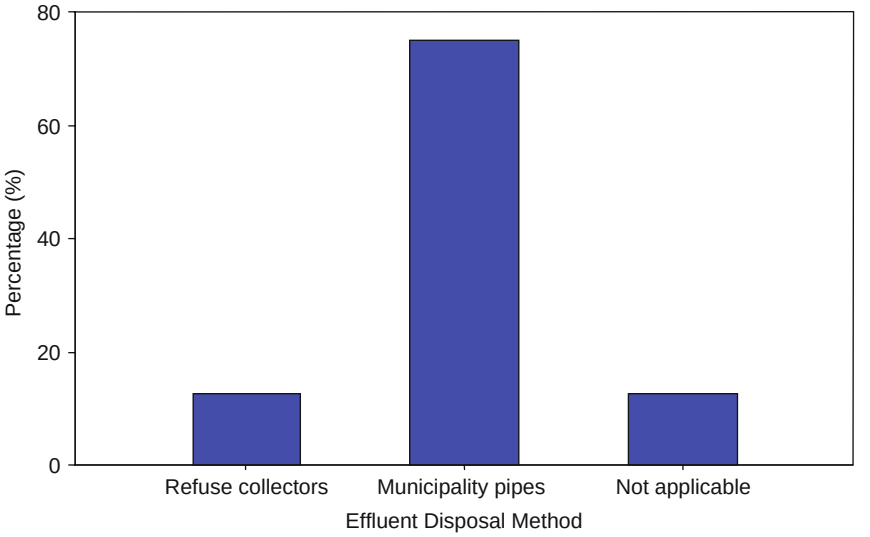

Fig. 3 Method of effluent disposal mainly used by companies in Old Ardbennie

The use of municipality effluent pipes can be attributed to the old corporate notion that 'the Municipality is solely responsible for the management of all waste produced'. A paradigm shift is required since Harare City Council is no longer copying with the collection of high amounts of waste that are being produced by industry. The results from the survey indicated that little is being done in terms of effluent management by the Old Ardbennie cluster. On average the cluster managed to reduce the level of wastewater by 2.88 and 50% of the members were not doing anything on their effluent. The survey results show that 37.5% of the members were influenced by their participation in the cluster to change their wastewater management practices. This is important because the Old Ardbennie cluster sits on Harare's water supply catchments. Cluster members are getting advice from Cairns Foods that has started some work on effluent recycling and treatment. Cairns Foods' compliance with limits after implementing good effluent management practices may serve as a motivator for other companies.

Solid Waste Management

The results of the effect of industrial clustering on solid waste management are shown in Fig. 4

About 57.1% could not distinguish the contribution of industrial clustering to solid waste minimisation from other efforts such as ISO 14001 and ISO 9000. Hence they declared partial contribution from clustering. On average the cluster is achieving 2.7% solid waste reduction per month with a maximum of 8% being realised by Cairns Foods. Solid waste management can also be improved through the adoption of waste trade links both within and outside the cluster. Nu Naks and Cairns Foods could sell or give their agricultural waste to Hamish Cameron for further processing into stock feeds. Steel Line, Waterflow and Samburn Pressings may combine their efforts to contract a large metal recycling plant or individuals to buy their scrap metal. Apart from selling their agricultural waste to Hamish Cameron, Cairns Foods and Nu Naks can open waste trade links with other stock feed manufacturers such as Agrifoods (Pvt.) Ltd. Proplastics may start waste trade links with Polywaste. Invicta Construction and Carrara Marbles may sell or give their rubble to the cluster

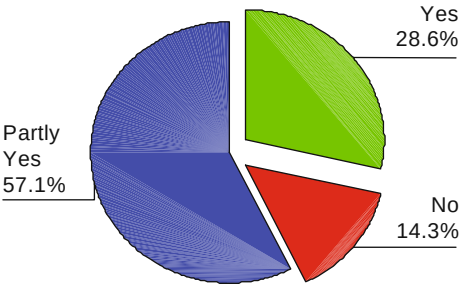

Fig. 4 Number achieving solid waste reduction due to cluster advice

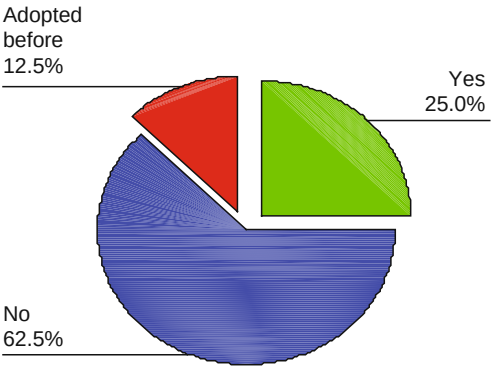

Fig. 5 Adoption waste separation practices due to participating in cluster

for pothole and pit filling activities. Bowline Furniture and Dunlop Zimbabwe, a tyre manufacturer may give their waste to Cairns Foods and Nu Naks to help in firing their boilers. Waste Away as a private company responsible for collecting waste may take the responsibility of disposing hazardous waste safely on behalf of other members. Currently 87.5% of the companies are involved in waste trade links in one way or another but there is a need to increase the amount of solid waste being used since on average only 50% of the waste is being used. The proceeds from the waste trade links may then be used to fund other environmental programmes. Less than 50% of the companies are using waste separation practices as shown in Fig. 5.

Energy Conservation

Survey results showed that 75% of the Old Ardbennie cluster members had faced critical power shortages before and hence the need to save energy. Of those facing critical power shortages none had managed to avert this problem through cluster activities, hence the need for the cluster to act collectively on energy conservation. However, the results also show that the cluster as a whole managed to achieve a reduced energy consumption of 4.25%. Results also showed that only 37.5% of the members managed to reduce energy consumption due to cluster initiatives.

Air Pollution

It was found out that there are no air pollution minimisation programmes in the cluster despite the fact that 60% of the respondents mentioned that they were complaining about air pollution from their neighbours. There is need for the cluster to start air pollution minimisation programmes so as to achieve green manufacturing.

Cluster's Corporate Social Responsibility Activities

About 62.5% of the members of the Old Ardbennie cluster had been actively participating in corporate social responsibility activities ever since they joined the cluster. Fifty per cent of the firms indicated that they realised an improved corporate image from their social responsibility efforts. Industrial clustering also helped in information dissemination through seminars and meetings. On average the Old Ardbennie cluster members hold two seminars (meetings) that deal with environmental issues per year. Increased environmental awareness through campaigns is helping in ensuring that industry achieves good corporate citizenry, a central tenet of sustainable development and green manufacturing. These campaigns are also luring non-members to the cluster and ensure that neighbouring residents participate in clean ups. A major social responsibility achievement for the Old Ardbennie cluster was the clean up of Mukuvisi river on the World Environment Day in 2003. Harare residents in Mbare are using the reclaimed areas for urban agriculture. The cluster assisted the City of Harare's Department of Works by providing a truck to ferry personnel and materials to repair potholes on the roads.

Cluster Challenges

Although members of the Ardbennie cluster are showing some commitment to improve their environmental performance by monitoring performance indicators and setting improvement targets, not much is being done on self-regulation and peer review. The results of the survey in Fig. 6 show that the greatest challenge that members are facing in trying to implement cluster initiatives is the mobilisation

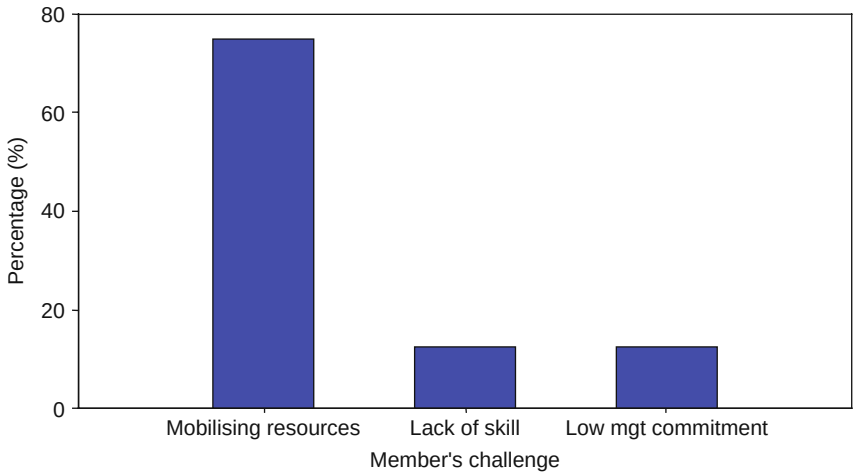

Fig. 6 Major individual challenges faced by Old Ardbennie cluster members

of resources. The challenge can be attributed to the fact that it is difficult to make a direct link between company profits and environmental improvements. However, improving the environment in which corporate company operates can contribute to corporate sustainability through the opening up of new green markets.

The results also show that lack of skills and technical know-how is one of the impediments to successful implementation of cluster initiatives by members hence a need for more education and training programmes. Another major issue was low commitment by some of the members. There has been inconsistent attendance at cluster meetings resulting in disruption of cluster activities. Few active companies attended almost all meetings. Attendance data showed an average of 14 appearances out of the possible 32 meetings. This slowed down the implementation of scheduled programmes. To increase the effectiveness of the cluster there is need for top management commitment to clustering and its activities.

The findings showed that most organisations have less than five members who are aware of the existence of the cluster as shown in Fig. 7. This was a major drawback when a change in position or organisation by a representative occurred. It also reflected low employee involvement.

Information dissemination about the cluster and its objectives is important. Most of the members (75%) cited increased environmental awareness as the major motive for joining the cluster.

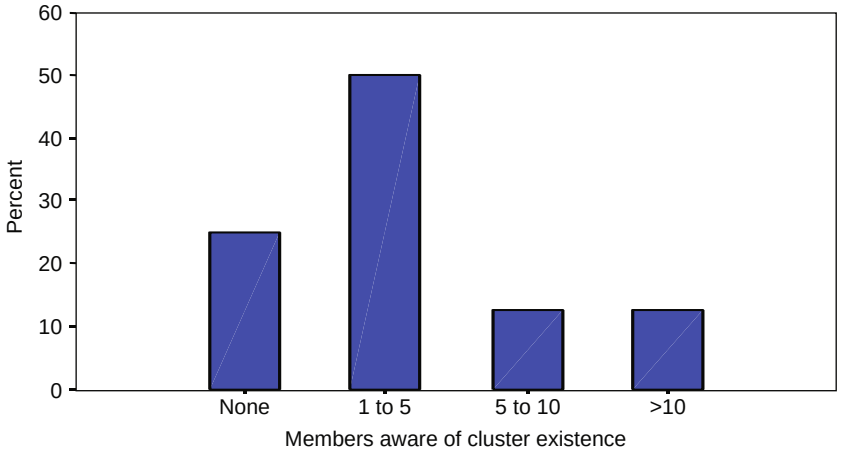

Fig. 7 Members aware of existence of the cluster – Old Ardbennie

Cluster Champion, Cairns Foods, Performance

On average Cairns Foods managed to reduce its water consumption by 17.53% per tonne of product between 2003 and 2005. Maximum water saving of 27% per tonne of product was achieved in the canning process through repairing of leakages and

process re-engineering. Absolute water usage was reduced from 189.7 Ml in 2003 to 111 Ml in 2005. This resulted in reduced water bills for the company lowering the production cost and leading to low-priced and competitive products. Coke usage was reduced by 38% per tonne of product leading to the conservation of this fossil fuel. A typical pattern of the company's monitored waste results is shown in Figs. 8 and 9. A 2% moving average trend line showed a continuous decline in waste over time. The company was in the process of implementing the ISO 14001 certified Environmental Management System (Cairns, 2004).

From the survey and interview results, it was deduced that the company is playing a pivotal role in corporate social responsibility activities. The company observed

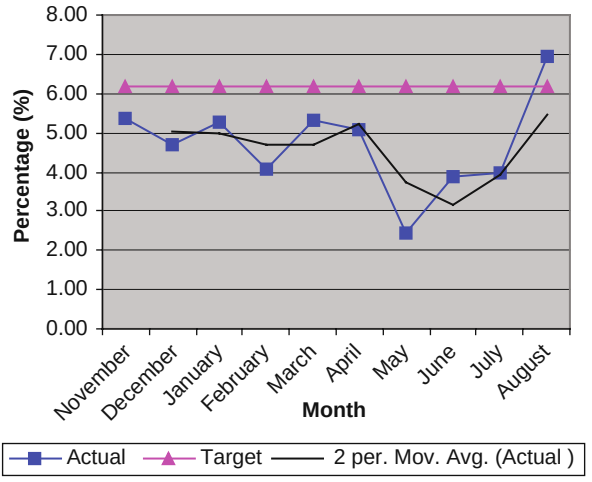

Fig. 8 Cairns Foods potato waste, November 2004–August 2005

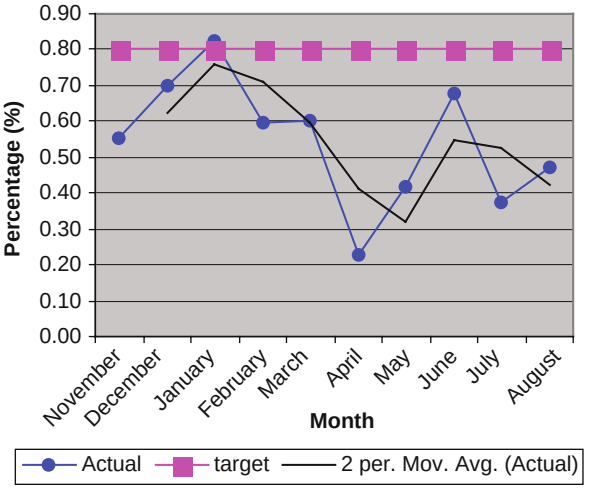

Fig. 9 Cairns Foods other food types waste, November 2004–August 2005

almost all important dates on the environmental calendar, particularly the Tree Planting Day, World Wetland Day, World Water Day and Clean Up Zimbabwe Campaign Day. On average the company held about eight seminars and workshops that deal with the environment every year. This may be attributed to the fact that the company seriously embarked on the ISO 14000 system implementation. While attaining ISO 9001:2000 and ISO 14001:2004 will enable Cairns to penetrate overseas markets, industrial clustering is also aiding to improve the company's relationship with stakeholders, such as the Harare City Council and its neighbours. Through sharing information with other cluster members and implementing chosen alternatives, the company was able to reduce the levels of solid waste by about 8% against its target of 5%, through reuse, recycling, process re-engineering and waste trade links. The achievements realised are in line with the concept of sustainable development. However, it is difficult to quantify with exactness how much clustering is contributing towards the company's bid to achieve the green manufacturing, but what is of notable importance is that industrial clustering has been shown to complement the ISO 14000 initiatives and to hasten the rate at which cleaner production is adopted within the company.

Concluding Statement

The cluster has achieved remarkable savings particularly in water (15.76%). Individual companies that have sound environmental management systems performed better than the whole cluster due to previous experience. Commitment and participation to cluster activities was low and was one of the major challenges for the cluster. Effluent management by cluster members is still poor with most companies using the municipality pipes for untreated effluent disposal. There is a potential for the cluster to reduce its solid waste through establishing waste trade links. Reduction in solid waste due to clustering was low (2.71%). Overall, the cluster has not been effective in reducing energy consumption. It was found out that clustering improved the corporate image of some members through participation in social responsibility activities. It can therefore be concluded that environmental clusters improve knowledge sharing, information dissemination, waste trade and optimal environmental improvement initiatives.

References

Ahern, R. (1993) Interfirm co-operation is an important form of economic interaction. *Environment and Planning A* 25(10): 1511–1526.

Ball, J.M., and Blight, G.E. (1986) Ground water pollution down-stream of a long-established sanitary landfill. *Municipal Engineer/Munisipale Ingenieur* 17(9): 17–24.

Barton Group (2005) *Collaboration and Mentoring to Access Market Opportunities*. Adelaide, South Australia. http://www.waterindustry.com.au/newsletter/index.php

Blackman, A., and Kildegaard, A. (2003) *Clean Technological Change in Developing Country Industrial Clusters: Mexican Leather Tanning*. Discussion Paper 03-12 Mexico.

Cairns (2004) *Cairns Safety, Health and Environmental Report*. Harare, Zimbabwe.
Chenga, N. (2004) *Multi-Sectoral Approach Vital to End the City's Water Woes*. The Herald, 10 December 2004. Harare.
Clarke, G.M. (1982) *Statistics and Experimental Design: Contemporary Biology.* Edward Arnold Publishers, Great Britain.
Daniel, W.W. (1990) *Applied Nonparametric Statistics*. PWS-Kent, Massachusetts.
Environment Africa (2005) *Environment Africa Statement on World Environment Day*. Kubatana.net http://kubatna.net/html/archive/arch_index.asp
Fisher, E., and Reuber, R. (2000) *Industrial Clusters and SME Promotion in Developing Countries*. Commonwealth Trade and Enterprise Paper No. 3. Commonwealth Secretariat, UK.
Green, R., Cummingham, J., Duggan, I., Giblin, M., Moroney, M., and Smyth, L. (2001) *The Boundaryless Cluster: Information and Communications Technology in Ireland.* Innovative Clusters: Drivers of National Innovation Systems, OECD, Paris, France.
Helmsing, A.H.J. (2001) Local economic development: New generations of actors, policies and instruments. A summary report prepared for the UNCDF Symposium on Decentralisation local Governance in Africa. In *Local Governance and Decentralisation in Africa*, pp. 59–78.
Kativu, D., and Matayaunga, M. (2005) *Participatory Corporate Environmental Management: Industrial Clusters (ii)*. Paper presented at ZIE Congress 2005.
Ketels, C.H.M. (2003) *The Development of the Cluster Concept-Present Experiences and Further Developments*. Paper presented at the NRW conference on clusters, Duisburg, Germany. 5 December 2003.
Kim, Y., Barkley, D.L., and Henry, M.S. (2000) Industrial characteristics linked to establishment concentrations in non-metropolitan areas. *Journal of Regional Science* 40(2): 231–259.
Kouts, C.A. (1984) Working Paper. Municipal waste to energy plants: The siting problem. *The Journal of Urban Analysis and Public Management* 8(1): 85–89.
Mbohwa, C. (2006) Evolving corporate environmental management strategies for sustainability. *Proceedings of the Zimbabwe Institute of Engineers* 4(1): 57–64.
McCormic, D. (1998) *Enterprise Clusters in Africa: On the Way to Industrialisation.* Discussion Paper No. 366.
Nhapi, I., and Hoko, Z. (2002) *A Cleaner Production Approach to Urban Water Management: Potential for Application in Harare, Zimbabwe*. A paper presented at the 3rd WaterNet/Warfsa Symposium, 'Water Demand Management,' Dar es Salaam, 30–31 October 2002.
Oppenheim, A.N. (1996) *Questionnaire Design, Interviewing and Attitude Measurement*. Printer Publishers, London, UK.
Otieno, F.A. (1992) Solid waste management in the city of Nairobi: What are the prospects for the future? *African Urban Quarterly* 7(1 and 2): 142–149.
Pratt, B., and Loizos, P. (1992) *Choosing Research Methods: Data Collection for Development Workers*, Development Guidelines 7. Oxfam, Britain.
Schmitz, H. (1995). Small shoemakers and fordist giants: Tale of a super cluster. *World Development* 23(1): 9–28.
UNIDO (2006) *SME Cluster and Network Development Principles and Practice*. UNIDO. http://www.unido.org/clusters
Yap, N.T. (1999) Environmental scarcity and development opportunities through cleaner production and consumption in Southern Africa. In *Cleaner Production and Consumption Challenges and Opportunities in East and Southern Africa*. Weaver Press, Avondale, Harare, Zimbabwe.

"*This page left intentionally blank.*"

Part IV
Sustainability and Social Responsibility

"*This page left intentionally blank.*"

Assessing Sustainability: The Missing Elements in Current Environmental Assessment Approaches

Tarsha N. Eason (Dargan), Yaw A. Owusu and Hans Chapman

Abstract Assessing the impact of industrial activity is a complex challenge for policy makers, scientists and engineers. In an effort to evaluate industrial systems, a range of alternative methods have been developed. From qualitative matrix models to data-intensive computer models, decision-makers are able to choose from a variety of tools to appraise the potential environmental impact. However, these methods stop short at demonstrating how industrial activity affects sustainability. The purpose of this work is to advance the area of environmental assessment by developing a method of evaluating the sustainability implications of industrial activity (products and processes). This chapter covers the definition of sustainability, its key factors and elements, the state of the art for environmental assessment and the shortcomings of the current environmental assessment methods. This research agenda was carved out of a survey of research needs within environmental assessment and industrial ecology. From this study, it is evident that assessing sustainability requires a cross-disciplinary study of factors and interactions linking demography, consumer demand, economic activity, industrial activity and resource use to sustainability. Further, a key component of assessing sustainability is population. As such, this chapter serves as an introduction to the development of the "Population Based Model for Assessing the Sustainability Implications of Industrial Activity" (PMASI). This approach is relevant to both developing and industrialized countries.

Keywords Sustainability · Industrial ecology · Environmental assessment · Sustainable development · Life cycle assessment

Introduction

Over time, the cumulative environmental impact of humans has reached a global scale (Schulze et al., 1996). A requirement of meeting the demands of a growing population is increased industrial activity and consequently more environmental

T.N. Eason (Dargan) (✉)
Florida A&M University, Tallahassee, FL, USA
e-mail: eason@eng.fsu.edu

I.N. Luginaah, E.K. Yanful (eds.), *Environment and Health in Sub-Saharan Africa: Managing an Emerging Crisis*, DOI 10.1007/978-1-4020-9382-1_9,

impacts. It is evident that there is a relationship between population growth, increased human activity and environmental impact. But, what is that relationship?

Dr. Thomas Graedal, one of the pioneers of industrial ecology (study of the relationship between industry and its surrounding environment), noted that population growth is a major factor fuelling industrial growth and increased consumption of materials. Further, Graedal explained that while industry has been successful at developing products and processes to meet the needs of the growing population, yet has been less proficient at identifying some of the long-term consequences of satisfying those needs. Finally, he indicated that the goal is to make industrial decisions today that will be viewed with favour 20 or 30 years from now (Graedal and Allenby, 2003; Graedel et al., 1995). The objective of this chapter is to introduce such a strategy.

Industrial Ecology and Sustainability

Industrial ecology is the study of industry and its environment or in short, the industry–environment interaction. It recognizes the technical, economic, sociological and cultural links involved in meeting and maintaining sustainability. While sustainability itself considers the availability of resources for future needs and is related to minimizing environmental damage caused by industrial emissions (Ruwaard et al., 1995). The objective of sustainable development is reduction of toxicity and minimization of resource use. The concept of sustainable development arose in reaction to discussions on limits of growth. The United Nations is notably responsible for promoting the topic of sustainable development through the Brundtland Report and Agenda 21. The now infamous, Brundtland Report, developed by the World Commission on Economic Development (WCED) provided the first definition on sustainable development which simply stated is meeting present needs without adversely affecting the ability of future generations to meet their needs (WCED, 1987).

As recognized by many professionals working in this area, current development practices are contradictory to the sustainability paradigm (World Bank, 2003). Further, some view economic growth and sustainability as being mutually exclusive ideals (Davidson, 2001). Therefore, it is impossible to assume that sustainable development will result from proceeding as normal. Contrary to traditional development strategies, the sustainability paradigm is not about "trading-off" or balancing one goal over another; rather, it is the integration of economic, environmental and social issues (Berkel, 2000). Figure 1 conceptualizes the amalgamated nature of sustainability. Hence, sustainability can be described as a tri-fold optimization of

1. natural capital;
2. human capital;
3. manufactured/financial capital.

However, one of the major challenges in sustainable development is the lack of a method for assessing sustainability.

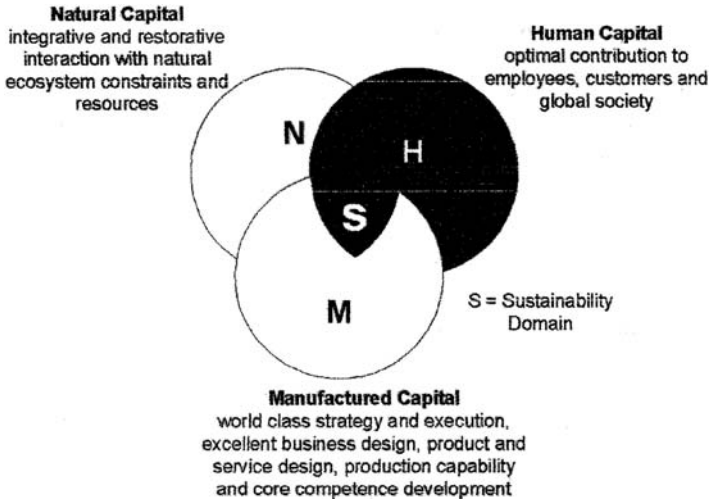

Fig. 1 Model of sustainability (Rowledge et al., 1999)

In conjunction with Agenda 21, the Commission on Sustainable Development (CSD) has compiled a variety of measures of sustainability. These sustainability measures are based on the pertinent issues within the primary focus areas: social, environmental, economical and institutional. Table 1 is a partial list of the sustainability themes, sub-themes and indicators.

In a policy setting, sustainability is measured by the indicators outlined by the Commission on Sustainable Development (CSD). Those indicators require that current information be readily available in order to measure these indices within the social, environmental, economical and institutional themes. While the broad scheme of sustainability is covered, it still does not provide a method of determining the sustainability of industrial products and processes. A further assessment of the CSD themes demonstrates the inner/intra connectivity between the themes (i.e. a change in one theme would affect all of the others and vice versa). This "web of interaction" reflects the complexity of developing a sustainability tool (Dargan, 2006).

State of the Art in Environmental Assessment

Traditional methods of determining the environmental effects of industrial activity are life cycle assessment and risk assessment. Other popular strategies include the impact (I) as a function of population (P), affluence (A) and technology (T) (IPAT) (otherwise, known as the IPAT equation) and ecological foot printing. These methods are summarized in Table 2. A life cycle assessment (LCA) evaluates the environmental impact of a product or process throughout its life cycle stages from raw material extraction to waste management. It is typically used for comparative

Table 1 Sample sustainability indicators from CSD framework (CSD, 2001)

Social		
Theme	Subtheme	Indicator
Health	Drinking Water	Population with access to Safe Drinking Water
Population	Population Change	Population Growth Rate
Environmental		
Theme	Subtheme	Indicator
Atmosphere	Climate Change	Emissions of Greenhouse Gases
Economic		
Theme	Subtheme	Indicator
Economic Structure	Economic Performance	GDP per Capita
Consumption and Production Patterns	Energy Use	Intensity of Energy Use
Consumption and Production Patterns	Waste Generation and Management	Generation of Industrial and Municipal Waste
Institutional		
Theme	Subtheme	Indicator
Institutional Capacity	Science and Technology	Expenditure on Research and Development as a Percent of GDP

evaluation and to assess potential environmental impact during product/process design (Rosselot and Allen, 2002). While an LCA may indicate potential human health impact, it does not provide a true picture of actual populations affected by the product or process. Risk assessments estimate the risk of damage from exposure to a particular substance. They are incorporated into decision-making along with economic, social, political and technological considerations (Arnold et al., 2002).

In the 1970s, Paul Ehrlich and John Holdren proposed a model to describe the factors that contribute to environmental impact (I). This model is mathematically described in Equation (1) given the parameters: Population (P), Affluence (A) and Technology (T); where, affluence and technology rely on the economic and environmental information. With the inclusion of Population, Economic and environmental components, this model represents the first attempt to provide a quantitative method of assessing sustainability.

$$\text{Impact} = \text{Population} \times \text{Affluence} \times \text{Technology} = \text{P} \times \text{A} \times \text{T} \tag{1}$$

While the IPAT equation is the foundation of qualitative studies linking demographic, economic and environmental components, the view of pollution is restricted

Table 2 Output comparison of life cycle asssessment, risk assessment, IPAT and PMASI.

Method	Model elements	Output
Life Cycle Assessment	Resource inputs, Emission output and Toxicity	 EI Life Cycle Stage Total Impact $= \sum_{i=1}^{n} EI_i$
Risk Assessment	Emission, Toxicity, Fate, Transport and Duration	Cummulative Risk $= \sum_{i=1,j=1}^{n,m} CR_{ij} \langle 10^{-6}$ (Carcinogen) Cummulative Hazard Index $= \sum_{i=1,j=1}^{n,m} HI_{i,j} \langle 1$ (Non – Carcinogen)
IPAT	I = f(P,A,T), where P = Population, A = Affluence, and T = Technology	$I = P \bullet A \bullet T$ Master Equation : $EI = \text{Population} \times \frac{\text{GDP}}{\text{person}} \times \frac{\text{Impact}}{\text{unit GDP}}$
PMASI	Population growth, resource Demand (and Availability), Emission amount, toxicity, fate, Transport, Duration and Susceptibility of population to chemical	Sustainability → RA_n, $HRE_{l,t}$ where, HRE=human receptor effect at location (l) and time (t) RA = resource availability of resource (n)

to the mass emissions approach. These conceptual models have primarily served to highlight the multidisciplinary linkages between population and environment, yet research must go from a qualitative to a quantitative approximation of the factors, links and interactions. Ecological footprint analysis is based upon the concept of carrying capacity. As defined by Catton (1986), carrying capacity is the maximum load that can be supported in a habitat without irreparably damaging the habitat's productivity. The focus of the analysis is the demand of populations on nature versus the availability of resources.

Limitations

While each of the methods discussed provide insight into the interaction between industrial activity and the environment, they fall short of providing a full sustainability assessment. For example, typically LCA and risk-based LCA methods consider the toxic effect at a given time without considering location. They do not truly consider whether the substances are being emitted in an environmentally significant area, whether human health impacts will occur if the distance to human populations is significantly large and attenuation is possible, or the susceptibility of the exposed population to toxic effect. Further, the pertinent sustainability factors, such as population growth and corresponding increase in resource use have not been satisfactorily considered. These missing elements are considered gaps in the development of a sustainability-based assessment. As noted in Table 3 by filling in the "gaps" left by current assessment strategies, a new comprehensive model is established.

The primary components of sustainability are economic, environmental, demographic and social factors. Common parameters or indicators relating to these factors are population growth and resource use and availability. These factors have not been successfully incorporated into a life cycle method. Sustainability far surpasses the boundaries of environmental assessment. A successful model must integrate knowledge from demography, geography, industrial ecology, impact assessment, toxicity, epidemiology, manufacturing and systems engineering. Consequently, one of the major hurdles in developing a sustainability model is that it requires a cross-disciplinary approach (Dargan and Owusu, 2003). Accordingly, the root of the Population Based Model for Assessing Sustainability Implications (PMASI) method development is analysis of pertinent data, parameters and interactions from these disciplines in order to develop a model that links the critical factors from demography to sustainability.

From Population Growth to Sustainability

It is evident that for many activities, such as energy use, as population increases so does the demand on resources relative to a particular activity. The following

Table 3 Scope of assessment strategies

				Industrial activity		Emissions analysis				Output				
	Demography	**Economic Activity**	**Demand**	Inputs	Outputs	Characterization	Exposure, fate and transport	Intake	Susceptibility	Emissions	Resource use	Resource availability	Human health	Unitless
LCA														
Risk Assessment														
LCA-RA														
IPAT														
PMASI														

statement by Graedal (2003) highlights the dire consequences of population growth and its link to resource use and industrial activity. Further, it identifies the importance of developing model that determines the effect of industrial products and processes on the environment.

> Human activities appear to be rapidly consuming the ability of the atmosphere to act as a sink for the by-products of our economic practices. . . Human population growth is, of course, a major factor fueling this explosive industrial growth and expanded use and consumption of materials. . .what is not frequently realized, but is critical, is how closely human population growth patterns are tied to technological and cultural evolution. . .. Industry has, however, been less adept at identifying some of the long-term consequences of the ways in which it goes about satisfying needs. . .. The goal is to make industrial decisions today that will be viewed with favor 20 or 30 years from now.

Accordingly, modelling sustainability must involve identification of the complex parameters and interactions that link population growth to sustainability.

Sustainable development crosses the boundaries of demography, economics, science (political, social and natural) and engineering. Work has been done in the individual disciplines. However, multidisciplinary problems require multidisciplinary approaches. Indigenous methods must be evaluated and relationships must be established to link the boundaries of thought and practice. A thorough evaluation of sustainability should consider the following relationships:

- **Consumer–Producer**: Population growth and its effect on industrial activity
- **Producer–Resource**: Evaluation of resource use and availability over time and location
- **Producer–Emission:**Toxic character and expected emission concentration in environmental compartments over time (due to producer process emission)
- **Resource–Emission**: Toxic character and expected emission concentration in environmental compartments over time (due to resource extraction emissions)
- **Emission–Intake**: Sensitivity of chemical to the intake route and amount of the chemical that reaches the intake route (dermal, inhalation and ingestion) of the human population
- **Intake–Receptor toxic effect:** Susceptibility of the population to the chemical

As noted by Chertow (2001) and Castro (2004), these interactions are tantamount to measuring sustainability, yet they have not been fully explored.

The model introduced in this chapter explores these relationships and interactions in order to provide a foundation for a sustainability assessment of industrial products and processes. This new method bridges the gap between the effect of consumer demand, resource use and availability and receptor effect.

Figure 2 is the foundation for the development of the Population Based Model for Assessing Sustainability Implications (PMASI) model. The PMASI model comprises all elements from the Consumer–Producer relationship to Intake–Receptor effect. The catalyst of the model is consumer demand which is represented as a function of population growth. **Consumer** demand "sparks" increases in **producer**

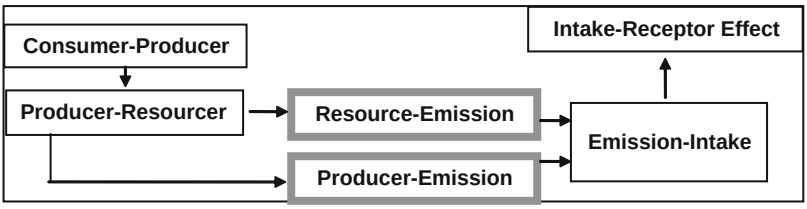

Fig. 2 Pictorial representation of the interaction and relationship model

activity (industrial activity: product and process demand). Increased demand for **producer** industrial output fuels increases in **resources** demand (RD) of required resources. The ability to meet the resource demand is based upon the resource availability (RA) of resource (1 . . . n) and the efficiency of extraction and processing. The usable material becomes the resource **I**nputs from the**s**ource, the **resource**-related **emissions** or resource wastes (RW) of emissions are released into the surrounding environment during extraction and processing. Similarly, in the industrial life cycle, the inputs are transformed through process operations into usable products, residues are recycled, reused or remanufactured and **producer**-related **emissions** are released as solids, liquids or gases. These emissions are transferred to environmental compartment via transport and fate. Humans are exposed to the **emissions** through an **intake** exposure route. Based upon inherent toxicity and **receptor** characteristics, the **intake** may result in toxic effect. These susceptibility attributes relate to geographic, demographic, spatial and temporal aspects of the release environment, which include location–time dependant land-use patterns, location–time dependant population density, and location–time dependant sensitivity of population to chemical. The output of this evaluation is the sustainability in terms of resource availability and human health receptor effect.

This new method bridges the gap between the effect of population growth on industrial activity, resource demand (RD) and the sustainability of human health and resource availability (RA). As shown in Fig. 3, the PMASI method incorporates the key sustainability components (demographic, economic and environmental).In order to develop such a method a systems approach is employed. The model

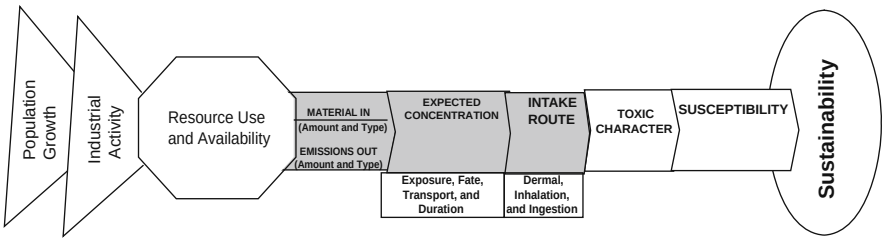

Fig. 3 Model structure of the PMASI method (Dargan, 2006)

development for the PMASI method commences with background and analysis of population growth modelling and the relationship between population growth and economic activity.

Concluding Remarks

Assessing the long-term consequences of industrial activity is a key concern in industrial ecology. Although, a variety of tools and methods have been developed to evaluate environmental impact, these methods do not provide a true sense of the sustainability implications. As such, this chapter provided background of sustainability, environmental assessment strategies and limitations. Further, it served as an introduction to the development of the "Population Based Method for Assessing Sustainability Implications". Development of such a method would provide the decision-maker with the knowledge of the design adjustments and technology enhancements necessary to meet the production demands of a growing population. Moreover, such a method would serve as a planning tool regarding resource requirement affording lead time for safe harvesting and/or developing environmentally sound materials. The tool described in this chapter is of key importance to developing and industrialized nations for planning and assessing the long-term implications of industrial activity.

References

Arnold, F.. et al. (2002). *Chapter 2: Risk Concepts, Green Engineering: Environmentally Conscious Design of Chemical Process*, (eds.) D. Allen and D. Shonnard. Prentice-Hall Inc.: Upper Saddle River, NJ.

Berkel, R.V. (2000). "The Sustainable Development Challenge for Technology: Will It Work in Time?", *Australia at the Crossroads: Scenarios and Strategies for the Future*, Perth, Australia, April 30–May 2, 2000.

Chertow, M. (2001). "The IPAT Equation and Its Variants: Changing Views of Technology and Environmental Impact", Journal of Industrial Ecology, vol. 4, no. 4.

Castro, C. (2004). "Sustainable Development: Mainstream and Critical Perspectives", Organization and Environment, vol. 17, no. 2.

Catton, W. (1986). *Carrying capacity and the limits to freedom.* XI World Congress of Society, New Delhi, India, 18 August 1986. Paper prepared for Social Ecology Session 1.

CSD: Commission on Sustainable Development (2001). CSD Theme Indicator Framework.

Dargan, T. (2006). "Population Based Model for Assessing the Sustainability Implications of Industrial Processes and Products", Dissertation, Florida A& M University.

Dargan, T., and Owusu, Y. (2003). "Environmentally Conscious Design and Manufacturing for Sustainable Development: An Industrial Engineering Perspective", National Technical Association, September 9–13, 2003.

Davidson, J.L. (2001). "Sustainable Development: Business as Usual or a New Way of Living" in *Taking Sides: Clashing Views on Controversial Environmental Issues, 9th edition*, (ed.) T.D. Goldfarb. McGraw_Hill/Dushkin: Guilford, CT, pp. 294–296.

Graedel, T.E. (2003). Greening the Service Industries. *The Service Industries Journal*, 23(5): 48–64.

Graedel, T.E., and Allenby, B.R. (2nd ed.) (2003). *Industrial Ecology*. New Jersey: Prentice Hall

Graedel, T.E. Allenby, B.R., and Comrie, P.R. (1995). "Matrix Approach to Abridged Life Cycle Assessment", Environmental Science and Technology, vol. 29, no. 3.

Rosselot, K., and Allen, David (2002). "Chapter 13: Life Cycle Concepts, Product Stewardship and Green Engineering", *Green Engineering: Environmentally Conscious Design of Chemical Processes*, (eds.) D.T. Allen and D.R. Shonnard. Prentice Hall: Upper Saddle River, NJ, pp. 419–453.

Rowledge, L., Barton, R., Bradley, K., Fava, J., Ligge, C., and Young, S. (1999). *Mapping the Journey: Case Studies in Strategy and Action Toward Sustainable Development*. Greenleaf Publishing: Sheffield, UK, p. 29

Ruwaard, J.M., et al. (1995). "Interactions Between Operations Research and Environmental Management". European Journal of Operational Research, vol. 85, pp. 229–243.

Schulze, P.C., Frosch, R.A., and Risser, P.G. (1996). *Engineering with Ecological Constraints*. National Academy Press: Washington, DC.

WECD. (1987). *Our Common Future: World Commission on Environment and Development.* Oxford University Press: Oxford.

World Bank. (2003). *World Development Report 2003: Sustainable Development in a Dynamic World*. http://www.worldbank.org. Accessed 20 June 2007.

"*This page left intentionally blank.*"

Precarious Balance: The Future of Environmental Degradation in Sub-Saharan Africa

Godwin Arku and Paul Mkandawire

Abstract This chapter examines the future of environmental degradation in Africa. While acknowledging the relative role of population growth and unsustainable agriculture practices in environmental degradation in the region, the chapter considers the role played by excess consumption, poverty and HIV/AIDS, corrupt African states and international capital in determining the future of natural resources in Africa as critical. The relationship between states and international business corporation has been particularly detrimental to the region's environment, and will continue to present a formidable threat to natural resources, especially as the World Trade Organization becomes more influential in ensuring unrestricted movement of international capital. Alternative imagination by the New Partnership for Africa Development (NEPAD) that sees Africa's development beyond the current economic and political order is critical for arresting future environmental degradation.

Keywords Environmental degradation · Sub-Saharan Africa · Unsustainable agriculture

Introduction

Abraham Lincoln once remarked that anyone who enjoys eating sausages and using the law should avoid seeing how either is made (Forsyth, 2003). The same can be said about environmental issues the world is facing today. The very fact that there is an intricate connection between the environment and human welfare provides a basis for being sceptical of accounts that seek to divorce environmental issues from politics. In other words, the centrality of natural resources to human well-being and survival means that laws and policies governing the environment are bound to be

G. Arku (✉)
Department of Geography, Social Science Centre, The University of Western Ontario, London, ON Canada N6A 5C2
e-mail: garku@uwo.ca

I.N. Luginaah, E.K. Yanful (eds.), *Environment and Health in Sub-Saharan Africa: Managing an Emerging Crisis*, DOI 10.1007/978-1-4020-9382-1_10,

infused with values. Therefore, identifying and acknowledging political facets of the global environmental crisis issue is among the first steps in efforts to understand and seek sustainable solutions to climate change.

This concluding chapter concerns the future of environmental degradation in the sub-Saharan region. The aim is not necessarily to prescribe a future or foretell the environmental trajectory of the continent. Rather, the chapter seeks to highlight some of the critical conditions and trends currently prevailing in Africa that have discernible potential to make certain environmental future scenarios more likely than others. This analysis seeks to be suggestive and illuminative of the future of the environment in the region rather than being explicit and determinate. We argue that while population growth remains a critical factor in environmental degradation in the region, unsustainable consumption patterns, corporate–government nexus, poverty and HIV/AIDS are decisive. We seek to demonstrate that environmental degradation takes place in the context of the interplay between consumerism, international capital operating relatively outside government regulation or indeed in collusion with political regimes, and the deepening HIV/AIDS and poverty crises. The amount of allowable space for this chapter precludes a full and comprehensive elaboration that a subject matter of such diversity and depth deserves. At the risk of oversimplification, what we attempt to expose in this chapter is little more than skimming of the above-mentioned critical issues and the manner in which they foreground the future of the environment on the continent.

In the first decade of the twenty-first century, the question of mitigating global environmental degradation has been framed within the broader debates about sustainable development (Adams, 2009). Temporally, though, concerns about the human relationships with the environment have roots dating back to medieval times in Europe (Thomas, 1983). However, while practical action aimed at addressing environmental degradation in the region only dates back to the colonial era, the need to stem environmental degradation acquired more currency during the post-colonial period. These concerns coloured debates that took place at the United Nations Conference on the Human Environment in Stockholm in 1972, the World Commission on the Environment and Development in 1989, the Earth's Summit in Rio in 1992 and the Sustainable Development Summit in 2002 in Johannesburg. More recently, these views have gained more prominence through the Millennium Development Goals (goal # 6) that seek to galvanize global commitment to achieve sustainable development. The effort to repackage seemingly antagonizing goals of poverty reduction and environmental protection as mutually constitutive, rather than mutually exclusive, objectives has been lauded as one of the most significant outcomes of debates on these forums, especially the Earth's Summit in Rio de Janeiro in 1992. This particular framing is especially useful for the African continent because it provides a theoretically sound framework for reconciling economic and environmental goals in development policy and planning in a region where poverty and environmental degradation are simultaneously pressing problems. However, whether these two objectives are truly reconcilable in practice is a different matter, and somehow outside the purview of this chapter.

This chapter proceeds by providing a historic overview of the previous conservation efforts that have taken place in the sub-Saharan region. A synopsis of environmental discourse and a brief account of who, among different actors in the environmental policy sub-system, has the power and credibility to influence and define environmental reality and policy are then presented before a discussion of the factors that are more likely to condition the future of the environment in the region is described. The chapter ends with a brief conclusion.

Overview of the History of Environmental Protection in the Region

In this section, we make an incursion into the past, but this foray is not a digression. It is not necessarily a detour because we seek to identify some key historic events and dwell on these antecedents with sole objective of throwing some light on matters of the present so that we can catch a glimpse of the future, without necessarily being deterministic or trying to make a prediction. Our analysis of the critical historic events is with almost complete disregard for connecting stretches of time and traverses several disciplines. In addition, this chapter is inevitably selective in its coverage of literature because the sheer volume of the history of global environmental issues in the sub-Saharan Africa precludes the kind of cursory treatment that we attempt hereunder.

The origin of environmental issues in sub-Saharan Africa cannot be fully explained without recourse to the advent of colonialism (Allen, 1976). The British, in particular, had very keen interest in the ecology of the African sub-continent and were convinced that the wilderness in this region contained virtues that were much greater than the scientific benefit of description and taxonomy of fauna and flora. A utilitarian and materialistic interest of the British in the African ecological reserves during the colonial period was revealed in such arguments as nature in Africa had the potential to provide lifeline of forestry, agriculture, grazing and mineral resources (Adams, 2009). In addition, ecological research lent itself highly valuable to the study of disease ecology, especially relating to sleeping sickness and malaria. Therefore, the ecological stakes of the British were generally inseparable from their imperial expansion in the region. Burgeoning scientific research interest in the region's nature reserves was ultimately inaugurated through the establishment of the British Colonial Research Council (Salisbury, 1964). The overarching logic driving these efforts was that through scientific advances and concomitant rational organization of government bureaucracy, the abundant nature in the region could be better understood, manipulated and controlled for the benefit of 'mankind' (Mackenzie, 2000).

On the basis of this understanding colonial regimes were fashioned to organize relations between the state, the people and nature. These reforms were aimed at deliberately positioning the colonial governments to intervene in the ecosystem and impose an environmental management regime that ensured continued flow of

benefits from natural resources to the elite. Some commentators have argued that the development of railway network to the sea coast by colonial governments reflects the underlying imperial motive of draining the continents natural resources (Ferguson, 1999). The growing influence of the colonial ecological science on development thinking during this period inevitably necessitated a shift in government attention towards indigenous production systems. While colonial regimes and European settlers exercised virtually unrestrained freedom to extract natural resources, including the hunting of game as a sport, the logic of indigenous agricultural systems came under intense scrutiny for any potential or real impress of such livelihood activities on the environment (Adams, 2009).

By the 1960 s and the 1970 s the theoretical and practical relationship between ecology and development had been firmly established in the post-colonial government development planning logic. Efforts had now shifted towards avoiding or at least minimizing negative impacts on the environment, with special focus on the role of technology. However, environmental thinking around this time was largely grounded in the neo-Malthus paradigm (Elrlich, 1972), and Gareth Harding's 'tragedy of the commons' further entrenched neo-Malthus views. Catastrophist views of the environment have been remarkably persistent despite overwhelming historical counterevidence and are still widely invoked in environmental planning and policy making in the sub-Saharan region.

The history of environmental issues cannot be fully examined without the role of international scientific organizations. Key bodies include the International Biological Program, Scientific Committee for Problems of the Environment (SCOPE) and the Man and Biosphere (MAB) among others. The role played by these organizations is diverse but those that stand out include efforts to draw developing countries further into the global environmental movement, coordination of global research, provision of relevant practical research for use by actors involved in environmental and economic policy making, and amplification of global awareness of environmental concerns (Adams, 2009). One of the key successes linked with the international scientific organization has been the assertion that conservation of natural resources could be achieved alongside their utilization for human betterment.

Whose Environmental Reality Counts?

The conventional wisdom is that the sub-Saharan Africa region is undergoing extensive environmental degradation. It is the established wisdom, an unquestioned policy fact. But this section attempts to critically reflect on this seemingly unproblematic and taken-for-granted assumption. To interrogate this assumption is not necessarily to deny incidence of nature destruction or depletion. Rather, deconstructing this assumption represents an attempt to acknowledge the complex nature of the ecology of the sub-Saharan continent and appreciate limitations of efforts that seek to draw simplistic generalizations about the state of the environment in the region. It is also an effort to come to terms with what is true about environmental

change and what is a myth in the region. Environmental change tends to be theorized and viewed differently by different actors (Grove, 1977). For example, corporations involved in commercial logging in tropical forests and peasant communities working on the margins of these reserves are bound to hold divergent ontological views about nature. Therefore, a more critical and nuanced analysis of how environmental realities are framed by different stakeholders helps us to understand why certain views about the environment in the region are dominant and why other opinions are not, or what kind of environmental policies may be placed on the table or what kinds may enter the debate (Forsyth, 2003). An acknowledgement of existence of multiple environmental actors and realities alerts us to the notion of who has the credibility to define or influence environmental reality and policy in the region. It makes us aware that even the dominant narratives about the environment only provide a partial account of the reality of nature. More important is the recognition that the dominant representations of nature represent the ideology and interest of the prevailing social order.

Powerful and emotive images of environmental decline in the semi-arid regions of Africa under pressure from agriculture misuse and other alleged primitive forms of land use have led to a persuasive and self-confirming perception of environmental degradation in the sub-continent (Adams, 2009). However, there seems to be general lack of empirical evidence to corroborate such dominant narratives despite the fact that they continue to form the basis of policy in the region. Even where data has been available, it has been deemed unnecessary to pay close attention to it because the ideology of degradation has been overly persuasive to generate policy. Dominant descriptions of desertification have found a ready audience in some quarters, especially where they tend to serve special interests and ideological predispositions of certain elite groups including government officials, international aid agencies and scientific communities.

Political regimes in the region often harbour special interests in resources that exist in their domestic ecosystems and have always sought to strengthen and expand their claim on natural resources as a means for consolidating their grip on power. International aid agencies, as integral part of the development industry, tend to represent the interests of their patrons or sponsors who in most cases tend to be rich countries. Because they wield a lot of political, economic and technical power, these institutions tend to frame environmental concerns in ways that do not only place the environmental problem in the context of local poor people's transgression of ecologically defined limits (Adams, 2009), but also in ways that simultaneously rationalizes external intervention (Crush, 1995). Often the problem is framed in ways that serve interventionist interests of aid agencies (Power, 2003; Panitch and Leys, 2006). International organizations such as World Wild Fund wield great influence in shaping environmental policies in developing countries (Peet and Watts, 2004). The scientific community, although obviously helpful in providing informed understanding of the functioning of ecosystems, often tends to define environmental problems in ways that seek to place researchers in a position as the most credible and reliable sources of knowledge. Consequently, views of lay people, especially environmental knowledge of indigenous communities acquired by virtue of

intimate working relationships with these environments over generations, tend to be discounted, subordinated and marginalized. Lay people's ways of knowing are considered illegitimate because they do not stand the cannons of scientific of rigour (Agrawal, 1995). Ironically, many of these so-called scientific studies on the environment often only span relatively short periods of time – usually limited to duration of PhD research and therefore fall short of sufficient timescale necessary to accurately establish the true temporal character of the ecosystems.

But other studies of temporal land use from regions such as Machakos in Kenya, which have been previously been portrayed by the colonial government as degraded wastelands blamed on primitive modes of agricultural production by indigenous populations, seem to vindicated a different storyline altogether. It has been argued that secular variations in climatic conditions constitute a key factor in discerning environmental degradation on the African continent (Lamb, 1979). In addition, emerging evidence seems to suggest that the relationships between human activities such as agriculture, fishing, hunting and environmental change is more complex than previously imagined, and that localized environmental changes are not completely disconnected from the global atmospheric system, including the potential impact of carbon dioxide and global warming (Adams, 2009). The new understanding places relatively less emphasis on explanatory models that seek to pigeonhole explanations about environmental change in the region within the realm of livelihood activities of indigenous populations, or the neo-Malthus paradigm that tends to entirely place the blame on population growth. Further, different approaches employed to determine the exact extent of environmental degradation tend to produce inconsistent results. While certain research techniques reveal increasing incidence of environmental degradation, other methods suggest little or no change at all (Thomas and Middleton, 1994). Warren (1996) has argued that the truth seems to be that degradation is not a problem in its own right, but rather that it is an outcome of a complex set of activities which vary spatially and temporarily. Although the inconclusiveness of the empirical evidence might seem inconvenient, especially to those of us with ambitions for generalizations, it is worth reminding that challenges of inadequate and inconclusive data are not alien to knowledge patterns of environmental change. The only snag is that scientific uncertainty tends to create opportunities for sneaking special interest into environmental policy making and analysis (Harrison, 1991). Inevitably, it is the ideologies of the powerful that carry the day.

The Future of Environmental Degradation

In the previous section, we argued that dominant discourses about the state and condition of the environment and appropriate policies to address ecological problems often represent views and interests of dominant groups in society. Views of the weak and the disenfranchised are often marginalized. Because the powerful groups tend to benefit disproportionately from nature, it is inevitably in their best interest to ensure that environmental policies do not, at the least, undermine current and future flow of those benefits. Therefore, attempts to imagine the future of environmental

degradation in sub-Saharan Africa should make a deliberate attempt to draw from perspectives that have roots in political ecology.

The future of environmental degradation in the sub-Saharan region can therefore not be adequately discussed in isolation from factors external to the region. This is because localized environmental impacts in the region should be understood as closely linked with processes taking place at spatially remote scales (Adams, 2009). In this chapter, we examine the future of the environmental degradation in the region as it relates to three distinct but interconnected phenomena. We argue that the future of the environment in Africa lies in the balance, and that it is contingent upon three interrelated processes namely poverty, consumption habits and corporate interest.

Poverty and HIV/AIDS

Sub-Saharan Africa is the poorest region in the world, irrespective of the method one uses for poverty assessment (see UN MGD Report 2008). But what is even more disconcerting is that prospects of reversing the trend of poverty in the region remain extremely bleak. Despite rhetorical commitment, even the most optimistic predictions suggest that Millennium Development Goals (MGDs) will only reduce the number of people living on less than US$1 per day in the region by only 33% by the year 2015 (World Bank, 2008). Yet, poverty is a known key determinant of environmental degradation. Although specific environmental outcomes may depend on the context – depending on the ways in which communities interact with their natural environments given that poverty and conservation links tend to be multifaceted and complex (Walpole and Wilder, 2008) – in general, rising poverty erodes people's livelihood options and pushes them into a state of increased dependence on the natural environment for survival, and thereby creating even more pressure on ecosystems. Poverty also tends to encourage migration (Potts and Bowyer-Bower, 2004). Throughout much of sub-Saharan Africa, depressed rural economies – legacy of the World Bank and International Monetary Fund Structural Adjustment Programs (SAP) – is a key push factor responsible for burgeoning urbanization. The search for survival involves high degree of movement between rural and urban areas. Embedded with this mobility is the spread of HIV/AIDS (Kalipeni et al., 2004). In cities these migrants end up in slums and informal settlements and tend to occupy land parcels close to mining and industrial complexes, waste disposals – usually with no security of tenure (Adams, 2004). While they disproportionately suffer from environmental exposure, their concentration on these marginal spaces greatly contributes to ecological breakdown. While in urban areas, frustrations arising from joblessness and financial insecurity tend to militate for alcohol and drug abuse in men, leading to tensions in the household. This fosters breakdown of domestic relationships. In these distressing circumstances sexual exchange by women is common, not as means to obtain luxury goods, but as a basic means for survival (Kalipeni et al., 2004).

That Millennium Development Goals will not deliver the sub-Saharan region to the promised land should hardly come as a complete surprise. In part, this is because these aspirations are framed as though the world's social problems are embedded in historic vacuum (Bond, 2005). Poverty in the sub-Saharan region has its roots in historic antecedents, and therefore proposed solutions can potentially be effective when they are designed with root causes in mind. Slave trade has had an enduring impact of altering social relations between the slaved and former slave masters (Turshen, 1984). While resource pillage during mercantile period of European expansion in the region continued and expanded with colonialism (Hoogvelt, 2001; Rodney, 1972), the post-colonial period entrenched these inequalities through technological rents, unequal international trade and debt peonage. Further, Structural Adjustment Programs (SAPs) by the World Bank and the International Monetary Fund (IMF) annihilated economies in the region, deepened poverty and pushed the poor further into the marginal lands and fragile rangelands (SAPRIN, 2004; Moyo and Yeros, 2005). The HIV/AIDS epidemic, and its links with poverty, is also central to environment change in the region. As the epidemic takes its toll in the region, poverty will continue to deepen thereby further intensifying unsustainable environment practices on the part of poor communities.

Consumption Habits

While extreme poverty on the one hand is a critical determinant of environmental change, excess consumption also accelerates the rate of environmental degradation. Transposing the environmental question in this manner helps us to understand that reducing inequalities are central to resolving the problem of environmental change. The focus on consumption and lifestyles is critical because of its potential for achieving significant environmental gains without necessarily committing additional scarce resources. However, the power of consumption in transforming social and ecological landscapes cannot be underestimated. This is because consumption plays an important role in people's lives that often goes beyond immediate physiological needs, as it can also be an expression of social power and status. As demonstrated by Mintz (1985), for example, European demand and changing meaning associated with consumption of sugar between the period 1500 and 1900 were largely responsible for driving a section of humanity into slavery. One of the main outcomes was the transformation of the demographic and ecological profiles of both Africa where the slaves came from and the New World where plantations were established.

Excess consumption is linked to corporate drive. It is a structural problem embedded in the capitalist logic of expanding production for the sake of accumulation. Without excess consumption, the quest for profit stalls. The consumerist culture is strong and fast growing, especially in rich nations of the north and elites in African metropolitan areas. Mass consumption has been engrained into the cultural psyche of northern societies. Evidence of excess consumption can be seen from rising

volumes of waste. Rubbish output in the United States has doubled over the past 30 years. With only 4% of the world population, the country churns 30% of the Organization for Economic Cooperation and Development (OECD) waste output (Rogers, 2005). Consistent with acceleration in consumption waste handling has become a lucrative business. The largest garbage corporation in the United States, Waste Management Incorporated (WMI), reported revenue of US$11.5 billion in 2003 (Panitch and Leys, 2006), equivalent to more than four times the current gross domestic product of Malawi (World Bank, 2008). This continual expansion of consumption and production puts excessive pressure on natural resources and contributes to environmental degradation. However, while the benefits of excess production tend to accrue globally and largely to the rich, the cost of environmental exploitation is usually borne locally and unequally felt by the poor (Balmford and Whitten, 2003).

Similar asymmetries in the distribution of environment-related costs and benefits pervade other related ecological issues in the region, with important implications for the future of the environment. For example, while the value of protected species and habitats in national parks and game reserves in the sub-Sahara is enjoyed by remote and relatively affluent wildlife lovers in the north – directly through tourism or indirectly through television (Adams, 2009) – the cost is largely borne by local poor peasants who lose their livelihoods otherwise provided by these resources. For example, 21% of land in Malawi is designated as protected and consist of game parks (Malawi Government, 2001). Even the government concedes that environmental and economic value of these enclosures to local Malawians is generally tenuous. The problem of land inequality is made more galling because high population density coexists with large expanses of parks scattered across the country. It is estimated that about 33% of smallholder farmers in the country cultivate between 0.5 and 1 ha (Chirwa, 2005). Yet, land is a critical determinant of food security in Malawi (Ellis, 2003).

The enclosure of forests from encroaching local peasants in many countries in sub-Saharan Africa is a highly preferred policy prescription. Although recently there have been deliberate efforts to engage local communities in the management of these resources, the reality is that government still drives the agenda and local people are still treated as intruders, encroachers and poachers in these ecosystems. Nature-for-debt swaps that many developing countries are currently pursuing with their respective developed country creditors only serve to consolidate the draconian ways of enforcing environmental conservation policies in these developing countries. But equally important, these treaties serve to reveal vested interests of northern governments in the developing countries' ecological resources (Panitch and Leys, 2006). Tropical rainforests such as the Congo Basin are critical for global environmental renewal because they act as carbon sinks. While the scientific rationale for forest preservation is indeed valid, this logic is nonetheless ethically problematic. Nature-for-debt swaps do not only have the effect of curtailing the access of indigenous peoples to these areas, thereby denying them a livelihood. More important is that such policies obscure the political question of excess consumption in the north and developing country metropolitan elites responsible for disproportionate

carbon emissions into the atmosphere in the first place (Panitch and Leys, 2006). It is important, therefore, that efforts to imagine the future of environmental change in sub-Saharan region should also consider what is taking place elsewhere.

International Capital and the Role of National States in the Region

This section examines yet another dimension that greatly bears on the future of the environment in Africa. It has often been argued that the sub-Saharan region exists on the margins of, or even external to, the globalized world (Hoogvelt, 2001). While this is true to some extent, this chapter takes the view that while a great part of sub-Saharan Africa has been rendered relatively irrelevant with the advent of globalization, there are still nodes on the sub-Saharan landscape which are integral to global capitalism (Ferguson, 2006). To understand how the sub-continent is functionally appended to the global capitalist regime requires some historical background. European imperialism on the African continent took dramatically different forms than in temperate neo-Europe regions. At the end of colonialism, continued extraction of resource wealth with limited settlement generally pivoted on exacerbating and establishing new forms of inequalities in land and society (Weis, 2007). Once large tracts of land had been sold to European settlers, exclusive mineral rights and full corporate equity had been granted to metropolitan firms, it was possible to exercise control over resources in the former colonies without direct overlordship (Hoogvelt, 2001). This meant that productive sectors of the colonies had already been slotted into the global capitalist regime by the time colonialism came to an end in most parts of Africa.

The colonial legacy of highly unequal land ownership structure is still in place across much of Africa, and is responsible for much environmental stress the region is currently experiencing. Sharp land inequalities still existing in the region implies that a growing population is made to live off the same quantity of land (Moyo and Yeros, 2005). While land inequalities tend to exert undue pressure on the environment, the involvement of international business corporations (many of them militarized) in agriculture, minerals and logging sectors compounds the environmental problem in the region. The case of Shell and attendant environmental concerns in Nigeria provides a classic example. More recently the sinister motive of China has been noticed. China is the largest importer of timber from tropical Africa, but up to 50% of these imports are deemed to be illegal (Bond, 2006).

Coupled with these challenges is the emergence of new and creative forms of nature appropriation that seem to amount to fraud. WTO's definition of property rights under the Trade and Intellectual Property Rights (TRIPS) to include corporations collecting and patenting genetic resources such as seeds and traditional medicine, many of them from the developing countries including sub-Sahara (Weis, 2007), has been characterized as 'looting' (Bond, 2006), 'bio-piracy' (Shiva, 1997) or 'appropriation by dispossession' (Harvey, 2005). By patenting indigenous seed, TRIPS will help to secure the ability of transnational agro-input companies to drive

poor farmers into the market for commodified seed in a corporate-controlled web of inputs in agriculture with concomitant implications for poverty and environment in the region.

These practices suggest that the African continent remains interconnected with the globalized world but in very specific ways. It has been argued that international capital 'hops' over unusable Africa, alighting only in mineral-rich enclaves that are starkly disconnected from their national economies (Ferguson, 2005). This results in the emergence of huge areas of the continent that are effectively off the global grid. While one of the major reasons cited in Africa's partial integration into the global world is political instability, paradoxically, it is the conflict-riddled regions such as the Democratic Republic of Congo, Angola, Nigeria and Sudan that are sucking in record inflows of international capital over the past decade amidst declining total foreign investment to the region (Bond, 2006). This has drawn into focus the complicity of states in facilitating accelerated extraction of natural resources. It has been argued that IMF and World Bank's Structural Adjustment Programs have had far-reaching political effect on African states (Ferguson, 2006). The 'rolling back' of the state has precipitously eroded the capacity of governments to provide social services. Budget cutbacks and resultant reductions in real wages have spurred mass exodus of skilled workers from governments. Those remaining are paid less than a subsistence wage, with the inevitable result of corruption (Ferguson, 2006). In such environments, it has been relatively easy for some elements of the state to collude with international private capital and engage in illegal transactions, including extraction of natural resources.

As highlighted above, the fact that countries that are poorly governed such as Liberia, Sierra Leone and Nigeria continue being attractive destinations for international private capital continues to raise critical questions related to governance. It also serves to confirm the notion that interests of the African bureaucrats and elite tend to be bound up with those of international capital and militate against welfare of the poor. For example, the collusion between Shell and the government of Nigeria in oil extraction has not only failed to address poverty in the country, but has also served to fuel social disintegration and pollution. Oil spillage has contaminated water sources and threatens the health of local people in the Niger Delta (Ikelegbe, 2006). Similarly, privatization of water in South Africa means that while the majority, who are also the poorest face the risk of cholera, a minority of rich farmers can afford the luxury of irrigating their commercial agricultural fields (Woodhouse, 2008; Desai, 2002).

The role of New Partnership for Africa's Development (NEPAD) is critical for the future of the environment in the region. The NEPAD Strategic Framework arose from a mandate given to the five initiating Heads of State (Algeria, Egypt, Nigeria, Senegal and the Republic of South Africa) by the Organization of African Unity (OAU) to develop an integrated socioeconomic development framework for Africa. The 37th Summit of the OAU in July 2001 formally adopted the strategic framework document and has been ratified by almost all countries in the region. Its goals are not entirely new, and have been stated elsewhere including by the United Nations. They include to eradicate poverty; to place African countries, both

individually and collectively, on a path of sustainable growth and development; to halt the marginalization of Africa in the globalization process and enhance its full and beneficial integration into the global economy; and to accelerate the empowerment of women (NEPAD, 2001). However, these aspirations are confounded when it comes to the details of how exactly they are going to be realized. In practice, it is evident that NEPAD follows a neo-liberal path and seeks to further integrate Africa into the global economy on the basis of market liberalization and unfettered movement of capital. This is revealed in the ironical conjugation between 'African renaissance' and the 'building of a strong and competitive economy as the world moves towards greater liberalization and competition (Tandon, 2002). Inevitably, it raises the question of whether it is possible for African continent to take 'its rightful place in the world' by being further drawn into the very global political and economic system it accuses of being exploitative for centuries. Therefore, it is evident that despite NEPADs rhetorical aspirations, strategies being pursued are consistent with those of the World Bank, World Trade Organization and the International Monetary Fund. For example, while the observation that Africa has been 'plundered for centuries' is incisive, the apparent lack of realization that unfettered international capital mobility is largely responsible for destruction of nature and environmental pollution means that NEPAD holds little promise for the continent. Efforts to contain environmental degradation in the region are undermined by the free-market imperative because the discipline continues to comprise poverty reduction efforts and allows free capital to engage in the destruction of natural resources.

Conclusion

In this chapter, we have attempted to highlight some of the major issues that set the conditions for the future of environmental degradation in Africa. We have argued that environmental change in the region is contingent upon poverty trends, consumption styles and corporate interest intertwined with official illegality. While population change remains critical for environmental degradation, corporate–state practices, consumption habits, poverty and HIV/AIDS remain decisive. In placing more emphasis on these factors, this chapter acknowledges that environmental degradation is complex and requires solutions that recognize the political nature of environmental issues. Political ecology provides more robust conceptual framework for understanding the ecological crisis the region is facing and providing a sense of where the continent might be heading if these trends persist.

The role of NEPAD also, particularly, remains decisive in the region. This is because the more neo-liberalism seems to offer little hope for the region, including stopping and reversing the plunder of the region's resources. NEPAD's own aspirations are overrun by strategies that embrace the neo-liberal ideology. More important, the indifference on the part of NEPAD in seeking alternative imaginations of development seems to suggest that the unholy alliance between predatory

international capital and official illegality in the region will continue to thrive. It is the concatenation of these factors that foreground the future of the environment in the region. But more importantly, this chapter provides a sense of the enormity of the environmental challenge at hand, and what it will take to halt and reverse environmental degradation in Africa.

References

Adams, W.M. (2004) *Against Extinction: The Story of Conservation*. London: Earthscan.

Adams, W.M. (2009) *Green Development: Environment and Sustainability in a Developing World*. London: Routledge.

Agrawal, A. (1995) Dismantling the Divide Between Indigenous and Scientific Knowledge, *Development and Change* 26(3): 413–439.

Allen, D. (1976) *The Naturalist in Britain*. Harmondsworth: Penguin.

Balmford, A. and Whitten, T. (2003) Who Should Pay for Tropical Conservation, and How Could the Cost be Met? *Oryx* 37: 238–250.

Bond, P. (2005) *The Elite Transition.* Pietermaritzburg: University of KwaZulu Natal Press.

Bond, P. (2006) *Looting Africa: The Economics of Exploitation*. London: Zed Books.

Chirwa, W. (2005) Macroeconomic Policy Choices and Poverty Reduction: Access to Land, Poverty and Growth in Malawi, Policy Brief. Zomba.

Crush, J. (ed.) (1995) *Power of Development*. London: Routledge.

Desai, A. (2002) *We are the Poors: Community Struggles in Post-Apartheid South Africa.* New York: Monthly Review Press.

Ellis, F. (2003) *Human Vulnerability and Food Insecurity*, Paper for Forum of Food Security in Southern Africa. Johannesburg.

Elrlich, P. (1972) *The Population Boom*. London: Balantine.

Ferguson, J. (1999) *Expectations of Modernity: Myths and Meanings of Zambia Life on the Zambian Copper Belt.* London: University of California Press.

Ferguson, J. (2005) Seeing Like an Oil Company: Space, Security, and Global Capital in Neoliberal Africa, *American Anthropologist* 107(3): 377–382.

Ferguson, J. (2006) *Global Shadows: Africa in the Neoliberal World*. Durham: Duke University Press.

Forsyth, T. (2003) *Critical Political Ecology: The Politics of Environmental Science.* New York: Routledge.

Grove, A. (1977) Desertification, *Progress in Human Geography* 1: 296–313.

Harrison, K. (1991) Between Science and Politics: Assessing the Risks of Dioxins in Canada and the United States, *Policy Sciences* 24: 367–388.

Harvey, D. (2005) *A Brief History of Neoliberalism*, New York: Oxford University Press.

Hoogvelt, A. (2001) *Globalization and the Postcolonial World: The New Political Economy of Development.* Baltimore: Johns Hopkins University Press.

Ikelegbe, A. (2006) The Economy of Conflict in the Oil rich Niger Delta Region of Nigeria, *African and Asian Studies* 5: 23.

Kalipeni, E. et al. (2004) *HIV and AIDS in Africa: Beyond Epidemiology*. Oxford: Blackwell Publishing.

Lamb, P. (1979) Some Perspectives on Climate and Climatic Dynamics, *Progress in Physical Geography* 3: 215–335.

Mackenzie, A. (2000) Contested Ground: Colonial Narratives and Kenyan Environment, *Journal of Southern African Studies* 26: 697–718.

Malawi Government (2001) *Malawi National Land Policy*. Lilongwe: Malawi Government.

Mintz, S. (1985) *Sweetness and Power: The Place of Sugar in Modern History*. New York: Penguin Books.

Moyo, S. and Yeros, P. (eds.) (2005) *Reclaiming the Land: The Resurgence of Rural Movements in Africa, Asian and Latin America*. London: Zed Books.
NEPAD (2001) *Strategic Framework for Africa's Renewal*. Johannesburg, South Africa.
Panitch, L. and Leys, C. (eds.) (2006) *Coming Terms with Nature: Socialist Register*. Monmouth: The Merlin Press.
Peet, R. and Watts, M. (2004) *Liberation Ecology: Environment, Development, Social Movements*. London: Routledge.
Potts, D. and Bowyer-Bower, T. (2004) *Eastern and Southern Africa: Development Challenge in a Volatile Region*. London: Prentice Hall.
Power, M. (2003) *Rethinking Development Geographies*. New York: Routledge.
Rodney, W. (1972) *How Europe Underdeveloped Africa*. London: Bogle-L'Ouverture Publications.
Rogers, H. (2005) Titans of Trash, *The Nation* 281: 21–23.
Salisbury, E. (1964) The Origin and Early Years of the British Ecological Society, *Journal of Ecology* 52: 13–18.
SAPRIN (Structural Adjustment Participatory Review International Network) (2004) 'Structural Adjustment, Poverty and Inequality (Chapter 9) in: *Structural Adjustment: The SAPRIN Report.* London: Zed Books, pp. 203–225.
Shiva, V. (1997) *Biopiracy: The Plunder of Nature and Knowledge*. Boston: South End Press.
Tandon, Y. (2002) On NEPAD: Critical Civil Society Perspectives, *SEATINI Bulletin* 5(4).
Thomas, K. (1983) *Man and Natural World: Changing Attitudes in England, 1500–1800*. London: Allen Lane.
Thomas, D. and Middleton, T. (1994) *Desertification: Exploding the Myth.* Chichester: Wiley.
Turshen, M. (1984) *Political Ecology of Disease in Tanzania*. New Brunswick: Rutgers University Press.
United Nations (2008) Millennium Development Goals Report: New York.
Walpole, M. and Wilder, L. (2008) Fauna & Flora International, *Oryx* 42(4): 539–547.
Warren, A. (1996) Desertification, in: WA Adams et al. (eds.) *The Physical Geography of Africa.* Oxford: Oxford University.
Weis, T. (2007) *The Global Food Economy: The Battle for the Future of Farming*. London and New York: Zed Books.
Woodhouse, P. (2008) *Water Rights in South Africa: Insights from Legislative Reform*. Brookes World Poverty Institute Working Paper.
World Bank (2008) global Monitoring Report. Washington, DC.

Index

Note: The letters *f* and *t* following the locators refer to figures and tables respectively

I.N. Luginaah, E.K. Yanful (eds.), *Environment and Health in Sub-Saharan Africa: Managing an Emerging Crisis*, DOI 10.1007/978-1-4020-9382-1_BM2,