Adapting Urban Settlements to Climate Change:
Local Vulnerability and Adaptive Capacity in the Urban Areas of Malawi

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INTRODUCTION

The emergence of climate change as an increasingly important challenge for countries, communities and households has come with recognition that the tools to face current and coming changes are insufficient. In particular, the social and demographic dimensions of climate vulnerability and adaptation are not well understood, and this lack of understanding risks undermining both broad-based and local adaptation efforts (Schensul and Dodman in this volume). Causes of this gap include lack of understanding of mechanisms, historical limits in the study of climate change, particularly among social scientists, failure to marshal existing data in a way linked to climate change impact modeling, and failure to integrate the results of vulnerability analysis into existing climate change responses. Generating and using reliable sources of relevant data can address these barriers and thereby help to strengthen adaptive capacity and reduce vulnerability.

These issues are of particular relevance in low-income countries, where the impacts of human-induced climate change are likely to be felt first and most severely. The UN Framework Convention on Climate Changes (UNFCCC) recognizes Small Island Developing States (SIDS), Africa and the Least Developed Countries (LDCs) as being particularly vulnerable, and together these form a group of about 100 nations identified by Huq and Ayers (2007) as being the 'Most Vulnerable Countries'. Malawi is therefore an important case in understanding context, strategies and capacities in the response to climate change, particularly with regard to adaptation. It is designated a LDC based on its combination of low income, low indicators of health, nutrition and education, and economic vulnerability. It is located in a region expected to experience significant climate impacts. Yet from a policy standpoint, Malawi is highly engaged on the issue of climate change, both in government, among non-governmental organisations (NGOs), and with representatives of the international community. And from a data perspective, it has a relatively recent population census – 2008 (GoM, 2008) – as well as a just completed demographic and health survey (GOM, 2011b). Therefore, with the right approaches, capacities and partnerships, Malawi could be well situated to develop a strong and innovative climate response programme.

This case study combines spatial analysis of the Malawi 2008 census with detailed national and local qualitative data analysis focusing on stakeholders and policies relevant to Malawi's climate change response to generate a better understanding of climate change vulnerability and to influence the direction of adaptation policy and implementation. An emerging body of work (e.g. Guzmán 2009, Balk et al 2009, and the Guzman and Balk chapters in this book) is demonstrating that many of the social and demographic factors shaping vulnerability can be illuminated through analysis of census data. A wide range of data on spatial location, demographic characteristics, housing, services, energy use, education and other critical determinants of vulnerability are reported in the census (Guzmán 2009 and in this

volume). Further, in many countries, the 2010 round of census made a great leap forward in the use of geographic information systems (GIS), allowing highly localized analysis that can be linked to the geography of climate exposure (Balk in this volume).

A National Climate Change Programme (NCCP: 2013-2016) is also currently being developed in Malawi to coordinate work on climate change to achieve resilient and sustainable development. The focus of the NCCP will be on capacity building, policy formulation, national climate change investment plans and financing, and the national response framework. Key partners in this include 19 government ministries and departments, a number of multilateral agencies led by UNDP, academics, technical specialists and NGOs, with support from several donor countries. However, UNDP has reported that data on climate change is perhaps the weakest aspect in generating the NCCP. Because of this, UNDP and partners are starting to work on vulnerability analyses and hazard mapping, and in late 2011 were working on a capacity assessment on hazard mapping with the Department of Disaster Management Affairs (DoDMA).

There is also a growing body of literature and case studies examining specific elements of climate change impacts, vulnerability and adaptation in Malawi, including papers on urban agriculture (Mkwambisi, 2008; 2010; Mkwambisi et al., 2011), waste management (LCC, 2010; Chipeta and Binauli (2005), Matope (2002), Manda (2006, 2007), desertification (Stringer *et al*. 2010), spatial planning (Brown 2011), vulnerability assessments (see DODMA), climate change and economic development (Munthali, 2011b), water and sanitation (WaterAid, CCODE). This chapter is intended to support existing vulnerability assessment efforts through the inclusion of new data and new analysis.

Urbanization and climate vulnerability

The changing proportion of the population living in urban areas has significant consequences for the nature of poverty and vulnerability. As Schensul and Dodman (this volume) explain, the concentration of people and economic activities in urban areas can mean that larger numbers of people are exposed to particular hazards; at the same time, if planned and managed effectively it can result in more cost-effective protective infrastructure and improved adaptive capacity for individuals and households. Although much attention to date has been given to rural vulnerability, at least partially as a result of the clear impacts of climate change on agriculture, the pace and scope of urbanization in many countries means that the terrain of adaptation will be increasingly urban. The coincidence of rapid urbanization with increasing climate impacts is something many countries will experience over the coming decades, with significant implications for the societal impacts of each (McGranahan, this volume). The high concentration of people and economic activities in towns and cities; their reliance on a wide range of resources from outside their geographical boundaries; the inadequate provision of water, sanitation and drainage; inadequate funding from central government; lack of coordinated efforts by stakeholders; and pre-existing environmental challenges related to solid waste management, air pollution and water pollution means that urban centres and their inhabitants in low- and middle-income countries are highly vulnerable to the effects of climate change (see Romero-Lankao and Dodman 2011). Given the range of potential outcomes that depend on how urban growth and planning for it occurs – whether slums emerge and expand, how services and infrastructure expand with growing population and economies, and how land and housing is distributed relative to exposure – urbanization and climate vulnerability is a

specific focus of this case study. And as this chapter shows, urban vulnerability and adaptation has been a major gap in Malawi's climate change response, despite rapid population growth rates and serious deficiencies in service provision in both the large cities and in emerging urban areas.

METHODOLOGY

This chapter presents the findings from a case study of population dynamics and climate change in urban Malawi. There are two main components to this case study methodology, which can be adapted and applied in other contexts[1]:

1. Spatial analysis of 2008 Malawi census, focusing on vulnerability stemming from location, population density and composition, built environment, human, social and economic capital.
2. Analysis of the key stakeholders and policies that shape and inform climate change responses at national and local level.

Spatial Analysis

The spatial analysis was conducted through a working partnership between UNFPA headquarters, UNFPA Malawi, the International Institute for Environment and Development (IIED) and the Malawi National Statistical Office. At its core is the combination of census data with a digitized map of the country, a process more technically challenging than in many other instances because this is the first time that significant spatial analysis of the Malawi 2008 census has been conducted. The base unit of the analysis is the Traditional Authority, or TA, an aggregate of the enumerator areas that were the smallest unit of census data collection. In ideal circumstances, the analysis would have been based on enumerator areas themselves. However, problems with the digitization of maps resulted in large numbers of enumerator areas (as many as 20 percent, particularly concentrated in urban areas) not being captured. TAs are a much more robust analytical unit, with nearly a complete match between the census data and digitized maps.

Spatial analysis focuses on five urban extents (see Map 1), each containing an urban area plus any adjoining TAs in order to capture people living beyond the formal urban boundaries but still in close proximity. These are the four official cities of Lilongwe, Blantyre, Zomba and Mzuzu, as well as the secondary urban centre of Karonga. The statistical analysis techniques used are primarily descriptive, as much can be learned about climate vulnerability from the spatial distribution of census-based variables through simple proportions and indexes. Further, when results are based on descriptive analysis, they are more accessible to policy makers and communities, meaning they are more likely to be used. And finally, the results presented in this paper can be replicated in Malawi and elsewhere without advanced capacities in statistics.

Stakeholder and policy analysis

[1] IIED and UNFPA are currently engaged in a similar programme of work in Indonesia.

The stakeholder and policy analysis were undertaken through qualitative interviews with a range of partners in September and October of 2011, as well as through review of relevant documents including the Second National Communication (GOM, 2010) and the State of the Environment Report (GOM, 2012) and the Malawi Growth and Development Strategy II (2011-2016). From government departments and ministries, interviews were conducted with the Ministry of Development Planning and Cooperation (MoDPC), Environmental Affairs Department (EAD), National Statistics Office (NSO), Department of Disaster Management (DoDMA), and the District or City Councils of Lilongwe, Blantyre and Karonga. Among UN organizations, information was collected from United Nations Development Programme (UNDP), United Nations Population Fund (UNFPA) and United Nations Human Settlement Programme (UN-Habitat).

Non-governmental organizations that were covered include Centre for Community Organisation and Development (CCODE), National Smallholder Farmers Association (NASFAM) Centre for Environmental Policy and Advocacy (CEPA), the Coordination Unit for the Rehabilitation of Environment (CURE), Environment Africa, Foundation for Community Support Services (FOCUS) and the Red Cross. From academia, data was gathered from Leadership in Environment and Development in Southern and Eastern Africa (LEAD-SEA), Bunda College of Agriculture and Malawi Polytechnic.

This chapter continues with a presentation of key population indicators from Malawi based on outputs from the 2008 Census. This is followed by a review of climatic variability and change in the country, and an assessment of vulnerability to climate change at the city level. The final section explores the policy implications of this analysis, and examines the role of local authorities and non-governmental organizations in responding to climate change.

POPULATION DYNAMICS IN MALAWI

Malawi's total population has grown from about four million in 1966 to over 13 million in 2008, and is expected to reach 16.3 million by 2015 and 26 million by 2030 (GOM, 2008; 2010c). The country is divided into three administrative regions – North, Central and South – with a total of 28 districts. Only 15.3 percent of the population lives in urban areas, though that proportion is growing rapidly and projected to reach 33% in 2050. Over 77 percent of the urban population in Malawi lives in the four cities: Lilongwe (669,532); Blantyre (648,852); Zomba (81,501); Mzuzu (127,539). Each of the four, plus a secondary urban centre in the North, Karonga, is highlighted in this case study. Taken as a whole, the analysis covered a population of 3.42 million people, 1.79 million of whom live within urban boundaries.

According to the Malawi NSO's Thematic Report on Spatial Distribution and Urbanisation (p38), "the recent increase in the level of urbanization in Malawi has been due to the development of new relatively small towns that are growing at fairly rapid rates." The country has witnessed a significant economic deterioration in both rural and urban areas. Malawi's economy is predominantly agrarian with agriculture accounting for 33-37% of the GDP and 85% of the export earnings. However agricultural markets, especially tobacco, have deteriorated over time such that large estates and other commercial farmers have withdrawn from the sector. Notably, urban centres have generally poor living conditions, with the Malawi State of the Environment report (2010, pp27-8) highlighting that "in 2001 it was

estimated that over 90% of Malawi's urban population lived in slums characterised by, among other things, overcrowding, lack of potable water and poor sanitation facilities".

Although Malawi, like most African countries, has a relatively small proportion of its population living in cities – just 15.7 percent – the annual urban growth rate between 2010 and 2015 is projected to be 4.2 percent (UNDP, 2011), corresponding to a doubling of the urban population in only 17 years. This makes Malawi one of the fastest urbanising nations in the world. The official census growth rates for major cities of Mzuzu, Lilongwe, Zomba and Blantyre are 4.4%, 4.4%, 3.0% and 2.8% respectively (GOM, 2008); with Mzuzu city having the highest inter-censal growth rate of 54%.

Table X Population projection for main urban centres in Malawi

	Midyear population					
Name of City	*2000*	*2005*	*2010*	*2015*	*2020*	*2023*
Mzuzu	99,095	134,399	156791	223740	306265	363244
Lilongwe	498,185	669,114	768012	1037294	1365724	1589975
Zomba	74,915	101,423	101083	138583	184724	216532
Blantyre	554,578	711,233	721063	884497	1072684	1197692

Source: Government of Malawi 2005, 1998, 2010c

With regard to influencing urbanization, one strategy has been the creation of quasi-urban growth centres in rural areas that can provide similarly attractive environments. In these centres, roads, business shells, schools, clinics and markets have been the priority, together with catalyzing small and medium enterprise emergence. Power generation and ensuring adequate water supplies have been significant barriers in this strategy. Malawi has also recently embarked on a process of political and economic decentralization, though it has since stalled. The CEO of Blantyre stated that "the slow implementation of the decentralization process has contribution to the stagnation [of urban programmes]. Urban areas are being pulled between the center and the local level because the process of decentralization is incomplete."

There are also distinct regional patterns in the distribution of population in Malawi. The proportion of the population residing in the southern region has declined from 47% in 1998 to 45% in 2008; whilst the central and northern regions have each seen an increase of 1% over the same period. Given that fertility rates in urban areas are still high, a significant portion of urban population growth is associated with natural increase, or births over deaths.

The median age of Malawi's population is 17 years, with 67% of the population aged under 25 and 54% aged under 18(GOM, 2011b). This has significant implications both for the dependency ratio (which is high) and for the trajectory of future population growth, given the large number of women entering childbearing years (which heightens population growth even under circumstances of decreasing fertility, a phenomenon known as population momentum). Census data show that the proportion of female

headed households is lower in the focal urban areas than rural areas – about 18 percent compared to 29 percent – which could be an indication of male labor migration to the cities. Multiple types of internal migration flows exist in Malawi, according to the Thematic Report on Migration (GOM 2010): rural-urban migration, but also significant urban-urban and urban-rural migration (Table X). District to city movements (e.g. Lilongwe District to Lilongwe City) or from other nearby districts to cities (e.g. Mzimba to Mzuzu) are common, suggesting that proximity matters for internal migration decision-making. All cities had significant net gains through migration between 1998 and 2008: 41% in Lilongwe City and Mzuzu City; 30% in Blantyre City and 16% in Zomba City.

Table X: Resident Total Population and Migration

Area	Population	In-Migrants	Out-Migrants	Net Migrants
Northern Region	1,679,491	261,417	278,933	-17,516
Central Region	5,497,252	897,760	758,089	139,671
Southern Region	5,852,755	952,004	1,074,159	-122,155
Blantyre District	339,406	61,878	65,216	-3,338
Blantyre City	648,852	323,075	129,324	193,751
Lilongwe District	1,232,972	71,600	159,398	-87,798
Lilongwe City	669,532	349,213	73,331	275,882
Mzuzu City	127,539	77,730	25,491	52,239
Zomba	81,501	48,079	34,667	13,412

[Source: extracted from the 2010 Thematic Report on Migration (based on 2008 Census), Table 2.1]

Anecdotal reports during qualitative data collection suggest that urban-rural linkages remain strong, including links to peri-urban areas for small-scale agriculture. The prevalence of proximity-based migration as observed in the census provides some support to these reports. Further, reinforcing a point made by Tacoli in this volume, these data suggest that in- and out-migration cannot be thought of separately.

CLIMATE CHANGE IMPACTS AND VULNERABILITY IN MALAWI

While the production of downscaled climate projections or hazard geographies for the national and sub-national level remains a significant challenge, several government agencies and non-government organizations have identified the potential impacts of climate change in Malawi.

Text Box: Climate Change Impacts in Malawi

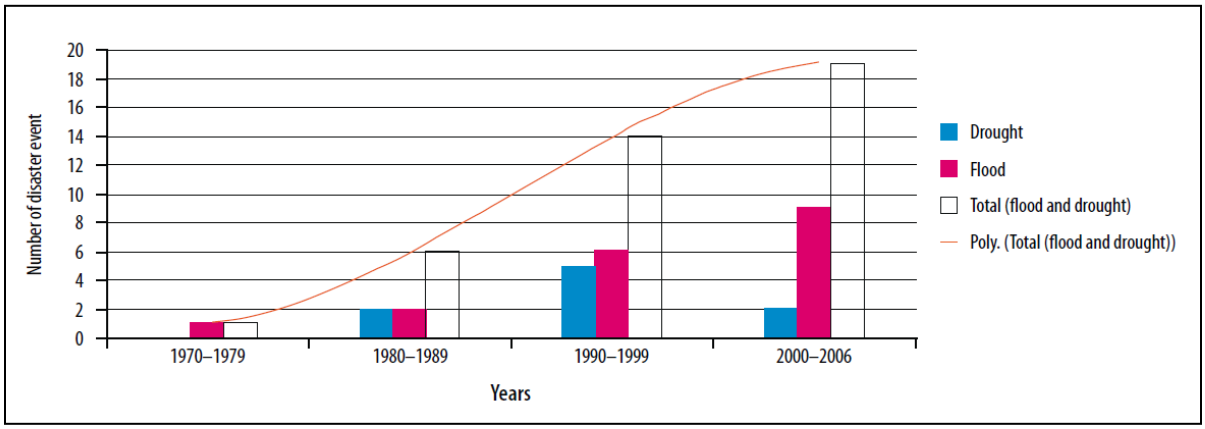
- **Agriculture** (rain fed): reduced productivity due to droughts; crop losses; scarcity of raw materials; malnutrition / famine
- **Water**: availability / scarcity; reduced quality; lower hydro-electric power generation; waterborne diseases
- **Health**: temperature trends and water availability; spread of malaria; diarrhoeal diseases; malnutrition
- **Gender**: droughts affect availability of resources; women walk longer distances (to collect water, food and firewood); women nurse the sick

- **Energy**: affected by droughts; scarcity of firewood; lower hydro-electric generation potential
- **Fisheries**: affected by droughts and floods; reduced reproduction; loss of biodiversity; destruction of ponds
- **Wildlife**: droughts affect water and food availability; reduced reproduction; migration
- **Forestry**: reduced productivity due to droughts; land degradation; forest fires; loss of biodiversity

[adapted from Figure 10.1 in Malawi State of the Environment Report (2010)]

There is inadequate detailed climatic information about changes in past climate to draw significant conclusions, although there is some evidence that the frequency of extreme weather events has been increasing in recent decades (Figure X). This type of figure needs to be interpreted carefully, as it is not based on a scientific review and relies on reporting of events as disasters.

Figure X.X: Frequency of Extreme Weather Events in Malawi



[Source: Action Aid (2006), reproduced in Malawi State of Environment (GOM 2010b), Figure 10.3]

According to discussion with DoDMA, the most common hazards Malawi faces include prolonged dry spells, droughts, floods, water-borne diseases resulting from floods such as cholera, and strong rains and winds that damage many substandard dwellings. This is supported by various other sources: “Almost three million hectares of the country are semi-arid or dry sub-humid, with drought both common and largely unpredictable. Approximately 90% of the country’s 13.6 million inhabitants rely on rain-fed, subsistence agriculture to feed their families and sustain their livelihoods (Stringer et al citing GOM,2006).” There is increasing awareness among small holder farmers about the threat of climate change, according to representatives of the National Small Holder Farmers Association of Malawi, particularly in perceptions of increasing numbers of dry spells and floods. Given rapid urbanization and the emergence of changing weather patterns as a source of concern among Malawians, the convergence of these issues will only increase in importance over time (McGranahan, Chapter X).

As a whole, the focal areas for this case study exhibit significant diversity in vulnerability, with water, food security, housing, energy and livelihoods expected to be the hardest hit but with significant

variations in the adaptive capacity of households and communities. Among the major concerns are housing and service access across the country. Wide disparities exist between cities and rural areas, and also within urban areas where variation is almost double that of rural areas. One exception is water access, defined as piped water either into or near the home: levels are consistently high – above 80 percent – in neighborhoods inside the study area urban boundaries. Literacy is high in both rural and urban areas, and without significant variation.As a proxy of both income and connectedness, radio ownership levels are only somewhat higher in urban areas than rural areas, but there is significant variation and the magnitude of both is not that high (Table X).

Table X: Selected socio-economic and adaptive capacity indicators: urban and non-urban

	Areas within urban boundaries		Areas outside urban boundaries	
	Mean	Standard Deviation	Mean	Standard Deviation
Adjusted STI	36.97	19.81	5.39	2.32
Improved toilet	17.5%	21.2%	2.3%	1.4%
Literacy	84.3%	7.6%	67.5%	7.9%
Radio ownership	73.2%	8.9%	60.7%	7.9%

A recent study by Stringer *et al.* (2010) identifies intra-rural and rural-urban migration in Malawi as the "main adaptation strategy" (p153) being adopted to manage the impacts of low crop yields, frequent drying of rivers, flooding, destruction of ecosystem integrating and loss of biodiversity. However, these authors also note that climate change impacts are just one of a range of 'push' factors encouraging migration from rural areas, alongside land shortages, conflict, lack of employment opportunities and disease. In Malawi, with regard to influencing urbanization, respondents indicated that one strategy has been the creation of quasi-urban growth centres in rural areas that can provide similarly attractive environments. In these centres, roads, business shells, schools, clinics and markets have been the priority, together with catalyzing small and medium enterprise emergence. Power generation and ensuring adequate water supplies have been significant barriers in this strategy.

At the same time, climate change may produce opportunities for rural livelihoods, such as winter crop production and fishing in areas where there is more frequent flooding such as Chikhwawa and Nsanje.

There are strong rural-urban linkages that shape both vulnerability to climate change and broader environmental impacts around issues of housing construction and energy provision. The use of burnt bricks for housing contributes to deforestation in areas around urban centres, where it is used heavily due to the high cost of building materials (Malawi State of the Environment 2010, p28). Urban elites are purchasing land from the peri-urban areas thereby reducing agricultural land for the poor. This is increasing rural vulnerability and contributing to rural-urban migration. Similarly, although of somewhat less relevance in urban centres, approximately two-thirds of Malawi's houses are built of traditional materials (including tree poles and grass) from natural forests without replacement, which also contribute to deforestation (GoM 2010, chapter 2). The fact that urban households consume more

water than rural households also affects rural-urban dynamics, with the consequence of higher levels of demand and extraction in towns and cities. Although the national average domestic water demand is estimated at 125 litres per day per capita, the figure for rural areas is 27 litres, and in urban areas is estimated at 200-360 litres (GoM 2010, pxxix).

Nearly 85 percent of urban households in the five study areas rely on biomass, primarily charcoal, for cooking energy. The figure for rural areas is almost 98 percent, essentially all wood. Urban households in Malawi are still heavily dependent on wood and charcoal for energy. This dependence on biomass for fuel creates significant spatially concentrated environmental impacts on the areas surrounding the urban centres. The spatial distribution of forest stock is uneven in Malawi, with large surpluses in the north that are too costly to bring to the central and southern population centers, meaning local degradation is significant (Kambewa and Chiwaula 2010).Use of biomass as a fuel in urban areas has also increased in recent years due to the lack of capacity of the hydro-power plants supplying electricity.

The flows of energy sources, building materials and water between rural and urban areas are shaped by population dynamics, with growing urban populations increasing the spatial concentration of demands on these natural products, and growing urban income increasing demand. But their use also shapes patterns of urban vulnerability: as low-income residents are more heavily dependent on biomass for energy and natural materials for houses, they will suffer the most as the natural asset base is depleted. However, even the limited number of households that utilise electricity may be affected by climate change, as this is expected to have negative consequences on hydroelectric power generation (GoM 2010, section 4.2.3). Despite these multiple links, “current policy infrastructure neglects to recognize the horizontal links between rural and urban parts” (Stringer *et al.* 2010, p156).

Local Analysis of Vulnerability

This section examines the focal urban centres more closely, disaggregating vulnerability between and within each, including links to population and housing characteristics and the distribution of vulnerability across space.

Lilongwe

Lilongwe became the capital of Malawi in 1975. A city built with the support of South African planners, it was designed to be relatively dispersed, with residential areas on the margins. Stretching north/south more than east/west, plans called for large residential and agricultural areas to the north, between the city center and the airport. Due to lack of services and distance from the city center, however, the north has remained for the most part unsettled, while population has grown rapidly both in the center and in the south.

Discussions with the Lilongwe City Council suggested that most recent growth has been informal, with stagnating growth in the formal areas of the city during the intercensal period, whereas some informal

settlements have doubled in population over the same period.[2] In addition, city authorities reported that people are moving just beyond the southern border of the city, where they can take advantage of proximity to the city without paying city rates. Population density (see Map 2) is indeed extremely high in the southeast corner of the city, where informality is high.

Access to agricultural land has been one of the key draws of moving to Lilongwe, given its large land area and proximity to both urban and peri-urban agricultural areas, and the National Small Holder Farmers Association of Malawi has mobilized farmers to form the Lilongwe North and Lilongwe South Associations. However, census results show that Lilongwe (along with Blantyre) is one of the fastest growing cities in the world, with so much demand for residential land that the Lilongwe City Council Director of Planning said "open spaces are no longer open". Representatives of the Center for Community Organization and Development (CCODE) made a related but somewhat different point, suggesting that while land is available in some places available, Lilongwe has "run out of land for low-income housing". CCODE's work on housing and upgrades has therefore focused more on the outskirts of the city.

Climate change is not the foremost priority for the city's policies and interventions. Lilongwe City Council Directors reported that the influx of people into urban areas is rendering existing services inadequate, and that the Council is "being pushed…. Instead of managing the city, the people are managing us." For the Lilongwe City Council Director of Planning, in most cases the city deals with issues on a "fire-fighting basis, [and the] issue of climate change is peripheral to what we do. Climate change is looked at as much more distant than the need to provide land and services. We need to deal with informal settlements and services before dealing with climate change." The data show the challenges in addressing land and services, but also the links to climate vulnerability in the longer term.

The adjusted Secure Tenure Index[3], a proxy for slums, shows some of the starkest inequalities in Lilongwe, and indeed in Malawi, with the central swath of the city near the highest levels of the index, while the informal segments of the city to the southeast – particularly Areas 23, 24 and 36 – show levels much closer to rural areas (see Map 3). Lack of permanent and serviced housing creates fundamental vulnerabilities that cut across both well-being and vulnerability to climate change (see Guzmán, this volume). These results do indeed show that informality and lack of access to services are a critical priority, both in urban and rural areas; and that these also contribute significantly to climate vulnerability.

Lilongwe residents, along with many other urban residents in Malawi, rely heavily on agriculture (Mkwambisi et al., 2010), with the census indicating that about 14percentof the labour force members

[2] Within city analysis of intercensal change is beyond the scope of this paper, which only examines 2008 census data at the small area level.

[3] The Secure Tenure Index is used in the estimation of slums for MDG 7.10. The five components of this index are electricity connection, regulatory compliance of structure, permanency of structure, connection to the sewer and water access within 200 meters (Herr and Karl 2002). Four of these five – the exception being regulatory compliance – can be found in some form in the Malawi census (and many others). All STI references are therefore an adjusted version using just the four available inputs without regulatory compliance. A range of statistical comparisons with STI calculation in other contexts suggested that the adjusted version is sufficiently robust.

within the city boundaries working in agriculture. Showing the extension of urban lifestyles beyond the formal boundaries, only 60 percent of the workforce in surrounding TAs works in agriculture. Both within the boundaries and outside, many more use urban or peri-urban agriculture to supplement income or food stores. Further, the Lilongwe City Council Director of Engineering reported that trading, especially of agricultural goods, is one of the main drivers of movement to Malawi's cities, both permanent and temporary.

The DoDMA disaster dataset describes a number of hailstorms late in 2007, 2008 and 2009 that hit the entire Lilongwe District, with significant damage to both houses and crops. Houses with grass ceilings are more vulnerable to damage caused by hailstorms and other severe weather events; most houses of this type are outside the city boundaries, as shown in Map 4, as were DoDMA's reports of damage from the storms.

Heavy rains and flooding have also sometimes been a problem, for example in Chilinde and Ntandire high density locations in 2011/12, and could increase in a changing climate. Two variables associated with flash flood vulnerability – impermanent material for walls and floors and use of pit latrines – continue to highlight the southeast areas as the most vulnerable in the city. Unlike essentially all the other variables, nearly all households across Lilongwe have access to water piped into their homes or to community stand pipes. This stands in stark contrast to the surrounding rural areas, which rely entirely on wells and boreholes. Urban water infrastructure may increase resilience to heatwaves, both in relation to the potential need for water for drinking in hot weather, and to the increased potential for transmission of water-borne and water-washed diseases in higher temperatures.

Commenting on climate change in urban areas, the Lilongwe City Council Deputy Director of Health and Social Welfare said:

> Over the last ten years we have witnessed an increase in dust and that wind velocity is always high. This is mostly due to tree cutting that have taken place within and outside the city. We have seen that all the wetlands (*dambos*) in urban areas no longer exist and people are now constructing houses in areas that were river beds. The city is also receiving little rains and Lilongwe River that used to flood every year is no longer causing any flood related problems. Recently we have observed that Lilongwe City is warmer throughout the year due to deforestation and lack of evaporation.

While the rural areas around Lilongwe City rely almost exclusively on wood for cooking, the informal areas of the city have much higher proportions of charcoal use. Rates of use of improved cooking fuel – propane, electricity and the like – are low in informal areas but substantial in the more formal parts of the city. Cash markets for charcoal in informal areas create a range of vulnerabilities linked to fluctuating prices, and the decreasing forest stock puts an extremely large number of households at risk of significant energy insecurity. In addition, burning of both wood and charcoal creates hazardous fumes that tend to disproportionately impact the health of women and girls tasked with cooking. The areas around Lilongwe are increasingly being deforested, due to a wide range of demands for wood, including as a key cooking source. The Lilongwe City Director of Environment suggested that widespread tree

cutting has destroyed the tree cover, reducing water absorption capacity in the ground and exacerbating the drying of streams.

The Lilongwe Director of Engineering stated in an interview that certain infrastructure projects have also increased climate vulnerability, for instance through generating greater surface run-off than planned, which stressed drains and damages roads, as well as through greater pressure on the city's resources. Protection work on roads is a major priority in the city, using both city and national resources through the Roads Authority. More frequent de-sludging of waste water treatment plans is also critical, as is lobbying the central government to maintain infrastructure more broadly.

Blantyre and Zomba

Blantyre is the primary city economically as well as the most densely populated. It was a colonial city that started as an agricultural node, with a dense city center that expanded over time without significant planning. Recent effects of urban land expansion without planning have included settlement up steep slopes on the city's outskirts, which are vulnerable to landslides.

Blantyre City is the oldest urban centre in Malawi, established by the Scottish Missionaries in the 1870s and declared a planning area in 1897. It is the hub for communication, industrial, commercial activities and cooperation in Malawi. The influence of Blantyre declined when Lilongwe became the capital city in 1975. However, it has maintained its grip as the commercial capital of Malawi. The city offers a number of economic opportunities but lacks resources to meaningfully implement its strategies and provide the required basic social infrastructure and urban services required for economic development to take place. Over 65 percent of the city's population lives in informal settlements which occupy about 23 percent of the land in Blanytre. Poverty stands at 24 percent while unemployment stands at 8 percent.

"Malawi: Blantyre Urban Profile". 2011. UN-HABITAT.

Blantyre's Chief Executive Officer is centrally focused on the issue of urbanization and population growth within the city. His perception was that rural-urban migration was being driven by the perception that urban areas offer better opportunities, in part because the land that people depended on is not reliable anymore. The question, according to the CEO, is not whether the government should stop people urbanizing, but how to manage cities to accommodate people.

Addressing population density (see Map 5) and resulting congestion in Blantyre, as well as other cities, has been a priority. Special challenges that have in some instances been exacerbated by density have included service delivery, environmental impacts, health problems among the densely settled poor, strife cause by inequality between poor and rich, and interference by the wealthy in Blantyre's development plans.

In aggregate, indicators relevant to this study point to equal or lower vulnerability as compared to Lilongwe. Also apparent from the data is that variation in these indicators within Blantyre is substantially lower than in Lilongwe. This is not to say that inequality is low: the map of adjusted STI (Map 6) in

Blantyre shows a similar pattern to that of Lilongwe, with a central swath in the highest quintile while large numbers of neighborhoods are in the third and fourth quintiles. A recent survey (Africa Food Security Urban Network (AFSUN), 2011) found high levels of food insecurity, particularly among female headed and centred households, households with large family sizes, and low-income households. Food transfers from rural areas and other towns were a critical contributor to food security, and almost one-third (31%) of sampled households used urban agriculture as an additional livelihood strategy.

Within Blantyre, the key development challenges have had to do with the effects of increasing consumption: making sure garbage is taken away and re-used/recycled where appropriate, dealing with the surging number of vehicles in the last five years, problems of air quality and inadequate sewer systems for removing human waste. Mapping household toilet facilities (Map 7) shows large parts of the city without improved toilets. According to Blantyre's CEO, health services in the city have declined due to funding constraints, with community clinics for children being particularly adversely affected.

Zomba, to the northwest of Blantyre, is also defined as a city but functions in many ways as a satellite urban area to Blantyre. According to UN-HABITAT's Zomba profile, "the local economy of Zomba comprises of trade and distribution, community and social services, agriculture, and some light industries. Poverty stands at 29 percent and over 60 percent of the population lives in informal settlements." As the map of adjusted STI (Map 8) shows, Zomba also has a relatively well serviced central area, with rapidly declining physical infrastructure outside of the center and shares many of the urban challenges being experienced by Blantyre.

Karonga

With relatively low population density compared to Lilongwe and Blantyre, Karonga is an emerging urban area on Lake Malawi in the northern region. Key informants reported that many residents in Karonga have been engaged in a range of informal income generating activities, especially trading small items, due to cross border business and the presence of mining, though the large majority (over 86 percent within the urban boundary, and about the same outside) rely on agriculture as their main source of income. Proximity to the lake and several wetlands provide residents with access to fish and to productive land for rice, cassava and bananas.

In Karonga, a number of the settlement areas are between the North Rukuru River and the dyke. In 2010, the river over flowed and flooded the first settlement area and rice fields before breaking the dyke to flood the whole town. Upper catchment areas have been deforested, enhancing the likelihood of water runoff and river flooding.

Karonga's housing infrastructure varies in its vulnerability to flooding (see Maps 9 and 10). In most areas within the urban boundary, around half of households have earth floors, and a very high proportion rely on pit latrines or other non-improved toilet facilities, which are especially vulnerable to flooding and linked to cholera in the aftermath. Only in the center of town are vulnerability indicators substantially lower. The rest of Karonga town falls far short of these benchmarks, with areas outside the urban boundary even worse off.

DoDMA data also include flooding in other rivers in the district, including the Songwe River. Despite the long history of floods, people continue to live in flood plains, some still in tents provided as relief during floods, and to this point there have been few interventions to help residents adapt to the flooding. One exception has been a programme to reallocate key services in Karonga to higher ground, which is being implemented by the Ministry of Housing and Urban Planning with support from UN Habitat.

A number of droughts have also affected Karonga: data from DoDMA show that a drought in 1996/97 impacted 36,000 households, and the response involved significant relief efforts from the national government and domestic and international NGOs. On the positive side, as Map 11 shows, the large majority of urban residents in Karonga town have access to piped water, either in the home or through community standpipes (the latter being far more prevalent), providing some protection during droughts depending on water supply.

Mzuzu

Mzuzu City, with a population of 133,968 and growing at 4.2 percent per annum, is one of the fastest growing cities in Malawi and is the third largest urban centre after Lilongwe and Blantyre. It is the hub of government administration, business, industry, commerce, and services for the northern region of Malawi, and it serves a hinterland with a population of 1,708,930. Declared a city in 1985, it originated from a Tung Oil Estate in 1947 and has grown from 23km^2 to 143.8 km^2 in 2008. However, the city lacks adequate infrastructure and services. Over 60 percent of the population lives in unplanned settlements. The city does not have adequate policies and regulations to support orderly and planned growth. Improvement and expansion of service delivery, proper urban planning and good financial management are crucial for the development of the city.
"Malawi: Mzuzu Urban Profile". 2011. UN-HABITAT.

Mzuzu has a familiar spatial structure for Malawi's urban areas: a reasonably well serviced and formal center that declines as it moves to the outskirts of the urban boundary and then to rural areas entirely outside (see Maps 12, 13 and 14). Within Mzuzu, three townships stand out as very low vulnerability on housing and service access indicators: Kaning'ina, Masasa and Chasefu. These are not the most densely populated areas of the city though.

Just to the south of these three townships are Viphya and Msongwe, with a combined population of almost 15 thousand and near diametrically opposed vulnerability indicators, including STI in the fourth quintile and fewer than 10 percent of households with improved toilets. Mzuzu and its surrounding areas have relatively higher flood risk, and clearly there are massive disparities in vulnerability and resilience within the city.

IMPLICATIONS FOR MALAWI CIMATE CHANGE POLICY: INTEGRATING URBANIZATION AND POPULATION DYNAMICS

National policy development on climate change

Existing reports and policies on the environment and climate change in Malawi do not address many of the issues contributing to vulnerability that are described above. The policy responses to climate change recommended by the State of the Environment Report (2010) have a stronger emphasis on reducing greenhouse gas emissions and addressing mitigation concerns (see p225-6) than on the reduction of vulnerability. Similarly, existing policy responses that have been recommended to address the impacts of climate change and climate variability make little or no recognition of urban issues, or of issues related to population dynamics. The 2006 National Adaptation Programme of Action (NAPA) addresses eight sectors (agriculture, human health, energy, fisheries, wildlife, water, forestry, gender) and identifies six main locations of 'vulnerable communities' (Karonga, Chongoni, Salima, Chikwawa, Nsanje, Zomba). Only two urban areas are included in this list, and the main sectors identified are mainly rural, including sustainable rural livelihoods, forest restoration, agricultural production, preparedness for droughts and floods, and the sustainable utilization of Lake Malawi and lakeshore areas.

Within government, at national level climate issues are coordinated by the Ministry of Development Planning and Cooperation. Within this Ministry is the Economic Planning Division, which coordinates three climate change related programmes: the Poverty Environment Initiative (PEI), the Agricultural Development Program (AAP), and the National Programme for Managing Climate Change. This fits well with national development goals as it also aligns with the implementation of the Malawi Growth and Development Strategy (MGDS). Further, population and development issues are covered by the same Ministry's Population Unit, generating a suitable institutional entry point for issues related to urbanization and other population dynamics.

Several policy related processes are in place at national level. A national policy road map is in place to facilitate the formulation of the National Climate Change Policy, with the University of Malawi being engaged in mid-2012 to produce this. The issues paper informing this policy has identified several areas including agriculture, health, human population (which includes population dynamics), and capacity building. The government also has a climate change management structure in place. For example the MoDPC chairs the Steering Committee, while the Technical Committee is chaired by the DCCMS with EAD as the Secretariat. The structure also includes Government-Development Partner Working Group chaired by the MoDPC.

Currently, 19 government ministries and departments are engaging in climate change mainstreaming processes, and it has been recommended that a national climate change body be established to coordinate all areas of climate change including research, capacity building, adaptation and mitigation (GOM 2011c and GOM 2011d).

Government has also committed to having cabinet approve before the end of 2012 for the revised National Population Policy, which will include the links between environment, natural resources and population. This will provide the multi-sectoral guidance in ensuring integration of population dynamics and emerging issues like climate change in national, sectoral and decentralized level development plans and programmes. Relatedly, the Government of Malawi has, for the first time, prioritized population and sustainable development into a stand-alone sub theme under social development in its Malawi Growth

and Development Strategy (MGDSII: 2011-2016). Environment, natural resources and climate change have also been prioritized into a stand-alone theme in the same MGDS II.

Additionally, there is a National Disaster Preparedness and Relief Committee and there is also a process of formulating a National Disaster Risk Management Policy which is incorporating issues of climate change. The policy will facilitate the effective coordination of disaster risk management programmes in the country and ensure that disaster risk management is mainstreamed in development planning and policies of all sectors in the country. Notably, Malawi is a signatory to the Hyogo Framework for Action.

DoDMA has managed to support communities affected by climate change related hazards. However, the findings of Malawi Vulnerability Assessment Committee (MVAC) coordinated by DoDMA at district and national level have not been accepted in many cases. For example, in Karonga, the Director of Development and Planning (DPD) indicated that the MVAC findings are questionable and not owned by the local institutions. This sort of support rarely includes population issues. Previous studies have shown that urban population are not getting the required support because they do not have traditionally accepted structures that are used for channeling aid.

In addition, there is a significant gap in urban coverage of disaster reporting and support. District commissioners' offices or city councils conduct assessments and submit them to DoDMA for relief assistance. However, disaster risk management committees formed at the village and district level tend to be only in rural areas, so district councils are actually better able to respond to disasters than city councils. DoDMA in fact indicated that there is no consistent reporting of disaster impacts from cities, pointing as an example to unreliable and inconsistent reports on property damage and other impacts of recent rains in Mzuzu. City councils also tend not to consider disaster risk issues, particularly in zoning, housing construction and other development projects. DoDMA pointed out that there is a need for planning authorities in urban areas to work closely with them, but to this point it has not happened.

To this point, consideration of environmental risks has been consistently excluded from planning. Discussions with the Environmental Affairs Department made clear that mitigation continues to be a priority in climate change response, and that deforestation in and around the cities is one of the central focuses. Regarding land, one of the problems is a lack of policy harmonization, for instance between water and agriculture. Forests and catchment areas have not been preserved. Developers are supposed to get approval from EAD, including an Environmental Impact Assessment, but they often do not, or do but only after building has begun. The political will exists within the EAD to change the nature of development, but it does not have the strength within the government system to reject applications.

The role of local authorities

There is considerable recognition of the need to involve and support local authorities (including city assemblies) in the process of reducing risk from environmental hazards and climate change: for example, a strategic goal in Malawi's 2010 report on progress towards the Hyogo Framework for Action recognizes the need for investment and proactive measures to support local development structures at district and city assembly levels. Indeed, the Local Government Act of 1998 mandates local authorities to

do all planning; and while the power of controlling development is held by the Minister responsible for planning, this is delegated to local authorities in Blantyre, Lilongwe, Zomba and Mzuzu with specific town planning committees mandated to oversee development control (Malawi State of the Environment 2010, p31).This is also explicitly linked with the broader issues facing human settlements in Malawi as a result of urbanization, including the provision of adequate safe housing for a growing urban population. The Hyogo Framework for Action report also identifies the absence of a policy framework for human settlements, and the need for disaster risk reduction to be incorporated in the design of these areas.

The Second National Communication on Climate Change does not make explicit mention of the role of sub-national levels of government in reducing vulnerability and risk for urban residents. However, it does see the "limited institutional capacity for the city and town assemblies" (executive summary, p lxxxi) as a barrier to mitigation, and recommends that "enhancing the capacity of City and Town Assemblies" is a key element for supporting mitigation (Section 5.4).

There is a general recognition in other literature of the importance of action by local authorities to address climate change risk. Stringer et al. (2010, p157) conclude:

> "The current trend towards urbanization in Malawi highlights the need to define a clear role for local governments in urban areas to better engage them in the adaptation process. In doing so, this could provide multiple benefits across a range of different sectors and enhance support for the local practices and adaptations that rely on existing rural-urban linkages."

Despite these important linkages, city councils are not represented in the existing management structure. Indeed, overall budgetary allocations from central government to city councils are very small, and national statistics indicate that progress towards most of the Millennium Development Goals is lagging in Malawi's urban centres (Munthali 2011a). Given the findings around vulnerability and potential climate impacts within cities in this report, as well as the strong and constant links city policy makers have with climate-related projects, one clear recommendation is that the councils of the main cities be formally included – both in the gathering of the necessary information to plan for risk reduction, and in the implementation of specific activities. This will also require substantial increases in the financial and technical resources available for this purpose.

NGOs and climate change response at national and local level

Most of the non-governmental organizations have rural development focus for both poverty reduction and climate change response. The Civil Society Network on Climate Change, coordinated by the Centre for Environmental Policy and Advocacy (CEPA), is the main inter-NGO platform for policy advocacy on climate change issues. The Network has 22 members, including national and international NGOs. The national NGO members also focus heavily on disaster risk reduction, particularly for floods and droughts. Most focus on small scale agriculture and crop diversification. Key climate change issues for the network include mainstreaming it in the planning process, influencing allocation of resources towards

environment and climate change related issues (including of lower-level urban centres) and capacity building of implementing institutions.

There are few urban activities undertaken by the members of the Network, many of whom focus on Community-Based Adaptation in rural or peri-urban areas. The Executive Director of the Centre for Environmental Policy and Advocacy explained that it was about targeting need, and "the old thinking that the ones that need support are in the rural areas." Donors drive much of the prioritization of work at national level, and there is a sense that donors are unlikely to be sympathetic towards work in urban areas on the assumption that they are better off. Mkwambisis, et al. (2012) also suggests that lack of official administrative structures in urban areas such as Area Development Committees and Village Development Committees has resulted in the urban poor failing to access services from the government.

Some activities are increasingly linked to rural trading centres, and urban areas rely heavily on rural areas to supply resources for food, energy and construction. Many of the specific resources identified by the NGO community as means of enhancing adaptive capacity of low-income communities are also explicitly rural in their focus: for example CARE (2009) identifies agricultural skills, farmer based organizations, irrigation infrastructure, seed and grain storage, and micro-insurance as the key forms of community capital that need to be supported – most of which have only limited relevance in urban contexts.

There is increasing recognition of the potential for community-based responses to climate change in low- and middle-income nations, specifically around community-based adaptation (CBA), and several CBA projects have been implemented in rural Malawi. CBA is based on the premise that local communities have the skills, experience, local knowledge and networks to undertake locally appropriate activities that reduce vulnerability to a range of factors including climate change (Ayers and Forsyth 2009). However, in practice, most CBA has been undertaken in rural communities, and to be effective in towns and cities will have to accept a broader and more complex definition of "community" that is not solely based on geographical location, and will have to engage in the more complex political economies characteristic of urban areas (Dodman and Mitlin 2011). If this can be done through community organization and the development of collective solutions, then the approach has the potential to bridge local environmental conditions and the broader institutional frameworks shaping urban development (Soltesova et al 2013).

Although not explicitly addressing climate change, the type of activities undertaken by CCODE can contribute significantly to the building of resilience for low-income urban residents. The Centre for Community Organization and Development is a support NGO for the Malawi Homeless People's Federation, and its role is to strengthen the ability of communities to identify alternative ways of addressing everyday challenges. Their focus, determined by community members, is resilience, savings, conducting enumerations and negotiating with the private sector and government. Programme areas focus on land and housing, water and sanitation and health and livelihoods. Mzuzu, Blantyre and Lilongwe all contain project sites.

CONCLUSION: BRINGING SPATIAL DATA TO URBAN AND CLIMATE ADAPTATION PLANNING

Malawi has been able to initiate an impressive process to establish a climate response framework, albeit one with significant gaps—gaps that are shared by many other countries as well, some far more resourced than Malawi. This paper has examined both climate vulnerability and adaptation responses for the presence and relevance of population dynamics – particularly urbanization – and how spatial analysis and visualization of census data can be a defining data source in understanding vulnerability.

As described above, the analytical methods used in this paper are not complex. The most challenging part involved processing the census data and census geography in order to link the two, a prerequisite for spatial analysis. This analysis represents the first effort to do this, and as such met with challenges that in other contexts may have already been addressed. Despite the hurdles, the results have shown how a range of demographic and socio-economic factors, coupled with exposure to particular hazards, can contribute to the vulnerability of households and communities both around and within Malawi's urban areas.

In addition, despite the impressive efforts and technical capacity of many government departments, data about population dynamics have not been incorporated within climate change responses, resulting in very general understandings of vulnerability and the exclusion of urban areas from the set of priority concerns. Integrating urbanization, spatial distribution and its links to exposure, and census-based indicators of sensitivity and adaptive capacity into the climate response can help to ensure that Malawi's climate change planning is better targeted at meeting the needs of the most vulnerable groups. Further, the mapping of these results can provide a powerful means of communicating differential vulnerability and adaptive capacity to key stakeholders, from government to NGOs, community leaders and the private sector.

Additional work remains. These data and results need to be jointly examined with stakeholders in Malawi to identify specific entry points for policy relevance and to maximize validity. Hazard mapping is still limited in Malawi, meaning that climate-relevant geography is not well specified. At such point as it is, the building blocks of the census will allow data to be produced specifically for those geographies: flood plains, heat island effects, precipitation and the like. Malawi's National Statistical Office has human and hardware resources in GIS, and could eventually be in a position to generate results for climate exposure geography. It is also critical that, in preparing for the next census, the NSO makes maximum use of its GIS capacity and infrastructure by enhancing the process of digitizing census maps. Enumerator areas remain the best building blocks for generating spatial results, and it would be ideal if the digitization process captured them more accurately in the 2018 census.

Practical, intersectoral, participatory adaptation planning and programmes remain a work in progress all over the world, and particularly in countries where resources are limited. There is still lack of clarity in the structure of emerging National Adaptation Plans (NAPs) as defined during the COP17 negotiations in Durban in 2011, and a lack of data on vulnerability is one of the key gaps. To the extent that census data can be effectively marshaled for adaptation planning, it will go a long way towards creating an evidence-based foundation for effective climate change responses.

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