The World We Live in and The World We Want To Live In

magazine

This Edition: A focus on Africa

## Maasaii Pastoralism

Alt Energy Sustainable Energy Solutions in Ghana Mount Kilimanjaro's Micro-Climates

Ghana Floods Hydro-climate Hazards

Volume 1, 3rd edition, Spring 2009

Visions Magazine is dedicated to the world we live in and the world we hope to create. Visions is a non-partisan, peer-reviewed publication that contains articles from disciplines associated with environmental studies. Just a few of these disciplines include poilitcal science, economics, philosophy, religion, art, and English. Visions Magazine is a faculty-student organized and operated publication which features the works of Elon University students and student-faculty collaborations. The ultimate goal of Visions is to allow students to explore scholarly research, writing, and review in a professional setting. In addition, Visions provides the opportunity to publish for students with interests in the environment and sustainable development.

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Visions Magazine seeks compelling, interesting, well-written, creative contributions on environmentally related topics. Major contributions to the magazine should be grounded in scholarly literature and/or reflect the conventions of research and writing associated with a specific academic field of study. All submissions must receive positive blind peer reviews before consideration for publication. We discourage submissions that are political or purely editorial in nature. For the next issue of Visions, we are especially interested in fiction, poetry, and photographic submissions.

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### Visions Magazine Table of Contents

## Features

Page 2:	The Socio-Economic Roots of Vulnerability to Hydro-climate Hazards in Northern Ghana By Andie Diemer and Mica McCullough
Page 5:	The Prospects for the Implementation of Sustainable Energy Solutions in Ghana By John McGreevy and Kristin Schulz
Page 12:	Economic Growth, Urbanization & Air Quality in Mexico City and São Paulo By Dan Jennings
Page 24:	Temperature-Altitude Zones on Tanzania's Mount Kilimanjaro By Maggie Zimmerman
Page 28:	Effect of Increased Carbon Dioxide on the Growth Rate of Juncus roemerianus By Mariana Poole, Gracen Smith, Brant Touchette
Page 30:	Livelihoods, Land Use and Landscape Conservation in East Africa By Evan Ross
Page 46:	Poetry -feeding the Birds -Jury By Chris Pickens -A Green Drake Hatches on West Branch Pond By Cory Landon -Sockeye Love By Luke Johnson -At the Community Garden in Moulsecoomb By Hilry Hazelwood
Regular R	ead <i>s</i>
Page 27:	Book Recommendations
Page 44:	Quick Reads
Page 48:	Who's Counting?

Saturday Morning - Photo courtesy of Shifted Reality.

## The Socio-Economic Roots of Vulnerability to Hydro-climate Hazards in Northern Ghana

by Mica McCullough and Andie Diemer

Abstract: Floods and droughts-collectively termed hydro-climate hazards-are responsible for considerable human suffering in the semi-arid regions of West Africa, including the biological transition zone between the southern Sahara desert and the wooded lands to its south known as the Sahel. Since there has been a history of drying events in the Sahel, many countries have created drought emergency plans. However, there are few vulnerability assessments for the more occasional flood events, despite the significant impact of both hazards. In August and September 2007, extreme flooding affected more than one million West Africans in 17 countries; more than a quarter of those affected lived in northern Ghana. This paper uses newspapers, academic journals, and personal interviews with US-based experts on Ghana and Ghanaians from late 2007 to early 2008 and January 2009 to analyze recent unintentional and deliberate flood events in northern Ghana. The purpose of this research is to examine why the events were so damaging and evaluate solutions for mitigating the effects of potential floods on northern Ghana and its people. Our research suggests that intensive grazing, poverty-induced deforestation and poorly planned development projects have exacerbated desertification and the harmful effects of floods. In order to mitigate these effects, directing additional funds and resources towards the northern region by the Ghanaian government is recommended. The northern region is far less developed in educational attainment, employment opportunities, infrastructure, and disease control, in comparison to Ghana's southern region. One inexpensive solution to northern Ghana's woes would be for the government to distribute tightly woven nylon cloth water filters to areas where people are suffering from dracunculiasis due to ingestion of water contaminated with guinea worm larvae. Worldwide, dracunculiasis is higher in northern Ghana than anywhere on earth other than the Sudan and flood events can spread contaminated waters and thus the likelihood of contracting the disease.

#### Introduction

n 1999, extreme flooding in northern Ghana damaged or destroyed homes, crops, irrigation networks, dams, and livestock and killed at least five people (UN, 2001). The resulting lack of access to clean water and water-borne diseases affected as many as 290,000 people and created considerable threats from cholera, diarrhea, and typhoid (Hastings 2005, 56). In late August and early September 2007, after months of drought, heavy rains again caused major floods across much of West Africa's Sahel. Northern Ghana was hit especially hard, with at least 20 people killed and more than 400,000 displaced (Ross, 2007). By late September 2007, nearly 20,000 homes had been destroyed in Ghana's Upper East Region (Serving in Mission, 2008). In northern Ghana, these environmental hardships exacerbated socio-economic inequalities faced by the predominantly Muslim population. The northern and southern regions differ greatly in their ethnic identities, cul-Page 2 Visions Magazine

tural practices, religious beliefs, and overall lifestyles; the north is often considered under-developed in comparison, a situation that is further exaggerated by the effects of desertification and flooding. This paper examines why recent flood events were so damaging and evaluates solutions for mitigating the effects of potential floods on northern Ghana and its people. The authors used newspapers, academic journals, and interviews conducted between 2007 and 2009 to analyze hydro-climate hazards including droughts and recent unintentional and deliberate flood events in northern Ghana.

### Northern Ghana's Environmental History

The environmental degradation and exploitation of resources started before British colonization. Since Ghana's independence from Britain in 1957, the overall trend of exploiting resources with minimal regard for the environmental consequences has generally persisted, especially in the north. Although Ghana's Constitution allowed for some regional autonomy in Ghana's poorer regions, such as the Northern, Ashanti Eastern and Volta regions, the central government was charged with creating and enforcing all environmental policies (World Bank, 2006, 27). There was little effort on the part of the central government to protect the environment, whereas every effort was made to ensure that the economy could flourish. Little was done to address deforestation, overcultivation and urbanization, all of which were becoming increasingly common and detrimental. Although urbanization and the consumer-oriented lifestyles that were more typical of Ghana's south were the origin for much of the country's environmental degradation, people in rural areas in the north were also using resources in different—but still environmentally harmful—ways.

Environmental problems, which were especially pronounced in the north, included the following: collection of

wood for cooking or sale, the removal of vegetation and compaction of the soil by grazing domesticated livestock and the burning of wood to create charcoal for use as fuel. All of these practices were increasingly suspected of contributing to the desertification process (Thomas, 1994, 81). In the 1970s, in an effort to assist the northern inhabitants in their region's drying condition, the Ghanaian Government drilled boreholes to improve access to drinking water. This effort at environmental management had several unintended side effects, including the



Organic matter that accumulated on tree branches during the floods serves as a reminder of the rise in water levels during the floods. Photo by Mica McCullough

concentration of grazing near the boreholes, which intensified vegetation loss, root system damage, and soil compaction. The destruction of root systems exposed the soil and increased the likelihood of erosion. The harder ground reduced the rate at which rainwater infiltrated into the soil, thereby increasing the risk of flooding after heavy rains (Thomas, 1994, 69-71).

Although Ghana once contained the largest moist tropical forest in West Africa, currently less than 15 percent of the original forest vegetation remains (Aryeetey-Attoh, 1997, 37) Reforestation programs designed to slow desertification, alleviate soil compaction, and reduce the risk of flooding have been hindered by spiritually-based resistance in some northern villages. According to George Awudi, (2007), program coordinator on desertification for Ghana's chapter of Friends of the Earth, people in the Bongo district believe that those who plant a tree will die as soon as the tree outgrows them. With fewer trees to act as windbreaks, wind storms are more destructive. Because of the decreased forest cover, environmental education in the Bongo district is more important than ever; as part of these environmental mitigation efforts, the burning of wood to create charcoal has been banned (Kokutse, 2007). Urbanization is another means by which rainfall absorption has been reduced in northern Ghana. With the increase in impervious surface area, the quantity and force of water runoff increases, resulting in destabilized soils, damaged vegetation, and polluted water sources.

### Socio-Economic Vulnerability to Flooding in Northern Ghana

To better understand and appreciate the environmental history of northern Ghana, it is integral to place the region in the national context of a 'north-south divide' (World Bank, 2006). The socio-economic inequalities between the north and south are significant; the average per capita income in the north is two to four times lower than in the south, and while the overall number of poverty-stricken people is relatively stable, the depth of poverty is far worse in the north (World Bank, 2006).

A history of discrimination, regional underdevelopment and illconceived development projects has left northern Ghana especially vulnerable to hydro-climate hazards. People with few resources engage in land use activities that accelerate soil compaction and erosion, drive desertification, and increase the frequency and severity of flood events. The disadvantaged people of the north have significant trouble recovering from such damaging drought and flood events, and the limited resources the people possess could result in

a very slow reconstruction process. Therefore, if events are closely spaced, recovery from one event may not be completed by the time the next event strikes.

The severity of flood-related damage in the northern subregion was magnified by the release of a considerable volume of water from an upstream dam in neighboring Burkina Faso to alleviate its own flooding problems. As the ground saturated, walls began to collapse and in some instances entire villages were washed away, which led to excessive displacement. Much of the damage in northern Ghana could have been lessened if homes had been constructed of cinderblock walls on concrete foundations instead of the baked mud and wattle walls placed directly on the ground, as the majority of this poor rural area's housing was constructed. Further damage included drinking water contamination, destruction of countless crops, and the loss of large amounts of livestock (Ross, 2007).

The August-September 2007 floods were not a total surprise since they arrived during the typical May to October rainy season, but communities simply lacked sturdy homes and sufficient facilities to deal with the floods; such facilities include storm drainage systems, flood warning systems, flood insurance, and flood zone demarcation or enforcement programs. Because of this lack of flood-related infrastructure, people in the hardest hit northern regions had no legal right to demand compensation for damage, but were forced to rely on the efforts of various agencies including the UN, Salvation Army and Red Cross. Ironically, due to its ease of access, most relief efforts were centered in Tamale, the capital of the Northern region, which suffered less damage than the poorer, rural areas (UN News Service, 2007).



Warthogs graze in Mole National Park. Contrary to the tropical forests of the south, northern Ghana maintains a savanna environment.

Photo by Evan Ross

Ghana's Deputy Minister of Local Government, Rural Development, and Environment, reiterated that the central government was committed to the development of Northern Ghana. However, he advised northerners against politicizing development projects and requested that external agencies continue assisting the region to amend its flood-related damages (Bongo, 2007). The tragic flood events of late 2007 did not prompt the government to invest in projects that might mitigate the impact of future flood events in Ghana's north. As a result, northern Ghanaians continue to remain vulnerable to flood events and the recovery and rebuilding process may take much longer than necessary because of the region's inhibited ability to recover from flood-induced losses.

### Conclusion

Livestock grazing, cutting trees and other human activities are not necessarily detrimental, but rather "it is their intensity, the specific localities that they affect, and their occurrence relative to other environmental attributes that lead to degradation," (Thomas, 1994, 83). If Ghana were to invest more heavily and more wisely in its northern region, it is likely that intensive grazing and excessive woodcutting could be curbed, thus potentially reducing desertification, soil compaction and erosion, and subsequently the severity of future flood events. Despite multiple devastating floods within the past decade, the Government of Ghana has found that creating a flood policy or program to reduce the vulnerability of northerners is more challenging than anticipated.

Ghanaians elected a northerner, John Mahama, to the Vice Presidency in January 2009, but given Ghana's weak overall economic situation, Mahama will likely be unable to dramatically increase funding to the north in the near future. One in-

### Page 4 Visions Magazine

expensive approach to improving conditions in northern Ghana would include stepped up efforts to eradicate guinea worm. This could be undertaken by the Government of Ghana in conjunction with non-governmental organizations by distributing tightly woven nylon cloth water filters to people suffering from dracunculiasis due to ingestion of water contaminated with guinea worm larvae. Worldwide, dracunculiasis is higher in northern Ghana than anywhere on earth other than the Sudan and flood events can spread contaminated waters and thus the likelihood of contracting the disease.

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## The Prospects for the Implementation of Sustainable Energy Solutions in Ghana

by John McGreevy and Kristin Schulz

**Abstract:** Most poor households in developing countries, reflecting more than 2.4 billion people or more than one third of humanity, rely on burning traditional biomass fuels like crop waste, dung, and wood to meet their basic energy needs. As a developing nation, Ghana is currently taking progressive steps towards widespread utilization of renewable energy, particularly to reduce dependence on nonrenewable energy sources that may harm both the environment and economic sustainability. This study assesses the prospects for the implementation of sustainable energy solutions in Ghana, through analysis of newspaper articles, published surveys and studies, and information obtained from Ghana's Ministry of Energy and the Energy Commission on hydroelectricity, nuclear fission, wind and solar energy, biomass use, and biofuels. Findings included that although Ghana has steadily increased its fossil fuel use since 2000 and has moved from being a net exporter of energy, mainly electricity, to a net importer, that the country has made considerable advances in hydroelectric and, to a lesser extent, solar energy use. The most cost effective means to improve Ghana's energy independence along with human and environmental health will be through the widespread adaptation of small, fuel efficient stoves, especially in rural areas. These findings are important because they suggest that smaller scale projects and relatively modest funds can bring considerable positive energy returns not only to Ghana, but also potentially many other developing countries currently heavily reliant on biomass fuels.

A s a developing nation in a world that is facing unprecedented environmental issues and serious concerns about the future of Earth's natural world as well as the sustainability of vital resources, Ghana has the chance to learn from the mistakes of older countries to develop in a new way that will not only minimize harmful effects on the environment but also propel Ghana towards economic success and prosperity. This paper presents the renewable energy sources Ghana is currently exploring, considers the positive and negative aspects of each, and examines future possibilities based on failures and successes in other regions. It also examines the government's and the general public's stance on the use of sustainable energy technology in Ghana, their beliefs about its implementation and what is being done to educate the population and encourage these technologies.

The research presented here was collected from reports of previously conducted surveys and studies in Ghana and sub-Saharan Africa done both domestically by independent researchers and by international organizations, information compiled from recent Ghanaian newspaper articles, and websites such as Ghana's Ministry of Energy and the Energy Commission. The paper explores six renewable energy technologies that have already been applied or are in the planning stages of implementation as well as lesser known, newer technologies that could be viable solutions in the future such as hydroelectricity, nuclear fission, wind and solar energy, biomass and biofuels. Finally, information about current government policies, programs, barriers to widespread utilization of renewable energy technology and suggestions for dissemination are presented.

### Hydroelectricity

Ghana became independent in 1957 and within four years began construction of a large dam and hydroelectric power plant that would lead to the formation of the world's largest man-made lake. Ghana became a key supplier of electricity to neighboring West African countries, but the economic gains were not without environmental consequences. The Akosombo Hydroelectric Project (HEP) was one of Ghana's first big undertakings as an independent nation. The construction of the Volta River Project at Akosombo began in 1962 and by 1966 Lake Volta, the world's largest man-made lake (covering a total area of 8,500 square kilometers or 4% of the total land area in Ghana), was completed (Tamakloe 1994). Its original purpose was to provide electricity for the Volta Aluminum Company (Gyau-Boakye 2001), but as its production boomed it became a central power source for the entire country and the surplus of electricity became profitable for Ghana in its export to neighboring countries. However, "during the last decade electricity production has become insufficient and a growing number of power outages took place which threatened

Ghana's economic development," and lately Ghana has even had to turn to Nigeria to import fossil fuels to ease the demand (Afrol News 2008).

This project was seen as the key to Ghana's industrial development. Although well-intentioned, the program lacked adequate planning and was not executed well for a number of reasons. In order to create the space for Lake Volta, the government of Ghana required the resettlement of some 80,000 people scattered across 7,770 square kilometers and nine different ethnic groups (Tamakloe 1994). Most of these people were subsistence farmers and the policy forced them into artificial settlements and onto small, uncleared farming plots (Tamakloe 1994).

Cultural practices were also broken down as a result of the dam because many sacred places of ancestors were submerged by the project and/or culture groups were dispersed due to the mandatory resettlement which broke down their traditional social order (Gyau Boake 2001). Tamakloe (1994) states that the major dilemma with Ghana's institutionalized resettlement plan and the hydroelectric project in general was that the Ghanaian government promoted sustainable development in terms of Western-style innovation. Groups of resettled people were unable to identify with a structure and system that seemed so foreign to anything they were used to and thus they felt no personal connection with the need for it to be a successful venture.

In addition to the farming, economic, and social stress issues that were created due to the resettlement plan, the Akosombo Hydroelectric Project (HEP) has led to microclimatic changes. "Since dam construction there has been a general increase in shoreline recession rates to the east of the Volta River, caused by reduction of sand supply from the river following dam construction" (Ly 1980). Soil erosion has led to the destruction of agricultural land (Gyau-Boakye 2001).

There is evidence that the project has caused such ecological changes as a decline in the diversity of the flora and fauna in the region and increase in the incidence of some common endemic water-borne diseases. Figure 1 is a graph showing the dramatic increase in reported cases of endemic water-borne diseases based on data collected by the Water Resource Research Institute taken between 1986 and 1988 (Gyau-Boakye 2001).



Figure 1: Rise in bilharzia, malaria, and ochorcereiasis (river blindness) following construction of the Akosombo Dam, source: Gyau-Boakye, P, 2001.

The Volta River Project cleared vegetation from such a large area in the savannah zone that currently there is not enough plant life to break winds or protect water reservoirs from concentrated sun exposure. The lack of these natural bar-



South of the Akosombo Dam, the Adome bridge crosses the Volta River. Photo by Kelly Parshall

riers is subjecting Lake Volta to intense evaporation from the rising temperature caused by this phenomenon (Gyua-Boakye 2001). Furthermore, there is evidence of detrimental effects of erosion in the Volta river basin. This is because the dam prevents the natural flow of sediments and periodic flooding that is key for proper soil nutrition. The dam has also increased suspended sediment concentration in parts of Volta River, which has been known to harm fish populations. Based on measurements from the Water Resource Research Institute (WRRI), there is evidence of significant sediment erosion around the piers that support the dam thus creating concern about the stability of the structure (Gyau-Boakye 2001). Following the construction of Akosombo Dam, the flood-flushing of the river mouth stopped which is causing an eastward shift of the river's path and threat of a rapid release flood that could have a disastrous effect on estuarine communities and other regional fauna (Gyau-Boakye 2001). The decline in amounts of natural sediments along with morphological changes in the direction of the river's flow and climate change factors are correlated with the bloom in aquatic weeds that is becoming an impediment to both lake transportation and the fishing industry (Gyau-Boakye 2001).

Although the dam has been an important power source and successful in increasing certain industries and commercial activities (lake transportation, tourism, and seasonal farming along the lakeshore), the negative effects have outweighed the positive. Moreover, the dam is not effectively serving its primary intended purpose- to generate the required electricity that would satisfy both industrial and domestic consumption and bring electricity to more people. In fact, starting as early as 1983, power rationing has taken place in Ghana (Gyau-Boakye 2001). We can see in this example that the first Ghanaian administration showed remarkable innovation for their time by trying to implement a source of sustainable energy in such a young, developing nation. Their downfall lies in their lacking of expertise, planning, and execution of the project that has now led to even more problems socially, economically, and environmentally.

The Ghanaian government has shown even more interest recently in applying other forms of renewable energy in the country. Concern arises in considering whether lessons have been learned from the mistakes with the Akosombo HEP, or if they still lack the expertise, funding, and effective management to effectively and safely implement such complex undertakings as building nuclear power plants, harnessing wind energy, employing solar photovoltaics, and utilizing other new and sustainable technologies. Small scale hydroelectric use has been shown to achieve promising results for minimal negative impact on the environment and quality of human life in the surrounding area.

### Nuclear Energy

The concept of developing nuclear power in Ghana is a topic that is currently receiving a great deal of media attention. Both those supporting and opposing this idea have been adamantly arguing their cases, and the discussions will likely continue for some time.

Despite some controversy on the matter, the Accra cabinet has decided to go forward with plans to build a nuclear power plant that would produce 400 megawatts of electricity. This plan is intended to help cater to the demand that is not sufficiently being met by hydro and thermal sources alone (Afrol News 2008). Ghana's Energy Minister stated that nuclear energy is not as dangerous as it used to be, that it "would be the most feasible addition to Ghana's current power sources", and that only "ignorance" was causing continued fear of this promising energy source (Afrol News 2008). Erasmus Aborley, coordinator of the Friends of the Earth Ghana non-governmental organization, argues that "Ghana lacks the expertise and the managerial ability to establish the Legal Infrastructure for Nuclear Energy Programme and the Draft Nuclear Regulatory Authority (NRA) Bill (begun at the Ghana Atomic Energy Commission in November 2007)" (Koranteng 2007). In response to this argument, the Ghanaian government has taken careful steps in their decision and is by all means not rushing into the process of developing nuclear energy within the country. Focus groups and specific commissions have been formed to explore nuclear energy in depth and ensure that Ghana would be taking the necessary precautionary steps. These include the primary governmental advising boards-The Ghana Atomic Energy Commission and The Radiation Protection Board.

A specific academic department: the Radiation Protection School of Nuclear and Allied Sciences has also been developed by the University of Ghana. The Ghanaian government is also working closely with international organizations, particularly the International Atomic Energy Agency. In doing so, they attempt to analyze what has and has not worked in other countries currently developing nuclear energy.

Professor John Humphrey Amuasi, Dean, School of Nuclear and Allied Sciences, University of Ghana, Atomic Energy Campus said the introduction of a nuclear power programme in Ghana and its successful execution would depend largely upon Ghana's ability to master operating a reliable and adequate electric power generation, transmission, and distribution system and how to implement expansion when the need arises (Ameyibor 2007).

### Wind Energy

Initial studies to assess the wind potential of the country concluded that Ghana did not have favorable wind conditions for the generation of wind power, but more recent research has shown that potential exists along coastal regions. Here, winds may produce up to 2000 MW of power. There are indications that within the next few years, the first wind park in Sub-Saharan Africa could be built along the



While most of the country is considered unsuitable for wind energy production, winds along Ghana's coast have the potential to produce up to 2,000 MW of power. Photo by Evan Ross



Ghana receives an average solar radiation of 16 to 29 MJ/m2/day. Photo provided by John McGreevy

coast of Ghana (Edjekumhene and Brew-Hammond 2001). Wind energy development in this and other Sub-Saharan nations is facing challenges as a result of the limited access to information on wind technology and wind resource assessment. Largely due to low wind speeds and high prices of equipment, the bulk of wind machines found in Sub-Saharan Africa are used for large and medium scale water pumping (primarily by large rural farmers) rather than for electricity generation (Ministry of Energy 2008). However, a number of countries in the region (such as Namibia, Zambia, Zimbabwe, Mauritania and Kenya) have made some encouraging progress with larger scaled wind machine projects (Ministry of Energy 2008).

### Solar Energy

Although some solar energy use has been seen in Ghana over the years, the power of the sun has been described by some as "largely untapped" in this African country (Edjekumhene et. al. 2006). Other studies argue that the strategy of rural solar photovoltaics (generating electricity directly from solar panels) implementation in Africa is unrealistic and in need of broad reform (Karekezi and Kithyoma 2002). Whatever happens to the photovoltaic (PV) industry, the potential for harnessing solar energy cannot be ignored, especially in the northern regions. Ghana basks annually in an average solar radiation from 16 to 29 MJ/m2/day (Painuly and Fenhann 2002). In the United States, average solar radiation ranges from 12 MJ/m2/day in the Pacific Northwest to 20 MJ/m2/day in the desert-laden Southwest, where large amounts of solar radiation are converted to electricity (Emerson and Weiss 1992). While areas of southern Ghana receive highly diffused sunlight, the northern region is hit with more direct sunlight, making these largely rural areas a prime site for utilizing solar radiation (Painuly and Fenhann 2002).

When thinking of solar energy in rural Africa, mental images arise of ideal villages where every hut has a solar panel on its roof and residents smile as they cook dinner and light their homes with the clean, renewable electricity powered by rays of sun. The fight for renewable energy in Africa over recent decades has focused on photovoltaics technolovy (PV). Using this technology, solar cells convert light energy from the sun into usable electrical energy without releasing harmful chemicals or particulate matter. The idea has been so widely supported that nearly every country on the African continent has a solar PV project (Karekezi and Kithyoma 2002). A more in-depth look into the feasibility of rural PV use shows various implementation issues that may take away much of the solar enthusiasm in Ghana and all of Sub-Saharan Africa.

Studies suggest that a renewable energy strategy in Ghana based mainly on solar PV will not provide the desired results. Even the most basic of PV solar collector systems have higher costs than the GNP per capita of Ghana. Furthermore, a large influx of PV technology would prove detrimental to the Ghanaian economy. Given that over half of the costs of this energy source comes from imported solar panels and solar batteries, both an increased dependence on foreign imports for energy and a lack of job creation will result (Karekezi and Kithyoma 2002).

Using building methods for maintaining relatively constant air temperatures in buildings is often overlooked in solar energy studies. Due to the low implementation costs if done at the proper time, these techniques can help conserve energy in the those areas of Ghana where this may be necessary.

### Biomass

Keeping to the common trend amongst developing nations, Ghanaians use traditional methods of energy production above all others. Due to limited modern fuel source access in rural areas, high costs of petroleum-based fuels, and the availability of woodfuels, biomass remains the number one energy source of the country. Led by the 18 million tons of fuelwood burned annually (mainly in the form of firewood and charcoal), biomass accounted for 69% of Ghana's total energy use in 2000 (Edjekumhene et al. 2006).

This fuel source is used mainly for cooking and water heating, and comes in the form of firewood, charcoal, and some crop residues. In the residential sector, firewood is the main energy source for 63% of households, while charcoal acts as the main source for 31%. These two sources alone account for the main energy source of 94% of Ghanaian households, and the majority of this is used as cooking fuel. While both urban and rural households use biomass as their primary energy source, the dependence is even more pronounced in rural areas (Edjekumhene et al. 2006).

Not only does this fuel account for 94% of the energy in these households, but many poor and rural families rely on biomass collection and sales as their main source of income (Edjekumhene et al. 2006). Rural households also tend to use firewood over charcoal, accounting for 84% of the cooking fuel. This is due to the high availability of firewood from natural sources. The cost of cooking fuels is also related to this trend, as seen by the negative correlation between the cost of fuels and the percentage of households that use it as their primary cooking fuel. From most to least expensive and from least to most commonly used in rural households, the cooking fuels are as follows: electricity, liquefied petroleum gas (LPG), kerosene, charcoal, firewood (Edjekumhene et al. 2006). This trend is slightly different for urban households, which still rely heavily on biomass but use charcoal as their primary cooking fuel. This is due to the increased availability of charcoal compared to wood in urban areas (Ghana Statistical Service 2000). The percentage of households using various cooking fuels as their primary fuel source is shown in the graphs below.

The question at hand is whether or not biomass in Ghana is truly a "renewable" resource. If used correctly, this energy source has potential to become entirely sustainable. Furthermore, through the use of designated woodplots and afforestation, this industry may become beneficial to the Ghanaian environment by increasing the number of trees in the country.

One current government effort to preserve forests and decrease dependence on destructive biomass use has been the promotion of liquefied petroleum gas (a condensed mixture of butane, propane, and other hydrocarbon gases, also known as LPG, commonly used as a cooking fuel) as an alternative. The negative effects of LPG may be overshadowed by the immediate danger of massive forest lost and ecosystem destruction in Ghana (Edjekumhene et al. 2006). Other methods with only minimal implementation thus far include afforestation, reforestation, and dedicated woodlots. Promising data can be seen in the recent success of these initiatives on American soil. Contrary to popular belief, the total number of trees in the United States has increased over the past four decades, and this has been significantly attributed to the national environmental improvements of tree farming for the paper industry (Lowman 2008).

While there is potential for sustainability, current trends in the clearing of natural forests do not support this. Onetenth of the biomass used in Ghana comes from such clearly renewable sources as sawmill chippings, crop residues, and replanted forests; the other 90% comes directly from the destruction of virgin forests (Edjekumhene et al. 2006). For this reason, even if the total number of trees were increased, virgin forests and unadulterated ecosystems will still be dismantled without proper regulation. Due to the short-term economic advantage of continuing these destructive techniques, the Ghanaian government must intervene.

The current woodfuel industry in Ghana is far from sustainable, but this does not render the situation hopeless. Through government initiatives and specific mandates for reforestation, the currently destructive trend of timber harvesting can be reduced. In time, the use of designated woodlots could even increase the total number of trees in the country. Furthermore, the use of excess agricultural waste and other forms of discarded biomass can both reduce the amount of waste accumulation and increase the amount of sustainable energy available to Ghanaians. Because of the larger impact this may have on less developed areas, it is vitally important that the wellbeing of rural families is considered when implementing a renewable energy plan under which significant changes to the rate of biomass consumption may occur. To respect the livelihood of these families, any program with proposed substitutes for biomass use must also include equal job opportunities in the rural regions of Ghana. Done properly and with the support of the local communities, these endeavors will not discourage traditional Ghanaian use of biomass for heating and cooking.



Ghana Statistical Service. "Report of the Fourth Round (GLSS 4)" Ghana Living Standards Survey, October 2000. http://www. worldbank.org/html/prdph/lsms/country/gh/docs/G4report.pdf (accessed March 28, 2009).

### **Biofuels**

Excluding some advancements in South Africa, the African continent has had little development in the area of biofuels ("Benefits and Risks" 2007). However, there have been a few pilot projects in Ghana involving the use of oil from palm kernels, sunflower seeds, jatropha, and other plant products for biodiesel and bioethanol production. The most promising of these ventures has been attempts at community-based production of biodiesel, as done by Dumpong Pineapple Growers Cooperatives in eastern Ghana. With the help of American partners, this company is using a simple palm kernel oil processing technique to extract the glycerine molecules necessary for fuel. The extraction is done by a mechanical system that is both easy to assemble and relatively cheap to create. In this system, two steel drums are welded together with an opening for an electrical heating tool. Dumpong Biofuels claims that this simple process creates palm oil fuel with a cost that is 25 percent less than the current market price of diesel fuel ("Community-Based Biodiesel" 2007). Moreover, new job opportunities and

sources of income have been brought into this community. From the increased production of palm kernel oil, the construction of the proper machinery, the operation of the biodiesel separation system, and the distribution of the final product, new jobs arise that did not previously exist ("Community-Based Biodiesel" 2007).

Reduced greenhouse gas emissions and reduced particulate emissions are amongst many of the potential benefits of this renewable energy source. Little is known about air quality and pollution levels in Ghana, but a rapidly increasing trend in urbanization and increased automobile use in these cities provides incentive to cut harmful emissions (Arku et. al. 2008).

Increased biodiesel and bioethanol production in Ghana will also lead to many economic improvements, including reduced fuel costs, decreased dependence on petroleum importation, and improved energy security ("Benefits and Risks" 2007). Perhaps the most promising benefit, however, is the potential increase of job openings for the growing feedstock, converting this to usable fuel, and dispersing the final product. Entirely new industries will be created with a shift to domestic biofuel production, along with increased economic activity. This may be particularly promising for Ghana, whose historically fast level of technological advancement when compared to other African nations, along with prime growing conditions for various biodiesel feedstocks, could lead to the export of this energy source to neighboring countries ("Benefits and Risks" 2007).

As with other potential renewable energy sources in Ghana, biofuels bring with them many uncertainties and possible negative effects. When introducing this into the national energy plan, it is important to recognize that biofuel is a new technology with many unknown factors, particularly for use in African countries. Some countries have had moderate success with this energy source, but Ghanaians must

Page 10 Visions Magazine

address a few fundamental concerns before full implementation takes place. The most essential of these is how feedstock production will affect land use and food production. In 2007, the price of food rose 3.1% in the United States, due primarily to the increased ethanol production (Barta 2007). The biofuel market uses 30% of the national grain harvest, nearly doubling the 16% used in 2006 (Barta 2007). The same resources are required for both biofuel plant products and agriculture in Ghana. Only after making sure that its full-scale implementation will not negatively effect food production in Ghana will biofuels be an appropriate solution.

Other concerns include the large start-up costs and policy issues. For a successful biofuel industry in Ghana, a comprehensive governmental policy is needed. Under this plan, the subsidy system for conventional fuels must be revised to give biodiesel and bioethanol opportunity for competitive pricing. The large start up costs will render this technology unfeasible for most small-scale farmers and manufacturers without funding from domestic and international investors ("Benefits and Risks" 2007).

This issue was addressed in 2006 when India donated

"...energy issues are on the forefront of Ghanaian minds"

\$250 million to fifteen West African nations for improved biofuel production ("India Gives" 2006). Of this sum, Ghana received \$35 million for increased biodiesel production from jatropha, creating a partnership between private farmers and commercial banks ("India Gives" 2006). While this by no means solves the

implementation problems of biofuels in Ghana, it shows that international support for such endeavors exists.

### Ghana's Environmental Programs and Policy

With the crisis of rolling blackouts and generally deficient access to electricity in rural areas, energy issues are on the forefront of Ghanaian minds. "An estimated 60-65% of the population is without electricity or any other form of modern energy" (Edjekunhene and Brew-Hammond 2001). Ghana will struggle to move forward as a developing nation if they cannot first harness reliable and sustainable power sources. Ishmael Edjekumhene and Abeeku Brew-Hammond argue (2001) that any sustainable development agenda must ensure that future generations have the same capacity to develop as future generations and that its overarching aim should be to raise the living standards of the people. Energy's role in this move forward cannot be stressed enough as it facilitates both public and private human activities. Furthermore, studies prove that "lack of available energy services correlates closely with many poverty indicators" (Edjekumhene and Brew-Hammond 2001). For this and other pertinent reasons, Ghana must have alternative energy research and programs for implementation at the top of its priority list.

The most important thing to consider is how these changes will affect the people who call Ghana home. Errors in assessing these changes can be seen in the detrimental social consequences of dam construction in the Volta Region. A comprehensive energy plan for this nation must address how the livelihoods of citizens will be affected.

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### Economic Growth, Urbanizaton & Air Quality in Mexico City and São Paulo by Dan Jennings

**Abstract:** This study explores the effects that economic growth, together with recent rapid urbanization in Latin American nations, has on the air quality of mega-cities. The research focuses on Mexico City, Mexico and São Paulo, Brazil, the region's two largest urban agglomerations as well as the most polluted. To determine future policies for quickly growing urban areas such as Lima, Peru and Santiago, Chile which face rising air pollution, an analysis of Mexico City and São Paulo's urban and economic development was conducted as well as an examination of their past and current measures of pollution control. An exploration of the influential factors contributing to air pollution as well as current obstacles was undertaken. In order to gain a perspective of current, local attitudes towards air pollution, which might influence the future of air quality policies, research into the content and tone of newspaper articles about air pollution from each city's leading news source was conducted. Based on economic transitions, migration patterns, and proposed policy ideas, combined with an examination of local perspectives, the future of air quality in the emerging cities of Latin America can be addressed, but will be dependent in part on geographic location which can play a considerable role in a city's air pollution levels.

### Introduction

Ver the past few decades, rapid rates of urbanization have led to the emergence of large urban agglomerations in developing nations. Thirty years ago, five of the world's ten largest cities were located in developing nations; by 2005 that number had risen to eight (United Nations 2005). In developing nations rural populations are moving to cities in search of opportunity as these cities become the center of their nation's industrial production. Yet, increasing urbanization in much of the developing world means that ever increasing numbers of people are being exposed to polluted city air (French 1990). Further, the booming population and increasing economic growth in the urban areas of developing nations are taking their toll on the environment.

Latin America is one of the most rapidly urbanizing regions in the world and as its cities grow they face the negative effects of air pollution, which results in more than 24,300 deaths each year (Romieu et al. 1990). This region contains two mega-cities, (generally defined as urban areas with a population greater than 10 million) both among the world's five largest cities: Mexico City, Mexico and São Paulo, Brazil. Both Mexico City and São Paulo have experienced severe pollution problems, especially in terms of air quality (Lewis 2007). As Latin America continues to grow economically and urbanize, rapidly growing cities such as Santiago, Chile and Lima, Peru are also facing growing air pollution.

Over the years, Mexico City and São Paulo have had limited success in enacting policies to fight air pollution, and air quality remains a problem with serious detrimental health effects on the nearly 20 million inhabitants of each city's metropolitan area. This paper will examine the effects of economic growth and urbanization on air quality in rapidly growing cities in developing nations, focusing specifically on Mexico City and São Paulo and what past and current measures they have taken in combating air pollution with the hope of determining future policies for the emerging cities of Latin America.

Page 12 Visions Magazine

### Methodology

For this study government reports, non-profit organization policy papers and Elon University's electronic databases and standard library holdings were used to examine the air quality of Mexico City, Mexico and São Paulo, Brazil. Of particular interest were historical studies, environmental data, studies of demography and public policy. In order to gain local perspectives on air pollution, an analysis of newspaper articles from the leading newspapers in both cities, Mexico City's El Universal and São Paulo's O Estado De S. Paulo, was conducted. Articles that mentioned air pollution in their respective city between the years of 2003-2008 were analyzed to provide insight into current and recent outlooks.<sup>1</sup> Also, in order to gain some perspective of the pollution problems facing the recently emerging cities of Santiago and Lima, an analysis of articles from Santiago's El Mercurio and Lima's El Comercio was undertaken. The articles analyzed were only from 2008 in order to gain a current perspective as air pollution is an issue which both cities are dealing with more and more. All translations from Portuguese were made using 'Babelfish' (http://babelfish.yahoo.com/) and some translations from Spanish were made using the same site. The study analyzes the air quality of the two cities in their past and present contexts and the political, economic, social and geographical factors that have and continue to affect their air quality and therefore health and development. By examining the successes and failures of Mexico City and São Paulo's past and current attempts at dealing with air pollution, the study hopes to contribute to the understanding of air quality problems in emerging mega cities.

<sup>1</sup>One significant setback in the investigation of O Estado de S. Paulo's reporting on air pollution was that no articles on the subject from 2004 and 2005 could be found in the newspaper's online database.



Autombile use in Mexico City is the dominant contributor to the city's air quality problems-Photo by Alicia Krawczak

### Urbanization and Economic Growth

Developing nations are currently witnessing increasing rates of urbanization. This urbanization in less developed countries is promoted by industrialization, which occurs as a nation's economy develops. Economic growth then spurs migration of rural populations to urban areas in search of jobs (Brunn et al. 2003). Urbanization in Latin America is a result of both economic growth and rural to urban migration. The region is experiencing such rapid growth rates that it is currently the most urbanized region in the developing world and, if present trends continue, within two decades it will be the most urbanized region in the world (Hillstrom and Hillstrom 2004).

There are serious consequences that come with this type of rapid urbanization that Latin America is experiencing. One of these consequences is environmental degradation; air pollution in particular. In general, this degradation is most severe in the cities of developing nations because, while developed nations have the economic ability to address pollution problems, developing nations tend not to regard such problems as important as economic concerns like production and job creation (Brunn et al. 2003). Ramón López and Michael A. Toman (2006) define this as a sort of ideological bias. They explain that policy-makers, pressured to increase production in order to continue economic growth, place higher priority on increasing GDP than decreasing pollution. Regulation of industry in Latin America is unfavorable because of the restrictions it can have on economic production (Ristroph, quoted in Hillstrom and Hillstrom 2004).

According to a report by Princeton University, between 1950 and 2000, the percentage of Latin America's population living in urban area's rose from 40% to 75% (Angel 2004). At the forefront of this urbanization are the cities of Mexico City and São Paulo. A United Nations population study found that since 1950 both cities have seen their population rise from 2 million to nearly 20 million (United Nations 2005). As the economic centers of their respective nations, both cities have attracted rural dwellers in search of jobs. This migration, coupled with industrialization, has promoted the economic growth of both cities.

Key to urban growth was the centralization of industry in both cities. From 1950-1980 urbanization occurred in both cities as government policies concentrated each nation's industrial production in their largest city (Rodriguez 1997; Rowland and Gordon 1996). Industrial centralization meant job opportunities for the rural poor and thus spurred the migration of rural populations to both cities (Keeling and Ridout 2002; Santos 1996). By 1970, Mexico City accounted for 42.1% of all people employed in manufacturing (Rowland and Gordon 1996). Wendy Keeling and Mike Ridout's case study of the city examines the rural to urban migration patterns. They point to the fact that 65% of the nation's economic activity is located in Mexico City and that rural populations come in search of jobs in many of the city's major industries such as oil, chemical and food processing plants (Keeling and Ridout 2002, 203). The massive migration helped fortify Mexico City as the industrial center of the nation today with around 35,000 industries located in the metropolitan area (Secretaria del Medio Ambiente del Distrito Federal 2002).

While Mexico City has a long history as the dominant city in Mexico, São Paulo only really began to boom in the early 20th century. The city was located in a prosperous coffee growing region and the profits from the trade led to the development of other industries. However, substitution industrialization programs, in which Brazil made basic goods rather than importing them, established São Paulo as the industrial center of the nation. By 1942 there were 27,000 factories located within the metropolitan area, providing employment for over a million workers (James 1942, 795). In 1950 São Paulo became the location of the nation's first automobile plant (Brunn et al. 2003, 143). Migration to São Paulo from rural areas has been high over the past half century as workers found employment in the bustling metropolis. By 1996, São Paulo contributed around 30% of Brazil's GNP and was home to 2.1 million manufacturing workers making it the second largest industrial city in the world (Santos 1996).

#### Sources of Pollution and Contributing Factors

According to the U.S. Environmental Protection Agency (EPA), there are six common air pollutants: ozone ( $O_3$ ), particulate matter (PM), carbon monoxide (CO), nitrogen dioxide (NO<sub>2</sub>), sulfur dioxide (SO<sub>2</sub>), and lead (Pb) (EPA, Six Common 2008). With both Mexico City and São Paulo switching to unleaded fuel in the 1990s, levels of lead in the air have decreased, but the other five common pollutants remain a serious threat.

In the 1960s and 1970s, the most significant cause of air pollution was from industrial sources. A 1977 inventory of emissions in São Paulo's metropolitan area found that industry was the leading source of both Sulfur Oxides (SOx) and PM and that mobile sources such as automobiles, planes, trains, and buses only made up 10% of total SOx emissions and 7.8% of total PM emissions. Yet, a 2001 inventory of emissions in São Paulo revealed that mobile sources made up 56% of total SOx emissions and 51% of total PM admissions. The reason for the dramatic change was that São Paulo's vehicle fleet had increased 750% since 1970 (De Assunção 2002).

Factory emissions continue to play a significant role in polluting the air, but the leading cause of air pollution is the growing number of vehicles on the road. Nearly 6 million vehicles crowd the streets of both Mexico City and São Paulo (Barclay 2007). As the population increases and the economy continues to grow, more and more people are beginning to drive. In 1994, Brazil implemented the Real Plan in response to decades of inflation. This economic stabilization program increased the income of lower-income groups resulting in a Page 14 Visions Magazine

rise in consumption (Hudson 1997). The success of this plan led to growth in the transport sector as a larger percent of the population was then able to purchase automobiles (Pinheiro et al. 2004). As more people began to buy cars in Mexico City during the 1990s, estimates showed that a 1% increase in GDP led to more than a 3% increase in automobile demand. Trade liberalization has also dropped the price of automobiles in Mexico (Landa 1995). The centralization that established Mexico City as the dominant urban agglomeration in Mexico is evident in the fact that 30% of all of the vehicles in Mexico are concentrated in its metropolitan area (Fernández 2007).

Such heavy automobile use results in dangerously high levels of ozone in the atmosphere. In Mexico City, the standard ozone level is violated on about 80% of days (Molina 2004). In 2002 the Company for Environmental Technology of São Paulo recorded 82 days in which ozone concentrations were above the acceptable limit (Osava 2003).

A city's geographical location can play a large role in contributing to air pollution problems. As altitude increases temperature decreases. Yet, a temperature or thermal inversion is a situation in which cooler, denser air cannot rise above a layer of warm air which acts like a lid. This prevents pollutants from dispersing into the troposphere, causing the buildup of pollution (Jacobson 2002, 160-161). Thermal inversions in inland areas occur whenever radiation from the Earth's surface is less than the radiation received from the sun, creating the layer of cool air near the ground; therefore thermal inversions are more common in the winter when the angle of the sun's rays is low in the sky. At night, these inversions trap pollutants by preventing them from blowing away creating a still, hazy layer of air. Mexico City is especially vulnerable to the pollution build up caused by thermal inversions because it lies in a basin surrounded by mountains, isolating it from regional winds that would help to disperse the stagnant air mass (Los Alamos National Laboratory, 1997).

Large cities like Mexico City and São Paulo also experience a phenomenon known as the urban heat-island effect. The heat-island effect describes urban areas that have a higher temperature than the surrounding rural areas. As an area urbanizes, vegetation and permeable land are replaced by roads and buildings, making for dry, dark surfaces that absorb heat. As a result, the surfaces of urban areas are much hotter than the moist, shaded surfaces of rural areas, thus creating an "island" in which temperatures are higher than the surrounding areas. This heat-island effect encourages pollution as higher temperatures create ground-level ozone. Mexico City's high elevation coupled with the great amount of sunlight it receives "...contribute to photochemical processes which drive the formation of ozone" (Molina 2004). The urban heat-island effect has health consequences on the urban population as it facilitates the occurrence of gastrointestinal diseases, to which older adults and children are most susceptible (Rivera 2006).

One way of combating the urban heat-island effect is to create urban green space. Green spaces are undeveloped outdoor settings with vegetation, such as parks that are located within cities. They play an important role in controlling temperature and air quality in urban areas (Bonsignore 2003). Gaseous pollutants (such as ozone) deposited on the leaves of plants in the green space are either absorbed on the surface of the leaf or are diffused into the leaf through surface openings. Trees in green spaces can shape the climate of a city through shading. Pollutants in the air react with high temperatures and humidity to create smog. The shading the trees provide cools the temperature, reducing smog (Escobedo 2007).

Both Mexico City and São Paulo witnessed their green areas diminish as they grew. Deforestation on the edges of São Paulo led to dramatic variations in temperature within the city as well as an overall rise in temperature relative to the 1960s. Temperature differences in São Paulo can reach ten degrees between points as close as ten kilometers apart (FAPESP 2006). Similarly, in the winter the temperature in the city center of Mexico City can be 9° Celsius while it can reach 0° Celsius 13 miles away in the City's borough of Xochimilco (Rivera 2006).

Air pollution is also linked to poor road systems as Latin America relies excessively on roads as their means of travel and the building of new roads simply means more traffic (Figueroa 1996). The poor road systems of São Paulo contribute to its air pollution problems (Jacobson 2002). In Mexico City poor city planning has resulted in low-income housing in areas that lack sufficient road capacity and access to public transportation (Molina 2004). Mexico City has failed to expand its road and rail transit systems in the areas that have seen the largest population growth, resulting in traffic congestion that contributes to pollution.

### *Limited Pollution Control: 1970s-1980s Mexico City and São Paulo*

In the 1970s, increasing levels of urban air pollution prompted Latin America's two mega-cities to begin to enact policies to improve their air quality. However, these early attempts proved largely unsuccessful and not until recently have significant strides been made. Mexico City's first attempt to regulate air pollution was the 1971 Decree to Prevent and Control Environmental Pollution. This decree called for monitors of outdoor pollution to be set up, but a full set wasn't implemented until 15 years later (Jacobson 2002). Mexico City's anti-pollution measures largely remained stagnant during the 1980s as economic crisis took financial priority away from environmental protection policies (Kasperson et al. 1995). In 1986, low-leaded gasoline was introduced in Mexico but this positive step was not as successful as hoped as the U.S. Energy Information Administration reported that by 1996, 44% of the gasoline sold remained leaded (Jacobson 2002).

In 1989 Mexico City implemented the No Driving Day Program, which involved not driving one day during the week. The results were a 20% reduction of the vehicles in circulation, an increase in traffic speed and a decline in the rate of gasoline consumption. However, this changed when the government made the plan permanent. Unhappy with public transportation, people reacted by switching license plates on their cars and buying more vehicles so that they could always have one car available which could be legally driven (Landa 1995). The way the No Driving Day Program worked was "…only cars with odd-numbered license plates could be driven on a given day and that cars with even-numbered plates could be driven on the next" (Jacobson 2002, 227).

Due to increasing vehicle emission rates, public transportation is an important alternative. Yet, both Mexico City and São Paulo have a history of poor investment and regulation, which has not allowed public transportation to make a significant difference. Public transportation has proved unable to provide any substantial relief because it cannot keep up with the population pressure, which then increases incentives for



Like Sao Paulo, Brazil, Lima, Peru sit along the nation's coast-Photo by Chrissy Orangio Spring 2009 Page 15

automobile ownership (Landa 1995). Rapid population increase in Mexico City resulted in population patterns that defined the relationship between the people and the city's public transportation. As Mexico City urbanized, new residents settled in the northeastern part of the city, where rents were cheap but public transportation was poor (James et al. 1986).

The insufficient development of Mexico City's public transportation can be traced to the investment in road construction in the 1970s, which encouraged private automobile use. One of the most significant road construction programs was the building of seventeen avenues with five lanes in one direction known as "ejes viajes" in 1979 and 1980. Two of the five lanes were for public buses but an increase in congestion led to changing most of the public bus lanes into normal flow lanes (Sheinbaum and Meyers 1995). This was a significant step in the movement towards the increase in private vehicles that would begin to change the face of Mexico City's transportation. An economic recession in 1982 resulted in a reduction of investment in public transportation and the development of public transportation began to lag behind a rapidly growing metropolis that witnessed an increasing number of private vehicles on the road (Sheinbaum and Meyers 1995). Over the past twenty years all of Latin America has seen a decline in the share of passengers riding buses. The share of passengers riding buses in São Paulo fell from 51% in 1977 to 25% in 1997. Mexico City has witnessed an even more dramatic decline as the proportion fell from 42% in 1986 to 8% by 1995 (International Energy Agency, quoted in Hillstrom and Hillstrom 2004, 193).

### Progressive Action: Mexico City and São Paulo post-1990

While air pollution continues to pose severe health threats, both Mexico City and São Paulo have made significant steps towards cleaning their air. Both cities eliminated leaded fuel during the 1990s and added more catalytic converters on cars (Barclay 2007). Mexico City has improved its plan to limit vehicle circulation and the recent inclusion of Saturday circulation restrictions has been successful in decreasing air pollution 32% (Tierramérica 2008). The city has worked to improve fuel quality, enforced a semi-annual vehicle inspection program and has invested in public transportation (Molina 2004). São Paulo has worked to expand its rapid transportation system in recent years and, more strikingly, it began a program called PROCONVE that restricts drivers from using their vehicles one day a week (Barclay 2007). São Paulo's Environmental Technology and Sanitation Company achieved some success in 1996 when they were able to convince the 162 major polluters (responsible for 96% of particulate emissions) to follow recommended procedures (Santos 1996). While Mexico City has seen a slight decrease in CO, O<sub>3</sub>, and SO<sub>2</sub> since the mid-1990s, levels remain high and have been consistent over the last decade (Davis 2008, 42-44). In order to deal with air pollution more effectively, new solutions must be considered.

Three possible long-term solutions to improve air quality have emerged in recent years: the Center for Sustainable Transport plan in Mexico City, the use of ethanol fuel in São Paulo, and the option of Electronic Road Pricing. In 2002 EMBARQ – World Research Institute Center for Sustainable Transport – together with Mexico City's government, created



Page 16 Visions Magazine

São Paulo Afternoon -StockXChng Photo by Ludmilla Rossi



Mexico City Skyline-StockXChng Photo by Jeinny Solis S.

the Center for Sustainable Transportation (CTS) with the objective to reduce Mexico City's pollution. The four primary projects of the CTS are:

- 1. The development of a Bus Rapid Transit System
- 2. Diesel "retrofitting"
- 3. Test clean fuels and buses
- 4. Promote non-motorized transport.

The creation of a Metrobus system would have several benefits such as increased productivity from time not spent in traffic and an estimated reduction of 35,000 to 70,000 annual tons of CO<sub>2</sub>. The non-motorized transport objective works to raise public awareness and promote bicycling by expanding bicycling lanes. Yet the project that is likely to have the biggest impact is diesel "retrofitting" (EMBARQ Mexico City on the Move).

With funding from the EPA, Mexico City implemented a pilot project to "retrofit" the city's diesel buses in order to reduce pollution. This project of "retrofitting" is a two-step process. First, it requires the removal of old, dirty buses that cannot be retrofitted from service. Second, new buses with electronic exhaust control systems must be retrofitted with catalyzed diesel particle filters and ULSD (ultra-low-sulfur-diesel) fuel imported from the U.S. (EMBARQ Diesel Retrofit Pilot Project). ULSD is a cleaner burning fuel because it contains less sulfur than regular diesel fuel, thus reducing the emission of toxic particles (ECY WA DOE 2008). The pilot project was a success resulting in a 90% reduction of both particulate emissions and carbon monoxide for newer buses and a 20% reduction of PM and a 52% reduction of CO for older buses (EMBARQ Diesel Retrofit Pilot Project). The success of the pilot project has led PEMEX, Mexico's state-owned petroleum producer, to announce that it will begin production of ULSD by late 2007(EMBARQ Cities on the Move).

If emerging Latin American urban agglomerations want to improve air quality, switching to alternative cleaner sources of fuel such as ULSD is an important, although expensive, prospect. Another recent popular alternative fuel source is ethanol, an industry, which has seen growth in Brazil, fueling more and more of São Paulo's cars. Ethanol is an alcohol fuel processed from sugar cane and has been the focus of considerable debates as to its effects on air quality. According to a Secretary of the Environment state report, São Paulo State is the nation's largest state producer of ethanol (De Carvalho Macedo et al. 2004). Many argue that ethanol is a legitimate alternative fuel source to gasoline that will help reduce air pollution as it is a cleaner burning fuel. A gasoline containing 10% ethanol (E10) can reduce carbon monoxide emissions by 20% (Morris 2000). There are, however, many who oppose its use. The burning of cane fields during the harvesting of ethanol releases high levels of nitrogen in the form of ammonia and nitrogen oxides into the air. The ammonia reacts with the nitrogen oxides to create ozone. The impact is higher hospital admissions for asthma and an increased risk of cancer for sugarcane workers. The sugarcane industry union of Brazil hopes to eliminate the burning of cane by mechanizing the harvest by 2017 (Engelhaupt 2007). In his 2007 investigation into the possible effects of an increase in ethanol fuel in the United States, Mark Z. Jacobson argues that, while emission differences between ethanol and gasoline fueled vehicles have been studied, the potential health consequences such as cancer and ozone-related illness from ethanol use has not been examined. He concludes that ethanol use has a similar cancer risk as gasoline and a higher risk of ozone-relatedillness.

In his study of Mexico City, Ramiro Landa makes a solid argument for Electronic Road Pricing (ERP) as a way to reduce air pollution. The ERP system taxes highway and main street use to reduce congestion. A high enough tax would discourage the use of vehicles. Since those with low incomes use public transportation more than those with a higher income, toll revenues could go towards expanding and improving public transportation. Also, matching voluntary periodic motor inspection with a vehicle "tune-up" would give drivers the incentive "...to have frequent tune-ups in order to qualify for a low fee" (Landa 1995).

Both cities have been able to enact successful measures of combating air pollution in the last twenty years. However air pollution remains a serious problem and Mexico City and São Paulo need to look at projects with the potential for a long term solution such as retrofitting buses, switching to cleaner burning fuels or enacting Electronic Road Pricing.

#### Obstacles

While significant progress has been made in curbing pollution, air quality is still poor and these cities still face obstacles. Problems with government and administrative regulation remain and continue to hinder pollution control. According to Molina (2004), Mexico City needs a restructuring of the administration of environmental matters. The study points to Mexico City's current Metropolitan Environmental Commission (CAM) and its lack of an independent budget as well as a lack of power to enforce regulations. While state agencies have had some success with monitoring industry pollution, regulation of vehicle emissions in São Paulo has been difficult because they are considered a concern of federal regulation (Brunn et al. 2003, 145). Another problem is that governments don't view air quality as a priority and there remains the belief that management and environmental standards restrict development (Simioni 2004, 75).

The promotion of environmental awareness is an important measure that must be undertaken. In a scathing editorial, Jorge González Torres, the founder of the Mexican Green Ecological Party (PVEM), blasted the Mexican government for limiting access to pollution data and the lack of ecological education in scholastic programs, something he cited as fundamental to the people's well-being and development (Torres 2004). It is essential for government organizations such as CAM to encourage public participation, because environmental action on the public level has been slow to catch on in both cities. Communication between the government and the public in São Paulo is poor and many don't know about the outcomes of policies so they have been slow to mobilize (Simioni 2004, 75). Environmental awareness is starting to grow at universities such as the Universidad Autonoma Metropolitana (UAM) in Mexico City (Dieleman 2007).

Non-Governmental Organizations in both cities have struggled to succeed in influencing policy. Milano the New School for Management and Urban Policy examined NGO and government relations in Mexico City and found numerous setbacks that have prevented the success of NGOs. Many of the case studies pointed to low levels of community volunteerism as a result of a lack of trust in civil organizations. Lack of Page 19. Vicions Magazine

nain tion has translated into low volunteerism and distrust of civil disassociations. Organizations also suffered from a lack of funding from the government as well as autonomy (Gershberg et al. 2006). Ultimately the state has the power to change policies and their rocky relationship with NGOs continues to prevent such changes from being made. The lack of public participation is also a problem in São Paulo where people aren't motivated to cooperate with government programs and are unwilling to make sacrifices like giving up car use, as cars are a symbol of status. Though the number of environmental NGOs in São Paulo has increased, they generally aren't concerned with the issue of air pollution and public involvement remains low (Simioni 2004).

public participation has been part of Mexico's history perhaps

a result of hegemonic government politics; voter turnout for

the March 2006 election was only 30%. This lack of participa-

### Cities on the Rise: Santiago and Lima

Although Mexico City and São Paulo are the dominant urban agglomerations in Latin America, the region's tremendous urbanization is resulting in the rise of other large cities such as Santiago, Chile and Lima, Peru. By 2015, Santiago will have witnessed its population double over the past 30 years and Lima will have witnessed its population triple (Brunn et al. 2003). Similar to Mexico City, Santiago is located in a valley surrounded by mountains adding to its pollution problems (Barrett 2004) and Lima, located by the coast like São Paulo, also experiences thermal inversion (Nash 1992). Just like Mexico City and São Paulo, they have seen a rise in automobile ownership and their population growth has been a product of rural to urban migration as they are both the primate city for their nation; for instance Lima is responsible for 70% of Peru's industrial output (Brunn et al. 2003, 154).

Mexico City and São Paulo have been established megacities for the past 30 years with a longstanding history of air pollution. Santiago and Lima, however, have suddenly emerged with such rapid growth that they are now faced with many of the pollution problems Mexico City and São Paulo have been dealing with for years. As they are confronted with these problems, they must examine the cases of Mexico City and São Paulo, where poor public policy such as lack of investment in public transportation and failed attempts at control have perpetuated air pollution. These cities must also look to Mexico City and São Paulo and assess current measures being taken and their success.

### Analysis of News from Mexico City and São Paulo

The media plays a large role in influencing public policy as public access to information can bring about change. In order to gain insight into the attitudes of each city's inhabitants toward their air pollution, an analysis of newspaper articles was conducted. Articles from the online databases of both cities' leading news source were examined for their content and tone to formulate a local perspective of air pollution problems and to speculate as to what this might mean in regards to the future of urban air quality. In analyzing newspaper articles some were found to have a "warning" tone and it is important to define what characterizes this description. A "warning" tone is different from an informative tone because it stresses the

Page 18 Visions Magazine

	Editorials	Health Consequences	Problems of Regulation	W a r n i n g Tone	Positive Government Action	Criticized Government and Policies
Number of Articles	12	21	17	20	15	27

### Table 1. Analysis of Mexico City s El Universal

severity of the air pollution problem and is written in a tone which calls for change and action, while an article with an informative tone simply states basic information and statistics.

An initial search of Mexico City's El Universal online database revealed 140 articles from 2003-2008 which mentioned air pollution. Of those 140, 69 articles were about air pollution specifically in Mexico City and the greater metropolitan area. Results are displayed in Table 1.

An important aspect of the analysis of newspaper articles is investigating changes in the type of reporting and information that the public receives, especially in the case of Mexico City where the government has a history of downplaying the real consequences of air pollution (Kasperson et al. 1995). The findings from the analysis of El Universal reveal Mexico City's press as a sort of watchdog in regards to air pollution. An average of 11.5 articles a year about the city's pollution over the past six years shows that the urban area's air pollution is an issue of considerable concern in the press. Also, many of the articles were critical of the government and its policies to combat air pollution. Several of the editorials harshly reprimanded the government for doing little in response to the issue. As the level of air pollutants have decreased in recent years, so have the number of El Universal articles on the topic. Overall, an analysis of El Universal articles reveals a media that's focused on making progressive efforts to control pollution. The criticizing editorials and "warning" tone of articles look to alert the public and call them to action.

São Paulo's O Estado de S. Paulo online database contained 23 articles from 2003-2008 that were about São Paulo's air pollution. Results of the analysis are displayed in Table 2.

Based on the examination, São Paulo's media does not appear to be as concerned with the city's air pollution problems as Mexico City's. Also, the media's presentation of the air pollution problem that plagues its city isn't as thorough or complete as Mexico City's as most articles are brief and contain basic information like statistics. There are some exceptions to this neutrality in the media that are important to consider. One article warns that some scientific projections indicate that some pollutant concentrations will increase by more than 70% by 2020 (Brancatelli and Leite 2007). Yet there is only one editorial piece and overall the articles provide basic information without adopting a tone in regards to the poor air quality conditions. Perhaps this overall neutral position in the media is because Brazil believes the switch to ethanol fuel will soon reduce the urban air pollution.

In her analysis of citizen awareness in connection air pollution in São Paulo, Daniela Simioni (2004) explains that the media has played a central role in spurring public mobilization in efforts to combat air pollution, yet levels of involvement remain low because the issue it is not considered a priority by citizens as they are unaware of its seriousness. The point she makes is reinforced by the analysis of the tone of air pollution articles in O Estado de S. Paulo. Of the 24 articles analyzed, only four were written in a "warning" tone; 16% of the total number of articles. In comparison, the percentage of El Universal articles analyzed that written in a "warning" tone is nearly twice that. Few of the articles in O Estado de S. Paulo propose possible alternative solutions and those that do suggest options which seem highly unlikely to gain citizen involvement. For instance, Xico Graziano, the Secretary of the Environment of the State of São Paulo, suggests hitchhiking in order to mobilize citizens into environmental awareness (Graziano 2008).

The investigation into the presentation of air pollution in São Paulo's media highlights the need to overcome the obstacle of limited public involvement and awareness and reinforces the importance of a new, clearer discourse between the government and the public.

An analysis of newspaper articles of Santiago and Lima was also conducted in order to gain some information as to

	Editorials	Health Consequences	Problems of Regulation	W a r n i n g Tone	Positive Government Action	Criticized Government and Policies
Number of Articles	1	12	3	4	7	8

### Table 2. Analysis of Sao Paulo s O Estado de S. Paulo

both cities' current attitude toward their growing air pollution. To assess current stances, newspaper articles from 2008 were analyzed. The online database of Santiago's leading newspaper El Mercurio featured 15 articles over the past years, which were about the city's air pollution. El Comercio, Lima's leading newspaper contained 33 articles that mentioned the city's air pollution. Results are displayed in Table 3.

While Lima had twice as many articles about air pollution as Santiago, the number of articles from both cities in one year is rather high, thus showing that air pollution is of increasing concern. While many articles from both cities commented on future governmental action, most emphasized the point that in the past very little had been done by the government to deal with the high air pollution levels. One article from Lima's El Comercio mentions the creation of a Ministry of the Atmosphere in May of 2008, a positive step in dealing with air pollution. Yet the recent creation of a Ministry of the Atmosphere has been necessary for quite some time as an editorial from El Comercio explains that acute respiratory diseases stemming from air pollution resulted in the death of 10,373 Peruvians in 2001 (Orsi 2008). Similarly, articles from Santiago's El Mercurio highlight delays and unsuccessful government policies that have allowed pollution to remain a serious problem.

One interesting observation from the analysis of newspaper articles from both cities is the lack of information the public is receiving about the potential health threats of air pollution. El Mercurio featured only three articles which mentioned health in regards to urban air pollution and only one featured a thorough description of the health consequences of air pollution. Of the 15 articles in El Comercio that mentioned health, five were descriptive. Three of those, which were descriptive, were from editorials, showing a clear lack in detailed reporting of health consequences. While the number those articles featured in El Comercio is more than those featured in El Mercurio, one article highlights the public's lack of knowledge about the health impacts. A survey conducted by the University of Lima reported in El Comercio that only 36.7 percent of the people surveyed felt as though environmental problems have a large affect on their health (El Comercio June 4, 2008). Yet air pollution in Lima is responsible for 4,000 deaths annually (El Comercio November 19, 2008). This lack of public knowledge as to health consequences in both Santiago and Lima is similar to the obstacle of lack of public awareness that face Mexico City and São Paulo.

Overall the newspaper articles of both cities show that air pollution is an emerging issue attached to their urban population growth. The newspaper articles of El Mercurio and El Comercio are both characterized by their highlights of governmental stagnation in response to air pollution problems. If air pollution in Santiago and Lima continues to rise, their governments will need to increase their methods of control. Such methods can be determined by examining Mexico City and São Paulo's history of combating air pollution.

### The Future of Air Pollution in Latin America's Major Urban Centers

Half a century ago, Los Angeles and London, then two of the world's largest cities, had the worst air pollution on the planet (Jacobson 2002). Over the past fifty years, as their economies developed, they have been successful in efforts to lower their air pollution levels. Now, as Mexico City and São Paulo go through their own economic development, they have begun to make efforts to reduce air pollution. The future of air quality in Mexico City and São Paulo holds different possibilities for industrial and vehicular emissions. Economic growth and migration patterns will continue to dictate future air pollution patterns. The economic growth can be matched with an increase in automobiles on the roads but there is the possibility that economic growth may lead to better healthcare and cleaner technologies to reduce pollution (Krupnick 2006). In the past decade Mexico City and São Paulo have witnessed a change in migration patterns as other cities and industries have emerged in both Mexico and Brazil. São Paulo State Environmental Protection Agency's 2004 analysis expects a reduction of emissions as a result of industrial migration to the interior of the state and to other Brazilian states (Pinheiro et al. 2004). Industrial emission reduction is expected to continue in both cities as a result of decentralization and a shift in economic sectors. "As a country's economy matures, it relies less on manufacturing and more on service sectors, which are less polluting" (Krupnick 2006, 345). This positive trend may be the case for other emerging Latin American urban areas.

While Mexico City and São Paulo are experiencing decentralization, the same cannot be said for Santiago and Lima. Instead they are rapidly growing and their air pollution has become an increasingly large problem. Yet an analysis of newspaper articles from both cities reveals that while the problem grows neither city has done much to combat air pollution.

		Editorial	Health Consequences	Problems of Regulation	Warning Tone	Positve Government Action	Criticized Government and Policies
Number	El Mercurio	1	3	9	9	6	9
of Articles	El Comercio	4	15	14	13	8	24

### Table 3. Analysis of Lima s El Comercio and Santiago s El Mercurio

Page 20 Visions Magazine

Instead, governmental delays and inefficient policies have defined their attempts to deal with the problem. In order to address their own pollution problems they must examine the successes and failures of Mexico City and São Paulo, where lack of investment in public transportation and poor urban planning perpetuated air pollution.

### Conclusion

As cities in developing nations continue to experience population growth and economic development, environmental stress increases and pollution worsens. Latin America is one of the most rapidly urbanizing regions in the world, making pollution issues a major concern. An investigation of the region's two established mega-cities Mexico City and São Paulo, which have a history of dealing with air pollution, is important in shaping future air pollution policies of newly emerging megacities. Mexico City and São Paulo's development as a result of urbanization and economic growth, pollution policies and current local perspectives combine to generate an outlook on the future of growing cities facing problems of air pollution.

The pollution reduction that Mexico City and São Paulo are currently experiencing from decentralization as a result of economic growth, as well as an economic shift from the industrial sector to the service sector, reveals the evolution of the mega-cities of developing nations. Successful and unsuccessful past approaches to combat air pollution coupled with new potential long-term solutions can influence future policies of other growing urban agglomerations such as Lima and Santiago. An analysis of local media reveals current perspectives and highlights remaining obstacles such as the need for increased public awareness, which can help determine future approaches. By examining the urbanization and economic growth that led to the high pollution levels of air pollution in Mexico City and São Paulo and the past and current measures they have taken to combat air pollution, future air quality problems in the rapidly emerging Latin American cities of today can be more effectively addressed.

### About the Author

**Daniel Jennings** is a 2009 Elon graduate from Charlotte, NC majoring in International Studies with minors in Geography, Non-violence Studies and Latin American Studies. He enjoys spending time in the outdoors and playing basketball. In 2008 Daniel studied abroad in Costa Rica with the International Center for Development Studies, an experience that changed his career interests. He has been accepted into to the Peace Corps and is awaiting his assignment. After the Peace Corps he would like to study Sustainable International Development in graduate school.

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### Temperature-Altitude Zones on Tanzania's Mount Kilimanjaro by Maggie Zimmerman

As altitude increases, the air temperature decreases by approximately 1° Fahrenheit per 300 feet of elevation or 1° Celsius per 165 meters. These temperature changes are evident as one climbs a mountain in that there are accompanying changes in the variety and type of vegetation found as well as human land use practices.



Cultivated Areas - Altitude: roughly 2,600 to 6,000 feet This zone is home to the Chagga, an ethnic group that farms coffee and other crops on the fertile volcanic land.



Rain Forest - Altitude: roughly 6,000 to 9,200 feet

The rainforest of Kilimanjaro gets over six feet of rain each year, giving life to the many plants and animals that live in this zone. There are some sections that are so dense that sunlight does not even break through to the forest floor!



### Heath - Altitude: roughly 9,200 to 11,000 feet

This zone has an open landscape of heather like plants. These low to the ground plants help to guard the soil and conserve the little water received. The oxygen levels are beginning to decrease but the temperature is still relatively warm.



### Moorland - Altitude: roughly 11,000 to 13,200 feet

This zone is home to the sencios, a plant only found on Kilimanjaro. They have thick stems topped with rosettes of tough leaves. These plants serve as reservoirs for the little water found on this part of the mountain. Oxygen levels continue to decrease along with the temperature.



### Alpine Desert - Altitude: roughly 13,200 to 16,500 feet At this stage of the mountain there is almost no life other than a few tough grasses. The temperature is getting much colder and there is dust everywhere! From this region the summit of Kilimanjaro is in perfect view.



#### Glacial Summit - Altitude: roughly 16,500 to 19,340 feet

With such low oxygen levels, nothing lives at the summit of Kilimanjaro. Due to global warming, these glaciers have been depreciating every year, and those who live around the mountain fear that within ten years they will be gone. The views from the roof of Africa are breathtaking, but due to low oxygen levels, climbers must make a swift descent down the mountain after summiting.

### About the Author

Maggie Zimmerman is a senior at Elon University majoring in International and Environmental Studies and with minors in Geography and African/African-American Studies. Maggie spent the spring of 2008 studying international development in Kenya, backpacking through Uganda and Rwanda, and climbing Mt. Kilimanjaro for charity. After graduation she plans to move to Minneapolis to work as a case manager with the East African refugee population.

### **Book Recommendation** by Evan Ross

### A Walk in the Woods: Rediscovering America on the Applachian Trail by Bill Bryson

A Walk in the Woods is travel writer Bill Bryson's account of his attempt to hike the Appalachian Trail (AT). In his typical style, Bryson combines bits of history and exploration with biting humor and sarcasm. He is accompanied on his journey by Katz, an old college friend that reappears in Bryson's life after Bryson includes an invitation to join him on the AT in his Christmas cards. Yet, Bryson can't anticipate the troubles associated with Katz, an overweight recovering alcoholic with a temper. Bryson's characterization of Katz is full of humor and often exasperation, but he also displays appreciation for his companionship.

The AT is a 2,100 mile trail stretching from Springer Mountain in Georgia to Mount Katahdin in Maine. There are two types of hikers that take on the AT; thru-hikers attempt to complete the trail within one season, while the majority of people hike smaller segments. Bryson hikes by segment but completes the majority of the trail. Throughout his journey he shares his fears of bear attack in western North Carolina and hypothermia in the White Mountains, always with humor while recognizing their rationality. Bryson also provides a history of the trail, discussing its creation, controversies and a description. He also provides local histories of the areas he passes through along with descriptions of regional ecology and geology. He visits Centralia, Pennsylvania and gives an account of the fire that has been burning underneath the town since 1962 when a coal mine fire ignited the coal seam that runs beneath the town. At the Delaware Water Gap he describes the geology of the gap. Yet, what keeps the book of interest are his descriptions of situations and people that are wrought with sarcasm. Katz provides the bulk of the material. Early on Katz, exhausted and frustrated by the weight of his pack, begins throwing supplies along the trail to lighten his load. Bryson, aggravated by the significant loss of food supplies and Kat'z retainment of superficial supplies, reveals Katz's ridiculously crude and irresponsible



behavior and uses it to build a constant source of humor. Thus, A Walk in the Woods is an integration of human history, natural history, humor and travel writing intertwined into an adventure that remains a theme in Bryson's works.



Photo by Dave Elmore

Spring 2009 Page 27

### **Climate Change** Effect of Increased Carbon Dioxide on the Growth Rate of Juncus roemerianus (Black Needlerush) in the United States

### - Preliminary Findings from Research in Progress by Mariana Poole, Gracen Smith and Brant Touchette

ver the past several years, concern about the effects of climate change has drawn a great deal of attention. These effects, including rising sea levels and increased carbon dioxide in the atmosphere, are especially evident in marsh plants. A New England study (Warren and Niering, 1993) found that rising sea levels caused changes in

the vegetation of tidal marshes, with previous populations dying off or being replaced by species able to outcompete them in the new environmental conditions. Areas that maintained their original vegetation patterns were found to have higher rates of peat accumulation, which allowed the plants to stay ahead of the rising salt water. Estimates place the rate of sea level rise at approximately 0.10 to 0.25 cm per year, with North Carolina in particular seeing a rise of 0.8 m over the next century. One plant that is already being severely affected is Juncus roemerianus, a salt marsh plant also known as black

needlerush. This plant is native to the Atlantic and Gulf coasts of the United States (Eleuterius 1975) and occupies multiple zones within marshes, ranging from the lower marsh (where it is exposed to a largely undiluted saline environment), to the upper marsh, which is primarily freshwater (Touchette 2006). A change in sea level of the magnitude previously estimated would expose many J. roemerianus colonies previously in a freshwater environment to saline waters, which has been shown to be detrimental to the health of these plants. In previous studies (Poole et al., unpublished data), J. roemerianus that were acclimated to freshwater showed physiological responses similar to plants in drought conditions when subjected to salinities equivalent to those found in marine environments.

This study focused on the impacts of elevated CO<sub>2</sub> levels on the growth of Juncus roemerianus. Because CO<sub>2</sub> is a major component of the photosynthetic process of plants, including the synthesis of glucose, it is hypothesized that an increase in ambient CO<sub>2</sub> levels will result in increased plant productivity, the outcome of which will be plants with increased overall biomass, as well as increased leaf and root development. As coastal plants die, the decaying organic matter accumulates into a substance known as peat, which future generations of plants can use as a substrate. While we expect that plant growth will be enhanced by higher levels of CO2, if higher growth rate increases the overall productivity, and thereby increases the rate of peat accumulation, then it is possible that future generations of Juncus roemerianus will be able to survive climate change by staying ahead of rising sea levels.

Island, NC.

### **Methods**

In July of 2008, seeds of Juncus roemerianus were collected from natural populations and planted in trays. Trays were kept in a larger container which allowed them to be constantly submerged in water, the environment to which they are accustomed. The plants germinated and were grown in an environmen-

tal growth chamber (BioChambers

Inc., Winnipeg, Canada), which is

capable of regulating light, tempera-

ture, humidity, and CO<sub>2</sub> conditions.

The light cycle was maintained at 12h

light, 12h dark, and relative humidity

was maintained at 80% in both the

control and experimental chambers. Ten control trays were kept at ambient

 $CO_2$  levels (380 ppm) and ten experi-

mental trays were kept at 800 ppm.

Measurements were taken monthly

from five trays per treatment and

four averagely sized individuals were

sampled per tray. Plants were evalu-

ated based on their longest root and

Black needlerush (Juncus Roemerianus) in marsh on Bluff Photo by Evan Ross

leaf length (mm), and dry weight (g). Plants were dried in an oven for a minimum of two days. Data was analyzed using a General Linear Model with a repeated measures design followed by a Holm-Sidak test for post-hoc evaluations, using a critical value of P < 0.05. All data was log-transformed prior to analysis.

### **Preliminary Results**

The preliminary results of this study indicate that increased levels of carbon dioxide had a significant effect on the growth rate of the salt marsh rush Juncus roemerianus. Plant mass, root length, and plant height were all found to be greater in the experimental treatment than in the control (P < 0.001). For plant mass, these differences were significant in months 2, 4, 5, and 8 (Fig. 1). For leaf height, these differences were significant in months 2, 3, 4, and 8 (Fig. 2). For root length, significant differences were found in months 1, 2, 4, and 8. As expected, time was also found to be a significant factor in plant growth in all parameters over the 8-month treatment period (P < 0.001). A significant interaction occurred between time and treatment only in plant mass (p = 0.031); this may indicate that as time progressed the differences between the control and experimental group became more pronounced.

Plant Mass (log	-transformed)	Root Length (le	og-transformed)
Treatment	p<0.001	Treatment	p<0.001
Time X Treat	p=0.031	Time X Treat	p<0.001 p=0.152

Plant Height (log-transformed) p<0.001 Treatment Time p<0.001 Time X Treat p=0.815

Page 28 Visions Magazine



Fig. 1. Increase in plant mass over time for plants at ambient  $CO_2$  and at 800 ppm. Significance between treatments is shown by an asterisk, as can be seen in months 2, 4, 5, and 8. Data are presented as means  $\pm$  standard error.



Fig. 2. Increase in plant height over time in plants at ambient  $CO_2$  and at 800 ppm. Significance between treatments is shown by an asterisk, as seen in months 2,3,4, and 8. Data are presented as means  $\pm$  standard error.



Fig 3. Increase in root length over time in plants at ambient  $CO_2$  and 800 ppm. Significance between treatments is shown by an asterisk, as seen in months 1, 2, 4, and 8. Data are presented as means  $\pm$  standard error.

#### Discussion

While the preliminary data supports our hypothesis

that increased  $CO_2$  levels will increase plant biomass, it also suggests that the increase in biomass will not be enough to boost peat accumulation in coastal habitats sufficiently to offset sea level rise. The plants in the experimental treatment were approximately one month ahead of the controls in overall size and weight. In other words, a comparison of the plant height data (Fig. 2) reveals that the control plants in month 4 had reached the height of the experimental plants in month 3. However, based on current estimates of sea level rise, *J. roemerianus* would have to essentially increase its growth rate twofold, achieving twenty-four months' growth in twelve months' time, to accumulate enough peat to maintain a shoreline above sea level. Despite the bleak outlook provided by this preliminary data, we have noted a marked increase in the growth rate of the experimental plants that can be seen in month 8 of all categories of analysis (Fig. 1-3). Should this apparent escalation in treatment effect continue, it is possible that over time the plants will achieve the estimated necessary growth rate for survival.

North Carolina is particularly vulnerable to sea level rise, as much of its coastline is close to current sea elevations (Titus and Richman 2001). The wetlands that make up much of our coastal region, and of which Juncus roemerianus is a vital component, are ecologically important for a multitude of reasons and damage to them would result in far-reaching consequences. These wetlands provide a buffer for the winds and tidal surges that accompany the hurricanes that frequently batter our coast and they also preserve our shorelines by retaining sediments. They are able to mitigate human environmental impacts as well, by filtering excess nutrients and other pollutants from both surface and groundwater supplies. The data we will continue to collect for this study is anticipated to help us understand not only how vital resources respond to climate change, but also help us to preserve and protect coastal environments.

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#### About the Authors

**Gracen Smith** is a senior Biology major with a minor in Psychology. This project started during the summer of 2008, and she has been working on it ever since.

**Mariana Poole** is a junior majoring in Biology and Music Performance. She is a member of Phi Kappa Phi and Mu Phi Epsilon. She spent the summer of 2008 conducting this research along with Gracen Smith and Kirsten Rhodes.

**Brant Touchette** is an Associate Professor of Biology at Elon University and served as the faculty advisor for this research.

### Livelihoods, Land Use and Landscape Conservation in East Africa An analysis of the Viability of Pastoralism as a Land Use Compatible with Wildlife Conservation in Northern Tanzania Article and photography by Evan Ross

Abstract: The Kwakuchinja corridor connecting Tarangire and Lake Manyara National Parks in Tanzania's Maasai Steppe is essential for maintaining viable populations of wildlife that disperse out of protected areas during the wet season. Historically, the corridor was populated by the Maasai practicing traditional pastoralism that is considered compatible with wildlife conservation. However, recent changes are increasing cultivation and, consequently, fragmenting habitat with implications for wildlife. This study sought to examine the socio-cultural and economic trends in pastoralism in addition to local perceptions and expectations of wildlife to determine the viability of pastoralism as a land use compatible with wildlife conservation. Using a semi-structured questionnaire, members of 253 households were interviewed in six villages. Data was analyzed in SPSS using contingency tables and chi-square goodness of fit. Information from key informants supplemented questionnaires. Results showed the ethnic composition of the corridor is diversifying (65% Maasai, 32% WaArusha, and 3% other) and the Maasai are shifting away from pastoralism due to its inability to meet household needs, decreasing its security as a livelihood. Prices for livestock were dependent on market (p=0.02) but many respondents lack the ability to sell at high-price markets and most respondents (93%) sell the less productive East African Zebu cattle indicating that pastoralism in the corridor is not operating at its full economic potential. Current conservation initiatives are promoting pastoralism in the corridor. Attitude towards wildlife was dependent on livelihood (p=0.005) with pastoralists more likely than agro-pastoralists or cultivators to possess a positive attitude revealing greater compatibility with conservation. However, trends indicate exclusive pastoralism is not economically viable in the corridor with the implication that for these initiatives to succeed they must work to reverse current trends through capacity building, reducing the economic incentives to engage in agriculture by increasing the economic benefits of alternative livelihoods and reducing risk such as through the provision of vaccinations and boreholes. Other options involve moving the community towards wildlife conservation as a land use which must be preceded by creating a connection between economic benefits and wildlife conservation.

**P** astoral production systems, in which people rely heavily on livestock for milk and/or meat, exist in the arid environments of Southwestern Asia, Central Asia and Africa as a means of exploiting limited resources and turning them into sustenance and profit (Fratkin 1997). Rainfall on the rangelands in these regions is often unreliable and the success of livestock herding is attributed to the adaptive nature of pastoralism. Constant environmental evaluation and moving between seasonal pastures allows herders to exploit a shifting, patchy and unpredictable mosaic of water and grazing resources (Thompson and Homewood 2002).

Although pastoralism is still employed by a substantial number of people in rangeland environments, its continued existence is threatened largely through misunderstandings and misconceptions woven into policy in addition to social and economic pressures. This study analyzes trends in the general livelihoods of communities in the Kwakuchinja corridor with a specific focus on trends in the pastoral production systems and the current viability of pastoralism in the region from a socio-economic perspective. It further attempts to examine local communities' attitudes towards wildlife and wildlife conservation. These trends and attitudes can predict the future of

Page 30 Visions Magazine

land use in the corridor, the implications for wildlife, and can be used to determine whether pastoralism is viable as a land use compatible with wildlife conservation in the corridor.

The objectives of this study are to: 1) Analyze the trends in livelihoods in the region with particular focus on the sociocultural and economic dimensions of pastoralism to determine current viability; 2) Analyze the livestock markets in the region, capturing data on breeds, numbers sold, and prevailing prices; and 3)Determine local community views and expectations towards wildlife conservation.

### **Literature Review**

Garrett Hardin's 1968 "Tragedy of the Commons" described a process of degradation that develops under a pastoral system where resources are commonly owned (Fratkin 1997). The conclusion that follows from Hardin's theory is that the only way to prevent the degradation of resources is to move them from communal ownership to individual ownership (Fratkin 1997). The real-world translation of Hardin's theory is debatable and aspects of many pastoral production systems discredit his underlying assumptions. The first is that pastoralists have an irrational propensity to accumulate livestock (Livingstone 1985). However, this accumulation by pastoralists is based on systems of insurance and investment that are rational within the context of those environments and societies. The climatic variability of rangelands makes drought a constant threat for pastoralists as it can significantly decrease herd size. Thus, pastoralists must keep several times the number of livestock needed for subsistence to ensure that they have an adequate level remaining in the event of losses from drought. From an investment perspective, livestock provide a positive rate of return because one animal can produce multiple offspring over its life (Livingstone 1985). Consequently, most investments by pastoralists are made in the form of livestock. When these factors are considered the individual rationality of pastoralism that was assumed absent in Hardin's theory becomes evident.

Hardin's theory also assumes the absence of collective rationality. However, many pastoral systems that operate under communal ownership usually include mechanisms to prevent degradation based on collective rationality (Livingstone 1985). These take two forms: competitive exclusion and cooperation. Competitive exclusion usually functions as some members of society are pushed out of the pastoral sector during times of resource scarcity to avoid exploitation. Cooperation involves members agreeing to various regulations to ensure sustainable use of resources (such as only watering livestock every third day during times of low rainfall) (Livingstone 1985). These mechanisms allow pastoralists acting under traditional communal tenure regimes to sustainably utilize resources and avoid the "Tragedy of the Commons".

Unfortunately, Hardin's theory acted as a guiding ideology for policy in the 1970s and 1980s pushing for rangeland privatization (Fratkin 1997). Privatization proved inefficient and ineffective (Lene 1998) partially through conflict between the centrifugal ideology of pastoralists seeking mobility and autonomy and the centripetal ideology of the state that strives for sedentarization and dominance (Fratkin 1997). The transition to private ownership of land meant smaller tracts of land available for grazing by individuals which restricts herd mobility leading to localized areas of degradation (Fratkin 1997). The move from communal to individual ownership also dismantled the traditional regulatory mechanisms in place to prevent degradation (Livingstone 1985). Lastly, the misconceptions found in the "Tragedy of the Commons" influenced development initiatives aimed at pastoralists that now tend to focus on transforming traditional pastoralism (Lene 1998) and often include de-stocking or other grazing agreements that contradict the individual rationality described above (Livingstone 1985).

Population pressures also pose a threat to pastoralism as competition for land and resources increases. Growing populations also increase the demand for livestock products and are pushing the commoditization of livestock practices (Fratkin 1997). This commoditization is supported in policy such as through World Bank programs in East Africa which mandated commercialization of livestock production and privatization of land (Fratkin 1997).

A final threat to traditional pastoralism is the increasing movement towards the cultivation of rangelands. Governments, especially in Africa, push cultivation as a means of supplemental income and ignore existing cultural systems and knowledge (Solbrig 1992). The increasing presence of agriculture makes the practice of traditional nomadic pastoralism more difficult as pastoral communities are rapidly boxed in by cultivation, limiting access to pastures and leading to sedentary livestock that tend to weigh less and are unhealthy relative to nomadic cattle (Solbrig 1992). Also, many traditional pastoralists are moving towards agriculture to supplement their livelihoods. Although it is often argued that population pressures are driving the move towards agriculture, Waroux (2005) argues that trade-offs between different economic opportunities following privatization drive land-use decisions. This is complemented by Thompson and Homewood (2002) who state that trends in land use can be predicted by determining the economic returns of alternative production systems. Because pastoralism relies on mobility and seasonal access to land of varying quality, there are huge fluctuations in returns that tend to be lower than agriculture (Thompson and Homewood 2002). This partially explains the adoption of agriculture by pastoralists although other social factors are arguably present as well.

From a conservation perspective, the deterioration of pastoral production systems and the factors that threaten the future existence of pastoralism are unfortunate and alarming. Recent progress in understanding rangeland ecology has demonstrated how grazing and browsing can be vital for ecosystem



The village of Oltukai is populated exclusively by the Maasai.

health and productivity (Hatfield and Davies 2006). Further, extensive pastoralism practiced in unfenced savanna rangelands has proven to be highly compatible with wildlife conservation (Thompson and Homewood 2002). Thus, pastoralism can be an ecologically viable land use for areas of importance to wildlife conservation.

The threats facing pastoralism contrasted against its potential importance for wildlife conservation is exemplified in the East African context. Pastoralism in East Africa is dominant in areas where water is scarce and rain is unpredictable making agriculture unproductive and not dependable (Netting date unknown). Although nomadic pastoralism is present, transhumant pastoralism is also practiced largely by the Maasai in the Rift Valley. Transhumance is characterized by permanent villages, seasonal movements of livestock and the presence of small-scale agriculture (Schuyler date unknown).

Pastoralists, both in Tanzania and Kenya, have relied heavily on livestock herding and coexisted with resident and migratory wildlife populations (Thompson and Homewood 2002). However, wildlife conservation in sub-Saharan Africa is derived largely from western paradigms and past practices were generally exclusionary towards local people (Thompson and Homewood 2002). Governments incorporated savanna lands, areas necessary for local pastoralists, into national parks without providing compensation for lost resources or a means of profiting from the tourist industries that the parks generated (Solbrig 1992). Pastoralists living in and using arid areas are seen as disturbances in the system, a source of competition for wildlife, rather than a long-term part of the larger ecosystem (Fratkin 1997). For example, the Maasai are seen as environmental stressors and are excluded from game parks and prevented from grazing livestock in formerly shared ecosystems despite a history of sustainable land use and reliance (Fratkin 1997). Although local people are restricted from grazing inside of protected areas, wildlife can move freely between parks and surrounding areas transmitting diseases, competing for pasture, and predating livestock further complicating the relationship between conservation and indigenous communities (Fratkin 1997).

Other socio-political forces are transforming pastoralism and rangelands with implications for wildlife conservation. Current population densities in the highlands of Kenya and Tanzania have reached maximum levels and people are now moving into the plains that were traditionally used by the Maasai and Barabaig nomads (Solbrig 1992). Government policies have also driven immigration of non-pastoralist peoples into rangelands. Initiatives such as Ujamaa Villagization, implemented in Tanzania by the Nyerere government in conjunction with USAID and World Bank following the 1967 Arusha Declaration, helped facilitate these movements. The program created cattle dips, dams, wells and roads in hopes that the increased infrastructure would lead to more cattle sales from the Maasai. However, the development attracted immigrant farmers (Fratkin 1997) and the immigration of people into traditionally nomadic areas resulted in a decline in the quantity of land available for pastoralism (Solbrig 1992). Large numbers of agro-pastoralist are cultivating land that was once used for grazing leading to declines in cattle productivity due to the decreased efficiency of rangelands (Fratkin 1997). This is pushing pastoralists to find supplemental income, often in the form of cultivation (Fratkin 1997). Agricultural fields and permanent settlements resulting from this shift towards cultivation are blocking corridors traditionally used by wildlife for migration between parks and for wet season dispersal leading to a decline in wildlife populations (Thompson and Homewood 2002).



Most cattle-owning respondents reported owning East African Zebu cattle. Increasing cattle productivity could increase the security of pastoralism.

The aforementioned disconnect between the government, which has focused on exclusionary conservation, and local communities, who view the land as a part of their home and thus deserve the rights to access its resources, has become the focal point of present conservation efforts (Fratkin 1997). These efforts are especially important in the Maasai Steppe in northern Tanzania. Hosting the second highest biomass of wildlife on earth, the Maasai Steppe represents a critical hub for Tanzania's economic development and ecological integrity. The series of parks and reserves in the steppe protect the most densely populated wildlife areas but many wildlife populations disperse out of protected areas into adjacent lands during the wet season (Igoe 2005). The importance of surrounding lands is evidenced in the Kwakuchinja corridor that connects Lake Manyara and Tarangire National Parks and serves as important habitat for wet season dispersal. The continued viability of wildlife in the Tarangire-Manyara ecosystem depends on the ability of wildlife to use the corridor.

A 2005 report (Sumba et al. 2005) estimated that the human population within the Maasai Steppe region was 350,000 (the majority pastoralist Maasai) along with an estimated 1 million indigenous zebu cattle (AWF 2005). While pastoralism was historically practiced sustainably in the steppe, the factors that are influencing livelihoods in the rest of East Africa are present in this region affecting land uses and the viability of wildlife conservation. Local peoples experienced the exclusion from protected areas and the lack of sufficient compensation and benefits from parks and reserves. For example, Tarangire National Park, formed in 1971, displaced Maasai pastoralists from the Tarangire River and other critical water and food resources. More recently, an influx of non-pastoralists into the region over the past twenty years has increased resource competition and led to land use changes. While traditionally dependent almost entirely on pastoralism, competition for land is forcing the Maasai in the region to rely more heavily on other economic activities like agriculture (AWF 2005, Igoe 2005). Cultivation presents a barrier to migration routes such as the Kwakuchinja corridor. The increased prevalence of agriculture also heightens negative interactions with wildlife as crop damage accounts for the majority of human-wildlife conflict in the region (Newmark et al. 1994). In order for wildlife conservation to succeed, the savannas and the reserves within them must generate revenue and enhance development while maintaining adequate resources for traditional pastoralism in order to gain the support of local communities (Brockington 2001).

In an effort to address these conflicts and needs, local initiatives by non-governmental organizations (NGOs) such as the Kwakuchinja Easement for the Environment through Partnership Project (KEEP) and Tanzania Land Conservation Trust's (TLCT) Manyara Ranch aim to support both wildlife conservation and community needs. KEEP, organized through the African Wildlife Foundation (AWF), researches corridor statuses and then negotiates with the local community to expand/ establish wildlife corridors. They work to conserve wildlife, create community awareness, and provide local people with wildlife-compatible livelihoods (AWF 2004). Also initiated by AWF, Manyara Ranch protects a wildlife corridor between Tarangire and Manyara National Parks by restricting land use to sustainable grazing by the ranch and peripheral communities. The ranch also invests in community development by assisting with community development projects through donor aid. While these initiatives attempt to mitigate humanwildlife conflicts and promote community development, more research is necessary to adequately ensure the sustainability of economically viable livelihoods and conserve wildlife in the region.

The initiatives are important as Thompson and Homewood (2002) recognize that wildlife conservation is "unlikely to succeed in sub-Saharan Africa, unless it is able to enlist the support of reserve-adjacent dwellers" (109). However, it is important to recognize that the aim of these projects is to push local people away from land uses that are incompatible with

wildlife conservation (namely agriculture). These land uses are present due to economic incentives and for wildlife conservation policies/projects to be successful they must reduce these incentives. In many cases this may involve balancing the opportunity costs of not cultivating the land (Norton-Griffiths 1994). Thompson and Homewood (2002) also recognize that community conservation projects such as these must actively involve communities in management, coincide with local needs and perspectives, and ensure the equitable distribution of benefits. It is within this frame that these projects and the viability of pastoralism as an economically, socio-culturally, and environmentally viable land use are examined.

### Materials and Methods

### **Study Site Description**

The Tarangire Area covers approximately 35,000km<sup>2</sup> in northern Tanzania in the eastern limb of the Rift Valley and is part of the broader Maasai Steppe ecosystem. This study focuses primarily in the Northern Zone of the Tarangire area, as defined by Tarangire Conservation Project Final Report (1997), and concentrates on villages located within the Babati and Monduli districts of the Arusha region. These villages include Mswakini Juu, Losirwa, Makuyuni, Naitolia and part of Mswakini Chini in the Monduli district and the other part of Mswakini Chini and Oltukai in the Babati district. Overall human population for this area is 16,641.

### Ecology

The Tarangire Area is an arid rangeland that experiences a single rainfall season (average rainfall 650mm/year) beginning in November or December and continuing through April or May. The Tarangire Area is classified as Acacia themeda Scattered Tree Grassland. Although species composition varies spatially, Acacia is always the most common tree and Themeda triandra is the dominant grass species. Rainfall and grazing are important factors influencing vegetation species composition. T. triandra cannot withstand heavy grazing, and when grazing intensifies, hardier grass species replace T. triandra (TCP 1997).



Agriculture in the Kwakuchinja corridor is expanding, increasing the potential for human-wildlife conflict.

The area is also home to many large mammal species of economic and ecological importance. The most abundant large mammal species are zebra, wildebeest, buffalo, and elephant. The area also has fifteen species of antelope, a large population of common eland, a population of fringe eared oryx, and viable populations of lions and leopards. Other notable species include lesser kudu, greater kudu, bushbuck, hartebeest, and wild dogs (TCP 1997).

Two National Parks, several Game Controlled Areas (GCA) and Forest Reserves lie within the Tarangire Area. Tarangire National Park is the larger of the two parks covering 2,600km<sup>2</sup> and is surrounded by several GCAs with Mkungunero to the south, Simanjiro to the east, Lolkisale to the northeast and Mto wa Mbu to the north. The park's resource anchor is the Tarangire River whose permanent waters make Tarangire a dry season refuge for many large mammal species. Lake Manyara National Park is smaller at 32,500ha but maintains significance due to the high density of large mammal species and its establishment as a biosphere reserve in 1981. The two parks are linked by the Kwakuchinja corridor. The corridor is 400km<sup>2</sup> and bordered by the Mto wa Mbu GCA to the north, the Great North Road to the east, and Lake Manyara to the west. The corridor is a flat plain dominated by open grassland with patches of acacia woodland in the east and southeast. The corridor is important for migration between the two parks and for wet season dispersal and is used by species including wildebeest, zebra, elephant, buffalo, elephant, giraffe, lion and leopard. The viability of populations of large mammal species in the Tarangire area depends on the maintenance of these three areas (TCP 1997).

#### Socio-Economic and Political Context

The study area is dominated by the Maasai and WaArusha ethnic groups. Increasing populations of Iraqw, Warangi, Mbulu, Sandawi, Chagga, Nyiramba, Sukuma and Hehe are also migrating into the region usually becoming involved in the market economy (TCP 1997).



The Tarangire River is the resource anchor of Tarangire National Park.

Pastoralism and agriculture are the dominant land uses. Cattle, goats, sheep and donkeys are the typical livestock (cattle population in the region is 33,000) and sorghum, millet, maize, beans, cow peas, sweet potatoes and cotton are grown in the Monduli and Babati districts. Both small and large-scale agriculture can be found. Charcoal production is another economic activity in the region and is increasing due to demand from Arusha and Moshi. Mining is present in the Babati district by the Minjingu Phosphate Company (NIPCO).

Resource use and other local issues are regulated by village governments. Each village maintains its own government comprised of a Village Council, Village Chairman, and Secretary. Members of the Village Council are elected by the community and are divided between different committees which focus on specific issues (TCP 1997).

### Methodology

### Data Collection

Research teams of two students walked from boma to boma to interview residents of six villages (Mswakini Chini, Mswakini Juu, Makuyuni, Naitolia, Losirwa and Oltukai) in the Kwakuchinja corridor. Interviews were conducted over eight days in April 2008 from previously developed questionnaires through translators/local guides using the household as the sampling unit. Interviews were conducted within the framework of a Participatory Rural Appraisal (PRA) approach, an interactive tool that encourages shared learning and collaboration between residents and researchers. PRA involves the exchange of indigenous and professional knowledge in order to determine sustainable and viable solutions to identified problems. The questionnaire maintained a semi-structured format that included directed and open ended questions allowing the individual to elaborate on certain subjects. Questions related to livelihood strategies, land uses, attitudes towards wildlife/ wildlife conservation and possibilities for increasing benefits.

Additionally, key informants in the area were interviewed to provide further information and to elaborate on trends found through the questionnaires. Elders from Eslale and Mswakini were chosen to discuss community needs in addition to the views and expectations of local conservation initiatives. Employees from Manyara Ranch were interviewed to explain the role of the project and the status of current conservation initiatives in the corridor. These informants included Lendova (Community Liaison) to discuss current and past community development projects as well as the nature of communityranch interactions, Lusiga (Manager) to discuss the current status of the ranch and future plans and Pastoria (Ecologist) to discuss activities that ensure ecological sustainability of the ranch and region. A final component was an extensive literature review against which trends in pastoralism and wildlife conservation were examined.

Page 34 Visions Magazine

### **Data Analysis**

Responses from the questionnaires were quantified and entered into the Statistical Package for Social Scientists (SPSS) software. Inferential and descriptive statistical tests were used. Chi-square goodness of fit tests tested variations within the data to determine distributions and chi-square contingency tables were used to test relationships between variables.

#### Results

#### a) General information on sample population

The results are based on a sample population of 253 interviewed individuals distributed between Mswakini Juu, Mswakini Chini, Naitolia, Oltukai, Losirwa, and Makuyuni. There was no significant difference in the sex of respondents. Respondents were unevenly distributed between the six villages (X2=26.762, df=5, p=<0.001) with the largest number located in Naitolia (25%).

#### Table 1. Ethnic distribution between villages

		Eth	nicity of Respondent		
		Maasai	WaArusha	Other	N
Survey	Mswakini Chini	68%	32%		41
Location	Mswakini Juu	35%	57%	8%	49
	Makuyuni	78%	17%	6%	18
	Losirwa	98%	2%		43
	Ol Tukai	100%			35
	Naitolia	41%	54%	5%	63
Total		65%	32%	3%	249

The majority of respondents were Maasai (65%) with WaArusha being the second largest ethnic group (32%) and the remaining 3% composed of various other ethnic groups. The location of an individual was dependent on ethnicity (X2=78.782, df=10, p=<0.001). The majority of villages contained populations of both Maasai and WaArusha, with the exception of Oltukai which was exclusively Maasai (Losirwa was 98% Maasai). The Maasai were the majority in Mswakini Chini, Makuyuni, Losirwa and Oltukai whereas WaArusha comprised the majority in Mswakini Juu and Naitolia (Table 1).

### b) Trends in the general livelihoods and in pastoralism in the region

The greatest number of respondents identified agro-pastoralism (40%) as their primary livelihood followed by pastoralism (34%) and agriculture (20%) with relatively few involved in other activities (6%). Primary livelihood was dependent on

Table 2.	Primary	livelihood	according	to location
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		F	Respondent <sup>©</sup> Primary Livelihood					
		Pastoralism	Agriculture	Agro-Pastoralism	Other	Ν		
Survey	Mswakini Chini	2%	52%	38%	7%	42		
Location	Mswakini Juu	8%	49%	35%	8%	49		
	Makuyuni	11%	39%	50%		18		
	Losirwa	69%	4%	18%	9%	45		
	Ol Tukai	34%	3%	60%	3%	35		
	Naitolia	2%	48%	46%	5%	63		
Total		20%	34%	40%	6%	252		



Tarangire National Park hosts a substantial population of elephants. Local communities complain of crop raiding by elephants dispersing out of the park during the wet season.

location (X2=123.630, df=15, p=<0.001) with pastoralism dominant in Losirwa, agro-pastoralism dominant in Makuyuni and Oltukai, and agriculture dominant in Mswakini Juu, Mswakini Chini, and Naitolia (Table 2). The only locations where very few pure agriculturists were present were Losirwa and Oltukai.

Primary livelihood was also dependent on ethnicity (X2=35.037, df=6, p=<0.001) with the WaArusha being almost exclusively agriculturalists and agro-pastoralists and only 1% involved in pure pastoralism (Table 3). The Maasai were involved in all three livelihoods. The other ethnic groups were predominantly agriculturalists and were more likely to engage in livelihoods other than agriculture, pastoralism, or agro-pastoralism.

Table 3. Primary livelihood according to ethnicity

		1	Respondent@Primary Livelihood						
		Pastoralism	Pastoralism Agriculture Agro-Pastoralism Other						
Ethnicity of	Maasai	30%	28%	36%	6%	162			
Respondent	WaArusha	1%	1% 42% 51% 6%						
	Other	75% 13% 13%							
Total		20% 34% 40% 6%							

A minority (38%) of respondents reported that they engage in other activities or jobs outside of their primary livelihood to support their household. Of the respondents who engage in other activities (n=97), a majority were engaged in small-scale pastoralism or business. Whether an individual was involved in another activity was not dependent on ethnicity. However, when just the Maasai and WaArusha are compared one finds the Maasai are more likely to be involved in other activities than the WaArusha (X2=4.912, df=1, p=0.027). Pastoralists are most likely to engage in other activities whereas the majority of agro-pastoralists (82%) do not engage in supplemental activities.

The amount of land cultivated per individual is dependent on location (X2=96.009, df=35, p=<0.001) with Mswakini



Juu, Mswakini Chini and Naitolia being the only villages where respondents reported cultivating over 50 acres. In all locations, except Makuyuni, the average parcel size was 1-5 acres. The majority of crops grown (58%) were designated for subsistence. Only 2% of people reported using their crops exclusively for commercial purposes and 35% reported using some crops for food and others for commercial purposes (Figure 1). The motivation for involvement in agriculture was dependent on location (X2=77.997, df=15, p=<0.001) with the exclusive use of crops for commercial purposes observed only in Mswakini Chini and Naitolia.

Of those respondents who reported involvement in pastoralism, 27% reported that they did not own cattle. Of people who did own cattle, the largest percentage (27%) owned between 11 and 50. The number of cattle owned was dependent on ethnicity (X2=44.167, df=12, p=<0.001) with larger amounts of cattle associated more with the Maasai than the



Figure 4. Land use identified by respondents as most compatible with wildlife conservation (n-236)

Page 36 Visions Magazine

WaArusha. The greatest proportion of Maasai (33%) owned between 11 and 50 cattle whereas the greatest proportion of WaArusha (38%) do not own cattle.

The majority (57%) of respondents that owned cattle reported moving with their cattle seasonally. This was not dependent on ethnicity but was dependent on the number of cattle an individual owns (X2=17.644, df=5, p=0.003). Individuals who own between 11 and 50 cattle are more likely to move seasonally with their livestock and those owning over 100 were least likely to move with their cattle. Thirty-three percent of the respondents that move with their cattle reported moving between 11 and 20 kilometers with only 6% reporting moving more than 50 km. The majority (88%) of respondents that engage in pastoralism reported owning small stock (sheep and goats) with 1 to 10 small stock the most common herd size.

Of the respondents that engage in pastoralism, 42% responded that they engage in non-monetary livestock exchange and 53% of those reported that they exchange their livestock for different types of livestock. Only 23% of respondents who reported engaging in non-monetary exchange listed reciprocity as the reason. Whether the respondent engages in non-monetary exchange is not dependent on ethnicity or on the number of cattle owned.

#### c) Analysis of livestock markets

Of livestock owners, 93% reported owning the indigenous East African Zebu and only 1% reported owning Borana cattle and another 1% reported owning a combination of indigenous and Borana. Forty-two percent of respondents who owned cattle reported selling between one and five cattle annually with 34% percent of respondents reporting that they didn't sell any cattle in the past year. The number of cattle an individual sold last year is dependent on the individual's herd size (X2=122.151, df=20, p=<0.001). Although selling between one and five animals is the most common among all herd sizes, the likelihood of an individual selling a larger quantity of cattle increases with herd size.

The number of cattle sold is also dependent on ethnicity (X2=37.636, df=8, p=<0.001) with the Maasai being more likely to sell their cattle (only 19% of cattle-owning Maasai reported selling no cattle last year). The majority of cattle-owning WaArusha (53%) and individuals of other ethnic groups (38%) did not sell any cattle.

The majority of respondents sold cattle either in Minjingu (37%) or Makuyuni (21%) with 1% using multiple markets and only 5% selling in Arusha. Seventy-seven percent of respondents who reported selling cattle last year listed proximity as the main reason for selecting a particular market. The main reason for using the Minjingu market was proximity, whereas other reasons drive the use of the Makuyuni market. All respondents who sell in Arusha listed price as the decisive factor (Table 4).

Close	est Market	Reasons I Use I	Respondent Chos Particular Market	e to	Total
		Market Where Cattle Fetch Highest Price	Other		
Where	Arusha		100%		4
are	Minjingu	100%			40
sold	Makuyuni	64%	32%	4%	25
	Losirwa	100%			13
	Multiple	53%	41%	6%	17
	Other	64%	36%		11
Total		77%	21%	2%	110

Table 4.	Reason res	nondent	sells	cattle	at	particular	market (	(n=110)	
Lable 1.	iteason ies	ponacin	ocno	cattle	aı	particular	marker	II 110)	,

The majority of respondents who sold cattle received between 100,000 and 200,000 Tanzanian Shillings (TZS) per animal (USD 75.19 - 150.38). The price was dependent on the market used (X2=41.603, df=25, p=0.02) with the likelihood of receiving over 500,000 TZS greatest at the Arusha market and no one reporting receiving less than 100,000 tsh in Arusha. This supports the assertion by respondents that the decisive factor in using the Arusha market is that it fetches the highest price.

Of the respondents that own small stock, 72% reported selling one or more last year and the majority of those (75%) sold between one and ten (14% sold between 11 and 20, 10% sold between 21 and 80 and 1% sold more than 80). The price of small stock is also dependent on the market used (X2=516.401, df=42, p<0.001) with greater revenue available by selling in Arusha or by using various markets.

Cattle were sold for various reasons. Eighty-three percent of respondents that sold cattle used some portion of the revenue to purchase food. Revenue derived from the sale of cattle was also applied to other needs such as healthcare, education, emergencies, ceremonies, domestic costs, and livelihood costs (inputs for cultivation or livestock production). The uses of revenue from the sale of sheep and goats are similar to those of cattle (Table 5).

The majority (52%) of respondents involved in pastoralism reported that they did not sell any livestock products outside of live sales. Of those who did sell other products they were limited to milk and hide. The product sold is dependent on the ethnicity of the individual (X2=31.324, df=8, p=<0.001) with the Maasai more likely to sell other livestock products than other ethnic groups. The sale of milk exclusively is an activity dominated by the Maasai (21% compared to 9% among the WaArusha).

Table 5. Percentage of sample that sold stock that used some portion of the revenue for particular needs (each cell in Cattle row is n=139, each cell in small stock (shoats) row is n=141)

	Reason						
Туре	Food	Healthcare	Education	Emergency	Ceremonies	Domestic Needs	Livelihood Costs
Cattle	83%	15%	29%	4%	2%	13%	12%
Shoat	71%	17%	30%	5%	0%	20%	10%

### d) Views and expectations of the local community towards wildlife conservation

Ninety-five percent of respondents reported that they feel wildlife is imposing a cost on them and 60% of those identified crop raiding as the main cost. The type of cost experienced by a respondent is dependent on location (X2=123.260,



Giraffes are silhouetted against Lake Manyara.

df=30, p=<0.001). All sites experienced wildlife damaging crops and livestock predation. Exclusive damage to crops was least common in Oltukai and Losirwa and most common in Naitolia. Exclusive predation was most common in Losirwa and Oltukai.

Fifty-nine percent of respondents reported that they maintain a negative attitude towards wildlife while 52% reported they have a positive attitude towards wildlife conservation. The respondent's attitude towards wildlife is dependent on ethnicity (X2=13.049, df=6, df=0.042) with the Maasai maintaining a slightly more positive attitude towards wildlife than other ethnicities. The WaArusha are more likely to have a negative attitude of wildlife. Attitude towards wildlife is dependent on primary livelihood (X2=23.729, df=9, p=0.005). Pastoralists are more likely to hold a positive attitude towards wildlife and agriculturalists more likely to hold a negative attitude (Table 6).

Table 6. Attitude towards wildlife by primary livelihood						
		Respondent@Attitude Towards Wildlife				
					Do Not	
		Positive	Negative	Indifferent	Know	Ν
RespondentÖ	Pastoralism	49%	45%	4%	2%	51
Primary	Agriculture	21%	74%	3%	1%	86
Livelihood	Agro-Pastoralism	29%	57%	13%	1%	99
	Other	53%	40%	7%		15
Total		32%	59%	8%	1%	251

The respondent's attitude towards wildlife conservation was dependent on location (X2=36.897, df=15, p=0.001) with Mswakini Chini and Oltukai having the highest percentages of people with positive attitudes (67% and 66% respectively) and Makuyuni Juu having the highest percentages of people with negative attitudes (46%) (Figure 3).

Seventy-nine percent of respondents reported that they do not receive benefits from wildlife conservation, 14% identified community development as a benefit they receive from conservation, and 4% replied that they received monetary benefits.

Eighty-three percent responded that if they received money from wildlife conservation they would change their livelihood with the greatest percentage (42%) of replying that they would go into general business and trading, and another 11% replying they would go into exclusive pastoralism. Across all livelihoods (pastoralism, agro-pastoralism, agriculture, other) the largest percentage of respondents identified pastoralism as the land use that is most compatible with wildlife conservation (Figure 4).

### Discussion

### Trends in the general livelihoods and in pastoralism in the region

The Kwakuchinja corridor has historically been populated by the Maasai practicing traditional pastoralism. Although the Maasai comprised the majority of respondents (65%), 32% identified themselves as WaArusha. This reflects a recognized



A typical Maasai boma consists of several huts surrounding a ring of acacia that serves to hold livestock.

increase in migration of other ethnic groups, predominantly the WaArusha, into the corridor over the past twenty years (AWF 2005). The WaArusha were originally located in the foothills of Mt. Meru but land pressures due to extensive cultivation and the growing timber industry, along with population pressures from the expanding urban center, are driving their migration into surrounding districts (TCP 1997). This in-migration has several implications for the Maasai and pastoralism in the corridor.

The WaArusha are primarily agro-pastoralists (TCP 1997) with the majority (51%) of WaArusha respondents reporting agro-pastoralism as their primary livelihood. Increased in-migration of non-pastoralists increases competition for resources within the corridor and, consequently, the Maasai are finding it difficult to meet their subsistence needs based solely on pastoral production systems driving them towards cultivation (AWF 2005; TCP 1997). Waroux (2005) cautions against the assumption that cultivation is new to the Maasai. He recognizes that "pure" pastoralism was rare for the Maasai and evidence suggests that small-scale cultivation was already a part of their livelihoods before the eighteenth century. Further, changes to traditional land tenure regimes that accompanied colonialism and post-independent policies restricted the Maasai to permanent households forcing the adoption of transhumant pastoralism over nomadism (Kishel date unknown). This semisedentary system made cultivation for household consumption possible (Kishel date unknown) and Schuyler (date unknown) argues that arable agriculture is an important component of transhumant pastoralism. Thus, the presence of agriculture in Maasai homesteads is not necessarily new or a product of the recent in-migration of the WaArusha.

Yet, 36% of Maasai respondents identified themselves as agro-pastoralists and 28% as agriculturalists (Table 3) showing a shift away from even transhumant pastoralism towards a system more dependent on agriculture. Further, a 2004 report by African Wildlife Foundation (AWF) described Oltukai as primarily inhabited by livestock-keeping Maasai as well as some subsistence crop farming Maasai (Jones 2005). Yet, while all respondents in Oltukai were Maasai (Table 1), only 34% identified themselves as pastoralists compared to 60% as agropastoralists (Table 2). Of the other ethnic groups residing in the corridor, the majority identified themselves as agriculturalists and none as pastoralists (Table 3). The in-migration of non-pastoralists and the conversion of the Maasai towards agro-pastoralism and, in some cases, pure agriculture, reveals a general trend in the region away from pastoralism. Within the sample population only 20% identified themselves as pastoralists.

A trend is also evident in the use of agriculture. Waroux's (2005) claim that small-scale cultivation is traditionally a part of the Maasai production system describes subsistence agriculture. However, of Maasai respondents engaged in any level of cultivation (n=150), 37% reported using their crops for both subsistence and commercial purposes. Further, 31% of residents in Oltukai reported using some crops for commercial purposes. Although it is reported that the WaArusha are more likely to engage in the production of cash crops (TCP 1997), this study found no significant difference in the use of crops among the sampled ethnicities (p=0.942).

The decrease in the ability of pastoralism to fully meet a household's needs is also demonstrated by the percentage of pastoralists involved in other subsistence and economic activities. Seventy-nine percent of people identified as pastoralists reported that they engage in supplemental activities. Thompson and Homewood (2002) argue that land-use trends can be predicted by examining the economic returns of alternative production systems. While no analysis of profit differentials between various livelihoods was performed, one can infer from the fact that the pastoralists had the highest percentage of respondents engaged in supplemental activities (79% compared to 42% for agriculturalists, 18% for agro-pastoralists, and 53% for other livelihoods) that the economic returns of alternative livelihoods are greater. This is consistent with the literature which contends that returns from livestock herding are relatively low and tend to fluctuate with inter-annual climatic variations (Waroux 2005; Thompson and Homewood



Livestock predation by lions and hyenas was a common complaint of pastoralists residing in the corridor.

2002). The implication is that, at present, exclusive pastoralism is not an economically viable livelihood in the corridor and this differential will only continue to drive people away from pastoralism.

The data also demonstrate changes to traditional components of pastoralism. Kishel (date unknown ) cites a reduction in the number of cattle per person among the Maasai in Kenya from 13 to 6 between 1960 and 1987 that is attributed to the increasing confinement of the Maasai to smaller parcels of land that can not support many cattle. The corridor maintains a human population of 16,000 and a livestock population of 33,000 translating to a cattle per capita ratio of 2.1:1. However, this figure is misleading since the region contains a range of livelihoods so the distribution of cattle is skewed. Data on the number of people per household was not collected so a cattle per capita ratio for just pastoralists can not be determined for the sample population. However, only 16% of pastoralists (n=51) reported owning more than 50 cattle and traditional Maasai pastoralism requires roughly 10 cattle per individual (Kishel date unknown). While this may be sufficient for a household, there are risks involved with keeping numbers close to the 10:1 ratio. East African pastoralists are historically characterized by the keeping of large herds as a form of insurance against the effects of drought or epidemics and as a compensatory practice due to the low productivity of African cattle (Netting date unknown). Drought is considered the most serious risk for a pastoralist because it significantly impacts the resource base (McPeak and Barrett 2001) and past droughts have shown drastic reductions in herd sizes (Livingstone 1985). Thus, pastoralists traditionally keep herd sizes several times their subsistence level based on expected losses in the event of drought. In Kaputiei, Maasailand, Livingstone (1985) estimates the need for herd sizes four to five times subsistence level. Thus, even without data on the number of cattle per capita in the sample, one questions whether the number of cattle held by pastoralists provides a sufficient level of insurance. In the absence of adequate insurance exclusive pastoralism is insecure and diversification is understandable.

Mobility is another strategy employed by pastoralists to mitigate risk associated with temporal variability in water and forage. Restricted mobility potentially leads to localized environmental degradation and a decreased ability to cope with drought (McPeak and Barrett 2001). Currently, 90% of pastoralists (n=49) and 75% of agro-pastoralists (n=93) reported moving seasonally with their cattle. This reveals mobility as still an active part of pastoralism in the region. However, Mc-Peak and Barrett (2001) list the conversion of rangelands to agriculture as a factor that restricts mobility. Since the greatest percentage (36%) of respondents who reported moving with their cattle (n=144) only reported moving between eleven and twenty kilometers, if the role of cultivation in the region continues to increase the use of mobility could diminish.

Forty-two percent of respondents reported involvement in non-monetary exchange (n=107). Of those, 23% listed reciprocity as the reason. Reciprocity is a form of social insurance used to mitigate risk (McPeak 2001). This low level of reciprocity is consistent with Livingstone's (1985) indication that social cohesiveness and reciprocal agreements among pastoralists are deteriorating. A potential explanation for the low level of reciprocity is the in-migration of non-Maasai ethnic groups. Thompson & Homewood (2002) claim that the communal management of resources is "more likely to work where user groups are tied by a long history of reciprocal interaction and interdependence" (110). The threat that the in-migration of different ethnic groups poses to cooperative management and resolution is echoed by Livingstone (1985). It is a logical inference that in-migration could have similar impacts on other social practices including reciprocity. Decreasing numbers of people involved in non-monetary exchange could also be a result of the increasing commoditization of livestock activities cited by Waroux (2005). This commoditization is further observed with regard to other livestock products. The majority of people did not sell other livestock products. The Maasai were more likely to sell other products and the sale of milk exclusively is an activity dominated by the Maasai. Milk is an important product the Maasai derive from livestock for sustenance (Kishel date unknown) and their sale of milk demonstrates a shift from traditional subsistence use towards commercial use. The decreasing presence of these social components of pastoralism indicates that the future socio-cultural viability of pastoralism is in question.

#### An analysis of livestock markets

Of livestock owners (n=180), 93% own only the indigenous East African Zebu. Borana cattle, used by Manyara Ranch, tend to be more productive (Pastoria per com) but only 3% of respondents possess any number of Borana. The implication is that pastoralism in the region does not operate at an optimal level because livestock keepers receive less per unit than if they owned Borana and, therefore, must keep larger herds.

The greatest proportion of interviewed livestock keepers (42%) sold between one and five cattle annually. The number



Figure 3. Respondent@attitude towards wildlife conservation by location (n=228)





The Maasai are the dominant ethnic group in the Kwakuchinja corridor, although a recent influx of the WaArusha has been observed.

crease herd size and their propensity to sell more cattle is likely more a product of herd size than of culture.

Seventy-two percent of respondents that own small stock reported selling one or more in the past year. The reasons proper people sold small stock were similar to the reasons people sold cattle showing that the type of livestock sold is not dependent on the need (Table 5). Most people sold livestock to purchase food, followed by school fees and domestic needs respectively.

Most people sold cattle in Minjingu (37%) and Makuyuni (21%). The majority of respondents selling in Minjingu and Makuyuni listed proximity as the reason they selected that market (100% and 64% respectively). One hundred percent of

Page 40 Visions Magazine

people who sold cattle in Arusha chose that market because of price (Table 4). Price is dependent on market used (p=0.02) and the likelihood of receiving higher prices for cattle is greatest in Arusha. However, only 5% of people selling cattle sold in Arusha. A similar situation is seen with regard to sheep and goats. This demonstrates that the limiting factor for people selling cattle is transportation to markets since the majority of respondents chose closer markets due to proximity despite lower prices.

### Views and expectations of the local community towards wildlife conservation

An individual's attitude towards wildlife is dependent on livelihood (p=0.005) with a greater proportion of pastoralists (49%) maintaining a positive attitude than agro-pastoralists (29%) or agriculturalists (21%) (Table 6). The Maasai are more likely to engage in pastoralism (Table 3) which could explain the greater numbers of Maasai reporting a positive attitude than other groups.

Although the majority of respondents claimed they maintain a negative attitude towards wildlife, most (52%) responded that they have a positive attitude towards wildlife conservation. Attitude was dependent on location (p=0.001) with dominant livelihood the likely decisive factor (with Mswakini Chini aberrant in that context). The majority of respondents reported that they do not receive benefits from wildlife conservation. The 1996 Wildlife Policy mandated that 25% of revenue generated by the national parks be distributed to local communities but research indicates this distribution is rarely performed (Simba 2003) and this is reflected in our data. Benefits received by communities usually take the form of community development projects. Tanzania National Parks (TANAPA) is involved with building schools in local villages and built two classrooms and a house for a teacher in Mswakini Chini (Menakaiti per com). However, our data indicates that very few people (only 14%) recognize community development as a benefit derived from wildlife conservation. This is consistent with findings by Thompson and Homewood (2002) that game viewing dividends from Masai Mara National Reserve (MMNR) in Kenya that are channeled through administrative mechanisms into community development are rarely recognized as benefits derived from conservation because they are not experienced at the individual level. Norton-Griffiths (1994) contends that wildlife revenues must go directly to landowners, not to county councils or community projects, because there must be a direct link between profits and the current land use. Thus, because this connection is absent most local people feel they do not receive any benefits from TANAPA and, therefore, have a poor relationship with the agency. Those who do recognize TANAPA's contributions still maintain a negative attitude towards TANAPA because they believe they do very little for the communities relative to the revenue they receive (Menakaiti per com).

The local community maintains a better relationship with AWF (Menakaiti per com ). Manyara Ranch and the Kwakuchinja Easements for the Environment through Partnership (KEEP) project are the two AWF conservation initiatives currently in place in the area. The Tanzania Land Conservation Trust (TLCT) is responsible for managing Manyara Ranch for wildlife conservation and community development (Sumba et al 2005). Oltukai and Losirwa (part of Eslale) are



Sustainable pastoralism allows livestock and grazing wildlife, such as zebra and buffalo, to coexist.

partners with Manyara Ranch and the other four villages are considered peripheral villages. Partner villages retain that status because land that the ranch is on was originally a part of those villages. All six villages derive some benefits from the ranch, mostly in the form of community development. The ranch serves as a facilitator of development determining community needs and finding donors to implement projects. Development to date includes the construction of houses for teachers, the construction of offices for village governments, and livelihood enhancement strategies. The main benefit for the two partner villages is employment; 85% of ranch employees are from partner villages (Lendoya per com). Although Oltukai and Losirwa maintain high percentages of people with positive attitudes towards wildlife conservation (66% and 60% respectively), there is little difference between the partner villages and peripheral villages (Figure 3). The implication is that there is little extra benefit in being a partner. This disconnect between the extra sacrifice of the villages and the extra benefits received translates into a negative view of the ranch. When asked his opinion of Manyara Ranch, Letema, the elder from Eslale, responded that they would prefer ownership of the land the ranch occupies to the ranch itself because they once had open access to those resources and now face restrictions (Letema per com). The statements of the elder contrast with those of Manyara Ranch's community liaison who reported that community relations with the ranch are good because the community feels a sense of ownership (Lendoya per com).

The KEEP project is attempting to steer residents away from land uses that are incompatible with wildlife conservation and

finalized an agreement with Mswakini Chini on 11 April 2008 (Lusiga per com). The KEEP project in Mswakini Chini is taking an approach proposed by Norton-Griffiths (1994) for areas around MMNR of reducing the incentives of developing the agricultural potential of land by matching the opportunity costs of not cultivating. AWF is paying the village the equivalent of ten bags of maize per acre of land in the corridor that the village does not cultivate (Lusiga per com).

Unfenced savanna rangeland under pastoralist use can be compatible with wildlife conservation (Thompson and Homewood 2002) and both Manyara Ranch and the KEEP project are trying to capitalize on this compatibility to secure the Kwakuchinja corridor. The majority (53%) of respondents recognize pastoralism as the most compatible land use with conservation (Figure 4) and the high percentage of pastoralists reporting a positive attitude towards wildlife supports this claim. However, the trends apparent in the data are a move away from pastoralism due to its decreasing ability to support the needs of households. If adequate interventions that address the current economic shortcomings of pastoralism are not put in place then it is likely the shift towards cultivation will continue and the corridor will become fragmented.

#### Conclusion

Recent in-migration in the Kwakuchinja corridor is leading to a more diverse ethnic composition in a region that was historically dominated by the Maasai. The resulting increased competition for resources and the erosion of traditional insurance practices is decreasing the ability of pastoralism to meet household needs leading the Maasai away from exclusive pastoralism and increasing the role of agriculture in the corridor. Agriculture is not compatible with wildlife conservation and the trend towards cultivation threatens the ability of the cor-



ridor to support viable wildlife populations. AWF is attempting to encourage pastoralism in the corridor which is viewed as highly compatible with wildlife conservation. However, current trends indicate that exclusive pastoralism is not economically viable in the corridor. Thus, even though it is compatible with wildlife conservation, its economic dimensions are hindering its status as a viable land use. AWF's success in promoting pastoralism necessarily involves reversing the current trend which requires interventions to improve the security and economic returns associated with pastoralism. Community perceptions of TANAPA are poor due to a lack of benefits so initiatives are best implemented by AWF. Cur-

rent projects have potential but issues over ownership and access need to be addressed to gain community acceptance.

### **Research Recommendations**

An analysis of profit differentials between pastoralism and alternative livelihoods needs to be performed to determine the strength of economic incentives and opportunity costs.

· Carrying capacity of the corridor for livestock and for a combination of livestock and wildlife needs to be examined to determine the optimal level of pastoralism that is still compatible with wildlife conservation.

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### About the Author

Evan Ross is a senior Environmental Studies major with minors in Biology, Geography and African/African American Studies. Evan spent his spring semester 2008 with the School for Field Studies in Tanzania studying wildlife management and policy and performing field work in and around Tanzanian National Parks. He hopes to return to sub-Saharan Africa after graduation through the Peace Corps and eventually pursue graduate studies in Conservation Biology.

## **Quick Reads**

### Morris K. Udall Scholarship National Level Award for Students with Environmental Interests

The Morris K. Udall Scholarship is a national level award given each year to students in their sophomore and junior years in college. In 2009 approximately 80 scholarships for up to \$5,000 each and 50 honorable mentions for \$350 each were granted to sophomores and juniors who had demonstrated commitment to careers related to the environment. Students interested in being considered for a Udall Scholarship should:

1) Consult the Udall Foundation web page (http://www.udall.gov/OurPrograms/MKUS-cholarship/MKUScholarship.aspx) to learn more about the award.

2) Contact Elon University's Coordinator for National and International Fellowships regarding their interest in the award.

3) Approach a faculty member with related interests to nominate them for the award.

4) Complete the application, which includes several essays, in consultation with the faculty member nominating you. Plan to have to revise and rewrite your essays before submitting your application at the campus level.

5) Submit the completed application to Elon University's Coordinator for National and International Fellowships by the appropriate deadline. The National/International Fellowships Committee will then review your application and let you know whether: a) it is good to go and will be forwarded on to the national level, b) it is in need of further revision and strengthening before it can be passed on to the national level as representative of Elon, or c) is unacceptable and cannot be used to represent Elon at the national level.



Students pursuing Udall Scholarships should have at least a 3.5 GPA and be active in service/leadership. The Udall Foundation seeks future leaders from a wide spectrum of environmental fields, including, but not limited to: policy, engineering, science, business, education, urban planning, economics, health, and justice.

In 2008, Elon junior, Honors Fellow and Environmental Studies major, Breanna Detwiler won a Udall Scholarship for \$5,000. To learn more about her story, please visit: http://www.elon.edu/e-net/Note.aspx?id=928555

### Signatories to the Kyoto Protocol Experienced Greater Climate-related Innovation by Evan Ross

According to a recent study performed by the Center for Industrial Economics (CERNA), the Kyoto Protocol had a substantial impact on innovation in climate-friendly technologies. The study examined the number of patents in 13 classes of technologies including seven renewable energy technologies (wind, solar, geothermal, ocean energy, biomass, waste-to-energy and hydropower), methane destruction, climate-friendly cement, energy conservation in buildings, motor vehicle fuel injection, energy-efficient lighting and Carbon Capture & Storage. The number of patents was used as a measure of the output of innovation between 1978 and 2003. Their research revealed that the trend in innovation in climate-friendly technologies was relatively similar to that of all technologies until the late nineties, when the number of patents on climate-mitigation technologies began to increase dramatically while the trend for all other technologies remained stable. This sharp increase in climate innovation corresponds with the signing of the Kyoto Protocol in 1997. Yet, the boom in climate technologies after Kyoto was not experienced equally by all countries. The increase in patents was only observed in countries that were signatories to the Kyoto Protocol. Climate innovation in the United States and Australia (the former never ratified Kyoto and the latter ratified it only recently), measured as the number of inventions per year, remained relatively stagnant as it soared in signatory countries. The authors attribute this increase to the quick adaptation of innovators who expected significant policy changes requiring climate-friendly technologies following Kyoto's passage. As the economics of a climate treaty are likely to be a major focus as nations meet in Denmark in December to establish a post-Kyoto agreement, the potential for innovation evidenced in this study and the economic implications could help motivate leaders to adopt progressive climate policies.

#### Source:

Dechezlepretre, Antoine et al. 2009. Invention and Transfer of Climate Change Mitigation Technologies on a Global Scale: A Study Drawing on Patent Data. CERNA, Mines Paris-Tech and Agence Francaise de Developpement

# POETRY

### A Green Drake Hatches on West Branch Pond By Cory Landon '09

A loon sinks below the surface, comes up Closer to us. Do you remember when I used to think their calls were coyotes,

Or how you had to tell me when to cast? Sometimes I cannot remember your face, But I remember how to gut a fish—

Belly slicked, insides out, blood rinsed — and I Know your hands by heart, strong and swollen, hands That encircled my wrists, untangled lines.

Sometimes I think it's all you see when you Look at me, the girl who learned when to tug, How to break a neck. Now life has left my

Lungs clogged up. Daddy, were you ever lost Like me? You must have found yourself at the Bottom of this lake. Tell me something.

Tell me you loved me more then and I'll change Back for you, come back like I return here, Let air in again. You take up the oars

Pull us along for a few strokes then stop. Water droplets pool at the end of the Oars then fall. I feel a familiar weight

On my line, jerk the rod back, catch the lip Of a brook trout, and you pocket him in Your net. A nice one, too big to release.

**Chris Pickens** is a senior Creative Writing and Cinema double major from Nashville, Tennessee. He hopes to pursue a career in the film industry after graduation.

Cory Landon is a senior Creative Writing Major.

Page 46 Visions Magazine

### Feeding the Birds By Chris Pickens '09

First, I flung sunflower seeds over the ground outside the window of the breakfast room, the center

of our newlywed world. The squirrels got to them first, as soon as my back was turned. You laughed and I didn't.

Then I hung a feeder, a hollow lure on a curved pole, right outside the window. I bought a red seed scoop, labeled which day

I had fed them last, shoved my arms up to the elbows in the dry feed and asked you to do it too, but you didn't want dirty hands.

Birds discovered our feeder, and we watched chickadees, robins, purple finch, a titmouse, blue jays and red-bellied woodpeckers

flutter and flash just beyond the glass. You only looked, never watched. I wanted to open the window to let

cardinals skim through our dining room, wrens to nestle in our teacups and mocking birds to mimic the sound of the shower.

You wanted to keep them away, separate us from them, the outside from the inside, what we did from what we saw.

In winter, you stood outside with your hands under your armpits, checking the trees for birds left behind or hiding from us.

We checked the feeder each day from inside our box, wanting the birds to come back, wanting them to look inside and wonder

why we, earthbound, try to hem them in.

### Sockeye Love By Luke Johnson '07

Not knowing gleam from gill

when they crested sunlight splashing

upstream, I watched Reds slip out

and back in the river. Rock flour bled

into current, the blue till

a silt-gauze galaxy against a pale

almost white, river sky: flashing fish-backs

made constellations, shooting themselves

into the wind—that arc, that twisting glimmer.

### At the Community Garden in Moulsecoomb By Hilry Hazelwood '09

They told me the first day how rotten the soil is here, that the dirt is chalky as the Dover cliffs down the coast. I dig a trench for leeks, pausing to examine my progress and the foreign soil, consider if by working in it I'll grow accustomed to living in this new country. I grip the shovel's handle tighter,

splintered timber warm beneath curled fingers, and shovel dirt into a neat row lining the trench,

think of the sun overhead shining a different angle here than at home; things are always one way here, another there. Beyond the leeks, zucchinis grow with spotless skin and gentle curvature, but here they are courgettes, and arugula is rocket, and green beans are runner beans. As I bury my hands in the cool soil, scooping stray rocks from the trench, I imagine the sun rising over the Atlantic, kneeling and wondering if everything somehow takes root in British soil.

### **By Chris Pickens '09**

Jury

I found a heronry up in a dead oak tree, A hundred birds perched together, dotting the dead branches like seed pods, their gray and blue feathers pulled tight around their bony skeletons.

I had seen them alone, monarching over low marshes and cottonmouths, but they had to come together to mate, hunched against the valley wind, each one a wingspan apart from the next bird.

They didn't jostle or honk or take flight, they sidestepped and ignored each other. When I crashed through the underbrush to find a broken fence I had to mend, they all turned their orange beaks

in unison, like cattails in a breeze. Under the tree, the burnt-out husk of a truck rusted, vines inching up the wheel wells and the drive train. Country boys dragged it onto our

property, got drunk and torched it there, adding wood varnish to feed the fire. I wondered if the herons were there, if they watched the boys howl and hiss and stumble around.

Did they brood down over the flames, a silent, hunched jury? Were they quiet then or did their squawks echo from feathered throats, dousing the flames with sound?

They must have taken flight, each retreating to its own moonlit bend in the river, their verdict on the boys who left their evidence out for the earth to absorb.

Luke Johnson is a recent graduate of the MFA program at Hollins University. His work appears widely in national journals and was featured in the anthology Best New Poets 2008, guest edited by Mark Strand. This summer, he will be a Tennessee Williams Scholar at the Sewanee Writers' Conference. He lives in the Blue Ridge Mountains.

Hilry Hazelwood is a senior Creative Writing major with a Women's/Gender Studies minor. She spent summer 2008 in Brighton, England and worked in a garden where she harvest-ed vegetables, made pesto, and helped children pick runner beans.

Spring 2009 Page 47

### Who's Counting? Solar and Wind Energy

With the 15th Conference of the Parties (COP15) of the United Nations Framework Convention on Climate Change (UNFCCC) occurring in Copenhagen, Denmark from December 7-18, 2009 to establish an agreement on climate to follow the Kyoto Protocol after its 2012 expiration, the United States is under pressure to demonstrate its commitment to power the nation with carbon-free technologies.

U.S. Net Electricity Generation		
Coal	48.5%	
Natural Gas	21.4%	
Nuclear	19.4%	
Hydropower	6.0%	
Petroleum	1.6%	
Other	0.7%	
Biomass	1.3%	
Wind	0.78%	
Geothermal	0.35%	
Solar	0.05%	

Year	Wind Generation (GWh)	U.S. Investment (\$ in Millions)
2001	6,737	250
2002	10,354	230
2003	11,187	940
2004	14,144	750
2005	17,811	2,525
2006	26,589	7,180
2007	30,977	8,170

Year	Solar Generation (GWh)	U.S. Venture Capital In- vestment (\$ in Millions)
2001	1,011	7
2002	1,072	45
2003	1,161	50
2004	1,287	74
2005	1,447	208
2006	1,652	408
2007	2,143	1,569

Page 48 Visions Magazine

	Global Wind Turbine Market Share		
	Denmark	35.5%	
1	Spain	15.6%	
	United States	15.5%	
	Germany	15.4%	
	India	7.7%	
	Others	10.3%	

Global Solar PV Market Share		
Japan	43%	
Germany	17%	
China	8%	
Taiwan	5%	
United Kingdom	4%	
United States	3%	
Others	20%	

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The Elon University's Department of Environmental Studies offers both a B.A. and B.S. degree in Environmental Studies, blending scientific foundations with an appreciation of society's needs and concerns. Students enrolled in the Department of Environmental Studies take a balanced, interdisciplinary core of classes grounded in ecological understanding. The program's strength comes from an emphasis placed on considering the environment from many perspectives.



The World We Live In And The World We Want To Live In

Light Cascade - StockXChng photo by Flávio Takemoto

