THE POLITICAL ECOLOGY OF URBANIZATION:

FUELWOOD USE AND SOURCING IN MAUN, BOTSWANA

A Thesis

Presented to

The Faculty of Graduate Studies

of

The University of Guelph

by

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In partial fulfillment of the requirements

for the degree of

Master of Arts

May, 2007

Your file Votre référence
ISBN: 978-0-494-33919-0
Our file Notre référence
ISBN: 978-0-494-33919-0

ABSTRACT

**THE POLITICAL ECOLOGY OF URBANIZATION:
FUELWOOD USE AND SOURCING IN MAUN, BOTSWANA**

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Rapid urban growth has significantly transformed the social, economic and ecological living conditions of rural and urban Africans. However, while economic and political dimensions of rural-urban transformation have been explored, changes in human-environmental interaction driven by increasing anthropogenic ecosystem modification have been understudied. This study explores the political ecology of urbanization through an analysis of household fuelwood consumption and sourcing in the rapidly growing town of Maun, Botswana. Its findings are that: 1) commercial energy prices are important determinants of urban fuelwood consumption; 2) fuelwood harvesting patterns are determined more by relative deadwood abundance than source proximity or transport cost; and 3) house-hold urban-rural socio-economic linkages are critical influences on harvesters' responses to fuelwood availability patterns. The study concludes that both external and local factors have been key to the creation of a *socio*-ecological urban-rural gradient which, in turn, significantly influences urban fuelwood sourcing decisions in Maun and its hinterland.

ACKNOWLEDGEMENTS

I would like to thank my advisor, Alice Hovorka, for her constant encouragement and enthusiasm as well as (indispensable) criticism throughout the course of this research project. I would also like to extend my deepest gratitude to my research assistant, Mokgabo Kongore (a.k.a. TT) without whose unfailing hard work I would never have been able to navigate the diverse cultural and linguistic terrain of Maun. I was supremely lucky to encounter such an able, dedicated, and enthusiastic person to provide me with assistance and friendship throughout the course of the primary data collection process. To my committee member, René Veron, I would like to extend thanks for constructive advice both prior to and during field research, particularly in the context of sorting out the methodological conundrums presented by the fieldwork.

I would like to express my gratitude as well to all those who participated in the research, particularly: Kerileng Thela, for the grant of the research permit, enthusiastic assistance in Botswana and wonderful hospitality; Boiki Mabowe at the EAD, for enthusiastic support and much help in locating (sometimes obscure) publications not available on the usual shelves; Rra Mauano in Maun for so much help in both explaining "how things work" in Maun and in helping me to find vendors and other participants; Dr.s Gwebu, Kgathi, van der Post and Ringrose for your interest, hospitality and assistance with methodological and other difficulties; and all the guys at the TLB survey office for so much hospitality, friendship and help with GPS/GIS efforts. To all the household and vendor survey participants, my heartfelt thanks for taking the time to be involved, without which, again, there would be no project. Last, but by no means least, I would like to deeply thank my wife, Jessica, for her constant support, encouragement (and tolerance) through all of the stress and crazy hours that go into the two years' work of a thesis.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF MAPS

LIST OF ACRONYMS

AQCD – Air Quality Control Division
BDF – Botswana Defence Force
BEMP – Botswana Energy Master Plan
BHC – Botswana Housing Corporation
BPC – Botswana Power Corporation
BWP – Botswana Pula
CBD – Convention on Biodiversity
CSO – Central Statistics Office
DEA – Department of Environmental Affairs
DFRR – Department of Forestry and Range Resources
DTRP – Department of Town and Regional Planning
EAD – Energy Affairs Division
ECUP – Expanded Coal Utilisation Project
FAB – Forestry Association of Botswana
FED – Final Energy Demand
FINESSE – FINancing Energy services for Small Scale users
GDP – Gross Domestic Product
GIS – Geographic Information System
GPS – Geographic Positioning System
HOORC – Harry Oppenheimer Okavango Research Centre
LPG – Liquefied Petroleum Gas
MEWT – Ministry of Environment, Wildlife and Tourism
MFDP – Ministry of Finance and Development Planning
MMRWA – Ministry of Mineral Resources and Water Affairs
MSLB – Maun Sub-Land Board
NCS – National Conservation Strategy
NDP – National Development Plan
NGO – Non-Governmental Organisation
NPVREP – National Photo-Voltaic Rural Electrification Project
ODMPPS – Okavango Delta Management Plan Project Secretariat
ODMP – Okavango Delta Management Plan
PRA – Participatory Rapid Appraisal
PV – Photo-Voltaic
RAP – Rural Afforestation Project
REP – Rural Electrification Project
RIIC – Rural Industries Innovation Centre
SADC – Southern African Development Community
SWH – Solar Water Heaters
TLB – Tawana Land Board
UB – University of Botswana
UNCHS –United Nations
UNICEF – United Nations Children's' Fund
VAT – Value Added Tax

Chapter 1

1.0 Introduction

Urbanization or growth in the size, population, and dominance of urban settlements relative to their hinterlands is a key engine of change in Sub-Saharan Africa. While as yet only 37 percent of Africa's population is living in urban areas[1], the continent's annual urban growth rate of 4.87 percent is more rapid than that of any other[2] (UNCHS 2004). It is anticipated that 52 percent of the population will reside in urban areas by 2025 (Njoh 2003).

The living conditions of both rural and urban Africans have been dramatically transformed by this rapid transition (Myers 1999). Urban areas are created by socio-economic and political as well as ecological processes, which, in turn, produce geographic patterns of uneven development and corresponding social patterns of gain and loss (Neumann 2005) both within and beyond their nominal boundaries (Myers, 1999). In addition, not only do cities influence ex-urban environmental change (Myers, 1999), but they contain internal ecological dynamics as well (Pelling 1999). Thus the dialectical interaction between human and environmental systems, or between "politics"[3] and "ecology", is as important a process in urban as in rural areas (Swyngedouw and Heynen 2003). As urban areas grow in size and socio-economic importance they influence the directionality of changes in human-environmental interactions across the landscapes in which they are situated. Thus urbanization is implicated in the creation of specific sets of socio-ecological conditions, the benefits of which are distributed unevenly across both society and space.

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[1] As compared with a 2007 global level of 50% (UN-Habitat 2007)

[2] Such as South-Eastern Asia (3.82%); Eastern Asia (3.39%); Western Asia (2.96%); Southern Asia (2.89%); Northern Africa (2.48%); "Developed world" (0.75%) (UN-Habitat 2007).

[3] Used here in a broad sense encompassing social and economic dynamics as well as micro-political struggles, as per the usage of "political ecology"

1.1 Rationale for the study

Despite significant political and academic attention, contemporary understandings of African urbanization remain undeveloped in certain respects. While economic and political dimensions of rural-urban transformation have received attention, changes in human-environmental interaction driven by increasing anthropogenic ecosystem modification have only begun to be examined in urbanizing landscapes (e.g. Myers 1999; Swyngedouw 1996; 1997). As well, while the dynamics of socio-ecological systems have been somewhat explored in urban (Harper 2004; Hovorka 2006; Veron 2006), peri-urban (Myers 1999; 2002; Freidberg 2001), and rural contexts (Bassett and Zueli 2003; Page 2003; Turner 2003), we have inadequate knowledge of the ways in which these relationships are developing over time and across these conventional spatial boundaries. These gaps in understanding have major implications for urban policy-making and planning in Africa.

An important case in point is the confluence of rapid urbanization and heavy dependence on fuelwood for residential energy which, despite significant political and academic attention, remains a key issue of concern in many Sub-Saharan African cities. The growth of fuelwood reliant low-income urban populations (Chidumayo 1993; Kersten et al 1998; Brouwer and Falcao 2004) combined with the cost of long distance transport have created spatial concentrations of demand for woody resources in and around urban centres (Aweto 1995; Banks et al 1996; Boahene 1998). In the dominant narrative of the "fuelwood crisis" these trends have been translated into a generalized implication of urbanization in the creation of poverty-induced "waves of deforestation" spreading outward from African cities (Cline-Cole et al 1990; Boahene 1998; Brouwer and Falcao 2004) with potentially severe implications for agricultural productivity and resource conflict in urban hinterlands (Aweto 1995; Toteng 2001). In response to these assessments, state actors across the continent have developed energy and resource management policies that focus significantly on efforts to

encourage substitution of fuelwood with commercial fuels in the domestic energy sector and to contain urbanites' fuelwood harvesting activities.

However, some authors have contested this assumed linear correlation between the growth of urban poor populations and peri-urban landscape denudation explaining that fuelwood use and sourcing strategies are both strongly mediated by diverse socioeconomic, political, and ecological factors with significant temporal and spatial variation (Cline-Cole et al 1990; Banks et al 1996; Brouwer and Falcao 2004; Dovie et al 2004). They criticize the frequent use of aggregated data and an over-emphasis of quantitative modeling of energy supply and consumption characteristic of much fuelwood research to date, insisting on the necessity of contextualizing fuelwood use and sourcing in terms of disaggregated household, regional, and macro-level variables. While recent research has begun to contribute more nuanced analyses of these dynamics, additional studies are necessary to achieve a better understanding of the role of diverse local conditions in creating given patterns of use and sourcing. More importantly, there has been little examination of the effects of urban energy use and urban development policies on urban fuelwood use and on the spatial distribution of its harvesting across urbanizing landscapes. However, many such policies bear directly or indirectly on the energy use and procurement decisions of urban households, and hence ultimately influence patterns of woody biomass in hinterland areas. Increased understanding of these dynamics and their relationships to specific processes of socioecological change across the urban-rural continuum remains critical to policy makers' ability to guide urban growth dynamics in desired directions.

Botswana typifies Sub-Saharan trends with respect to both urban growth and household energy use. First, with an average annual urban growth rate of 3 percent between 1990 and 2004 (UNICEF 2006) and a rate of over 8 percent per year for the capital, Gaborone, during the 1980s (Mosha 1996), the country provides a classic example of recent

African urbanization patterns (Ijagbemi 2003). Second, despite having achieved a relatively high level of socio-economic development compared to most other sub-Saharan countries, Botswana's energy use profile is similarly dominated by fuelwood (MFDP 1997), which contributed 43% to Final Energy Demand (FED) in 1997 (CSO 2002a). While this figure represents a decline from its proportional contribution to FED of 58.3% in 1981, due largely to an increase in industrial energy use, its quantitative contribution rose from 15,456TJ to 21,456TJ[4] over the same period (ibid). This 39 percent increase is due mainly to an increase in the number of people using fuelwood rather than a shift towards increased fuelwood dependence (Gwebu 2003a). It is, however, indicative of the level of fuelwood dependence in the country as a whole, and particularly in the household sector[5], which, over the same period, was "the principal user of energy in the country...consistently responsible for over 45% of annual FED" (CSO 2002a). Furthermore, while rural households have long contributed substantially to residential fuelwood demand (MFDP 2003), urban residential fuelwood use has shown significant resilience despite increased state encouragement and household uptake of commercial fuels[6] in the towns and villages. The contribution of fuelwood to total household energy use can be as high as 95 percent in rural areas and remained at 78 percent for urban households in 1997, a decrease of only 3 percent from its 1991 level (EAD 2001). More recent reports indicate that little has changed since these estimates were made, as the Botswana Energy Master Plan reports: "fuelwood is still the most popular energy type used in households... [and] the shift to other energy types is very slow and in some cases close to nil" (EAD 2004). Since it is estimated that roughly 80 percent of all wood harvested annually in Botswana is used as fuel for cooking, heating and

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[4] TeraJoules

[5] Government institutions and small scale industries are the main other users of fuelwood energy in Botswana

[6] In African energy policy circles, this term is used to refer to the group of "modern" fuels including LPG gas, paraffin, and electricity, as opposed to "traditional" (often, but not exclusively directly collected biomass energy sources

lighting (MFDP 2003), urban fuelwood dependence continues to be an issue of significant concern for state agencies involved with urban energy security, rural development, and natural resources conservation issues (ibid). It is therefore important to gain a more nuanced understanding of the root causes of urban household energy use decision-making trends and the effects that these have on human-environmental relationships along the urban-rural continuum.

1.2 Approach, aims and objectives

In its engagement with the dominant theory of the relationship between fuelwood use and urban growth, the study relies on a conceptual approach which draws heavily from the theoretical perspectives of urban political ecology literature with respect to its attention to critical scrutiny of narratives of environmental change, attention to broader structural forces affecting the decisions of local actors and to differential patterns of resource access and environmental conflict. At the same time, however, this approach is significantly informed by urban ecological theory, from which it takes its focus on ecological dynamics along the urban-rural continuum and attention to spatial patterns of resource use and landscape change.

The overall aim of this study is to document and analyze the dynamics of household fuelwood use and sourcing in and around Maun, Botswana in order to understand the manner and extent to which urban development policies are shaping these patterns. In accomplishing this aim the study will contribute useful insights to policymakers and planners in their efforts to shape Botswana's development trajectory in the context of rapid urbanization.

In order to achieve this, the study has four main objectives:

(1) to identify and characterize key urban energy and development strategies in Maun;

(2) to document residential fuelwood demand patterns;

(3) to document fuelwood supply patterns and site characteristics;

(4) to analyze the impact of urban energy and development policies relative to other

factors on urban fuelwood supply and residential demand patterns.

1.3 Thesis overview

The thesis is organized into 6 chapters. Chapter 2 presents the conceptual approach from of the present study; it discusses the value of political ecological research, the need for new models in developing a political ecology of urbanization, and the potential of the urban-rural ecological gradient model to guide a landscape-level political ecological approach to urban growth. In chapter 3 the methods of the research are presented; a brief overview of the study site context is followed by a discussion of the methods used for data collection and analysis. Chapter 4 describes the structural context of urban fuelwood dependence in Botswana at the national and local levels. At the national level, the development of state perceptions, policy, and programs relating to household energy provision and woody resources use is presented. In Chapter 5 the results of the study are presented and analysed, and discussion of these and the conclusions of the study follow in chapter 6.

Chapter 2

2.0 Conceptual approach: the political ecology of urbanization

This chapter describes the theoretical perspective underpinning the current research. Chapter one described the importance of urbanization to the development of human-environmental relationships along the urban-rural continuum and the significance of urban fuelwood dependence in the African experience of urban growth. Chapter two builds on this foundation by describing first: the unique contributions of a political ecological approach to the investigation of socioecological dynamics; second, the lack of a well-developed model of urbanizing landscapes within the existing work of political ecologists; and third, a potential solution in a theoretical model developed within the field of urban ecology. In this way the chapter both locates the conceptual framework of the current research within the body of geographical literature and anticipates potential theoretical contributions.

Concern over the environmental consequences of human development has become a central social, scientific, and political issue over last few decades. In this context, political ecology has emerged to tackle the challenge of integrating socio-political, economic, and environmental analyses to synthesize a new, more holistic theorization of human-environmental interactions. Central to this process has been a consistent effort to dismantle constructed dichotomies such as human-nature, political-ecological, and global-local dualisms in favour of interrelational explanations of socio-natural relationships. In furthering this project, the field has recently begun to expand beyond its initial rural focus to investigate the dynamics of urban landscapes. This work has been diverse, insightful, and faithful to the project of dismantling dominant discourses of environmental change to expose hidden dynamics of power and marginalization. Nonetheless, perhaps due to its novelty, urban political ecological research has yet to thoroughly engage the issue of urbanization while

urban growth rates, particularly in Africa, are increasing along with the importance of their impacts on social and ecological systems.

Closer examination of this topical gap reveals a second, theoretical gap in the literature in so far as the hierarchical articulation of scale typical of political ecological research is an inadequate model for analysis of this process of dynamic, horizontal, transformation of 'nature' *across* socio-ecological space. The explanatory emphasis in political ecology, rooted in the "chain of explanation" model of early research in this subfield, has been focused on identifying the ways in which geographically localized events and relationships are shaped by forces originating at successively broader scales of abstract social, political and economic space. While there is nothing in this approach that inherently constrains the treatment of geographical scale, it has been implicated in a tendency among political ecologists to focus on "vertically" oriented explanations of the differences between localities rather than on the "horizontal" relationships between disparate places within heterogeneous landscapes. In this sense, the political ecological literature not only lacks adequate attention to the socio-ecological dynamics of urban-rural relationships in urbanizing landscapes, but also a theoretical approach to guide their study.

Urban ecologists'[7] research of ecological relationships between rural and urban has generated a conceptualization of urban growth based on a geographical continuum of landuse intensity. Just as rural political ecologists previously turned to ecological theory for new understanding of ecosystem dynamics, a political ecology of urbanization might gain more suitable spatial models from urban ecology. The current research therefore seeks to build on understandings of the socio-ecological development of urbanizing landscapes in a way that will help to fill these gaps in the political ecological literature.

[7] Referring not to the work of the Chicago school but rather, a subfield of ecology which emerged during the 1990s focusing on the ecological dynamics within, and ecological effects of, urban centres.

2.1 Political ecology

2.1.1 Critical roots

Whether described as a confluence of cultural ecology and political economy (Grossman 1999; Neumann 2005) or a Marxist approach to human-environment relations (Blaikie and Brookfield 1987), political ecology represents a theoretical perspective that identifies environmental problems as "simultaneously political and ecological, social and biophysical" (Neumann 2005, p.8). This *a priori* commitment is reflective of its interest in interrogating the power dynamics of dominant "apolitical" narratives of environmental degradation such as neo-Malthusianism and modernizationism (Robbins 2004). Founded in the writings of authors such as Ehrlich (1968), Hardin (1968), and Myers (1979), these approaches problematized population growth and 'irrational' resource management systems as ultimate causes of third world environmental problems. Fertility control and resource privatization and "expert" rationalization were therefore identified as key solutions (Robbins 2004; Neumann 2005). Foundational political ecological works sought to expose these theories as "simplistic, empirically unsubstantiated, and theoretically barren and to show that technocratic and managerial solutions ignored the social relations, economic constraints, and political power structures that shaped land and resource use" (Neumann 2005, p.27).

2.1.2 A broad background

Out of this debate emerged a vibrant field of critical inquiry, attracting researchers from diverse fields, each bringing new concepts to the developing transdisciplinary paradigm (Peet and Watts 2004). From cultural ecology and common property theory, for instance, careful attention to the logic of local resource users and the functioning of traditional resource management was acquired (Robbins 2004). The important influences of political economy, dependency theory, post-colonial studies and environmental history brought "a focus on the...roles and interactions of the state and the market and their influences on environmental outcomes" (Neumann 2005, p.6) and an interest in interrogating the legacy of

colonialism in these processes (Robbins 2004; Neumann 2005). From Marxist scholarship more generally was gained an appreciation of how material interactions between humans and non-human nature shape human history and social organization through relations of production (Robbins 2004). Emphasis on the way that environmental conflicts reflect symbolic struggles over "the meaning, definition, and categorization of rights, responsibilities and benefits" (Neumann 2005, p.7) stems from the influence of ethnography, while feminist development studies have highlighted the role of gender in these disputes (Robbins 2004). Post-structural researchers have broadened "politics" to include social movements "based on socially constructed identities of race, gender and ethnicity" (Neumann 2005, p.7), and analysed claims of "objectivity", "rationality", and "truth", exposing the relations of power that they hide (Neumann 2005; Robbins 2004). Furthermore, while early political ecologists assumed "that environmental problems existed in an unproblematic way, so that only their explanation was challenged" (Robbins 2004, p.208), greater awareness of the "new ecology" led to understanding of "degradation" as a highly relative and power-laden concept in itself (Nuemann 2005). Finally, critiques of theories such as Wittfogel's "oriental despotism" (1957) influenced a move away from "ivory tower" theorization towards a greater privileging of empirical research, from universal to particular contexts, and from single variable explanations to nuanced appreciations of complexity (Robbins 2004).

2.1.3 An Alternative framework

The political ecology that emerged from this synthetic process was complex and multifaceted with a wide diversity of research topics under its banner. However, despite the "challenge of defining a field that incorporates [such a] broad range of implied research questions" (Neumann 2005, p.8), political ecological research has certain distinguishing characteristics. Each of these originated as an explicit counterpoint to elements of dominant narratives, highlighting the foundational and ongoing critical project of political ecology

(Robbins 2004).

First, in contrast to the ostensibly "apolitical" nature of traditional accounts, political ecologists emphasize the political content of environmental conflict (Robbins 2004). "Politics" is defined very loosely in this paradigm due to the wide scope of, and continued debate over, the activities subsumed under this heading (Peet and Watts 2004). The central thread, however, is that current conditions are not "natural" and inevitable but anthropogenic and created (Robbins 2004), often through elite efforts to control resources or populations which are frequently justified through hegemonic narratives (Bryant 1998). Such activity, and its resistance by subordinate groups, is labeled political in the sense that it involves the shaping of institutions and relations of power in society (Bryant 1998; Peet and Watts 2004; Robbins 2004). Bryant and Bailey (1997) formulate this idea in terms of three assumptions of political ecological research that (1) distribution of the costs and benefits of environmental change is uneven (2) reinforcing or increasing socio-economic inequalities and (3) shaping the political power of various actors (from Robbins 2004). Rather than blaming overpopulation or "irrational" management they locate the causes of environmental degradation in a three-fold process of marginalization, which

> "is a process whereby politically and socially marginal (disempowered) people are pushed into ecologically marginal (vulnerable and unstable) spaces and economically marginal (dependent and narrowly adaptable) social positions, resulting in their increasing demands on the marginal (increasingly limited) productivity of ecosystems. (Robbins 2004, p.77).

This conception of politics and of the linkage between socio-economic and environmental processes reflects the defining, foundational assumption of political ecology (Zimmerer and Bassett 2003). This hybrid theory integrates ecological and environmental historical evidence with Marxian theory suggesting the path-dependency of ecosystem development and the ubiquity of anthropogenic influence on the one hand (Fairhead and Leach 1996; Robbins 2004), and the historical contingency of socio-economic systems and the centrality of

material relationships in their development on the other (Robbins 2004; Neumann 2005). The implication of this synthesis is that human and natural systems exist not as discrete categories that can be separately examined, but in dialectical unity such that neither can be understood independently of its historical and ongoing relationship to the other (Bryant 1992; Keil and Desfor 2003; Swyngedouw and Heynen 2003). Thus, the environment is understood not as "a malleable thing outside of human beings or a tablet on which to write history, but instead [as] a produced set of relationships that include people who, more radically, are themselves produced" (Robbins 2004, p.209). Additionally, in contrast to "conservationist" narratives, this perspective denies the existence of a "pristine natural state" to which a given environment can, or should ever be returned (Robbins 2004). Rather, political ecologists view both "nature" and society as continually co-producing each other in an ongoing and dynamic process that is both temporally and geographically contingent (Keil and Desfor 2003; Robbins 2004; Neumann 2005).

Second, in contrast to the logical positivistic philosophy characteristic of many narratives of environmental change, political ecology begins from a critical realist stance asserting not only the political creation of specific environmental outcomes, but also the political and economic content of ideas and representations of "nature" (Robbins 2004). Thus while environmental phenomena are understood to enjoy an ontological reality of their own (Neumann 2005), human explanations and knowledge of them are seen as socially constructed in the service of the (often narrow) political and economic interests of particular (often elite) actors (Brown and Purcell 2004; Robbins 2004). The critical realist position thus serves as basis for the discipline's central project of integrating ecological understanding of environmental "reality" with analysis of the "politics" or power struggles surrounding it. It engages post-structuralist concerns regarding environmental conflict by interrogating the discursive construction of various portrayals of environmental change, while avoiding the

relativistic quagmire of strong post-modern positions (Neumann 2005). Working from this perspective, political ecological researchers attempt to critically examine the political and economic subtleties of competing narratives of environmental change in contrast with "scientific" understandings, which are themselves subject to careful discursive scrutiny (Forsyth 1996; 1999). Models of environmental change are, therefore, seen neither as objective reality nor as mere discursively produced illusions (Neumann 2005), rather they are understood as useful but partial understandings of social and environmental dynamics to be used cautiously and with a keen eye to their roles in shaping discourse.

Third, as a counterpoint to the claims of "disinterested objectivity" of many mainstream discourses of environmental sustainability, political ecological research is performed in the interest of furthering an explicitly normative agenda (Robbins 2004). Beginning with the premise that all environments are socially produced, researchers move to the question of "what kinds of ecologies are being reproduced, by whom, and to whose benefit" (Robbins 2004, p.83). From observation of the uneven distribution of the costs and benefits of environmental change, they have drawn the conclusion that not all environments are equally desirable, just, equitable, sustainable, or democratic (Keil and Desfor 2003; Swyngedouw and Heynen 2003; Robbins 2004). The political ecological project, then, is not only to expose the social deficiencies of existing produced environments, but also to identify "the strategies through which a more equitable distribution of social power and a more inclusive mode of environmental production can be achieved" (Swyngedouw and Heynen 2003, p.898) in order to "advocate fundamental changes in the management of nature and the rights of people" (Robbins 2004, p.5). For political ecologists, therefore, the produced nature of individual social and ecological environments implies the possibility of creating different environments characterized by less coercion and exploitation, and increased socioecological sustainability.

2.2 From rural to urban, a persistent distinction

2.2.1 A strong rural tradition

The pursuit of the political ecological field of study was initially focused on rural areas, where a solid, and diverse body of work has been, and continues to be developed (Zimmerer and Bassett 2003; Robbins 2004; Neumann 2005). The following survey of political ecological studies in rural African contexts is presented in order to illustrate two key aspects of this body of literature of importance to the current research. The first is the versatility and potency of political ecological research, particularly highlighted by the recent shift in focus toward livelihood struggles within households, among resource users and between users and states which serves as a starting point for the present research project. The second characteristic of this body of work that is demonstrated here is the absence of studies engaging with either urban influences on rural landscapes or with changes in dynamics across heterogeneous landscapes more generally.

Carrying on the traditions of early political ecological work, a number of works have focused on challenging dominant explanations of environmental degradation. By way of example, Bassett and Zueli (2003) have offered compelling evidence that, contrary to received wisdom, desertification may not even be occurring in many Sahelian rangelands. Similarly, Turner (2003) finds that where land-cover change has occurred, it is the result of climatic variability rather than 'overgrazing". Such works draw on the influential research of Fairhead and Leach (1996) who provided a compelling critique of assumptions of environmental degradation in West Africa, illuminating the often positive role of humans in shaping ecosystem development and the historic variability of ecological systems in response to non-equilibrium climatic patterns.

Where anthropogenic "degradation" has been clearly observable, researchers have interrogated accepted models of proximate causation, shifting blame from "peasant" land users to elite, state, and global capitalist forces. Bassett (1988), for instance, explains agro-

pastoral conflict in Northern Côte d'Ivoire as a result of state initiatives to increase export revenues to service its massive foreign debt, thus locating ultimate causality at the level of international relations and global capitalism rather than overpopulation. Bell and Roberts (1991) follow this lead, explaining wetland soil-use patterns in Zimbabwe in terms of the continuing legacy of colonial era land management interventions. Similarly, Jarosz (1993) shows how deforestation in Madagascar stems more from French logging than contemporary population and swidden agricultural pressures. Turner's critiques (1993; 1999; 2004) of simplistic rangeland carrying capacity models explain that local Sahelian livestock management decisions and agro-pastoral conflict must be understood as functions of regional and broader economic, social, and political dynamics. Likewise, Ribot (1993; 1995) explains how the negative effects on rural Senegalese villagers of charcoal production for urban markets are primarily due to broader structural forces emanating from the market and its management by state actors. As well, Page's (2003) study shows unsustainable *Prunus Africana* bark harvests in Cameroon as reflective of conditions in the international pharmaceutical market rather than local irrationality. Similarly, Watts (2004) illustrates the disruptive effect of global capitalist projects on local political structures in Nigeria through the creation of factional struggles over oil-related rents. Finally, Moseley (2005) identifies international and state export cotton interests as the perpetrators of Malian soil degradation rather than the peasant farmers they have blamed.

Despite the continued importance in rural African political ecology of challenging received wisdom, others have broadened the field to include livelihood struggles between resource users, users and states, and within households (Robbins 2004). Glaesel (2000), for one, describes how state-led shifts in resource tenure structures created access conflicts between local and non-local fishers on the coast of Kenya. In a similar study, Derman and Ferguson (2003) illustrate how South African state water management reform led to struggles

over access to and control over water rights between elite and non-elite users in rural communities.

Conflicts between resource users and state actors have also been significantly represented in the literature. Moore (1998), Mackenzie (2003), and Neumann (2004a; 2004b) each document "people-park" struggles arising from state appropriations of land under the rubric of "biodiversity conservation" and the resulting livelihood-based resistance of local resource users. Following a similar theme Mackenzie (2000) details the negative effects on environments and "peasant" livelihoods of colonial and post-colonial state agricultural policies involving land appropriation and cash-crop farming. Myers (2002), by contrast, examines a more recent attempt at participatory biodiversity management, explaining associated "peasant"-state conflicts due to deep seated local social, institutional and political issues. Similarly, Awanyo (2001) explains the failure of market reforms to achieve the agricultural growth goals of the Ghanaian state in terms of the culturally, politically, and ecologically constrained nature of farmer decision-making.

Finally, intra-household, particularly gender-based, conflicts have also gained prominence in this field. In a seminal work, Schroeder (1993) exposes the tensions created by well-intentioned livelihood improvement initiatives involving market gardening agro-forestry in the Gambia. The first encouraged female populations to develop land-based resources, improving their productivity and increasing women's incomes. The second, due to its insensitivity to the details of local tenure systems, enabled male landowners to claim a portion of women's market-gardening incomes creating financial strain, and resulting in pronounced intra and inter-household conflict. Schroeder and other researchers (Schroeder 1997; Schroeder and Suryanati 2004; Carney 2004) detail this process further and elaborate on the political complications that must be addressed if currently popular resource improvement projects are to improve, rather than degrade, livelihood equity. In a different,

but conceptually related work, Mckusker and Weiner (2003) critically examine GIS representation and categorization of landuse in Limpopo province, South Africa, investigating its divergence from local understandings of "on the ground" patterns to illustrate the necessity of caution when applying "expert" knowledge in unfamiliar contexts.

Despite this diversity, however, rural African political ecological studies have focused chiefly on dynamics *within* particular rural areas. While local dynamics have been analyzed in the context of successively wider scales of abstract social, political, and ecological space, the geographic scale of research has been much narrower. An analysis of the specific spatial characteristics of each of these works revealed this trend dramatically: 13 of 28[8] papers exhibit research conducted within a single, homogeneous (in terms of the factors studied) area, whether a village, province, nation, or region. An additional 9 out of 28[9] studies examined multiple areas, but these were chosen in the interest of broadening a homogeneous field of study, rather than to contrast dynamics in different contexts. Thus, of the 28 studies a total of 22 chose study sites based on homogeneity while only 4[10] compared differing sites. Furthermore, none explored the manner in which parameters changed across a landscape of different landuses, ecosystem types, or population densities. Of equal importance, the initial confinement of political ecological research to rural areas is evident in the fact that only two of these studies explicitly treat the effects of urban processes, or urban growth, on rural areas[11]. While this might, perhaps, be explained by the predominantly rural location of African populations (ODI 2002), it is surprising nonetheless, when one considers the (increasing) rate of urbanization in sub-Saharan Africa (Freidberg 2001; Hovorka 2004;

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[8] (Bassett 1988; Jarosz 1993; Turner 1993; Moore 1998; Turner 1999; Mackenzie 2000; Myers 2002; Derman and Ferguson 2003; Mackenzie 2003; Mckusker and Weiner 2003; Turner 2003; Carney 2004; Schroeder and Suryanati 2004)

[9] (Schroeder 1993; Schroeder 1997; Schroeder 1999; Glaesel 2000; Awanyo 2001; Neumann 2004a; Neumann 2004b; Turner 2004; Moseley 2005)

[10] (Bell and Roberts 1991; Bassett and Zueli 2003; Page 2003; Watts 2004)

[11] (Ribot 1993; 1995)

Neumann 2005). The fact that this process is widely considered to be the most important agent of change in Africa suggests significant latitude for the expansion of political ecological research in this area (Myers 1999; Freidberg 2001; Neumann 2005).

2.2.2 Moving to the city

While urban political ecological research was initially rare, researchers are working actively to fill the void (Zimmerer and Bassett 2003; Neumann 2005). Political ecologists have begun to appreciate that "urban settings are products of political and ecological processes that produce a geographic pattern of uneven development and a corresponding social pattern of winners and losers" (Neumann 2005, p.155) in which processes of human marginalization are just as important as in rural areas (Myers, 1999). In addition, not only are cities frequently implicated in ex-urban environmental degradation (Myers, 1999), "the domination of nature, even in cities, is only partial" (Pelling 1999, p.259). Thus the dialectical interaction between human and environmental systems, or the interaction between "politics" and "ecology", is a process just as present in urban areas as elsewhere (Swyngedouw and Heynen 2003). Urban activities create "geographies of environmental and social distress" (Pelling 1999, p.259); and in urban areas "environmental conservation remains a mechanism for control; ...political conflicts are commonly articulated as ecological ones; ...[and] social movements emerge from the daily business of making a living" (Robbins 2004, p.216). While observers have expressed confidence that increasing urbanization and the intensification of global trade will increase the importance of urban political ecology (Robbins 2004; Neumann 2005), this area of research is yet young and undeveloped compared with the much unexplored terrain in front of it (Freidberg 2001; Neumann 2005).

Because of the paucity of literature treating this subject in the African context (Myers 1999; Freidberg 2001); the small size of this body of work generally (Robbins 2004; Neumann 2005); and its importance to this topic, a review of this research was conducted

without geographic or disciplinary constraints. Despite the diversity of the academic backgrounds reflected in the authors of the publications examined, however, the body of work reviewed was found to be topically narrow, revealing a focus on three main themes.

The first can be described as an examination of the distribution of environmental costs and benefits and resource-based conflict. The works of Harper (2004) and Véron (2006) typify this trend, exploring differential exposure to air pollution as a function of affluence and the associated health-related conflicts in Houston and New Delhi, respectively. Williams (2001), in a related piece, describes the patterns and politics of water pollution in Washington D.C. from the cities' founding to the present day. Inversely, Pedlowski et al (2002) and Heynen (2003) discuss the uneven distribution of greenery resulting from urban forestry initiatives, its correlation to neighbourhood wealth, as well as the frequent displacement of the poor to make room for urban "beautification" projects. Lupala and Lupala (2003) explain the failure of an urban forestry plan in Dodoma, Tanzania in terms of its conflict with the needs of marginal residents in this fuelwood and livestock-browse poor region. Smith (2000) and Loftus and MacDonald (2001) describe unequal water services provision and cost distribution between elite and marginal groups in Buenos Aires and Cape Town, respectively. Myers (1999) and Moffat and Finnis (2005) examine a broader set of resources, examining the quality, availability, and conflicts over land, water and other livelihood-related materials in peri-urban areas of Zanzibar and Kathmandu. Gendered analyses of the differential access of men and women involved in urban agricultural activities to urban and peri-urban resources such as land parcels of varying quality are provided in two studies by Hovorka (2005; 2006). Finally, in a study of a slightly different nature, Freidberg (2001) describes the decline of a once fruitful and culturally important market-gardening system in peri-urban villages near Bobo-Dioulasso, Burkina Faso due to environmental changes and governmental neglect. What is perhaps most interesting in the context of this discussion, is the emphasis she places

on the processes of urban development within "Bobo" as causal mechanisms of environmental degradation in these peri-urban areas, providing a somewhat unique analysis of linkages *across* socioecological space.

A second category of studies within this literature is a body of research into urban distributions of environmental vulnerability and risk. Beginning with his seminal work in 1999, Pelling has contributed a series of pieces (2002; 2003) dealing with flood hazard in urban and peri-urban Guyana, finding a strong inverse correlation between risk and income levels. Mustafa (2005) contributes a similar study of the Islamabad/Rawalpindi twin cities, but focuses on the political mechanisms that have constrained government flood-mitigation choices such that nonstructural options are not even considered. Emmel and Soussan (2001), by contrast, contribute an interesting study of the variable and stratified levels of vulnerability and social mobility *within* a marginalized group in a Mumbai 'slum'. Suarez and Lombardo (2004) present a study of the socio-economic and geographic distribution of water pollution exposure risk within greater Buenos Aires. Performed by ecologists, this study is noteworthy for its use of a landscape gradient model of pollution with overlays of socio-economic data and state and elite roles in moderating risk distribution.

The third major category of urban political ecological research to date discusses what might be called the "political economy of consumption". These studies take a distinctly general approach, dealing with either regional urban phenomena, rather than specific cities or with a specific city in general. Hobson (2004), for instance, discusses the political and cultural aspects of sustainability versus consumption in Asia-Pacific cities in terms of regional commonalities. Kaika (2003), by contrast, investigates the construction of water scarcity for elite economic gain in the city of Athens, but deals with the political-economic space of the city as a whole rather than any specific geographic areas within or near it. Two interesting series of studies stand out from the rest, however, due to their (limited)

exploration of linkages operating between urban and non-urban areas. Robbins, and Robbins and Sharp (Robbins 2001; Robbins and Sharp 2003a; Robbins and Sharp 2003b) examine the cultural, political, and economic forces shaping American lawn chemical use. This work is relatively unique in the urban political ecological literature for its (admittedly minimal) use of ecological data in a cursory analysis of the external ecological effects of suburban chemical consumption. The work of Swyngedouw and colleagues (Swyngedouw 1996; 1997; Swyngedouw et al 2002; Swyngedouw 2003), focusing on urban water system development in multiple cities and eras, is similarly noteworthy for its (somewhat peripheral and limited) examination of the peri-urban and rural impacts of urban growth. Their discussion of how the development and growth of cities is predicated on the capture and harnessing of surrounding (water) resources, creating ever mounting conflicts sets these studies apart from other works in this area in that it represents a step toward a comparative political ecology of urbanization rather than just of the urban.

All of these works can be categorized according to their treatment of urban space, a useful comparison in this context. The largest group is comprised of the 20/28 studies that focus their inquiry on a single, intra-urban space, with the partial exception of Robbins (2001) and Robbins and Sharp (2003a; 2003b), as well as Freidberg (2001) who, as mentioned does make some reference to external ecological effects. The defining factor of this categorization, however, is the predominantly non-comparative nature of these studies. Within this group there are studies that examine intra-urban locales[12], suburban areas[13], and peri-urban areas[14]. The other 8 studies[15] examined included some comparative work, but

[12] (Loftus and MacDonald 2001; Williams 2001; Pedlowski et al 2002; Heynen 2003; Kaika 2003; Lupala and Lupala 2003; Harper 2004; Hobson 2004; Mustafa 2005; Véron 2006)

[13] (Emmel and Soussan 2001; Robbins 2001; Robbins and Sharp 2003a; 2003b)

[14] (Myers 1999; Smith 2000; Freidberg 2001; Pelling 2002; Suarez and Lombardo 2004; Moffat and Finnis 2005)

[15] (Swyngedouw 1996; 1997; Pelling 1999; Swyngedouw et al 2002; Pelling 2003; Swyngedouw 2003; Hovorka 2005; 2006)

lacked any systematic evaluation of the relationship between rural and urban areas in terms of the change in dynamics across the space dividing the two.

2.2.3 Bridging the gap

Political ecologists have begun to recognize the importance of livelihood struggles, processes of marginalization, and the differential distribution of environmental costs and benefits in urban areas. They have recognized the presence of natural elements within cities, and hence the presence of a dialectical production of society and nature. They have, however, paid only minimal attention to *ecological* dynamics within and outside of urban areas, and have only begun to address the issues of the relationships between growing urban centers and their rural contexts. However, in the context of the rapid urbanization of many areas of the globe, particularly Africa, enhanced understanding of such concerns is becoming ever more important (Freidberg 2001; Hovorka 2004; Neumann 2005).

The continued importance of a focus on property rights structures in political ecological research and their effects on differentiating access to resources and land and patterns of inequality and conflict (Neumann 2005) suggests the relevance of this approach to an understanding of urbanization dynamics. Of central concern to this analysis has been the way in which land rights vary, and are contested according to "land type, land use, resource type, and location", "the importance of political-economic context in specific locales" and how these variations relate to patterns of degradation or conservation of resources (Neumann 2005, p.102). If, as Swyngedouw suggests, the capital upon which the growth of cities is predicated is "generated through the political-ecological transformation of the city's hinterland" producing "both a new urban, and rural socionature", then systems of rights, access, and the security of livelihoods must shift and change with urban growth (1996, p.79). If, as he continues, "the city's growth...is closely associated with successive waves of ecological conquest and the pushing outwards of the urban socio-ecological frontier" (1996,

p.79), then urban, sub-urban, peri-urban and ex-urban or rural landuse demands must at some point come into conflict. Rapidly changing land-use and displacement or co-optation of land-users is apt to create winners and losers, appropriation and marginalization. It is for this reason that Robbins calls for a new approach to urban areas that is capable of moving beyond "simply identifying the unequal distribution of risks and environmental 'bads' to explain how these urban ecologies are produced and why these ecological networks look the way they do" (Robbins 2004, p.216). This, he claims, will require tracing flows of materials, energy, and power *through* built spaces rather than just examining discrete locales.

Similarly, Zimmerer and Bassett criticize the fact that "the issues of urban and rural locales are still seen as largely apart in the realm of environmental ideas and conservation", separated into "the "green agenda" of rural wilderness conservation and the "brown agenda" of urban environmentalism that targets air and water pollution, toxic contamination and sprawl" (Zimmerer and Bassett 2003, p.280). They advocate that this legacy of anti-urban romanticism be set aside in favour of a model of urbanization that envisions an "urban-rural continuum of...habitat modification" (Zimmerer and Bassett 2003, p.279). Neumann supports this claim, emphasizing the necessity of moving political ecological theory beyond its urban-rural dualism (Neumann 2005 p.116). As Swyngedouw and Heynen add, this is all the more important since "there is no longer an outside or limit to the city" as the processes of urbanization contain socioecological processes that reach far beyond its nominal boundaries (Swyngedouw and Heynen 2003, p.899). Urban political ecology has yet, however, to examine "the urban as a process of socioecological *change*" (Swyngedouw and Heynen 2003 p.899). Neumann sees the solution to this problem in a return of urban political ecology to a more balanced treatment of ecology and politics and their dialectical relationship through processes of uneven development. In the future, he suggests, a key area of inquiry "will be exploring the socio-ecological interconnections that operate at multiple scales...that link

cities to each other and to rural regions" (Neumann 2005, p.157). In summary, the freshly minted subfield of urban political ecology has produced some insightful and provocative work, but there remains much room for its growth and development, particularly in the examination of the processes of urban growth.

2.3 A need for new models

The lack of attention to socioecological dynamics and relationships interacting across changing, and particularly urbanizing, landscapes in the political ecological literature cannot, however, be solely attributed to the recent emergence of urban research with the subfield. Rather, an examination of the body of urban political ecological work in comparison to its rural origins reveals that the methodological trends of this newer work are rooted in the emphasis on "vertical" relationships of the foundational works. On the whole, recent urban, suburban and peri-urban studies have tended to treat such areas as more or less discrete locales, explaining local realities in terms of internal dynamics, abstract hierarchies of political-economic influences or both with only modest attention to interactions across geographic space; a trend similarly evident in most previous rural political ecological research. Thus the failure of both to significantly engage in the examination of horizontally-oriented processes suggests the need for an examination of the prior theoretical and methodological commitments of the field.

2.3.1 Hierarchies of the past

As mentioned, political ecological research, in seeking to avoid the theoretical mistakes of the narratives it seeks to replace, originally emphasized beginning with ground-level, empirical research at the level of the "land manager" rather than grand "scientific" *a priori* theorization of environmental problems (Bryant 1998; Robbins et al 2001; Neumann 2005). This was done on the premise that, as key actors in local urban-ecological dynamics, they are the most well-placed to understand the conditions of resources, social dynamics and micro-political struggles of resource uses and the "on the ground" effects of various

management plans (Oelofse 2003; Myers 1999; Bryant 1998). Furthermore, this was seen to illuminate unevenness of environmental justice and equality since it is in daily reality at the local level that injustices are most visible (Heynen 2003; Kirby et al 2001). Thus, through beginning with individual land managers, political ecologists were able to address questions such as *who* has access to *which* urban resources and *how* their use contributes to larger 'beneficial' or 'costly' environmental trends.

While there was nothing in this aspect of the research tradition that precluded horizontal scalar configurations of analysis, it is in the contextualization of local realities within broader political economic trends that attention to geographic scale has been constrained. One of the enduring legacies of Blaikie and Brookfield's (1987) conception of political ecological research has been the continued, if increasingly subtle, influence of the "chain of explanation" model of analysis. In this framework, the decisions, struggles, and constraints of local land managers were explained in terms of successively larger scales of human activity (Peet and Watts 2004; Robbins 2004; Neumann 2005). Once the "chain" departs from the locus of the land manager it begins to follow a path through not geographical, but rather abstract social, political, and economic space. From a geographic perspective, then, the "chain of explanation" is an essentially "vertical" model predicated on a movement from a defined geographic locality upwards through abstract hierarchies of human power, affluence, and influence. While the "land manager" focus and "chain of explanation" model of inquiry and analysis have faded somewhat from the forefront of political ecological thought in the course of the broadening and development of the subfield, their lingering influence is adequately evident in the persistence of the urban-rural boundary in, and predominantly "vertical" orientation of, much rural and urban research.

2.3.2 From "chain" to landscape

This is not to suggest that beginning with the land manager as the initial focus of empirical observation is misguided, nor that the "chain of explanation" is an inappropriate tool for the exposure of larger causal forces influencing decisions at the local level. Rather, the observation that this "upward, hierarchical tendency...obscures horizontal relationships and non-human agents and factors" (Robbins 2004, p.210) in favour of a focus on human, political dynamics suggests that not so much alternative as complementary models may be needed for the investigation of certain phenomena. It is in the context of this observation that Zimmerer and Bassett argue "for a more creative consideration of geographical scale" (2003, p.2). In the context of urbanization, they argue, political ecological research must build new "geographic frameworks of linked urban-rural environments that seek to model and build on new images of this dynamic continuum" (2003 p.279). In a similar vein, Robbins suggests that more analysis of horizontal networks could help in developing a better understanding of recurring socio-natural situations (Robbins 2004). Urbanization is both such a recurring type of interaction between society and nature and one that involves a significant horizontal, geographically articulated pattern of socioecological relations. This suggests that the adoption of a spatial model that acknowledges the socio-environmental production of scale (Zimmerer and Bassett 2003) is more appropriate to the study of urbanization than a solely "vertical" analysis. In such a model, the spatial extent of the dynamics under study is allowed to define the scale at which they are examined. While the landscape dynamics occurring between urban to rural settings are predominantly generated by human landscape use patterns, urban centers and the processes of urbanization nonetheless exist within, and grow out into, the larger ecological landscapes within which they inhere. A shift towards greater attention to landscape and ecosystem scales such as Zimmerer and Bassett (2003) advocate would therefore appear to be a more relevant and appropriate approach to the analysis of

urbanization than the use of a pre-given set of socio-spatial containers (ibid) such as urban, suburban, etc. If the city is conceptualized as a socio-ecological subsystem of the broader ecosystem within which it is embedded then a horizontal, geographical conceptualization of scale, one which examines the city within, and its socio-ecological relationship to, the larger landscape of which it is a part, is needed for a nuanced understanding of urban processes such as spatial growth.

2.3.3 An alternative construction

In the nascent field of urban ecology, just such a model of urbanizing landscapes has been developed for the same end: to explain the ecological effects of urban growth on surrounding non-(or less) urban hinterlands. In the process of coming to terms with the need for a functional definition of the urban ecosystem, urban ecologists were forced to eschew urban-rural dichotomies which, in any event, failed to pass the tests of repeated empirical observation. Thus, based on a combination of urban theory and empirical research, the relationship between urban and non-urban areas was defined in terms of a graduation of increasing human influence, and associated shifts in landuse type and intensity with proximity to the urban "core". This relationship is understood to be dynamic, and is linked to the understanding of urbanization of the continual outward extension of the spatial footprint of the city and the ongoing concomitant increase in land-use intensity at its fringes (Mcdonnell and Pickett 1990; Walbridge 1997; Zipperer et al 1997; Niemel 1999). Rather than conceptualizing urban areas as "disturbed" from a 'natural' state (Dow 2000), therefore, human activity is understood as a dynamic ecological transformation from a less to a more human-dominated system resulting in a complex shifting mosaic of ephemeral land-use "patches" (Guntesbergen and Levenson 1997; Pickett et al 1997b; Zipperer et al 1997).

The approach of using Whitaker's (1967) "gradient paradigm", pioneered to some extent by McDonnell and Pickett (1990), is in effect a landscape ecological approach to the

study of the spatially varying effects of urbanization (Mcdonnell and Pickett 1990; Mcdonnell et al 1997) in the interest of understanding the dynamics of wider urban landscapes (Dow 2000). Essentially, the gradient paradigm is based on the view that environmental variation is spatially ordered, and that the resulting environmental patterns govern the functional and structural dynamics of ecological systems (Mcdonnell and Pickett 1990). The urban-rural gradient is seen to represent functional differences in transitional patches between city and countryside (Foresman et al 1997) which will not necessarily exhibit a linear relationship but exhibit a general transition in ecological dynamics due to a spatial shift in the degree and type of anthropogenic influence (Foresman et al 1997; Dow 2000)

The productivity of this approach is amply illustrated by the fact that it has been successfully used by urban ecologists to study a wide variety of phenomena, including: vegetation fragmentation and its effects on other ecosystem dynamics (Porter et al 2001; Hobbs 2005); vegetation processes (Gupta 1995; Kostel-Hughes et al 1998; Iakovoglou et al 2001); vegetation structure and diversity (Guntesbergen and Levenson 1997; Zipperer et al 1997; Burton et al 2005; Lockaby et al 2005; Loewenstein and Loewenstein 2005); the distribution of: terrestrial wildlife (Steiner1994; Germaine and Wakeling 2001); airborn wildlife (Jokimaki and Suhonen 1993; Wolda et al 1994; Blair1996; Blair 1999; Melles et al 2003; Stratford and Robinson 2005) and fish (Helms et al 2005); wildlife behaviour (Russo and Young 1997); and various aspects of soil dynamics (Pouyat et al 1994; Effland and Pouyat 1997; Mcdonnell et al1997; Pouyat et al 1997). In fact, its popularity and efficacy have emboldened Pickett et al (1997a) to claim that whatever other approaches may be used or developed for the ecological study of cities, the urban-rural gradient will remain fundamental to urban ecology.

2.4 A productive synergy

In summary, political ecology represents a unique and potent approach to the investigation of interrelated human and ecological systems, or, the production of socioecological systems. Research in this field has exhibited an unrivalled aptitude for exposing both the broader structural causes of undesirable environmental change and the processes of marginalization frequently associated with differential distribution of power over people and environments. Nonetheless, despite the increasing social and ecological importance of urbanization as a global phenomenon, political ecologists have yet to seriously engage its dynamics. This has been largely due to the lingering influence of a methodological model that places primacy on the explanation of spatially homogeneous trends in terms of political, social, and economic hierarchies, and the absence of a framework for the investigation of horizontal linkages across heterogeneous landscapes.

The urban-rural gradient model developed by urban ecologists represents a potential solution to this conceptual and methodological gap; a well developed and accepted approach to the ecological study of urbanization, it awaits the integration of political dynamics to achieve more holistic explanations of urbanization dynamics. Urban ecologists have recognized the crucial importance of integrating human and ecological concerns in the study of urbanization (Mcdonnell and Pickett 1990; Pickett et al 1997a; Walbridge, 1997; Dow 2000; McIntyre et al 2000; May 2004; Musacchio and Wu 2004) if novel solutions to complex socioecological problems are to be developed (Lockaby et al 2005). Nonetheless, they have had significant difficulty integrating social, economic and political institutions and knowledge constructions into this model (Niemel 1999; Dow 2000; McIntyre et al 2000; Wali et al. 2003). This has led to much advocacy within the field for increased cooperation with social scientists in order to develop a version of the gradient model capable of explaining the interrelated social and ecological dynamics of urbanization processes (Pickett

et al 1997b; Niemel 1999; May 2004; Lockaby 2005).

The development of a political ecology of urbanization based on the urban ecological urban-rural gradient paradigm, therefore, presents a number of fruitful opportunities. First, it represents a distinct move towards more direct engagement with the processes of urbanization, thus beginning to fill this gap within the political ecological literature. Second, it would showcase a new spatial model capable of "horizontal", or landscape geographical analysis, thus strengthening the field by adding a complementary methodology to the more "vertically"-oriented approaches predominating in the existing literature. Third, this horizontal approach has the capacity to create greater unity within the discipline and greater integration of the new urban subfield by providing the means for inter-contextualization of the diverse rural, urban, suburban, and peri-urban works that have been produced. Fourth, the use of this spatial model represents a key opportunity for urban geographical political ecologists to engage in more productive and direct interaction with the rapidly growing subfield of urban ecology. The current research therefore draws on political ecology for its understanding of the relationship between human and non-human actors and the roles of policy, affluence and influence in shaping this interaction. The political ecological approach, however, is informed by the urban ecological gradient model in terms of its conceptualization of the spatial socio-ecological dynamics of urbanizing landscapes.

Chapter 3

3.0 Research design

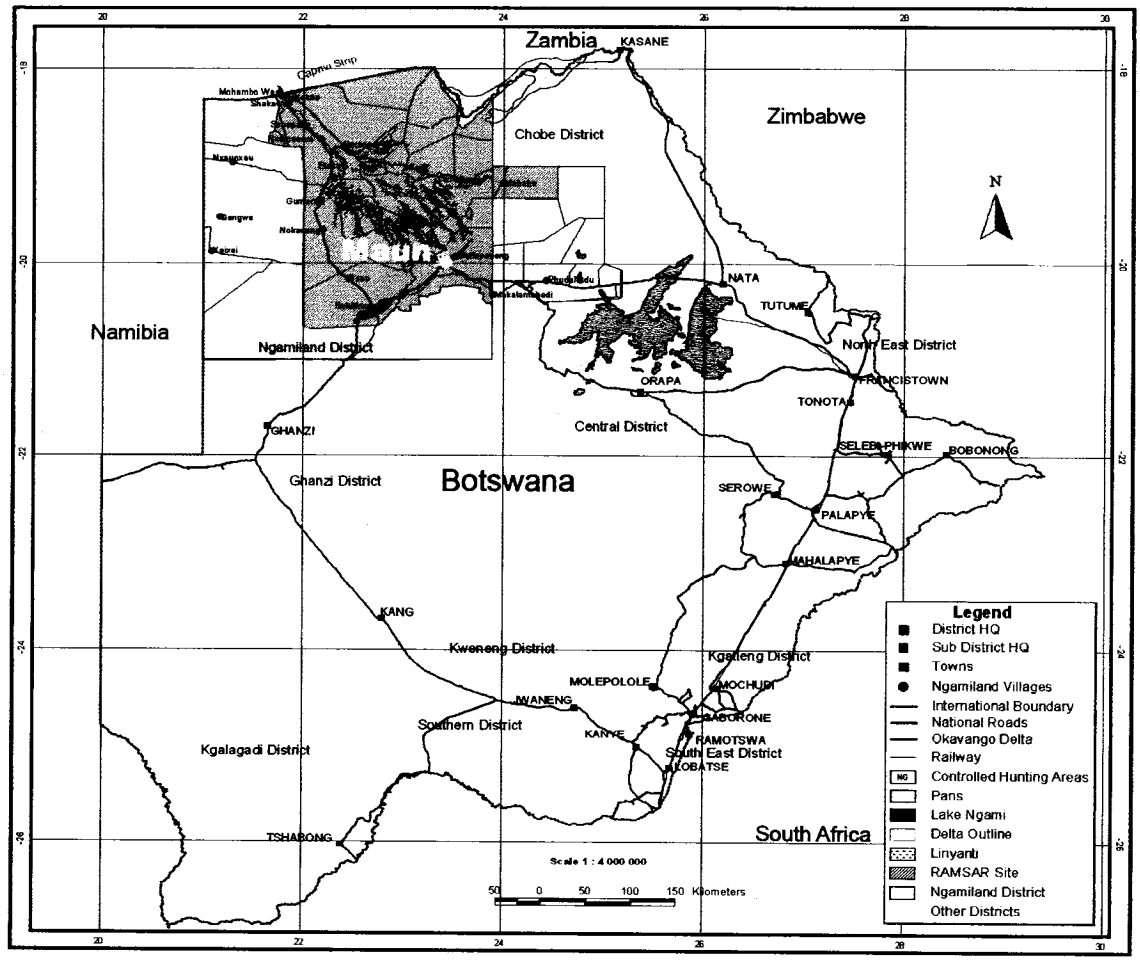
In this chapter the methodology of the current research is presented along with introductions to Botswana and to the town of Maun in its regional context. First, the study site information is presented moving from the national to the local level. Second, the discussion of the current research methodology is described beginning with the broad methodological approach followed by detailed descriptions of the methods used for data collection and for the analyses underlying the results presented in chapters 4 and 5.

3.1 Study site context

3.1.1 Botswana

The Republic of Botswana is a landlocked southern African country of 582,000 square kilometres which borders Zimbabwe, South Africa, Namibia and Zambia (MFDP 2003) (Map 3.1). With a 2005 population of 1,640,115, its mean population density is an extremely low 2.7 persons per square kilometre (CIA 2006). Almost 90% of this population, however, lives along the eastern north-south band of urban centres which follows the main road and rail routes linking South Africa, Botswana and Zambia (DTRP 1998).

The country is mainly composed of flat to gently rolling tableland with the Kalahari Desert dominating the central and southwestern regions. As Botswana is located in the sub-tropical high pressure belt of the southern hemisphere and far from southern Africa's coasts, temperatures tend to be high and rainfall levels low (ibid). Due to semi-arid conditions and the predominance of infertile sandveld soils its ecological landscape is considered to be relatively fragile (Hall. 1994). Aside from the Chobe forests in the north, the Okavango delta swamps in the northeast and the aquatic grasslands of the Makgadikgadi pans in the northern central region, it is dominated by savannas of acacia and other species tolerant of the long dry seasons and recurrent droughts (MFDP 2003).



Map 3.1: The Republic of Botswana (adapted from ODMPPS 2006)

Botswana is considered to be economically healthy in comparison to the sub-Saharan average (EAD 2004; Hovorka 2004) and well on its way to achieving middle-income status (EAD 2001). At independence in 1965 Botswana was among the world's poorest countries (Hovorka 2004) with high reliance on its modest, frequently drought-threatened agricultural sector; little infrastructure; low export earnings and significant dependence on foreign aid for both investment and recurrent government expenses (MFDP 2003). The discovery of diamonds and other minerals shortly after independence, however, revolutionized the economy resulting in extremely rapid growth and development (ibid; Hovorka 2004). While some diversification has occurred since 1983 when the mineral sector reached a peak GDP contribution of 52.6 percent, Botswana still relies heavily on mining revenues which

contributed an average of 35 percent of GDP, 82 percent of export earnings and 53 percent of state revenues between 1990 and 2004 (ibid; EAD 2004).

Despite national-level economic success, Botswana's median income remains low in world terms (EAD 2001) and the distribution of wealth is highly skewed (MFDP 1997; CSO 2003). Moreover, between 1993 and 2003 a shift was observed in the Gini coefficient from .537 to .573 indicating a continued increase in inequality despite a sustained rise in GDP per capita (CSO 2003). This trend is partly associated with the economic dominance of the mineral sector which generates significant revenues for central government and private stakeholders but only 3.5-4.0 percent of total formal employment.

An important component of this economic inequality is its urban-rural distribution due to the structure of the formal economy. Roughly 80 percent of Botswana's formal employment is in the government, commerce, construction, manufacturing and financial sectors which generate income opportunities mainly in the urban centres. The rural areas, by contrast, are characterized primarily by informal agricultural activities (MFDP 2003) and few formal employment prospects. As a result, while urban poverty persists, there is a general transition in mean cash incomes from the towns and cities through the urban villages to the rural areas where most household incomes are below the national poverty line (EAD 2004).

As in much of sub-Saharan Africa, urbanization is a major driver of social and economic change in Botswana (Hovorka 2006). With an average annual urban growth rate of 4.2 percent between 1991 and 2001 (Gwebu 2003b) and over 8 percent per year during the 1980s for its capital, Gaborone, (Mosha 1996), Botswana provides a classic example of the region's migration-driven urban growth (Ijagbemi 2003). While the level of urbanization was only 9.6 percent in 1971 it rose to 18.3 percent in 1981, 45.7 in 1991 (EAD 2001) and 54.2 percent by 2001 (MFDP 2003). While the extremely rapid growth between 1981 and 2001 was partly due to re-classification of certain large villages as urban centres and the rate

of urbanization has slowed since 1991, it remains high and is increasingly driven mainly by rural-urban migration (Gwebu 2003b; Hovorka 2004). An important driver of the growth of urban centres outside the capital region:

> "has been the designation of certain centers as district and sub-district headquarters...[as] such designation has been accompanied by decentralization of human resources, services and improvement of physical infrastructure, utilities and telecommunications...[which] has encouraged private sector investment and employment generation" (Gwebu 2003b p.3).

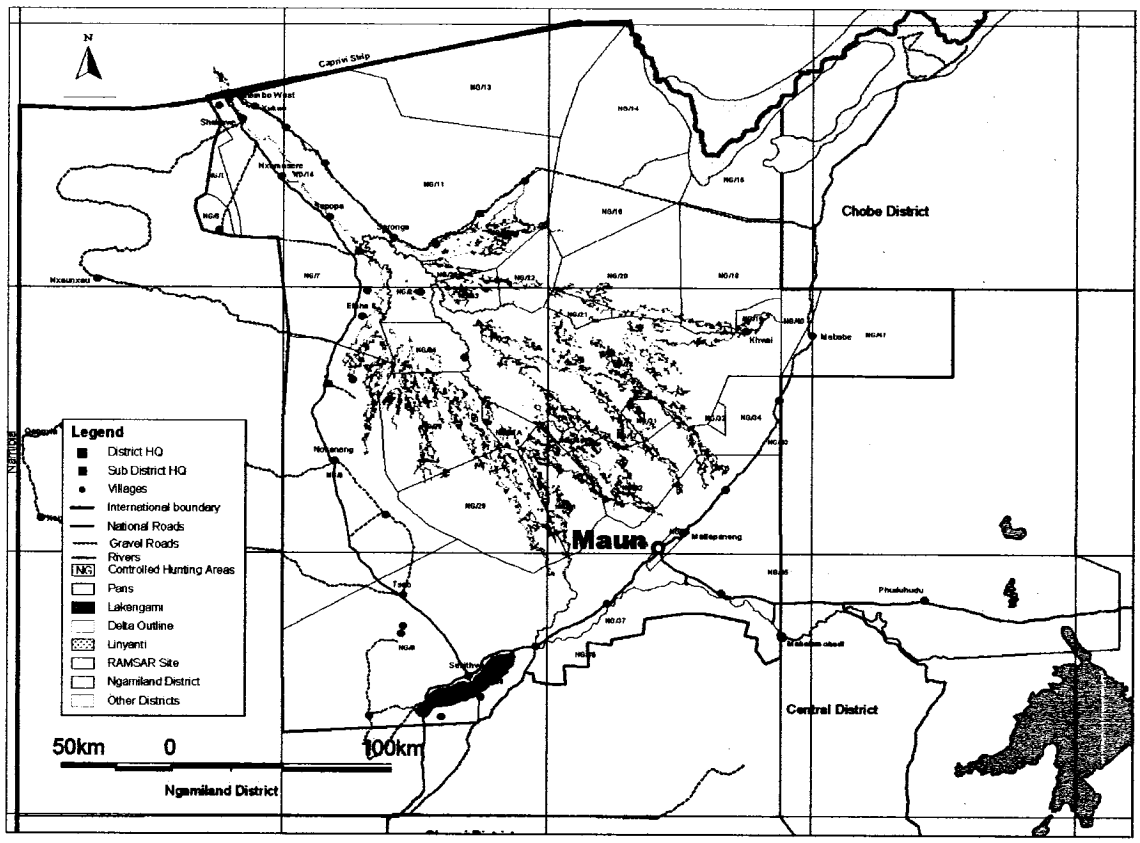
These developments have been particularly important in stimulating the population growth of isolated settlements in the northern and western districts of Botswana such as Maun, Ghanzi and Kasane which have become some of the fastest growing centres in the country.

3.1.2 Maun, Ngamiland

Located on the southern fringe of the Okavango delta[16] and centred on its primary outflow, the Thamalakane river, the "urban village" of Maun is both the largest settlement in Ngamiland district with over 30 percent of its population of 130,882 (CSO 2005) and its capital (Map 3.2). The character of this once quiet rural village has changed significantly over the past two decades due to a number of developments. First, its importance as a regional service centre to a large rural hinterland steadily increased during the 1980s due to government decentralization policies under which many central and local government offices were established in Maun (DTRP 1997; Gwebu 2003b). Second, during the rapid rise of the tourism industry during the 1990s Maun's emergence as a regional hub for through-traveling tourists resulted in the establishment of many lodges, offices and other facilities. These two developments fuelled Maun's growth by generating both the relocation of many private and public sector professionals to operate the new facilities (ibid; ODMPPS n.d.) and a significant attractive influence on rural residents looking for new opportunities (DTRP 1997; Gwebu 2003b). Third, rural-urban migration was further increased during the mid-1990s due

[16] The Okavango delta, the largest protected wetland under the RAMSAR convention is a dominant, striking feature of the otherwise semi-arid landscape of Ngamiland

to the outbreak of cattle lung disease and the closure of the Maun abattoir. The slaughter of Ngamiland cattle stocks in the 1995-96 efforts of the Ministry of Agriculture to eradicate the disease resulted in the almost instantaneous decline of cattle raising as a key economic activity in the region, at least in the short term. In the wake of the resulting social and economic dislocation many smaller herd owners left their rural homes to establish themselves in Maun (DTRP 1997; Cassidy 2003).



Map 3.2: Ngamiland district (adapted from ODMPPS 2006)

As a result of these developments this once quiet backwater village experienced a meteoric rise in population beginning in the early 1980s which has continued into the present outstripping all central government predictions such that Maun is currently one of the most rapidly growing urban centres in Botswana. Its mean annual growth rate from 1991-2001 was 5 percent, third highest among Batswana towns over 20,000, and 2 percentage points above the national average, and it has risen from 10th place in 1981 to become the 5th largest urban

centre in Botswana in 2001 (Brinkhoff 2006). This explosive growth in population has been accompanied by a sudden expansion of Maun's built area which grew from 4 to only 8 square kilometres between 1970 and 1981 but had already reached 88 square kilometres by 1997 (DTRP 1997).

Maun was chosen as the study site for a number of reasons. First, due to its remoteness and recent achievement of urban status it has been excluded from studies of urban growth and fuelwood issues in Botswana. However, the high fuelwood consumption of Botswana's northern settlements (EAD 2001), the rate of Maun's growth, its strong rural connections and large hinterland make it a particularly suitable case for the study of socioecological change in Botswana's urbanizing landscapes. Second, as population growth during the 1980s and 1990s far outstripped formal employment growth,[17] cash income levels have been low with 66% of Maun's households living below poverty datum line in 1996 (DTRP 1997). This suggests that many Maun residents may remain (or have become) heavily reliant on peri-urban or rural communal resources for in-kind or cash income. Finally, while the eastern settlements' hinterlands are characterized by pastoral and agricultural landuses, Maun is growing into a landscape somewhat enclosed by the protected areas of the Okavango delta to the north and closed rangelands and wildlife management areas to the east and south. The woody resource base for the supply of this rapidly growing urban centre is thus limited with potential for shortfall and conflict between urban and rural resource needs. As such, Maun's development trajectory presents an important test case for the evaluation of the influence of urban energy and development policies[18] on urban-rural socioecological change in Botswana.

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[17] The proportion of Maun residents "actively seeking work" rose from 5.3% in 1981 to 22.7% in 1991 (DTRP 1998).
[18] Particularly the policy of cost recovery for urban services provision and energy transition programs as detailed further in Chapter 4.

3.2 Broad research approach

The current research used a combination of quantitative and qualitative methods throughout in order to achieve a holistic understanding of the dynamics of fuelwood use in and around Maun. Quantitative methods were used where possible to determine the statistical significance of observed relationships whereas qualitative methods were used to obtain key information for the contextualization and interpretation of these trends.

3.3 Data collection

Data collection methods included individual key informant interviews and semi-structured interviews with samples of both urban households and fuelwood vendors operating in the Maun urban and peri-urban areas. Key informant interviews were conducted with academic researchers and employees of central government departments and parastatals in both Gaborone and Maun in English by the author. The semi-structured interviews took place in Maun only and were conducted in English and Setswana or occasionally in Hambukushu. When English was used the author engaged in direct dialogue with the interview respondents, however, a research assistant accompanied the author during all interviews in order to translate when necessary. The research assistant was hired from within the Maun community and training involved familiarization with the research objectives, methods, and the purposes behind the specific questions being asked in order to facilitate accurate translation of questions and the answering of respondents' questions about the research.

3.3.1 Key informant interviews

Individual key informants were interviewed (n=22) to obtain information on the history of energy and urban development policies at the national and local levels as well as on Maun's development beyond that available in the government and academic literatures. These semi-structured interviews were guided by questions prepared to achieve specific research goals but were open-ended in nature in order to allow for the emergence of unanticipated information. Such interviews were conducted with faculty of the University of

Botswana (UB) and the Harry Oppenheimer Okavango Research Centre (HOORC) with previous experience in fuelwood and urban growth research projects in Botswana in order to acquire supplementary information on this topic and to discuss methodological details of the household and vendor surveys. Interviews were conducted with senior staff at the Energy Affairs Division (EAD) in Gaborone, Department of Forestry and Range Resources (DFRR) in both Gaborone and Maun, the Botswana Power Corporation (BPC) in Gaborone and Maun, the Forestry Association of Botswana (FAB) in Gaborone, the Air Quality Control Division (AQCD) in Gaborone, the Okavango Delta Management Plan (ODMP) in Maun, the Department of Environmental Affairs (DEA) in Gaborone and the Tawana Land board (TLB) to obtain information on perceptions, policies and the outcomes of programs relating to various aspects of household energy use, fuelwood dependence and conservation concerns. As well, interviews were conducted at the Department of Town and Regional Planning (DTRP) in Gaborone and Maun, the TLB, Maun Sub Land Board (MSLB) and the BPC in Maun regarding past and present national and local development policies and programs. A list of these interviews is provided in Appendix A.

3.3.2 Household survey

The core data set of the current research was obtained through a series of 78 household interviews conducted in the urban and peri-urban areas of Maun. The purpose of the interviews was to collect data describing the relative importance of various potential influences on household fuel use and sourcing such as: residence type and location; socio-economic status; infrastructural context; local residence history; rural social or property ties; fuel type and use habits; and fuel sourcing strategies. The interviews were relatively structured as they were guided by a standardized questionnaire (Appendix B) to ensure comparability of responses and a minimum baseline of information. Additional discussion was pursued where relevant for clarification or in response to issues raised by respondents.

Due to the impracticability of sampling based on "neighbourhoods" or other spatial groupings of residences in the Maun context it was decided that an urban-rural transect approach would provide the most appropriate method of primary stratification for the household survey. The use of a set of transects radiating outward from the centre of Maun made it possible to ensure both adequate randomization of the sample while ensuring relatively even spatial coverage of the settlement such that no major areas were excluded, which significantly reduced the potential for spatial bias. In addition, a secondary stratification by income was used to ensure adequate representation of the range household of socioeconomic variability observed at each sampling point.

The origin and directions of the transects were established according to the following protocol. First, the locally accepted center point of the settlement was identified as the downtown post office through key informant interviews at the TLB. Second, the first transect azimuthal bearing was established by drawing a random number from 1-360 in order to preclude bias. Third, the remaining 5 transects were established at equal azimuthal degree intervals oriented to the first in order to both maximize spatial coverage and replicate the randomness of the first bearing selection in all subsequent transect bearings.

Interviews were conducted with members of the nearest 3 responsive households at each 1000m interval along each of 6 transects from the center of town moving outward until the termination of each transect. Due to the variability in the density of residential structures imposed by the Thamalakane river, the "village" landfill, the Maun international airport and other factors causing "dead spots" in the residential fabric, it was necessary to establish a protocol for deciding the radius at which residences would be accepted for sampling. As residences falling along a transect but more than 500m from a sampling point would be closer to either the previous or the subsequent points, it was decided to sample only within a 500m radius of any given point. If no residences met this requirement the point was

considered a "dead" spot on the transect and the interview team proceeded to the subsequent sampling point. The number of transects and the distance interval between the sampling points were chosen through consultation with local researchers in order to achieve the optimal balance between spatial coverage, total sample size and the time required to complete the survey. Transects were terminated after they had passed the outside edge of peri-urban settlement, which was established by either the passing of 3 successive sampling points where no households were present within a 500m radius or following one point where all the residences were cattle posts[19]. The 3 households sampled from the most proximate responsive residences at each point were selected, to the greatest extent possible, to include the highest, lowest, and closest to middle income residences from those available using the cost of the residential structures as a proxy for socio-economic status[20]. This was done in order to integrate a secondary stratification by income and reduce both the conflation of effects of income and location and the introduction of bias in the selection of three households from a group of more than three equally proximate residences[21] (established by GPS).

While the majority of responses to the questions included in the household questionnaire were recorded as verbal responses, two variables required alternate techniques. First, the location of each household interviewed was recorded using a Garmin GPS 12™ Global Positioning System unit due to the lack of a generally used plot number or address system in Maun, the difficulty involved in acquiring and using the TLB survey maps covering such a large area, and for ease of spatial analysis of the interview data using a Geographic Information System program. Second, as participant mapping exercises have been widely and successfully used as a key tool of Participatory Rapid Appraisal (PRA)

[19] On the basis that the cattle post is considered to be a definitively rural entity in the Botswana context.
[20] Multiple sources, including past surveys (EAD 2001) and local researchers indicated this to be both accepted practice, and one of the only practicable alternatives for establishing socio-economic status prior to interview.
[21] Which was found to be a common situation at many points during pre-survey exploration of transect routes and points

techniques, respondents were asked to identify fuelwood sourcing locations using a set of 3 maps of decreasing scale (Appendix D) in order to capture these responses as accurately and faithfully as possible. The largest scale map detailing Maun and environs was derived from tracing directly over the 2003 geo-referenced aerial photo basemap of Botswana[22]. The map was generated in this fashion due to the lack of suitable alternative maps for the Maun area, and as it allowed the inclusion of details such as major gravel roads as well as scaling to a manageable size. The second and third maps, which were obtained from the ODMPPS, had been generated from satellite images of Ngamiland. Respondents were asked to select the most appropriate map and depict fuelwood source locations themselves in pen, following a brief orientation to ensure understanding of the scales and features of the maps. A fresh map was used for each respondent.

While many similar surveys have relied on heads of households for interview responses, it was decided to accept respondents over the age of majority for this survey rather than only household heads for a number of reasons. Sampling household heads alone requires either the exclusion of households from the sample if the head is absent when the interviewer visits, or a series of visits and the arrangement of appointments which render the data collection process significantly more complicated and time consuming. On the one hand, time constraints and the availability of only one interviewing team precluded repeated visits. As well, while many household heads are absent during the daytime due to employment, business, subsistence or other activities, local civil servants and researchers confirmed that attempting to interview during the early or later evening would not only be seen as intrusive by many potential respondents, but could involve personal danger to the interviewers in some areas of Maun. On the other hand, excluding households based on the daytime absence of the

[22] The national aerial photo basemap is considered to be of acceptable accuracy as it is the basis of the majority of maps generated in Botswana for assessment, management and planning purposes.

household head has significant potential to bias the sample towards certain groups (such as the retired or the unemployed) and away from others (such as civil servants and businesspeople). Furthermore, the assumption that household heads are the optimal source of information on household characteristics is somewhat questionable per se as they may not be directly involved in the activities and decision-making patterns of interest due to divisions of labour among family members. This issue becomes particularly important in the context of compound family units, often composed of multiple dwellings with multiple semi-autonomous adult members and/or nuclear families on a single plot, which are common in Maun (DTRP 1997) as elsewhere in Africa (Brouwer and Falcao 2004). In such households, the "head" may be identified as such by household members due to his or her age and matriarchal or patriarchal position and titular ownership of the residential plot. As the results of the current research indicate, however, many such individuals are grandparents who, due to their age and family position, are cared for by the members of the extended family and are not involved directly in many aspects of daily household decision making. As well, since individual adult members or nuclear families may be relatively autonomous in many respects, their incomes may not be known to the identified "head" of the compound household. Despite this degree of independence, in Maun and elsewhere in Africa such families frequently share a "common pot" and, as such, represent not many but one household unit for the purposes of fuelwood and household energy research (Brouwer and Falcao 2004). It was assumed that adult members remaining at home during the day would be those most responsible for household duties such as cooking and fuelwood sourcing, and hence most able to describe the energy use and acquisition patterns of the households. In addition, a recent study on urban household energy use in Southeastern Botswana employed a similar strategy and found that respondents over 19 years of age understood and were able to respond to the questions asked of them (EAD 2001). While this approach did slightly bias the sample

toward women (66 percent of primary respondents were female) it is important to note that in addition to the fact that women are generally considered to be key actors in domestic energy use and sourcing, many, if not most interviews were conducted in the presence of multiple adults. As such, men were often present where women were the primary respondents and vice versa, reducing the effect of bias in either direction.

3.3.3 Vendor survey

In addition to the household survey, 26 of the fuelwood vendors selling wood to households in the Maun area were interviewed to acquire additional data describing the level and trends of commercialization of fuelwood in the Maun area and the harvesting locations and techniques used by non-direct use collectors. In particular, the interviews sought to elicit assessments of fuelwood scarcity levels from these key actors in the fuelwood supply who, by definition, harvest this resource more intensively and frequently than those collecting for single household use alone. The interviews were semi-structured; while they were guided by a pre-determined set of questions (Appendix C) designed to ensure comparability of interview responses and a minimum baseline of information, additional lines of discussion were pursued in the interest of clarification or in response to other issues raised by respondents. Additionally, just as in the case of the household interviews, since time constraints precluded the use of participant observation to identify the locations of often distant fuelwood harvesting sites, the PRA maps described above were also used to enable these respondents to identify wood collection areas.

Respondents were approached opportunistically and wherever they could be found as the informal and ephemeral nature of fuelwood vending patterns in Maun and the time constraints of the field study period necessitated encounter-based sampling of the vending community. First, a number of vendors were easily identified by the presence of roadside fuelwood stacks near their (mainly peri-urban) residences, particularly in the area of

Matlapaneng on the Northeastern fringe of Maun along the Maun-Shorobe road, a major local artery which terminates in Moremi game reserve. Following these, all other major routes, including the Francistown road to the south, the Ghanzi road to the west, and the ring roads in the northwest corner of Maun were explored and all roadside vendors encountered were interviewed. The sample of this cluster of stationary vendors includes every vendor available for, and willing to participate in, an interview. A second form of vending in Maun, occurring mainly in urban neighbourhoods, involves the sale of fuelwood from individual residential plots. As the identification of these vendors is difficult in a settlement involving roughly 10,000 households and 100 or more square kilometres, it was necessary to rely on key informants in the form of respondents to household interviews and the research assistant to locate vendors using this strategy. As the results of the household survey bear out, however, this vending approach is much rarer than the third, perhaps most common type which is the sale of fuelwood by rural residents on a mobile basis using donkey-pulled carts. As these vendors reside in peri-urban and (more often) rural areas outside of Maun and typically enter Maun for only brief periods of time, selling their wares within the interiors of various residential neighbourhoods, only a few were encountered by exploring the main roads. Due to time constraints it was necessary to rely on chance encounters during the course of the household survey to conduct additional donkey-cart vendor interviews.

3.4 Data analysis

The data analysis focuses on establishing the history and effects of urban energy and development policies (see Chapter 4) on residential energy use at the national level and, in the Maun context, patterns in household decision making around energy use on the one hand and fuelwood sourcing on the other using relatively standard methods. The literature and key informant interview responses were analysed mainly qualitatively. Linear regressions were used for survey responses where quantitative data were available to determine the strength

and significance of relationships between variables. As only nominal and ordinal data could be obtained for a number of parameters, however, crosstabs and simple percentage counts were used in many cases.

As socioeconomic status is generally considered to be the primary determinant of fuelwood consumption, the analysis of Maun households' energy use patterns primarily involved assessment of patterns of responses in relation to household incomes. While this is typically done using crosstabs of response percentages in various income categories, the results of the present study were analysed in a disaggregated fashion for two reasons. First, it was not possible to establish a satisfactory basis for the generation of a per-capita income categorization scheme. Whereas government studies have used the CSO ranking system (EAD 2001) for total household income, a scheme for categorization of per capita earnings, which much more accurately reflect household financial resources[23], could not be found. Second, it was found that aggregation of the data at times obscured important details in energy use trends whereas disaggregated displays were both more directly illustrative of observed behaviour patterns and allowed for greater nuance of analysis.

The analyses of harvesting patterns to a large extent used a similar method whereby responses were analysed in terms of the distance traveled by participants from their residences to fuelwood collection sites. This was done because, first, as the focus of this part of the study is relatively unique, no suitable methodology was found in the existing fuelwood literature. Second, as in the case of energy use analyses, it was found that this method both clearly and intuitively illustrated the observed patterns of responses in a way which preserved nuances in the original data. Third, use of this method also allowed for greater consistency

[23] The number of persons between which earnings must be divided is clearly an important factor in relation to household expenditure management decisions. In the context of the variety of household membership configurations observed this factor is particularly important as, for instance, a compound household of 12 with total earnings of 3000 BWP/month is clearly less affluent than a single individual with an income of 2200 BWP

between the fuelwood use and sourcing sections of the analysis.

Harvesting patterns were also analysed using GIS software for assessment and display of spatial patterns of wood collection by Maun households in peri-urban and rural hinterland areas. These analyses were generated from the PRA mapping activities in which respondents engaged and resulted in the two maps displayed in Chapter 5. The first (Map 5.1) displays a raster image of the cumulative harvesting pressure of vendor and household respondents. This was calculated by buffering each collection site point location to a radius of 500 metres at 100 percent (representing 1 harvester) harvesting intensity which was graduated from this point to 0 percent at a 3000m radius to reflect the "foraging" nature of fuelwood collection activities. While the final image, which represents the sum of the raster cells resulting from these radii, clearly does not provide an exact model of fuelwood harvesting behaviour, it does permit an accurate, if approximate, indication of the spatial distribution of fuelwood harvesting activities in the area.

The second map indicates the patterns of distances traveled by respondents from their residences (as measured by GPS) to bush and cattlepost harvesting sites (as indicated by the PRA mapping activities). The distance figures resulting from these calculations were also used for the response-pattern analyses described above. While these reflect straight line, rather than actual traveling distances, their use was not considered to affect the results significantly for a number of reasons. Chief among these, however, is that the trends observed in relation to distance from Maun are more reflective of ecological patterns of fuelwood competition and scarcity than are the actual routes taken by harvesters. For this reason they are also more appropriate to the focus of interest in the analyses for which the map and other patterns are used. In addition, while the PRA mapping technique inherently involves a certain margin of error, this was found to have a minimal effect on the results due to both the range of distances involved and the essentially qualitative nature of the analyses.

Chapter 4

4.0 Structural context

Botswana's government has long been concerned that the heavy fuelwood use of rapidly growing urban populations poses a threat to the achievement of urban socio-economic development, rural livelihood security and ecological conservation goals. Efforts to address this issue have included attempts to shift energy demand to alternatives such as coal, solar power, Liquefied Petroleum Gas (LPG) and electricity, and to increase both fuelwood supplies and woody resources stewardship through community afforestation programs. After more than 20 years of such initiatives, however, the total quantity of fuelwood energy used by the household sector has increased. As this chapter will illustrate, while weaknesses in program implementation have been partially responsible for their failure, the ongoing popularity of fuelwood in the household sector has been most significantly reinforced by government's insistence on cost recovery and an institutional vacuum in natural resource management which have reinforced the position of fuelwood as both the cheapest and most universally accessible energy source in urban and rural Botswana.

This chapter describes the structural context of fuelwood use and sourcing in Botswana at the national level through an exploration of the dominant narrative of fuelwood use and related environmental change articulated by state publications and actors. The history and nature of state assessments of this issue are analysed and a summary of policy and program responses is presented. The chapter concludes with an explanation of the failure of government's approach to this issue.

4.1 The nature of the problem: state perceptions

A glance through the past two decades of Botswana government publications pertaining to energy, development or environmental issues clearly indicates that concern over the effects of urban fuelwood dependence is by no means new. Already during the National

Development Plan (NDP) 5 period (1979-1984) "increasing scarcity of fuelwood supplies" was noted as an ongoing problem (MFDP 1985, p.298). The 1991 (NDP 7) assessment followed the same pattern suggesting that "...problems already exist or are envisaged around larger villages and urban centres where demand exceeds sustainable supply" (MFDP 1991, p.298) resulting in "deforestation...affecting land quality" (ibid p.250). The subsequent NDP 8, the first with a separate chapter on "Environmental conservation and land use" (MFDP 1997, p.325), listed the "depletion of fuelwood, especially around major settlements" as one of "the major environmental problems requiring solutions" under the newly developed National Conservation Strategy (NCS) (ibid p.328). Finally, the current NDP 9 clearly evidences the continuation of this trend noting that although "availability of fuelwood has...reached critical levels in certain parts of eastern Botswana" it "continues to be the primary source of energy" for rural and many urban households (MFDP 2003, p.19).

Official apprehension over apparent fuelwood depletion is chiefly due to its perceived potential to jeopardize three key national development goals: orderly and equitable socioeconomic development of the rapidly growing urban centres; enhancement of rural livelihoods, particularly in the interest of slowing rural-urban migration; and conservation of the nation's ecological endowment for the benefit of current and future generations. The first is seen mainly in terms of the impacts of fuelwood depletion on the urban households in the low income category (MFDP 1985; EAD 2001; MFDP 2003), which, due to the highly skewed distribution of wealth (CSO 2003), includes up to 42 percent of Botswana's urban populations (EAD 2001). The government recognizes that as "energy is a basic human need" (CSO 2002a, p.i) and "fuelwood dependence is strongly linked to poverty" (EAD 2001, p.xix) the availability of this energy source is most important to the welfare of low income urban households. In this context, since "concentration of population results in strong local demand for fuelwood and pressure on woodland resources" (ibid, p.3) Botswana's rapid

urban growth is seen as an engine of fuelwood depletion, jeopardizing the welfare of poorer households and hence urban developmental equity. Over the past 20 years, apparent increases in fuelwood collection distances (MFDP 1985; 1991; EAD 2001; EAD 2004) and urban wood prices (MFDP 1985; 1991) have been identified with the specific nature of this threat. On the one hand, it is assumed that, lacking access to alternative means of transportation, the urban poor collect fuelwood almost exclusively on foot, and may not be able to access more distant resources once proximate woody biomass is exhausted (EAD 2001; 2004). Conversely, as many households spend as much as 20 percent of their income on energy, it is understood that higher urban fuelwood prices associated with reduced availability may seriously impact on their ability to meet basic fuel needs (ibid). Furthermore, commercialization of the resource, expected to increase as scarcity increases its price and reduces accessibility, is expected to cause the "displacement of traditional woodfuel consumers who cannot compete with the commercial gatherers" (MFDP 1991, p.228), increasing household fuel costs and jeopardizing the energy security in the low income group (EAD 2001; 2004).

The depletion of urban hinterland fuelwood stocks is also viewed as a threat to the goal of ensuring the sustainability and amelioration of rural livelihoods. Whereas in the urban context the energy security of a population segment is at stake, in the rural scenario the perceived threat is not only to livelihoods more broadly but also to the majority of households. In essence, the concern is that increasing levels of urban biomass abstraction will reduce its availability to the point that rural livelihoods, which remain significantly reliant upon direct use of natural resources (MEWT 2004), will be degraded not only counteracting state efforts for their beneficiation but potentially fuelling additional rural-urban migration as well. While rural populations, by definition, reside further from the peri-urban areas considered to be most heavily impacted by urban fuelwood abstraction and hence have

potentially greater access to less heavily exploited areas, woody biomass is generally more important to rural ways of life than those of urban households. For one thing, while fuelwood is an important energy source in urban areas, it is nearly the sole energy source for most rural households (MFDP 1985; 1991; 1997; EAD 2001) meeting roughly of 90 percent of rural household energy requirements (MFDP 1997; 2003). In addition, wood is not only important as fuel, but is critical to in many "other activities, such as fencing and building [which] account for a large proportion of wood use" and trees supply certain fruit and medicinal products as well (MFDP 1991, p.228). The issue is particularly significant due to the fact that whereas large proportions of the urban populations are in the lowest urban income brackets, the majority of households in Botswana's rural populations have cash income levels among the lowest in the country (MFDP 1997). Their vulnerability to fuelwood depletion is hence due to both a lack of transport to sources beyond walking distance (ibid 1997; MFDP 2003) and an inability to pay for alternative forms of energy (EAD 2001; CSO 2002a; Gwebu 2003a). Apparent increases in collection time (MFDP 1985; 1997) have therefore increased concerns over rural woody biomass availability, particularly in the context of commercialization which is presumed to exacerbate over-exploitation of woody resources leading to the displacement of rural biomass users (MFDP 1991).

Finally, observations of woody vegetation loss have for some time raised concern over the prospects of achieving ecological conservation goals. Due to more explicit attention to the "intimate relationship" between the energy sector and the environment during NDP 6 (MFDP 1991, p.231) the ecological impact of fuelwood harvesting was identified as one of the "main environmental challenges" (ibid p.94), a finding echoed by the more recent NDPs 8 and 9 (MFDP 1997; 2003). Increasing state involvement in international conservation initiatives has elevated the status of ecological concerns and, in particular, "as a signatory to the Convention on Biodiversity (CBD) the Government of Botswana has committed itself

and its citizens to actively ensure that its biodiversity resource is maintained for generations to come" (MEWT 2004, p.vii). Although such involvements have broadened the range of environmental concerns that Botswana's policymakers seek to address, fuelwood depletion has remained at the rhetorical forefront not least due to its long presence in the official consciousness. Thus not only is it listed in newer environmental documents such as the Biodiversity Strategy and Action Plan (BSAP) as an almost cliché example of Botswana's human-environmental conflicts (MEWT 2004), but it is increasingly prominent in other reports and publications such as the Botswana Energy Master Plan (BEMP) (EAD 2004).

The environmental dimension of concerns over excessive fuelwood harvesting involves not only temporary losses of land cover but also the potential for long term degradation of the land itself. The regeneration capacity of Botswana's woody vegetation, at a national average rate of 0.93t/ha/year is considered to be "rather low" given the "estimated standing stock density ranging from 3.6 tonnes/ha to 48.0 tonnes/ha (CSO 2002b, p.2). In this biophysical context there is a perception that current levels of harvesting are causing a "decline in forest and woodland vigour, diversity, and actual area (MEWT 2004, p.40) with "resulting problems of deforestation and land degradation" (MFDP 2003, p.19). While the implications of the loss of tree cover itself for overall ecological stability and biodiversity have recently received particular attention (MEWT 2004), longer standing concerns remain over the effects of fuelwood-related "deforestation" due to which the "fertility and water retention properties of the soil suffer, and wind and water erosion becomes likely" (MFDP 1991, p.228) and "human life support systems in both urban...and rural environments are affected" (MFDP 1993, p.103). Again, the fuelwood trade is particularly (and increasingly) identified as a major culprit due to its unregulated nature and the perception that "traders do not account for environmental degradation, loss of biodiversity, [or] the time and distance they travel to collect fuelwood" and "increasing evidence that fuelwood traders cut live trees

to augment their stock" (EAD 2004, p.117).[24]

4.2 A suite of responses: reducing fuelwood demand and increasing supply

The long record of unease over urban fuelwood dependence and its effects on Botswana's socioeconomic and environmental development trajectory has been matched by an equally long history of programs aimed at shifting urban household energy demand away from woodfuel, providing alternatives to fuelwood energy to the rural areas and increasing rural and peri-urban supplies of woody biomass. In the interest of reducing urban fuelwood consumption, state agencies have tried to encourage the use of coal and renewable energy sources such as solar power, and more standard commercial energy sources such as LPG and electricity primarily through supporting research and development and public information dissemination and extension efforts. Similarly, in order to both reduce rural reliance on fuelwood and improve the prospects for rural socio-economic development, an ongoing program of rural electrification has been pursued for over two decades involving both the expansion of grid and non-grid electrical services as well as collective financing schemes to reduce the up-front costs of connection to potential customers. On the fuelwood supply side, afforestation has been pursued through a combination of research funding, information campaigns and a series of community woodlot development initiatives with the goal of both easing interim fuelwood shortages and encouraging "improved" environmental stewardship among the citizenry. The impacts of these efforts have been modest, however, and despite increased use commercial energy, fuelwood remains an important energy source for urban as well as rural households with sustained increases in national quantitative consumption levels.

4.2.1 Coal for the masses

While Botswana's extensive coal reserves have long been exploited by heavy industry,[25] this energy source has never featured significantly in the household energy sector

[24] See also Kgathi 1992; [FUP] 2001; Twine 2005

despite its relative cheapness (CSO 2002a p.i). In the context of concerns over fuelwood depletion and policy imperatives to "develop...indigenous resources in order to increase self-sufficiency and sustainable development" (MFDP 1991, p.231) and "ensure the availability of appropriate energy services to meet household needs" (MDFP 1997, p.217) energy policies have pursued the substitution of coal for fuelwood (MFDP 1991; EAD 2004). Beginning in 1987, with the implementation of the national Expanded Coal Use Program (ECUP), government has exerted efforts to "beneficiate coal and make it accessible and affordable" (MFDP 2003, p.168) in order to improve its appeal. As well, it has encouraged its uptake through the "dissemination of information" to "promote rational least cost choices" by households and institutions (MFDP 1997, p.217; 2003, p.168). During the NDP 6 period, ECUP initiatives already included design and testing of coal stoves, organization of a coal retailing network and rural promotional activities through extension teams" (MFDP 1991). Despite the "intensification" of these efforts under NDP 7, however "little switching to coal in households and small industries appears to have occurred" by the mid 1990s (Hall. 1994, p.7). Due to a slight growth in sales and to boost coal promotion without additional state expenditure, NDP 8 saw the leasing of the two central coal depots in Francistown and Gaborone to a private coal dealer. The modest rise in sales from 800,000 tonnes in 1997 to 948,000 tonnes in 2001, however, was largely due to increased consumption by state institutions (MFDP 2003). At present, policy objectives for this fuel are to: promote use of coal by households and government institutions where appropriate; support coal beneficiation; and improve the quality of appliances (EAD 2004). In order to implement these objectives a new tender was recently extended to determine the feasibility of coal

[25] "Botswana has over 212 billion tonnes of coal resources available in eleven coalfields" and "more than half of the locally produced coal is used to fire BPC's thermal plant for electricity generation...other major users are the BCL Copper-Nickel mine and Soda Ash Botswana (SAB), a cement producing industry. The three industries consumed 89 percent of the coal produced in the year 2001." (CSO 2002, p.1)

beneficiation on a commercial basis (EAD 2004) and the possibility of a national financing scheme for domestic coal fired stoves has been mentioned (MFDP 2003, p.171). As well, the substitution of coal for fuelwood in state institutions is being promoted (CSO 2002; EAD 2004) and key informants indicate that distribution is being improved with the construction of an additional coal depot in Ghanzi.

Despite the apparent optimism expressed in current policy goals, their striking similarity to those expressed in NDP 6 and 7 illustrates the relative failure of coal promotion to date. Despite a 1995 presidential directive that state institutions cease fuelwood use, the transition to other fuels has been slow and the indication is that institutions by and large still "do not like the idea of switching to coal for their energy needs" (EAD 2001, p.13). It is in this context that the BEMP notes positively that "there is a higher potential to promote coal use in Government institutions [some of which]...are large fuelwood consumers despite the fact that they can afford alternative fuels" (EAD 2004, p.125). As well, despite 20 years of public information campaigns, recent surveys indicate that, "surprisingly, coal does not feature at all as an important fuel in urban households" (EAD 2001, p.13) (Table 4.1) and the willingness to switch to coal "is not significant" (ibid, p.xvi). In rural areas the situation is much the same and, despite extension efforts including demonstrations of coal-fired pots, uptake remains extremely low (EAD 2001; CSO 2003; EAD 2004).

Table 4.1: Households using coal as the main fuel various activities by location (adapted from CSO 2003)

	National (%)	Rural (%)	Urban villages (%)	Towns (%)
Cooking	0	0	0	0
Heating	0	0.1	0.1	0

There are a number of reasons for continued household and institutional aversion to coal use all of which reflect issues unresolved since the announcement of the ECUP in 1987. First, Botswana's coal is considered to be of poor quality, with high ash content resulting in

excessive smoke, and requires beneficiation which has not yet been achieved (EAD 2001; 2004). As key informants revealed, recent studies have indicated that a commercial coal washing scheme would be infeasible, it seems unlikely that this problem will be addressed in the near future. Another issue is that the variety of stoves developed is insufficient to the variety of customer needs and have not been adequately promoted (EAD 2004). Distribution has also remained a problem with thus far only one major distributor in each of the two largest settlements and a few minor ones which are "limited in coverage and capacity" such that "reliability of coal supply in Botswana remains poor in terms of both coverage and efficiency of delivery" (EAD 2004, p.129). In addition, some government personnel are of the opinion that many people prefer fuelwood for reasons of tradition, familiarity and taste, and would rather leave the city to collect fuelwood for certain cooking applications even if it is cheaper to purchase coal in their own neighbourhoods. This trend has apparently not been significantly impacted by attempts to "disseminate information" as nationwide, "coal use remains hampered by...limited information on how to use the fuel" (EAD 2004, p.125). In the context of these concerns, the cost-recovery based sale of coal-fired stoves has been a significant barrier to coal uptake. Despite the long history of the ECUP coal stove prices have not been reduced and these remain very expensive and hence unaffordable to many fuelwood users, particularly in the lower income brackets (EAD 2001; MFDP 2003; EAD 2004)

4.2.2 Solar powered households

With motivations and an approach similar to those guiding coal promotion efforts, state actors have also sought to develop alternative renewable energy sources for the household and institutional sectors. In the early 1980s the Botswana Renewable Energy Technologies Pilot Project was implemented initiating a program of research and information dissemination to introduce inexpensive and easily reproduced technologies "focusing on the improved use of, or substitution for, wood" (MFDP 1985, p.291). By the middle of the

decade, the Renewable Energy Activities Consultative Committee was established to advise on coordination of all renewable energy research, development, installation and extension. The Committee, whose membership comprised a number of institutions associated with energy, technology and rural development under the leadership of the Ministry of Mineral Resources and Water Affairs (MMRWA), initiated a cooperative investigation into the potential use of wind, solar, human, animal and biogas energy (ibid). During NDP 6 it was planned that energy policy would place significant focus on increasing renewable energy supplies for the poor due to the fact that many households would not be able to afford other energy sources such as grid-based electricity. While it was recognized that during NDP 6 the installation of renewable energy technologies would "not be sufficient to prevent continued depletion of fuelwood resources" (ibid, p.306), "considerable efforts" were made promote indigenous renewable energy sources (MDFP 1985; 1991).

Unfortunately, by the time of the 1991 performance reviews entailed in the drafting of NDP 7, it had already become clear that certain alternative energy sources, such as wind and biogas, were unlikely to prove viable in Botswana. With respect to wind energy, significant research efforts including the development of a network of thirty four wind gauge stations, trial windmills and a national wind regime atlas resulted in the availability of robust technologies (MFDP 1991). Their use, however, was impeded by a combination of low average wind speeds and large seasonal fluctuations (ibid) and wind power was effectively dropped from the research program. Though its potential is still "being investigated", reports have shown that wind speeds in Botswana are adequate for localised water pumping but not power generation (MFDP 2003, p.166). Efforts to develop biogas generation in Botswana met a similar fate. Despite the successful installation and testing of several biogas digestors designed to produce methane from animal manure (MFDP 1991) and the widespread presence of cattle and other stock across the country, the nature of grazing practices

effectively preclude their use. As cattle and other stock are generally allowed to roam freely, their manure is spread over wide areas making collection difficult (ibid). As well, dissemination of wood-saving stoves has been attempted since the mid eighties but despite apparent public interest signs of their current use are "extremely scanty" as they are "expensive compared with their energy savings" (EAD 2001, p.xiii). Understandably, state enthusiasm for these technologies has waned and over the past decade renewable energy development has focused almost exclusively on solar power.

As Botswana occupies the highest mean annual insolation zone on the world solar map, it is considered to have excellent potential for both photovoltaic and solar thermal resource development (EAD 2004). Due to the failure of other alternatives, renewable energy has become synonymous with solar power in Botswana where it is now seen as "the only renewable energy source with potential to make a large scale strategic impact on the country's future energy supply" (ibid, p.140). Due to the promise of this resource to provide ostensibly low-cost energy to replace biomass in the energy use profiles of low income households, particularly in remote areas where commercial energy sources are difficult to obtain, government has given "special attention" to solar technologies hoping to become a "centre of excellence" in this field (ibid, p.141).

While promotion of Photo-Voltaic (PV) power use in urban areas has been ongoing, rural use has been emphasized in the interest of extend electricity availability to remote areas where cost-recovery based grid extensions and household connections are prohibitively expensive (EAD 2004). Exploration of strategies for PV development began in earnest with the implementation of the Manyana[26] PV initiative in 1992, designed "with the objectives of determining...the social acceptability and economic viability of PV systems in a village setting" (MFDP 1997, p.213). After a 1994 independent evaluation of the project indicated

[26] A small village in the hinterland of the capital, Gaborone.

positive effects in areas such as economic and social activities and student reading hours, an additional study was conducted in the three villages of Manyana, Takatokwane and Molepolole "which determined that there was willingness and ability to pay for electrification" (ibid, p.213). Enthusiasm over these results resulted in plans to replicate the Manyana project "nation-wide" with a financing system to enable villages to apply for group loans administered by the Rural Industries Innovation Centre (RIIC). Under this scheme, credit-eligible groups would pay a 15 percent deposit and the remaining balance over 4 years at an 8 percent rate of interest (ibid). In 1997, the scheme was subsumed under the new National PV Rural Electrification Programme (NPVREP) which included a similar financing system of state loans at the prime rate of interest. By 2003, however, only 300 (mainly household) power systems had been installed indicating "barriers to the widespread adoption of the technology" (MFDP 2003, p.166[27]). In order to reduce the costs of PV and other independent power sources a Southern African Development Community (SADC) project for Financing Energy Services for Small Scale Users (FINESSE) was planned to be implemented in Botswana but never continued as it "failed to attract private sector investment in SA, Malawi and Lesotho where it was initiated" (ibid, p.166). Despite low levels of uptake, however, the dissemination of PV technology remains an integral part of energy policy for households under NDP 9 as it is seen as an important potential tool for the implementation of policies of fuelwood use reduction, sustainable economic diversification, employment creation and poverty alleviation (ibid). Due to the problems experienced by the NPVREP, however, the program was cancelled in 2001 and a new institutional structure is being developed for the dissemination and financing of PV systems which is mainly limited to joint PV/grid electrical systems (EAD 2004).

[27] See also EAD 2004

The problems leading to the cancellation of the NPVREP encompassed affordability and financing as well as equipment standards and support issues. Assessments of the program indicate that public enthusiasm for PV systems was not matched by ability, or perhaps willingness, to pay the cost recovery-based price of the technology. Both internal and external evaluations indicated that the prices of PV systems were [and are] "too high and are not commensurate with [the] electricity service delivered" such that the majority of PV client households were headed by males with formal employment, excluding large segments of both the rural and urban populations (EAD 2004, p.142). Thus, while the government became a major purchaser of PV systems, household sector uptake has remained low (ibid). Furthermore, even the limited initial uptake involved problems for both consumers and suppliers of these systems as, by the close of the program, 70 percent of all customers were in default of repayment and the solar panels of various institutions were stolen, causing losses of about BWP 8 million (MFDP 2003). As well, difficulties with system reliability were compounded by inadequacies of the technical support network. The fact that systems were installed in 86 villages in 8 out of 10 districts created significant "challenges of effectively and timely servicing the clients...in such a large country" (EAD 2004, p.143). While it has been retrospectively noted that "providing financial credit facilities is not complete on its own without complementary institutional and technical capacity", the standards for PV systems and installations developed under the NPVREP have yet to be enforced (ibid, p.144). Finally, the contribution of PV electrification to reduced fuelwood use has been minimal because the major applications are lighting and powering of appliances such as radio and TV (ibid) which are not normally associated with fuelwood use.

Alongside PV electrification, the development and dissemination of solar thermal technology in the form of Solar Water Heaters (SWHs) has also been pursued. As with PV systems, despite significant state promotional efforts, public enthusiasm for the concept of

solar-heated water has not been matched by significant uptake. While household surveys have indicated that about 50% of urban Batswana would like to be able to use solar water heaters, only about 9 percent were found to be using them (EAD 2001). As well, this level of adoption has only been reached due to the significant support of government and industrial actors. Since the initial stages of SWH promotion, central and local government agencies have been the major consumers of these units for use in housing for civil servants built by the Botswana Housing Corporation (BHC) across the country and in the residences constructed for the employees of the mining sector (EAD 2004). As the units are quite expensive, and there are no financing schemes for households to obtain SWHs (EAD 2001), their use outside BHC and corporate housing has been mainly restricted to the residences of higher income households (ibid; EAD 2004). Furthermore, their use is declining due to a number of problems which have caused even the BHC, a state agency, to discontinue their installation (EAD 2004). One of these has been a persistent inefficiency "and hence poor performance of solar water heaters" (MFDP 2003, p.160) due to a lack of standards, poor maintenance and inadequate technical support (EAD 2001; MFDP 2003). Analyses of the programs have noted that due to these issues, particularly the high purchase and maintenance costs of the units, SWH units have not generated significant energy savings for their users and hence have not caught on with the general public (EAD 2001). While efforts to improve their performance have been ongoing, the successes of these have not been well communicated to potential customers and even the BHC has not been persuaded to resume installation (EAD 2004). In the context of fuelwood use reduction, therefore, the impact of this technology has thus far been minimal, particularly in view of the fact that water heating is only one among several fuelwood-using activities (EAD 2001).

On the whole, the impacts of efforts to develop and promote indigenous renewable energy alternatives have been minimal (Table 4.2). While wind and biogas failed due to

unsuitability, solar power, ostensibly more appropriate in the Botswana context has had only modestly greater success. In the final analysis, despite technological and institutional problems, observers have noted that the cost of these technologies has been a major factor as they "are only affordable to the better off social groups and institutions. The poor cannot afford them" (Gwebu 2003a, p.88).

Table 4.2: Households using solar energy as the main fuel for various activities by location (adapted from CSO 2003)

	National (%)	Rural (%)	Urban villages (%)	Cities (%)
Cooking	0.1	0	0.2	0
Lighting	0.4	0	0.1	0.9
Heating	0.1	0	0.1	0.1

4.2.3 Modernizing urban energy

In addition to coal and renewable energy alternatives, energy policies in Botswana have long emphasized the importance of achieving a household energy transition from fuelwood to "modern", "commercial" fuels such as LPG and electricity in order to achieve both conservation and socioeconomic development goals. The promotion of fuel switching has relied mainly on efforts to "ensure the availability of appropriate energy sources" by monitoring and supporting distribution networks and to "promote rational least cost choices" through "dissemination of information on available energy sources and [their] use" (MFDP 2003, p.168). As state interventions into the prices of commercial fuels and appliances has been extremely limited, these have remained high relative to the incomes of much of the population and successes in the achievement of increased LPG and electricity use have not yielded the anticipated levels of reduction in fuelwood reliance.

The use of gas (LPG), mainly as a cooking fuel, has been promoted in two ways. On the supply side, government has sought to "ensure adequate supplies of LPG" (MFDP 2003, p.168) through the provision of an "appropriate enabling environment for marketing gas throughout the urban areas" (EAD 2001, p.x) and to "facilitate a conducive environment" for

petroleum distribution network extension into rural areas where it has long been difficult to access (MFDP 1997, p.223). In practice this has meant that while government "monitors and coordinates the national petroleum requirements" (MFDP 2003, p.169), multinational oil companies have been responsible for all aspects of procurement and distribution (MFDP 1997; 2003; EAD 2004). On the demand side, efforts have focused on providing "appropriate services to inform households of cost-effective options" (MFDP 1997, p.217). This aspect has been the responsibility of the EAD extension wing which has responded by "addressing full council and kgotla meetings, attending agricultural shows, writing articles in the mass media, distributing pamphlets and making radio programmes" (MFDP 1997, p.223).

The promotion of electricity uptake has been pursued using a similar approach, albeit with greater state involvement due to the infrastructural investments required and the high political priority of the vision of achieving universal electrification by 2016 (EAD 2004; Key informant interview). On the urban supply side, government has sought to achieve the combined objectives of reduced fuelwood reliance, sustainable urban development and increased socioeconomic equity by mandating that all residential plots receive full infrastructural servicing prior to allocation for use (Mosha 1996; DTRP 1998). As many lower income households were unable to pay the cost-recovery prices for serviced plots, a scaled pricing system was developed such that high and middle income groups were charged higher than average prices to cross subsidise the lower income group for whom a four year payment plan was also introduced (DTRP 1998). In order to increase electricity supply to the rural areas the Rural Electrification Programme (REP) was developed with the ultimate goals of reducing reliance on "dwindling" fuelwood stocks and supporting rural development. In addition to resolving woody biomass depletion, it was hoped that by stimulating activities in agricultural and other production efforts and commerce electricity provision would also aid in improving the welfare of rural households in order to also slow rural-urban migration (CSO

2002a). Under this program government has supported ongoing efforts to extend grid-based electricity reticulation into rural villages by means of mandated infrastructural development targets for the BPC (MFDP 1991; 1997; 2003) and subsidizing the parastatal corporation where village projects do not result in the targeted 6 percent internal rate of return on investment (EAD 2004). As well, funds have been provided to support Rural Electrification Collective Schemes (RECS) to reduce the upfront costs of connection to individual customers. These schemes, administered by the BPC, provide financing for the shared connection costs of groups of 4 or more customers, which are repaid over time at low interest rates as connection fees are generally "too high and beyond the affordability of most rural households" (CSO 2002a, p.4). The approach to promoting electricity demand in both urban and rural areas has relied upon the dissemination of information on electricity costs and use along with other fuels such as LPG and coal as previously described (MFDP 1997; 2003; EAD 2004). While, unlike LPG prices, electricity tariffs are controlled by the central government, the promotion of these two fuels is also similar in that subsidies for the costs of these fuels or the appliances necessary for their use has yet been considered and even the financing of household connections proceeds on a strictly cost-recovery basis.

While commercial fuel promotion programs and strategies appear to have been relatively successful from the perspective of increased proportions of LPG and electricity using households, closer examination of energy use trends reveals that their impacts on fuelwood use reduction have been more modest. A cursory glance at recent statistics describing gas uptake levels indicates that the relatively rapid spread of this fuel has been one of the most significant changes in urban household energy use of the past 20 years (EAD 2001). According to the 2001 population census the national proportion of households mainly using this fuel for cooking increased from 22 percent to 41 percent between 1991 and 2001 while the proportion mainly using fuelwood dropped from 64 to 46 percent over the same

period (MFDP 2003; CSO 2003). As well, in many cities and towns LPG is used by as many as 70 percent of the households as a primary cooking fuel and by over 50 percent in the urban villages (EAD 2001; CSO 2003) where, in 1985, around 90 percent used mainly fuelwood for this purpose (EAD 2001). Furthermore, LPG has become popular across the income spectrum "with more than half the lowest income group...using gas" (ibid, p.29). The widespread transition from fuelwood to gas implied by these figures is, however, somewhat illusory. First, while as many as 40 percent of households in the rural areas would prefer to switch from fuelwood to gas for their cooking needs, the lack of LPG availability and the cost of the fuel and its appliances preclude significant uptake of the fuel by this segment of the population (EAD 2004, p.38). Gas use remains, therefore, a relatively urban phenomenon and fuelwood continues to supply the needs of 81 percent of the rural population (CSO 2003) with paraffin as the main secondary fuel (MFDP 2003). Second, while some recent assessments have optimistically described LPG as the fuel for all income levels, used by as many as 60 percent of low income urban households (EAD 2001), a significant portion of these use either little or no gas as reflected by the NDP 9 report that 22 percent of all urban households in Botswana rely on fuelwood for 98 percent of their energy needs (MFDP 2003). Third, several studies in Botswana have noted that energy source switching is not always complete such that households may "switch to another energy source but continue to use the old fuel as the principal fuel or alternatively use the new fuel as the principal fuel" (Kgathi 1992, p.1) and a great deal of partial switching has been observed in urban Botswana throughout the 1990s and into the present (Kgathi 1992; EAD 2001; EAD 2004). A recent survey indicated that as much as 30 percent of urban households in southeastern Botswana use a secondary cooking fuel in addition to their stated "primary" fuel (EAD 2001), a pattern which is assumed to vary according to the "availability of both the energy source and money to purchase the fuels" (EAD 2004, p.34). In particular, it is apparent that many urban

Batswana use LPG and fuelwood as complementary fuels as 44 percent of those who cook with fuelwood but also use secondary fuels use gas and 61 percent of those using a secondary fuel along with gas identified fuelwood as their choice (EAD 2001). Fourth, increased use of commercial fuels has also been due to sustained increases in energy use in the household sector at rates more rapid than those of population growth in association with economic development and the rising incomes of at least certain portions of the population (MFDP 1985; 1991; CSO 2002a; Gwebu 2003a; MFDP 2003). To some extent, therefore, urban households have begun to use commercial energy sources as additional rather than substitutive fuels and "LPG gas and electricity are making inroads as major sources of energy for cooking, without necessarily replacing fuelwood" (EAD 2001, p.61) Finally, as a recent survey of southeastern urban centres revealed, the proportion of households that prefer wood as a cooking fuel is significantly higher than the percentage reporting it as a main cooking fuel indicating not only its continued use in combination with other fuels but also "a tendency of reverting to fuelwood use" such that switching may not be permanent (ibid, p.61).

In a similar fashion, increased levels of household electrification have not translated into the displacement of fuelwood energy by electricity due to ongoing problems of access and costs associated with this energy source. While levels of electrification have evidently increased from the 30 percent of town households and 5 percent in the reticulated villages connected in the early 1990s (MFDP 1991; EAD 2004), current figures indicate that roughly 50 percent of town households and 75 percent in the urban and rural villages remain unconnected to the grid (MFDP 2003; EAD 2004). On the whole, the national level of household access to electricity has remained quite low, reaching only 28 percent by 2001 (ibid). Low rural uptake has been due not least to the fact that grid extensions have benefited only some areas and while the REP has seen the electrification of 234 villages since its inception, an additional 293 villages remain unconnected (EAD 2004). As well, village

reticulation has often not resulted in widespread household connection as low village population densities and their wide spread "make it difficult for the rural communities to group themselves to take advantage of the RECS" financing (MFDP 1997, p.212). In addition, despite the fact that since the first revolving fund was established in 1983 (MFDP 1991) the upfront portion of the RECS payment has been reduced from 40 (MFDP 1991; 1997) to 5 percent, the interest lowered to prime rate -1 percent, and the repayment period extended from 10 to 15 years (MFDP 2003), the high cost of rural connections has been a consistently identified barrier to rural electricity uptake (MFDP 1991; 1997; 2003; EAD 2004). In urban areas a similar situation has been observed where, despite the influence of cross-subsidisation and 4 year payment plans, a substantial portion of the lower income group has been unable to afford electrical service (Mosha 1996; DTRP 1998; EAD 2004). Finally, for all consumers not only the cost of electrical appliances (EAD 2001) but the cost of the energy itself has been a major barrier to actual use of the fuel (MFDP 1997; EAD 2001; EAD 2004) as "low incomes in the rural and low cost urban areas limit the ability of people to take advantage of high quality electricity supplies on a cost recovery basis" (MFDP 1997, p.212). As urban and rural low income households spend as much as 20-30 percent of their incomes on energy needs (EAD 2001; 2004) many of these rely on fuelwood and other energy sources rather than electricity which is much more expensive (Figure 4.1). In this context, electricity has remained the "energy source of the rich" (EAD 2001, p.xii) as it is used mainly by "urban-based private sector, institutional, and relatively better off households" (Gwebu 2003a, p.90), and levels of household electrification vary in direct proportion to income. Finally, due to its expense, electricity is used both sparingly and mainly for lighting and other activities rarely associated with fuelwood use (Table 4.3) while fuelwood continues to supply energy intensive activities such as heating and cooking due to its low cost (EAD 2001; 2004).

support" (ibid, p.38). However, as woodfuel production is responsible for an estimated 80 percent of all woody biomass harvested in Botswana (MFDP 2003), key informants indicated that concern over the socioeconomic and environmental effects of these trends have not diminished but increased over the past 20 years of fuelwood related policies and programs.

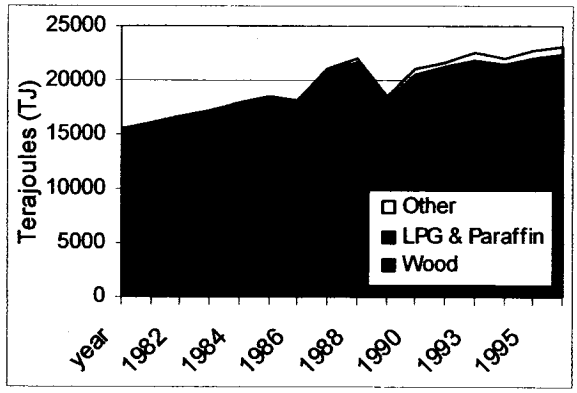


Figure 4.3: Final Energy Consumption of household sector (adapted from CSO 2002a)

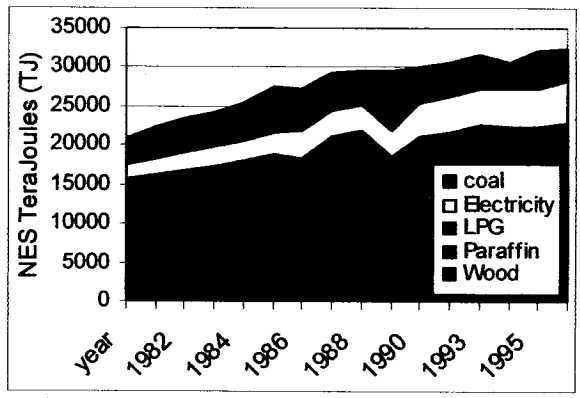


Figure 4.4: Net Energy Supply of selected fuels (adapted from CSO 2002a)

4.2.4 From deforestation to afforestation

In addition to the promotion of alternatives to fuelwood energy, there has also been a long history of efforts to increase the supply of woody biomass and reduce the socio-economic and environmental impacts of fuelwood reliance through afforestation and woodlot programs. Already in the late 1970s and early 1980s it was perceived that the pursuit of energy policies "oriented toward enhancing socio-economic progress" (MFDP 1985, p.298) would require programs designed "to maintain and increase the sources of energy available to the majority of rural people and reduce the time and ecological damage involved in firewood collection" (ibid, p.300). Furthermore, the importance of woody resource use and management "as a source of employment and household...income" has been emphasized in addition to environmental imperatives (MFDP 1991, p.269), and hence a policy of "encouraging and promoting community management of natural resources" continues to be part of the official strategy for achieving not only sustainable energy use but also sustainable economic diversification, employment creation and poverty alleviation (MFDP 2003, p.168).

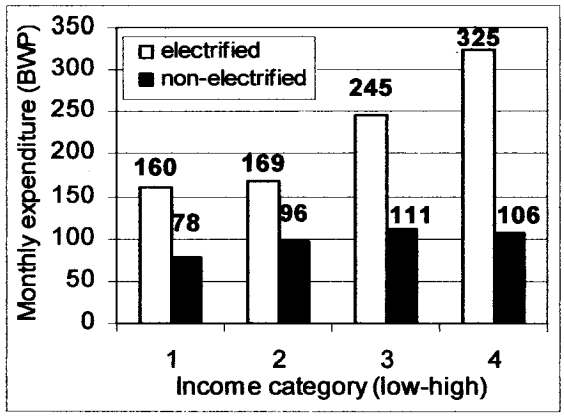


Figure 4.1: Energy expenditure of electrified and non-electrified urban households by income category (adapted from EAD 2001).

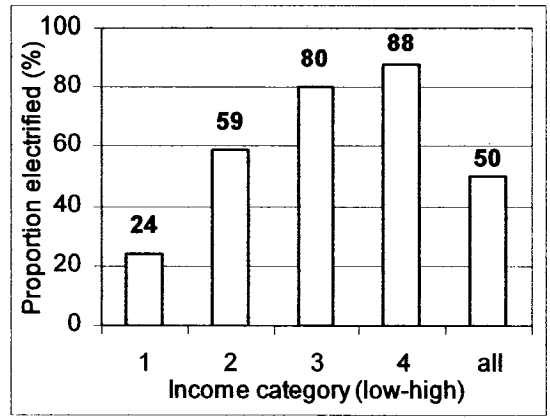


Figure 4.2: Urban household electrification by income (adapted from EAD 2001)

Table 4.3: Households using electricity as the main fuel for various activities by location (adapted from CSO 2003)

	Rural (%)	Urban villages (%)	Towns (%)
Cooking	0.9	3.3	4.8
Heating	1.5	7.4	18.7
Lighting	6.1	35.4	48

Overall, while the promotion of commercial energy sources has seen an increase in the use of these alternatives and hence a proportional decline in the fuelwood contribution to the household and national energy sectors, fuelwood has not only retained proportional dominance but its quantitative use has continued to increase (Figures 4.3; 4.4). Despite increased uptake of other fuels, particularly in urban areas, fuelwood continues to be used by not only 90 percent of rural households but also in roughly 50 percent of urban residences as well (Gwebu 2003a) and between 1991 and 1997 even its proportional contribution to urban household energy declined only slightly from 80 percent to 78 percent (EAD 2001). At present, fuelwood continues to be the most popular residential energy source (ibid; CSO 2002a; MFDP 2003; EAD 2004) as the "shift to other energy sources is very slow and in some cases close to nil" (EAD 2004, p.116). In light of this trend, it is recognized that "for a long time biomass will be the major source of energy" in Botswana (ibid, p.116) and "unless income levels increase, a significant shift to modern fuels is unlikely without government

From humble origins in the late 1970s research on indigenous and exotic species (NIR 1984) performance, the implementation of the Rural Afforestation Programme (RAP) progressed slowly, beginning with the establishment of 9 nurseries by the Forestry Unit by 1985 for the purpose of seedling production (MFDP 1985). As well, in conjunction with the Forestry Association of Botswana (FAB), an NGO formed in 1983, the Ministry of Agriculture involved itself in small afforestation projects through "provision of extension advice, public education, production of seedlings, training, research and financial assistance" (ibid, p.187). The planned large scale village woodlot programme however, had "not so far been adopted" due to the ongoing nature of research into "priority areas and optimum methods for woodlot development" (ibid, p.298). While research was ongoing during NDP 7, by 1997 the goal of expanding the nursery and woodlot programme had resulted in only modest achievements and due to "capacity constraints within government" only 75 household and 20 school nurseries, twenty tree planting projects and a meager 6 woodlots had been established countrywide (MFDP 1997, p.240). Despite the reiteration in NDP 8 of the rhetorical commitment "to promote small and medium scale afforestation activities to meet community needs for fuelwood products" (ibid, p.217, 221), the "widespread failure of forestry plantations and village woodlots in Botswana" already observed by the mid 1990s (Sekhwela 1995, p.vii) remained unresolved and plantation establishment was discontinued after the year 2000 (Key informant interview). At present it is generally accepted that efforts to support sustainable supply of fuelwood and poles have not been very successful (EAD 2004 p.115) and due to a lack of sustained public interest, budget and personnel constraints and the near disappearance of the FAB[28] community managed woodlots, as such, no longer formally exist (Key informant interviews).

[28] Due to Botswana's overall economic success, international donor funding for the FAB has dried up and has not been replaced by government or other support. As a result, the organization is currently "very low to the ground", its activities limited to some small scale monitoring of past projects (key informant interview)

4.3 Modest impacts: implementation, ideology and institutions

Despite the 20 year history of efforts to address official concerns over Botswana's heavy fuelwood reliance, there remains a gross mismatch between political goals and program results as well as between problem analyses and policy action: fuelwood remains a household mainstay; coal and alternative renewable energy sources are unpopular; increased use of commercial fuels, arguably due as much to increased incomes as any state promotional efforts, has largely failed to displace biomass energy; and community afforestation programs lie in ruins. On the one hand, it is only fair to note that some of the obstacles to the success of these initiatives, such as the diffuse nature of Botswana's population or the high ash content of its coal, pose significant challenges which only sustained commitment will eventually overcome. However, only a portion of the failure of fuelwood-related policies has originated outside the chambers of government, and if future efforts are to meet with more success, it will be necessary to address ongoing problems pertaining to inadequacies in policy implementation, the economic ideological commitments of the government, and the institutional structure of natural resource management in contemporary Botswana as detailed further below.

4.3.1 More rhetoric than results

Among the key reasons for the weak performance of fuelwood-related programs has been a pattern of general and persistent failure in their implementation. From each development plan to the next, the iterations of policy goals, challenges and strategies have remained essentially unchanged due to the presence of program obstacles that, over the course of more than two decades of fuelwood policy, have yet to be seriously addressed. An inadequate supply of financial and human resources, for instance, has been continuously identified as a key constraint to the implementation of energy and environment-related programs (MFDP 1985; 1991; 1997; 2003; EAD 2004). Capacity constraints continue to pose a major problem and even the EAD, despite its leadership role in energy policy, is not yet "in

a position to influence the policy-making processes to incorporate fuelwood issues" (EAD 2004, p.122) with the management of all national biomass subsector operations currently falling on the desk of a single officer. Similarly, problems pertaining to the "coordination of policy and...of energy related activities" were identified already in the early 1980s (MFDP 1985, p.291), resulting in efforts to "devise institutional arrangements" (MFDP 1991, p.230) which would "enable government to develop and implement a coherent energy policy" (ibid, p.232). By the late 1990s, however, the "institutional framework to effectively implement and coordinate fuelwood programmes [remained] weak" (MFDP 1997, p.220) and "there continued to be limited communication and duplication of activities" in the areas of petroleum and biomass (ibid, p.208). In order to resolve the issue it was planned, once again, to "establish an effective institutional framework" for the management of biomass energy issues during NDP 8, but by the writing of NDP 9 the EAD had not yet been adequately "strengthened and restructured into an effective institution" and its authority is, at present, still not "commensurate with the responsibility that it has" (MFDP 2003, p.168). To be sure, government pre-occupation with the urgent issue of HIV/AIDS has, in recent years, resulted in a major drain on human and financial resources (MFDP 2003; EAD 2004). However, despite the expressed importance of reducing fuelwood consumption, woody biomass depletion in the political agenda is generally given relatively low priority (EAD 2004, p.115). Hence, due to a lack of sufficient political will, paper rhetoric has not been well translated into adequately concrete, staffed, funded and coordinated programs (ibid, Key informant interview) and, as one key informant indicated, "the conservation goals related to fuelwood are a long way from being reached". The continued use of fuelwood by state institutions is a perfect example of the distance that has remained between policy and rhetoric on this issue. During the 1990s, state efforts to persuade the public to reduce fuelwood use and promote alternatives suffered from major credibility issues due to heavy consumption of wood energy

by schools, the Botswana Defence Force (BDF) and many other institutions (MFDP 1991; 1997; Key informant interview). This resulted in the issuance in 1995 of a presidential directive to discontinue institutional fuelwood use. While some progress has been made in this area (EAD 2001), progress has been slow and, more than 10 years after the directive, government institutions remain "large fuelwood consumers despite the fact that they can afford alternative energy sources" (EAD 2004, p.125).

Another, related, cause of the poor performance of fuelwood-related initiatives is that responses to the rhetorical commitments of government to address fuelwood dependence have been relatively dominated by research and planning initiatives. While the availability of reliable information is key to effective program design, the focus on these managerial tools has not resulted in, and to some extent has perhaps even precluded, state action to achieve its policy goals. For example, state-commissioned empirical studies of household LPG use have repeatedly called for price controls and subsidies for appliance purchase since the early 1990s (MFDP 1997; EAD 2001; EAD 2004) in order to remove barriers to its uptake and use. However, despite the fact that price controls have long been in place for all other petroleum products to control the effects of "the limited number of players in the local petroleum market" (MFDP 2003, p.169), government has only in NDP 9 committed to begin investigating the potential regulation of LPG prices and the possibility of subsidy has not yet officially been broached (ibid; EAD 2004). This situation is by no means unique to the arena of LPG promotion and the recommendations of state and other actors that government involve itself more directly in lowering electrical connection fees, supporting fuel distribution networks and providing greater institutional and financial support for community resource management have often met with initial inaction followed eventually in subsequent development plans by mandates for further research.

4.3.2 Policy blinders: cost recovery and poverty

Weaknesses in policy implementation, however, have not been solely to blame for the poor performance of energy policies to date. The relative intransigence of household fuelwood use in the face of official efforts to achieve a transition to alternative fuels has been significantly reinforced by prior ideological commitments of the state articulated through a predilection for private-sector, fully market based provision of services and a somewhat narrow interpretation of fiscal responsibility. The overarching principle guiding all public sector resource allocation in Botswana has been government's commitment to "sustainable budgeting" representing its determination to ensure long term self-sufficiency by maintaining a sound fiscal position (MFDP 1997; 2003). At first glance, the implementation of this policy would appear to be not only laudable but also eminently feasible in view of the state's sizable mineral revenues. However, the government's position on its duty in this regard is that:

> "since the nation's mineral revenues are derived from depleting a non-renewable asset, non investment recurrent budget expenditure must be financed from other recurring revenues such as income taxes, VAT and customs duties or interest earnings on government savings" (MFDP 2003, p.85).

As mineral earnings[29] constitute roughly 55 percent of current annual state revenue (ibid), adherence to this particular interpretation of public sector fiscal responsibility involves a significant constraint on the level of funding available to state agencies and it has been "necessary to restrain growth in government expenditures" (MFDP 1997, p.112). In practice this has been achieved through ongoing efforts to ensure "cost recovery through user fees" for all government services (ibid, p.112) and to "right size" the public sector by privatizing "functions which can be more efficiently by the private sector" (MFDP 2003; p.85).

While in many areas these approaches may be completely appropriate and effective, in the context of government's efforts to reduce fuelwood use they have proved counterproductive. Although the promotion of coal, for instance, has been hampered by the

[29] Mineral revenues are used, conversely, only for non-recurring, investment-type expenditures

failure to achieve its beneficiation, the high (unsubsidized) price of coal burning stoves has been repeatedly noted as another key barrier to the uptake of this fuel. Similarly, while the public has expressed significant enthusiasm for alternative renewable energy sources and fuel-efficient woodstoves, the considerable expense of the necessary appliances, provided on a strictly cost-recovery basis was found to be the single most important obstacle to their use. As well, notwithstanding the relatively high uptake of LPG, the high price of this fuel, which fluctuates with international petroleum market prices in the absence of either controls or subsidy, has limited both its uptake and intensity of use particularly in the lower income groups. Last, but certainly not least, the high price of electricity, both in terms of connections and service have ensured that this energy source has had minimal impact on the energy use patterns of low income urban and rural Batswana. Under the BPC act, the corporation is required to operate on a commercial basis to ensure its long term financial viability (MFDP 1991; EAD 2004). While government must approve all changes in electricity tariffs, the corporation is obliged, under the act, to set these to reflect not only the full cost of generation and distribution, but also the expected 6 percent rate of return on its infrastructural assets (EAD 2004). As such, while the parastatal has earned annual net profits of roughly 150 million BWP in recent years, the political imperative to ensure the financial independence of the BPC (MFDP 1985;1991;1997), all the more important in the context of current plans for its privatization (MFDP 2003; EAD 2004), prevents their application to tariff reduction. While government is capable of mandating or subsidizing tariff reductions, its overriding imperatives to recover costs and devolve functions to the private sector have precluded serious consideration of such options and Botswana's electricity tariffs (Figure 4.5) have remained "high in comparison with those of neighbouring countries" (MFDP 1991, p.225). While fiscal responsibility and financial stability are worthy management goals, the express efforts of government "to ensure that energy consumers are, wherever feasible, directly

accountable for the cost of supply, and that prices and tariffs properly reflect the resource costs" (MFDP 1985, p.300) stands in stark contrast to its policies on fuelwood use reduction. In general terms, it is clear that the low income households, whose budgets are already significantly impacted by energy costs, are unlikely to switch to more expensive fuels unless the original fuel becomes unavailable, household incomes increase, or the prices of alternatives are reduced. In the interest of preventing the first case, and despite the rareness of the second, government has insisted not only that even low income consumers pay market prices for fuelwood alternatives but, interestingly, that especially urban households be required to do so. Despite the fact that it is precisely urban fuelwood consumption that has been identified by the state as the greatest cause for concern in the area of fuelwood depletion the National Settlement Plan, which delineates nationwide urban development policy, stipulates that in order to increase rural prospects and stem the tide of urban-rural migration, urban service provision is to be achieved on a strict cost-recovery basis, while all state subsidies are to be directed solely at rural development (Mosha 1996; DTRP 1998). This policy in particular, while reasonable in terms of its stated objectives, seems inherently contradictory in the context of fuelwood use reduction goals.

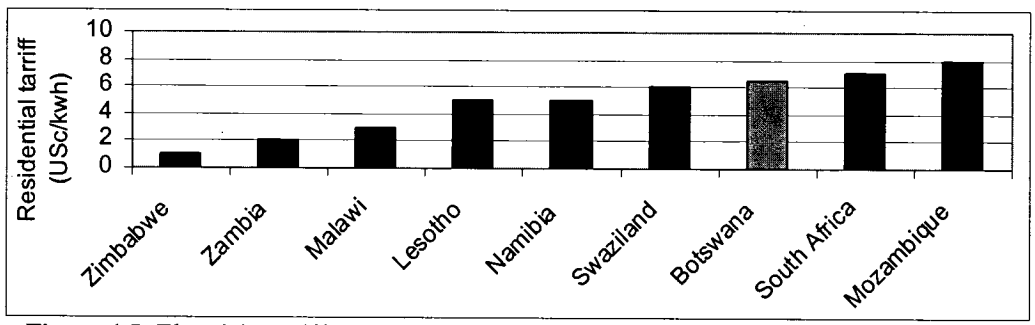


Figure 4.5: Electricity tariffs in southern Africa (adapted from EAD 2004)

4.3.3 Centralization, chiefly authority: who manages the commons?

Finally, sustained high levels of fuelwood use, particularly among urban Batswana have been critically reinforced by the fact that, due to an ongoing institutional vacuum in the area of woody resources management, fuelwood has remained a universally accessible

energy source despite localized depletions. Historically, authority to control the use of natural resources was vested in the hands of traditional chiefs and community elders whose intimate knowledge of local community needs, cumulative resource use patterns and ecological conditions enabled them to manage common resources to ensure both socioeconomic equity and long term viability. Shortly after independence, however, this power was divested from locally rooted authorities and subsequently assigned to the centrally coordinated district land boards endowed with the ownership of "tribal" lands in the name of the populace (Gwebu 2002; Key informant interview). The purpose of this centralization was to both strengthen the managerial powers of government and ensure the "ground level" realization of the constitutionally instituted universal right of access to land and resources (Key informant interviews). However, the "democratization" of resource access has, particularly in the case of fuelwood, not been accompanied by the development of adequate institutions for the management of resource use. While resource access on state land, including parks and wildlife management areas, is generally closed to the public (MEWT 2004), all citizens are technically free to harvest fuelwood on communal (tribal) land anywhere in Botswana (CSO 2002a) as the land boards do not regulate the gathering of this commodity (Key informant interview). The result has been similar to developments in South Africa where the rise of post-apartheid democracy has been implicated in creating "the widespread perception among rural communities that new-found freedom and democracy implies the right to free and unrestrained access to natural resources on communal land" (Twine, 2005, p.95). In the same way, observers in Botswana have found that due to "weakened chiefly authority...individuals tend to use the communal resources as dictated by their individual discretion, having been freed from traditional and collective responsibility on the sustainable utilization of common property" (Gwebu 2002, p.151).

Confused over the apparently lost "sense of stewardship towards natural woodlands" (EAD 2004, p.115) reflected in the seeming over exploitation of common property resources such as fuelwood, the question that has absorbed state actors has been "why are these private sector managers of the nation's natural resources not doing a better job of conserving the resources under their control?" (MFDP 1991, p.93). The answer has been that poverty has caused people to operate with a "short-term planning horizon" (MFDP 1991; 1997; 2003) such that "many of the costs of using resources or degrading the environment do not enter into the decision-making processes of those who are managing these resources" (MFDP 1991, p.93). Efforts to address the issue have therefore focused on the "need to improve awareness and understanding of the importance and value of maintaining biodiversity, and the will to do so among Batswana" (MEWT 2004, p.1) and to "encourage communities to be responsible for the management of the resources within their jurisdiction" (MFDP 1997, p.332). However, just as South African studies have found that "rural communities sense the need for regulation of access to communal resources" (Twine, 2005, p.95), research in Botswana has indicated that:

> "contrary to the common assumption that rural communities need to be made aware of the value of natural resources and the effect of overexploitation, the results clearly show that the public is aware of such problems....[and] can provide ideas and develop projects to address the situation (Walker and Mulalu 1996, p.iv).

Furthermore, the indication is that "traditional authority is the preferred solution for exercising such control" (Twine 2003, p.95) in both contexts as in Botswana,

> "the public is not only aware of the problems but is concerned about the loss of those cultural practices that traditionally ensured conservation of resources...[and] feels that control of resources at the national level allows free exploitation by outsiders...in contrast to the traditional management of resources in which chiefs and resources overseers were consulted before harvesting, which ensured that resource availability would be monitored" (Walker and Mulalu 1996, p.iv).

Key informants consulted in the course of the current research similarly indicated significant public dissatisfaction with centralized resource management which is seen by many as

attempting to reduce local harvesting rights in the interest of conservation while simultaneously permitting resource access by outsiders. While official recognition of the institutional gap in resource management and the potential of the existing traditional authorities to support effective Community Based Natural Resource Management (CBNRM) decentralization initiatives (MFDP 1997; Gwebu 2002; EAD 2004), little progress has yet been made in this direction, particularly with respect to fuelwood (Gwebu 2002; Key informant interview).

In summary, government has long been concerned over the perceived threat posed by urban fuelwood use to the realization of ecological conservation, urban socio-economic, and rural livelihood development goals in Botswana. After more than 20 years of initiatives to shift energy demand to alternatives such as coal, solar power, Liquefied Petroleum Gas (LPG) and electricity, and to protect fuelwood supplies and improve woody resources stewardship through community afforestation programs however, the quantity of household sector fuelwood consumption has increased. While this failure is partly due to program implementation weaknesses, government's insistence on cost recovery and the persistence of an institutional vacuum in natural resource management have been the primary agents driving continued residential wood energy use. Under the influence of these two key factors fuelwood has remained both the cheapest and most universally accessible energy source and hence a preferred fuel among many households in both urban and rural Botswana.

Chapter 5

5.0 Results and analysis

Whereas Chapter 4 described the history of fuelwood-related policies, programs and their outcomes at the national level, this chapter examines household fuelwood use and sourcing patterns in the rapidly growing town of Maun. First, the results of the household survey are described illustrating the role and importance of fuelwood vis-á-vis commercial alternatives in residential energy use profiles across the spectrum of household incomes. Second, an analysis of fuelwood sourcing patterns emerging from the results of the household survey is presented elaborating the nature and distribution of fuelwood harvesting across Maun's urbanizing landscape. Third, the results of both the household and vendor surveys are used to analyse the development of fuelwood commercialization in the Maun area and its socio-economic and ecological impacts.

5.1 Modern traditional ways of life: fuelwood use in Maun households

The results of the household energy use survey indicate that, in contrast to dominant academic and government models of urban African domestic energy use transition, fuelwood plays an important strategic role in the majority of Maun household energy use profiles. The long accepted "energy ladder" model (FAO 1993) suggests that households switch from fuelwood to successively more expensive (and convenient) individual fuels as income increases, characterizing fuelwood as the "energy of the poor". While current articulations recognize that more than one fuel may be used simultaneously, these "modified ladder" models largely still presume that energy use decisions are dictated mainly by ability to afford various fuels. As such, it is assumed that switching from "inconvenient" but cheap fuels like fuelwood and paraffin to more expensive alternatives such as LPG and electricity varies more or less directly with income resulting in fuel "clustering" by price along household income continua. In contrast, however, the current results indicate significantly greater complexity in

household fuel use patterns and a much higher persistence of fuelwood use in the upper income range than previously suggested. First, despite nearly universal use of commercial alternatives, fuelwood remains the most widely used energy source and is popular across the majority of the income spectrum. Second, the quantity of fuelwood used is remarkably resilient in the face of increasing household income. While even some of the lowest income households are able to rely almost solely on commercial fuels, the mean trend indicates that exponential increases in household earnings are associated with only incremental shifts from fuelwood to commercial alternatives. Third, temporal switching patterns indicate that fuelwood use across the income spectrum in Maun is characterized more by stability than any ongoing transition to "modern" fuels. Finally, fuelwood use persistence is found to be largely due to its unique role within the strategic fuel combinations used by households for specific applications. These patterns are driven more by fuel prices than incomes as "ability to pay" is not fully translated into "willingness to pay" below the highest income level. These findings are detailed further in the following sections.

5.1.1 A key fuel across myriad combinations

Despite the broad range in household incomes observed, widespread commercial fuel use and a complex array of fuel combinations, fuelwood remains an important energy source among Maun households. Moreover, minimal "clustering" of fuels by price was observed and fuelwood co-occurred with all other energy sources, particularly gas and electricity. While nearly 60 percent of the households surveyed (n=78) used electricity and over 80 percent used gas, fuelwood emerged as the most common domestic fuel with roughly 86 percent of respondents using it at least some of the time (Figure 5.1). Most households used more than one fuel simultaneously, however; only 10 percent of respondents were using one energy source alone, and while just over 40 percent were using 2 fuels, 49 percent used 3 different fuels in combination. Within the 9 different fuel combinations observed every individual fuel

occurred with each other fuel in at least some households indicating a high degree of flexibility and complexity in fuel combination and switching patterns (Figure 5.2). Finally, not only does fuelwood appear in 6 of the 9 observed combinations, but also its use is most often combined with (rather than displaced by) commercial fuel uptake. While the number of households using fuelwood alone (9%) is much higher than those using only gas (1%), only paraffin (0%) or only electricity (0%), it is dwarfed by the roughly 75 percent of households using fuelwood along with these other fuels. Moreover, a 65 percent majority of households used either or both of the two most expensive fuels (gas and electricity) in combination with fuelwood, the cheapest, and 42 percent used fuelwood, gas and electricity together.

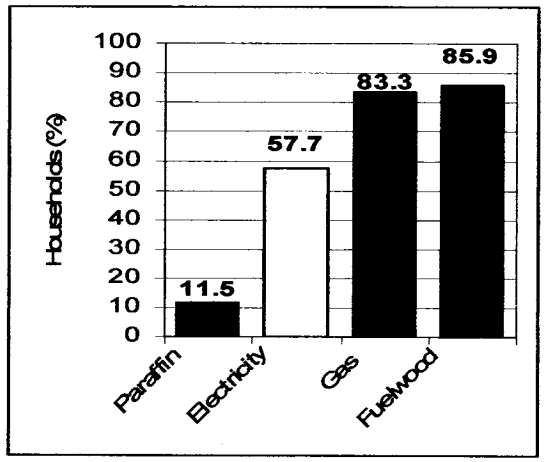


Figure 5.1: Proportional use of various fuels

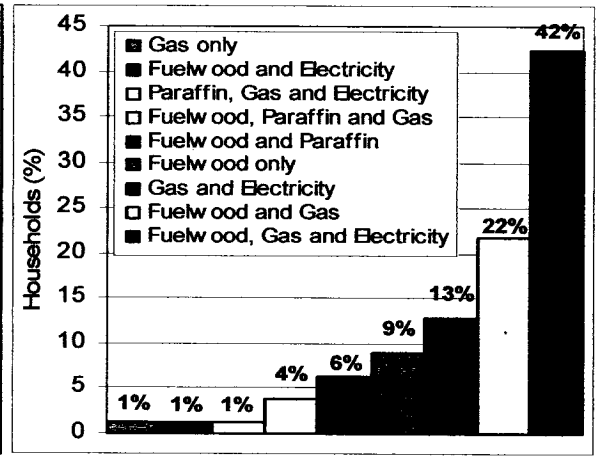


Figure 5.2: Proportional use of fuel combinations

5.1.2 Beyond the poverty line: fuelwood use patterns and household incomes

In contrast to its traditional characterization as the "energy of the poor", fuelwood use was found to be remarkably persistent across the range of household incomes in terms of fuel combinations used, per capita consumption quantities and within end-use proportional use levels. While a modest energy source transition does appear to occur with increasing income, use of all fuels is well spread across the per-capita cash income spectrum resulting in a somewhat vague and "unclustered" rather than clear-cut transition pattern (Figure 5.3)[30]. Use of electricity and gas alone is most common among the highest income households and

[30] Note: negative values are indicated solely for the purposes of display of low values

somewhat common in the middle-income range, but also occasionally occurs among the lowest income households. Furthermore, while electricity is used slightly more in the high and somewhat less in the low-income ranges, gas use is nearly universal and both occur frequently across the full range of the spectrum. Paraffin and fuelwood, widely considered to be predominantly fuels of the poor and rural, are also well spread. While paraffin use is not common, it is used across most of the income range and fuelwood use is prevalent across most of the spectrum. Although fuelwood is less universal in the upper middle than in the lower income range, it was used by the household with the 5th highest per capita income while even one of the lowest income households was able to avoid it entirely in favour of electricity and gas.

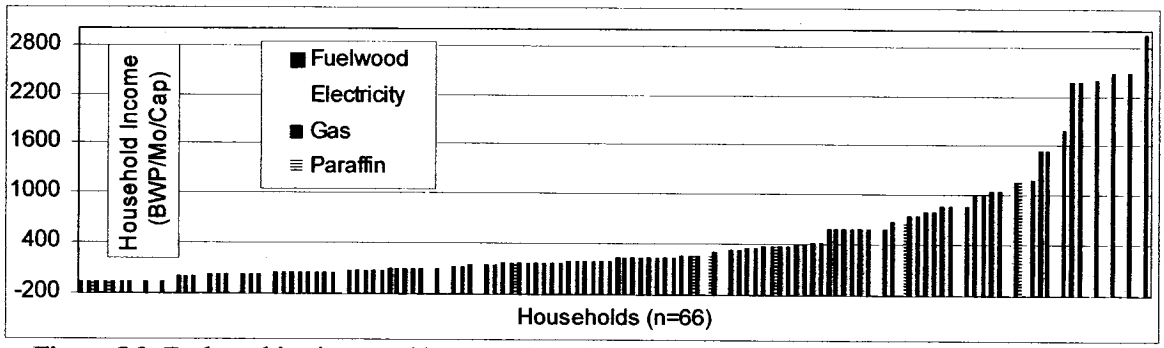


Figure 5.3: Fuel combinations used by Maun households ranked by per capita household income

Comparison of per-capita income to per-capita fuelwood use indicates a comparable pattern (Figure 5.4). On one hand, the highest use levels are observed in the lowest income households and the per capita use of the highest income households is in the lower range resulting in an exponential relationship between the two variables. The strength of the trend, however, is considerably weakened by two sub-patterns observable within the considerable variation in fuelwood use levels in the low-middle income range. On one hand there are a number of instances where extremely little fuelwood is used despite per capita incomes approaching the zero level. Conversely, as incomes increase from the 500 to the 1500 BWP/month/capita level, only a slight overall decrease in per capita fuelwood consumption

is observed, indicating that while near complete avoidance of fuelwood use is possible even at the lowest income level, significant increases in income are, in many cases, associated with only slightly reduced fuelwood use.

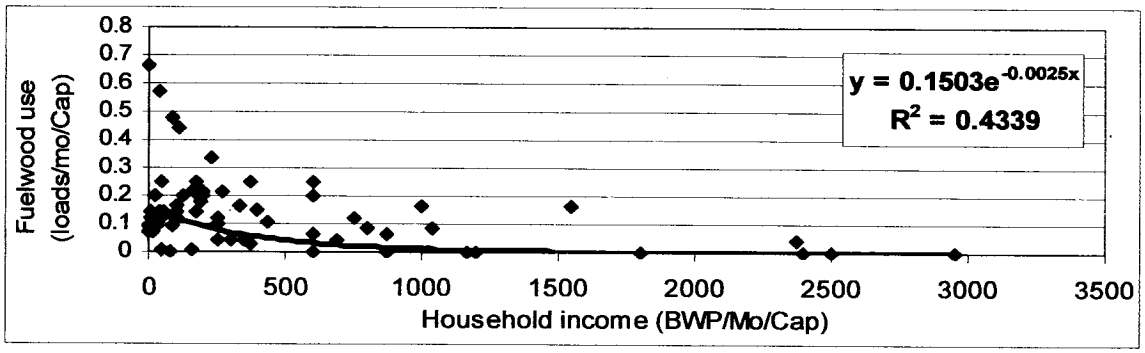


Figure 5.4: Household per capita fuelwood use versus per capita income

Furthermore, the relationship between household incomes and the proportional contribution of fuelwood to individual end-uses confirms the resilience of fuelwood use in the face of increased ability to afford alternatives. The mean incomes of households grouped by their proportional usage of various fuels for cooking indicate that, while paraffin and electricity do not exhibit clear trends due to their rare use for this application (Table 5.1), roughly linear changes in fuelwood and gas use levels are associated with exponential rather than linear shifts in mean incomes (Figure 5.5). On one hand, dramatic increases in mean household incomes are linked to only incremental reductions in the use of fuelwood for cooking, particularly in the case of the approximately 270 percent increase in average household cash earnings between the "sometimes" and "never" categories. The trend for gas is effectively the inverse of that observed in relation to fuelwood as exponential increases in household incomes result in only small increases in the proportional use of gas for cooking. In combination, these patterns suggest despite the clear transition in the relative importance of the two fuels from the lowest to the highest income ranges, the majority of households use both together in proportions which are relatively insensitive to increases in cash earnings.

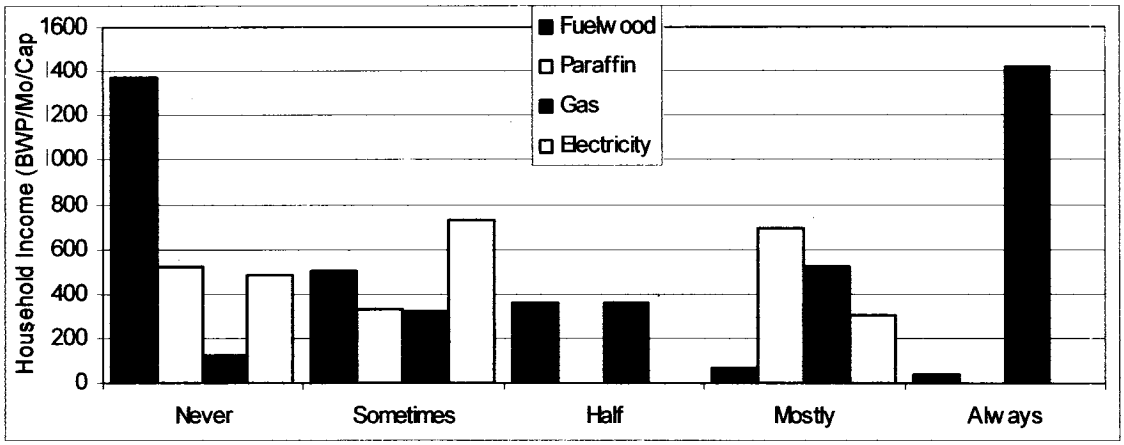


Figure 5.5: Mean household incomes of groups using fuels to various extents for cooking

Table 5.1: Proportions of households using fuels to various extents for cooking

	Fuelwood		**Paraffin**		**Gas**		**Electricity**	
	n	%	n	%	n	%	n	%
Never	12	18.2	61	92.4	16	24.2	56	84.8
Sometimes	18	27.3	4	6.1	18	27.3	9	13.6
Half	4	6.1	0	0.0	4	6.1	0	0.0
Mostly	20	30.3	1	1.5	19	28.8	1	1.5
Always	12	18.2	0	0.0	9	13.6	0	0.0

An identical analysis of the proportional use of various fuels for non-cooking related water heating yields comparable results. Although the grouping of the majority of households in the extreme categories (Table 5.2) indicates that transitions in fuel use for water heating are much less gradual than those for cooking, the trends of mean incomes follow a strikingly similar pattern (Figure 5.6). Incremental shifts from fuelwood to other alternatives, such as electricity, for this activity appear to be associated with exponential rather than gradual increases in average household incomes. Moreover, the level of fuelwood use for water heating is significantly less responsive to shifts in household income than in the context of cooking activities as nearly 70 percent of households used fuelwood for most or all water heating.

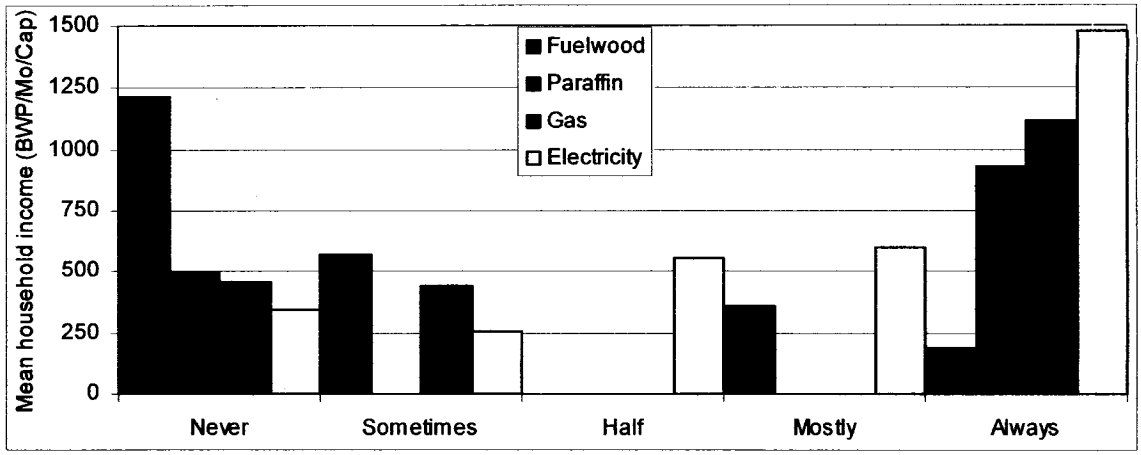


Figure 5.6: Mean incomes of households using fuels to various extents for water heating

Table 5.2: Proportions of households using fuels to various extents for water heating

	Fuelwood		**Paraffin**		**Gas**		**Electricity**	
	n	%	N	%	n	%	N	%
Never	19	28.8	64	97.0	53	80.3	51	77.3
Sometimes	2	3.0	0	0.0	6	9.1	4	6.1
Half	0	0.0	0	0.0	0	0.0	1	1.5
Mostly	6	9.1	0	0.0	0	0.0	1	1.5
Always	39	59.1	2	3.0	6	9.1	9	13.6

While the trend of mean incomes for these groups evidently masks internal variation within them, both the strengths of the trends and the patterns of within-group distributions, as exemplified in the case of fuelwood use for cooking (Figure 5.7), support the significance of the observed relationships. Moreover, removal of the few outliers and extreme values indicated by box and stem and leaf plots had almost no effect on either the exponential shapes of the trends or associated R^2 values. It is interesting to note, however, that the groups using fuelwood "sometimes" or "never" for cooking include a number of households with very low per capita incomes. Along with the persistent use of fuelwood in the upper middle income levels, this trend again suggests ability to afford commercial fuels even in the lower income levels and hence that much fuelwood use is due to factors other than economic necessity.

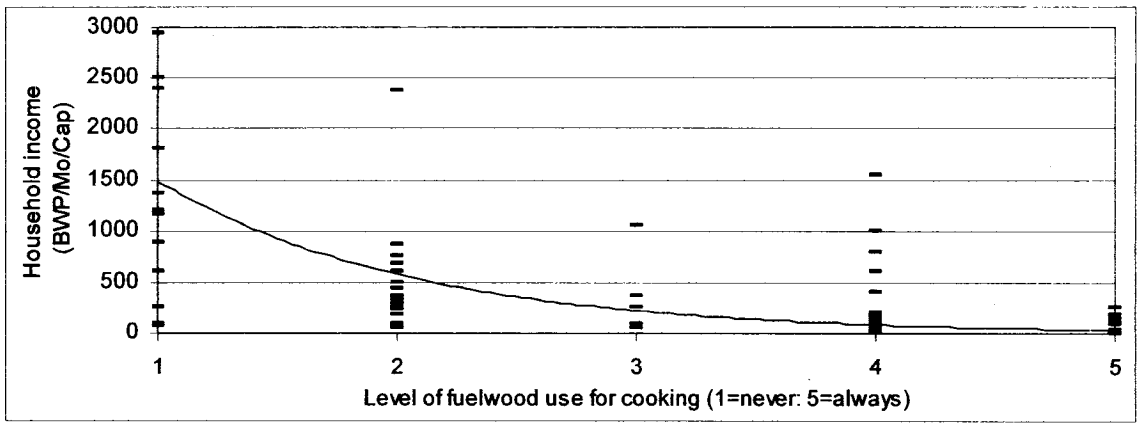


Figure 5.7: Distributions of household incomes by proportional use of fuelwood for cooking

5.1.3 "Progress" or stability? Fuel switching vs. energy use fluctuations

The trends observed in past[31] and planned future[32] energy use patterns indicate that, overall, use of all fuels is mainly characterized by net stability rather than reflecting any ongoing transition from fuelwood to commercial fuels. Although past transitions from commercial alternatives to fuelwood occurred only in the lower income range (Figure 5.8), shifts in the opposite direction occurred at all income levels. As well, switches toward and away from fuelwood have been near to equal in the recent past and almost 70 percent of respondents indicated no change in their fuel use patterns (Figures 5.9; 5.10). These trends indicate both that uptake of commercial fuels is not particularly new and, conversely, that fuelwood use has been fairly stable in the recent past.

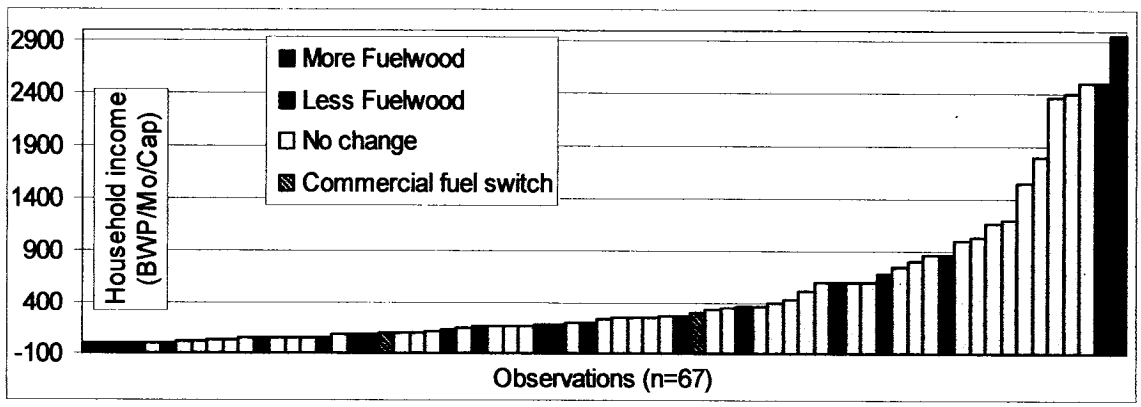


Figure 5.8: Past fuel switches ranked by household income

[31] Includes fuel switching across all activities
[32] Describes future switching plans in terms of cooking activities alone

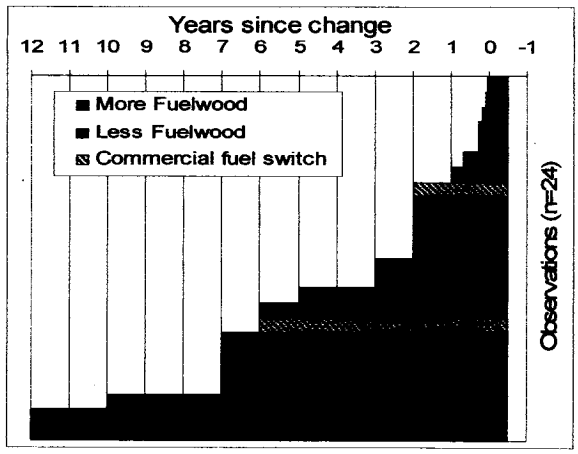


Figure 5.9: Past fuel switching types over time

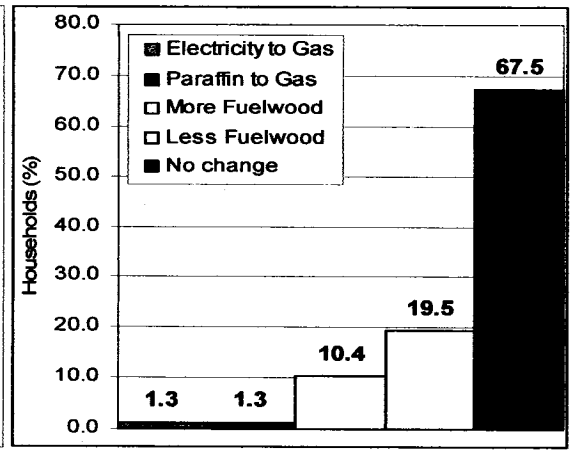


Figure 5.10: Proportions of past fuel switches

Second, responses regarding planned energy use changes do not suggest a pronounced future shift in fuelwood use levels either overall or within particular income ranges. As Figure 5.11 indicates, both increases and decreases in fuelwood use were projected by households at all income levels. However, in direct contrast to received wisdom, switches away from wood energy (34%) were most commonly anticipated by the lowest income households, among whom few felt they were likely to use more fuelwood in future. Conversely, while overall slightly fewer households expected to use more fuelwood in the future (22%), the majority of these occupy the middle to upper income range in which, moreover, switches toward fuelwood were noticeably more frequently suggested than were switches away. As well, the patterns of anticipated future switches across all fuels tended more toward stability than change. In the case of each individual fuel (Figure 5.12) the most frequent response was that no change in use level was planned or expected and switches toward and away were very close in number. Overall, the results indicate that despite a slight shift from fuelwood to commercial fuels, this change is occurring very slowly, is not clearly related to household incomes and energy use patterns tend more toward stability than change at present.

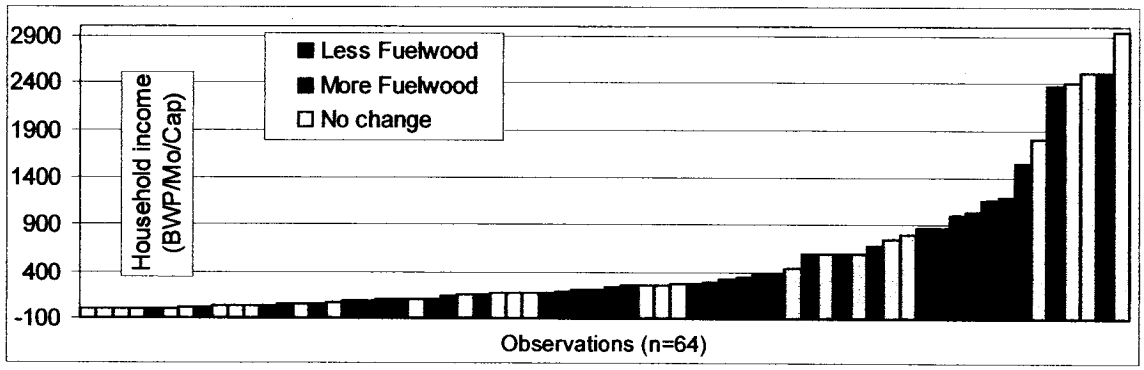


Figure 5.11: Planned future fuel switches ranked by household income

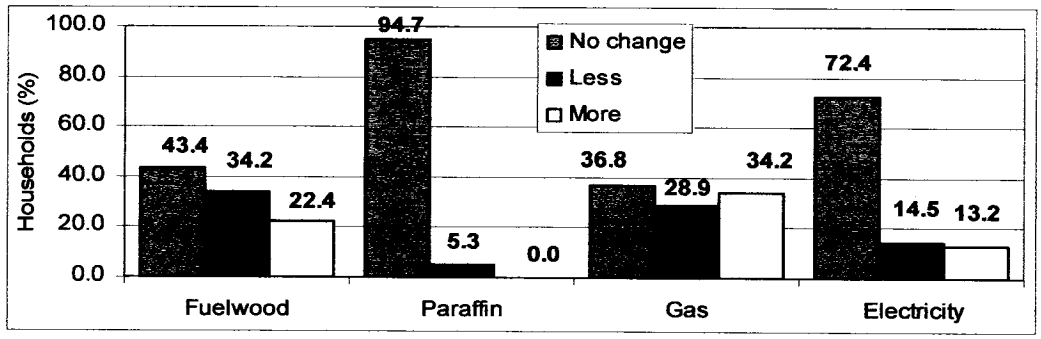


Figure 5.12: Proportions of future fuel use changes anticipated by households

5.1.4 Income vs. price: strategic roles for multiple fuels

The persistence of fuelwood despite commercial energy use, across the income spectrum and over time is found to be largely due to its unique role relative to the strategic combinations of fuels used by the majority of Maun households for individual applications within different end-uses. Moreover, these patterns of preferential usage of various fuels for specific purposes or under particular conditions are found to be driven more by responses to the relative prices of various fuels than by income as such. Trends in energy use for cooking best exemplify these patterns, partly because it most commonly involves the use of multiple fuels. While some households used only one fuel for all cooking needs, the majority of respondents indicated that the various energy sources available were not used as completely inter-substitutable fuels, but were applied almost exclusively to specific types of foods (Figure 5.13). In particular, gas and fuelwood, by far the two most important cooking fuels, were used for distinctly different applications in most households. Nearly 70 percent of

fuelwood users indicated that they used it for traditional foods like "hard beans", "stamp"[33] and "seswaa"[34] which are cooked for long periods of time requiring prolonged heat inputs. In contrast, over 60 percent of gas users employed it for "modern", mainly store-bought foods such as tea, coffee, rice, chicken, small pieces of meat and macaroni which cook quickly and hence are less energy consumptive. While paraffin use was uncommon, a similar application pattern was indicated and, while data on electric cooking applications are not available, the fact that among the few applying it to this end-use only, one used it for most cooking while the other 11 used it for less than half suggests use similar to gas and paraffin.

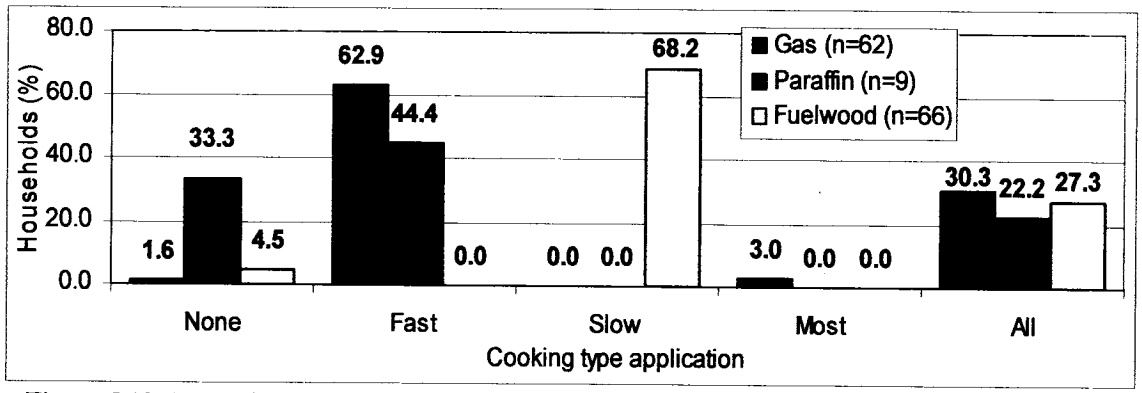


Figure 5.13: Proportional use of fuels for various cooking applications relative to total users

In addition, while respondents expressed a number of reasons for overall fuelwood preference or use, by far the most common (and often the only) reason indicated was its low price relative to other fuels (Figure 5.14). Conversely, while a high proportion of households used electricity for other purposes such as lighting, the most common reason given for avoidance or non-use of electricity for cooking was the expense associated with its consumption (rather than appliances) for this application (Figure 5.15). While, as noted above, gas was observed to be a popular cooking fuel, 33 percent of respondents also specifically mentioned the (increasing) level and fluctuations of its price as reasons for either switching to other fuels or (more commonly) economizing in its consumption, mainly

[33] A form of traditional "porridge" cooked from rough-ground millet or maize, cooked by slow boiling
[34] A traditional manner of cooking large pieces of meat by repeated boiling until dry

through continued, renewed or increased fuelwood use. Moreover, it is worth noting that as no question included in the survey questionnaire made reference to fuel prices, concerns over energy expenditure may be still more widespread than the results indicate.

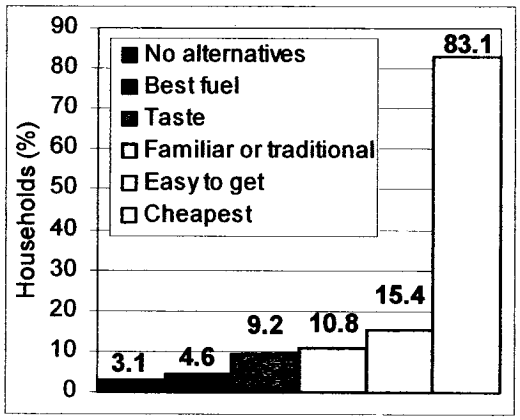


Figure 5.14: Proportions of reasons given for fuelwood use

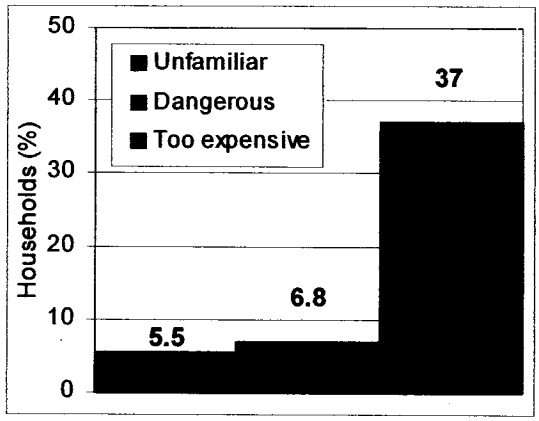


Figure 5.15: Proportions of reasons given for not cooking with electricity

Finally, price-related motivations for energy use decisions were both the most common and, in all cases, were quite evenly distributed across the range of per capita incomes. With respect to fuelwood, not only did the majority of fuelwood users indicated that price was a major, if not the sole motivation for its use, but the few that did not were equally distributed between the low and high income ranges (Figure 5.16). Similarly, indications that concerns over the prices of electricity and gas led to use of alternatives to reduce expenditure on these fuels, while individually less common, were observed with approximately equal frequency at nearly all income levels (Figures 5.17; 5.18). Cumulatively, these patterns strongly indicate that the persistence of fuelwood use is primarily due to its strategic importance as a means of economizing on household cash expenditure for energy. It is evident that this role is of significantly greater importance than household earnings in determining fuelwood use levels as while even some of the lowest income households found themselves financially able to rely completely on purchased commercial fuels the majority in the higher income ranges indicated unwillingness to cease (and in many cases desire to

increase) fuelwood use primarily in order to economise on energy costs.

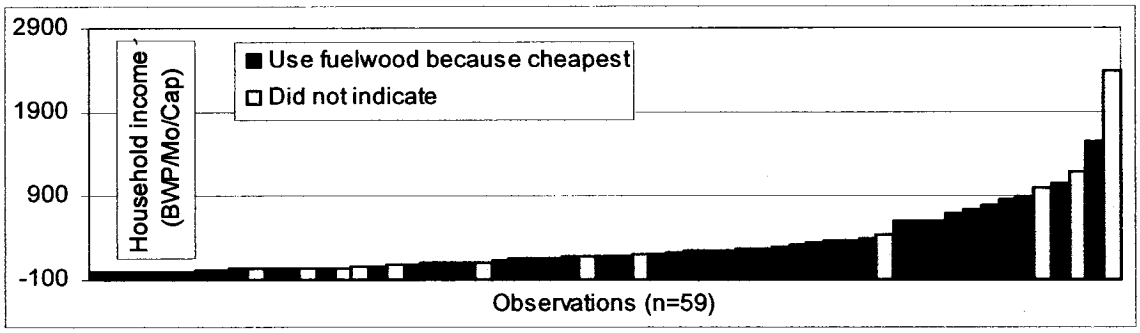


Figure 5.16: Households indicating price as a key reason for using fuelwood

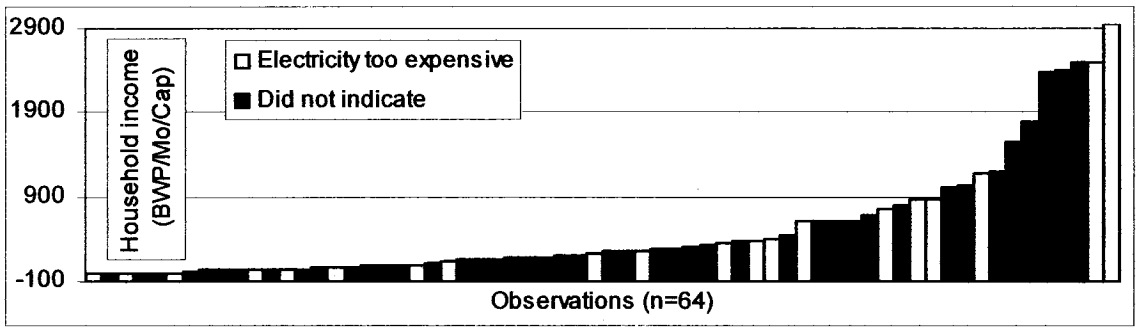


Figure 5.17: Households avoiding electricity use for cooking due to cost by household income

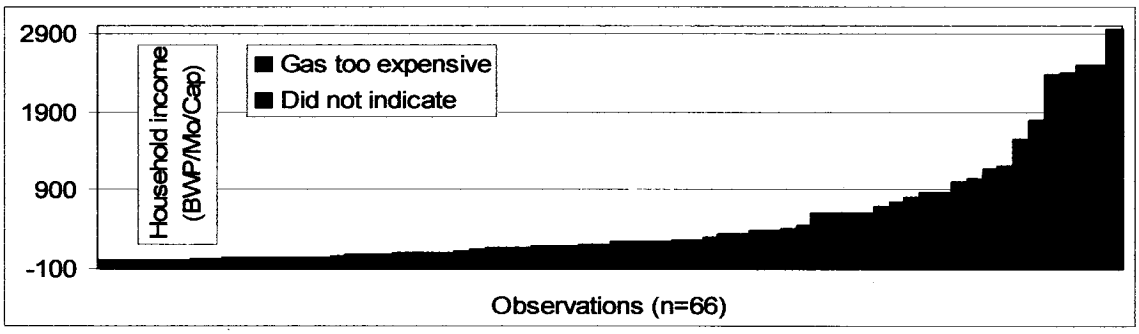


Figure 5.18: Responses indicating gas price as a barrier to consumption by household incomes

5.2 Cattleposts and communal land: responses to abundance and accessibility

The majority of models articulated in academic and government literature remain predicated on the assumption that, due to the transport constraints of the poor, fuelwood sourcing decisions are primarily proximity driven resulting in ecological damage, deprivation for low income urbanites and urban-rural resource conflict. In contrast, however, the results of this study indicate that fuelwood collection patterns of Maun households are distinctly more complex, reflecting responses to ecological and socio-cultural landscape dynamics generated by past and present processes of urbanization. While traveling distance remains

important for some, the wood sourcing decisions of many are determined primarily by perceived patterns of dead wood abundance, as well as other household activities and access networks resulting in responses which minimize environmental and socio-economic impacts.

Models of fuelwood collection dynamics generated at the height of academic research into the "fuelwood crisis" during the 1970s and throughout the 1980s predominantly revolved around the assumption that the overriding imperative governing fuelwood sourcing decisions was the minimization of traveling distance. As the "fuel of the poor", woody biomass was assumed to be harvested mainly on foot or by other cheap means of transport by those who could afford neither more expensive fuels nor more costly "modern" vehicles. Due to the time and labour costs involved in the procurement of daily energy needs by these methods it was inferred that fuelwood collectors would tend to harvest as close as possible to their homes such that proximate green wood would be preferred over more distant dry wood supplies. In the context of the harvesting pressure concentration caused by population growth of wood energy-dependent urban centres, therefore, fuelwood use came to be associated with "waves of deforestation" moving outward from African settlements (Cline-Cole 1990).

Since the early nineties, some researchers have noted that, as in much of Africa, peri-urban land cover change in Botswana is predominantly due to other causes (Sekhwela 1995; Kgathi 1997) as well as that fuelwood harvesting may follow patterns of abundance (Kgathi 1997) and can be associated with other activities such as the clearing of fields (Sekhwela 1995). However, the basic tenets of "fuelwood orthodoxy" (Cline-Cole 1990) have retained a significant influence in both academic and government circles and collection distance remains entrenched as a proxy measure for fuelwood scarcity. In Botswana, the influence of this "proximity-based" model of fuelwood sourcing is implicit in the articulations of government concerns over urban fuelwood dependence made in official publications and by state actors. As noted in Chapter 4, the perception in government circles is that the fuelwood

harvesting activities of urbanites are causing depletion of both live and dry wood around major settlements. This is seen to result in ecological damage due to land cover loss and negative socioeconomic impacts including both the endangerment of low income household energy security due to reduced access to fuelwood and threats to the sustainability of rural livelihoods dependent on both live and dead wood resources.

In contrast, however, the results of the current research indicate that in Maun, creative social and economic arrangements, as well as sensitivity to landscape patterns of resource abundance and socio-cultural accessibility result in harvesting decisions which significantly mitigate the potential for negative environmental, urban socio-economic and rural livelihood impacts. First, while some households were able to find adequate fuelwood near to Maun, between a third and a half of all self-collecting respondents[35] acted upon the growing peri-urban fuelwood scarcity and competition by traveling significant distances to collect dry fuelwood. The combination of this preference for deadwood abundance over proximity and the dispersal of harvesting pressure associated with the range of distances traveled indicates that fuelwood collection is associated with significantly lower environmental impacts than traditional models predict. Second, the consequent reduction in peri-urban fuelwood depletion, along with creativity and flexibility in social/economic arrangements resulted in significant mitigation of the effects of transportation constraints shoring up the ability of low income households to obtain fuelwood stocks and hence reducing threats to their energy security. The continued availability of deadwood near to Maun, as well as the fact that households across the income spectrum were able to access motor vehicles (koloi)[36] for transport such that collection distances were not determined by incomes indicate that low income households may be significantly less systematically vulnerable to localized wood

[35] 17.9% of respondents only purchased fuelwood, while 43.2 purchased at least some of the time

[36] Setswana word, used here due to its inclusion of a range of light cars, trucks (or "bakkies"), vans, etc.

depletion than has been suggested. Finally, while urban fuelwood collectors' sensitivities to gradients of scarcity and competition and the availability of transport are found to explain much of the spatial pattern of harvesting sites, the distinctly exponential trend in the actual distances traveled is found to be mainly a product of household responses to socio-cultural patterns of activities and resource access. As the majority who seek fuelwood outside the peri-urban zone of close competition travel significantly beyond its "boundary" to collect at their own (often very distant) cattleposts which they regularly visit for social and other purposes, the potential for negative rural socio-economic impacts and urban-rural resource conflict is significantly mitigated. At their cattleposts, urbanites retain simultaneous identities as legitimate rural residents with recognized rights of access to delineated resources minimizing competition with rural needs, while ongoing relationships with rural neighbours provide means by which competing resource claims may be negotiated. In the following sections these findings are elaborated with greater detail and with supporting evidence from the primary data collected.

5.2.1 Trading distance for abundance: ecological implications

While dominant understandings of fuelwood sourcing dynamics recognize that the growth of fuelwood-dependent urban centres generate urban-rural gradients of dry fuelwood abundance, they have generally assumed that urban resource seekers are insensitive or unable to respond to these patterns, resulting in a persistent association between fuelwood use and environmental degradation. In contrast, the results presented here suggest that Maun households' strong preference for sites with abundant dry wood has engendered a high degree of sensitivity among many to the developing gradient of fuelwood availability, resulting in harvesting behaviours which have significantly reduced the past and present ecological impacts of fuelwood harvesting in the Maun area.

In environmental terms, one of the most important trends in Maun area fuelwood harvesting is the rareness of live tree cutting by households despite high wood consumption levels Across the remarkable range of distances traveled, households almost exclusively collected ready-to-use dry wood generated by elephant activity or other factors (Figure 5.19). While "traditional" and government models expect that live trees will be harvested once nearby dry stocks are depleted, two spatial patterns in the responses indicate that deadwood preference overrides the imperative of proximity in this case. The first is that prior to the complete depletion of nearby deadwood stocks roughly half of all harvesting households traveled between 15 and 150 kilometres to obtain dry supplies. Conversely, while a few occasionally or even exclusively cut live trees, the wide spatial distribution of these responses suggests that reduction of traveling distance was not often a motivation. Together, these patterns indicate a high level of resistance to "green" wood harvesting, perhaps not least due to the extra time and labour required for its preparation.

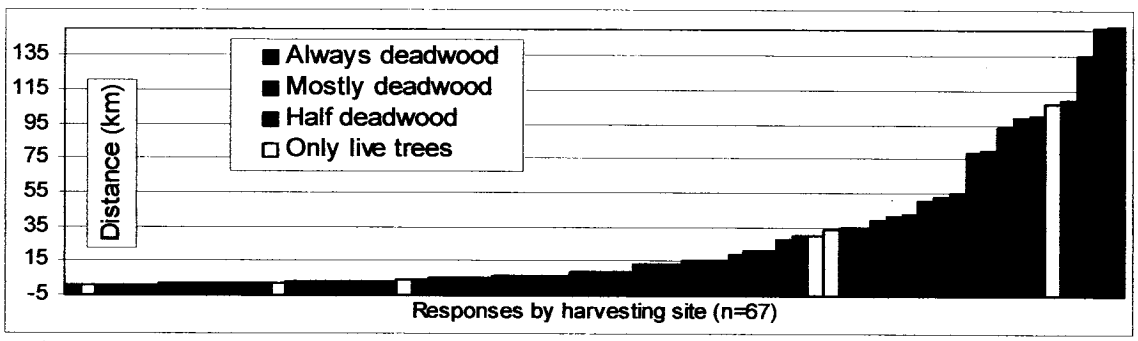


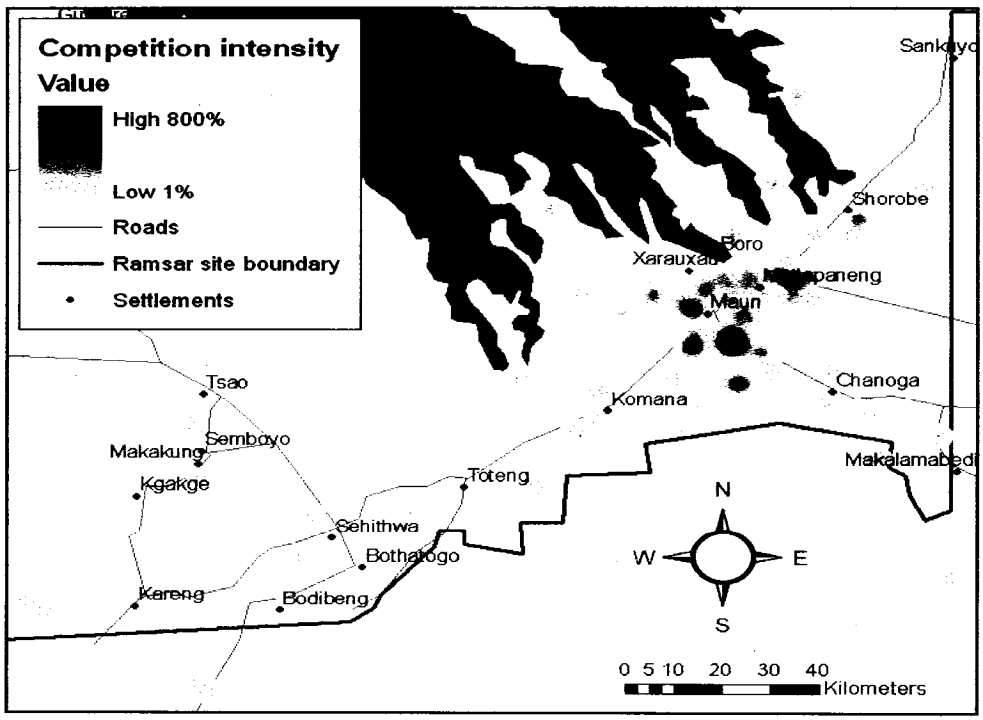
Figure 5.19: Proportion of live vs. dead wood harvested by distance from residence to harvest site

Furthermore, the majority of self-collecting households indicated that in making fuelwood sourcing decisions they also placed a high priority on overall abundance such that their collection site choices were significantly influenced by urban-rural gradients of availability generated by past and present urban growth, agricultural land use and fuelwood collection patterns. While some households did harvest relatively close to their residences due to occasional or ongoing transport and/or time constraints as traditional models predict,

many others did so because they were able to find areas where dry fuelwood remained abundant. This pattern, however, created much higher competition in most of Maun's immediate environs than elsewhere and, despite the fact that dry wood is far from wholly depleted in these areas, roughly half of all self-collecting respondents chose to travel beyond this "zone" to collect fuelwood in areas of higher abundance. As such, urban fuelwood seekers' responses to the existing gradient of deadwood abundance resulted in a significantly more diffuse pattern of harvesting pressure than dominant understandings predict, and hence reduced hinterland environmental impacts.

As the map of cumulative fuelwood harvesting pressure (Map 5.1)[37] indicates, a clear gradient exists between the closer competition for fuelwood in the immediate peri-urban environment and the extremely diffuse pattern of collection sites spread across Maun's rural hinterland. This pattern is also reflected in the spatial distributions of responses describing source site characteristics which illustrate the benefits of accessing distant rather than proximate fuelwood resources. As Figure 5.20 indicates, for instance, while a number of households harvesting in the Maun area were able to access areas with adequate fuelwood for their needs, it is apparent that fuelwood scarcity is significantly more prevalent in the immediate environment of Maun than in the higher distance range. A key transition appears to occur at approximately 15 kilometres, beyond which only one respondent indicated fuelwood scarcity was a problem. A similar trend is observed in the patterns of difficulties encountered in the course of fuelwood collection (Figure 5.21). While a fair number of households harvesting at distances less than 15 kilometres experienced various collection difficulties, the vast majority traveling further encountered no problems other than occasional unavailability of transportation.

[37] 100% harvesting intensity represents full harvesting pressure of one individual (see Chapter 3 for further information on the generation of the map)



Map 5.1: Cumulative harvesting pressure pattern of respondents

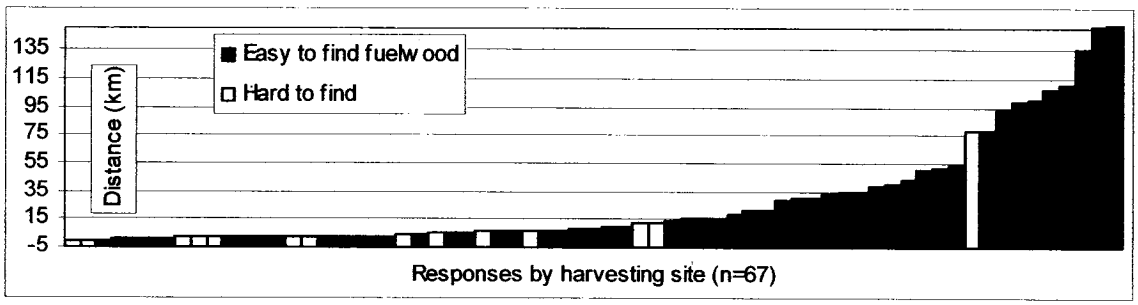


Figure 5.20: Relative abundance of fuelwood by distance from residence to harvesting site

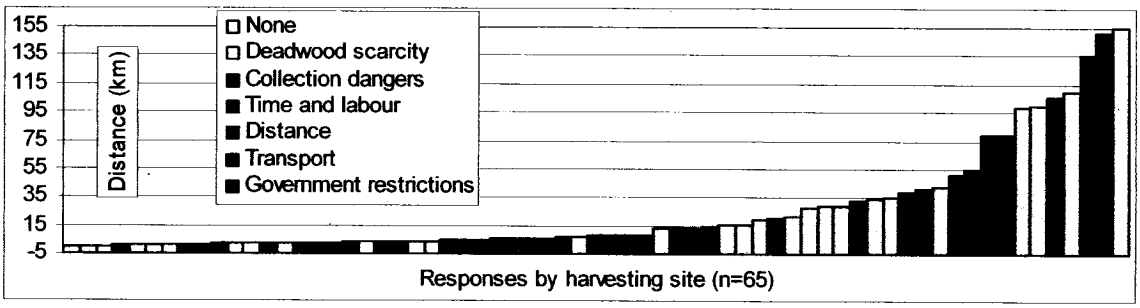


Figure 5.21: Fuelwood collection difficulties by distance from residence to harvesting site

Patterns in perceptions of competitors' origins and fuelwood sufficiency vis-à-vis competition levels also exhibited strong spatial trends (Figures 5.22; 5.23). The indication is that competition between Maun residents is common in the lower distances, while beyond 15 kilometres most harvesters encountered only rural residents or no competitors at all.

Moreover, while many felt that dry wood stocks in nearby harvesting areas are inadequate for the current harvesting pressure at their locations, there were few indications of such problems beyond the 15 kilometre mark. Finally, while anticipations of future collection difficulties were more common than reports of current problems (Figure 5.24), a shift again occurs around 15 kilometres from mainly pessimistic to much more often optimistic expectations.

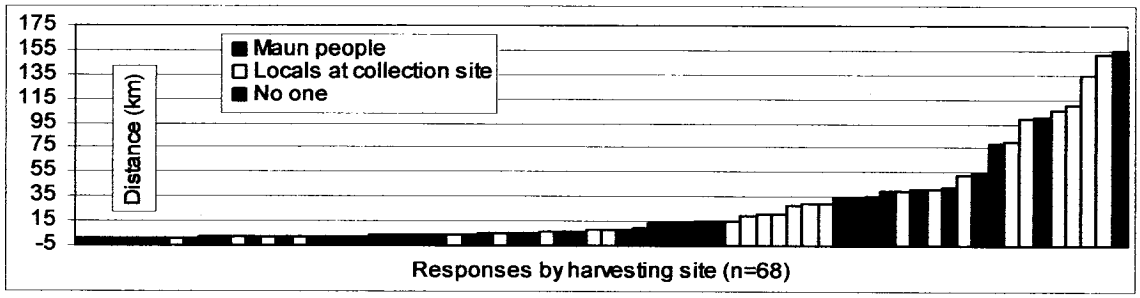


Figure 5.22: Origins of fuelwood collection competitors by distance from residence to harvesting site

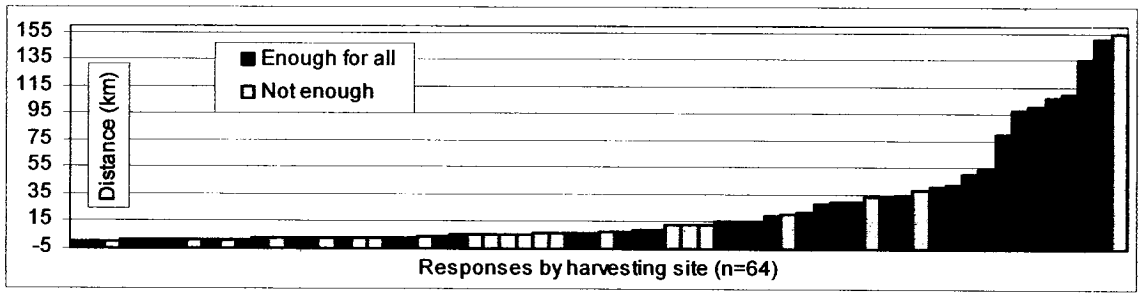


Figure 5.23: Abundance relative to competition by distance from residence to harvesting site

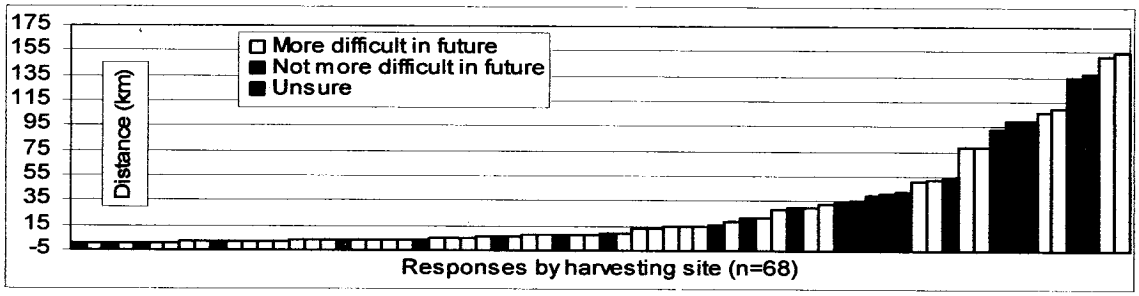


Figure 5.24: Anticipation of collection difficulties by distance from residence to harvesting site

Overall, these patterns of responses and the sheer range of distances involved clearly indicate that for the majority of Maun households abundance is a significantly higher priority than simple proximity in the selection of fuelwood collection sites. At distances of less than 15 kilometres harvesters were significantly more likely to encounter competition and while deadwood is still available in this range, there is a clear indication that it is becoming more

laborious to find. In response to these patterns, nearly half of all self-collecting respondents opted to travel (often far) beyond this distance to areas where dry wood is easily obtained and few difficulties are encountered in its collection.

In summary, the results of this study contradict the assumption that distant resources will only be accessed once the nearest supplies are completely exhausted, as many Maun households have moved their harvesting activities well beyond the zone of scarcity and competition long prior to the depletion of proximate deadwood. Moreover, due to these responses, much harvesting pressure is redirected away from peri-urban to rural areas where its diffuse nature significantly reduces the potential for negative environmental impacts.

5.2.2 Rent, borrow or ride along: urban socioeconomic implications

Aside from ecological impacts, urban fuelwood harvesting patterns are typically also seen to cause negative socioeconomic effects, particularly with respect to the energy security of low-income urban households presumably unable to access distant fuelwood stocks due to transport constraints. Interestingly, however, while this concern cannot be wholly dismissed, the results presented below indicate that among Maun households the relationship between income, mobility and fuelwood access is significantly more complex than previously indicated. Aside from the effects of reduced peri-urban harvesting pressure resultant from the harvesting patterns described above, some households even at lower ends of the income spectrum are able to use koloi transportation to access some of the most distant collection sites and other arrangements can be made to obtain fuelwood when transport is unavailable.

While 37 percent of self-collecting respondents traveled on foot and 19 percent used a donkey cart to procure fuelwood at least some of the time, 55 percent of respondents at least partly, and almost half exclusively, used a motor vehicle (Figure 5.25). The dominance of koloi use is particularly significant as, first, the majority of harvesting households occupied the lower income range and, second, koloi users included even some of the lowest

per-capita income households. As well, no correlation was found to exist between household incomes and the distances traveled by households to harvesting sites (Figure 5.26). Although many less affluent households traveled less than 15 kilometres from their residences to fuelwood harvesting sites, a fair number collected at significantly greater distances and the majority of the most distant sites were used by households with the lowest incomes. The ability of many to gain access to distant fuelwood harvesting sites, despite very low levels of disposable income, is due to a number of factors. Perhaps the most important among them is the fact that koloi use enables the harvesting of significantly greater quantities of fuelwood at once such that most were able to collect as infrequently as once every month or two, significantly reducing time and transport costs. In addition, quite a number of respondents indicated that though they did not own a motor vehicle themselves, they were able to coordinate collection with the traveling plans of neighbours or family members, whereas others borrowed or informally rented transport from the same. If transport was unavailable, many were able to meet basic needs by asking neighbours for wood[38] or by purchasing supplies from mobile vendors. Overall, the stress of collection distance increases on low income households was less systematic than has been suggested due to the potential for creativity and flexibility in social and informal economic arrangements.

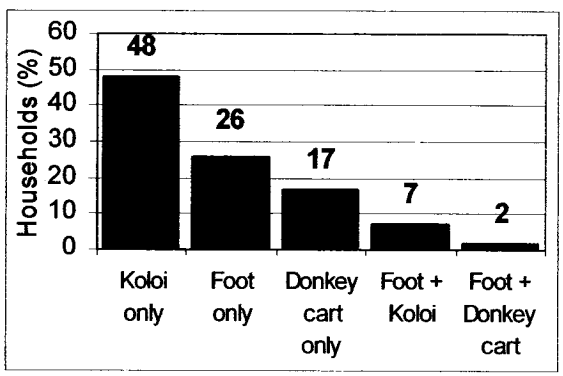


Figure 5.25: Proportions of collection transport

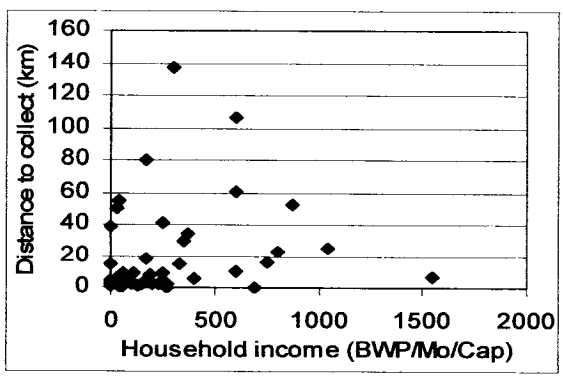


Figure 5.26 Collection distances vs. incomes

[38] Respondents frequently indicated that it is socially expected that neighbours in need of fuelwood will be given it for the asking, and the majority of respondents participated in this custom.

5.2.3 Cattlepost harvesting: implications for rural livelihoods

In addition to stresses placed on low income urban households urban fuelwood harvesting is also typically seen to engender negative impacts on the viability of rural livelihoods. The assumption is that as urban harvesters range ever further in search of dwindling wood supplies they must ultimately resort to abstracting resources from rural areas whose residents are dependent on both live and dead wood for a wide variety of daily needs in addition to energy. However, whereas the emphasis on distance in such models implicitly assumes a certain "equality of place" from the collector's perspective, the results presented here clearly indicate that Maun households are highly responsive to socio-cultural unevenness in the hinterland, choosing harvesting sites in ways which tend to minimise rather than promote conflict with other actors.

While responses to scarcity and competition and the availability of modern transport indicate the motivation and ability of many households to range beyond 15 kilometres from Maun for fuelwood, it is readily apparent that the distinctly exponential trend (R2=.97) in distances within which the maximum is more than an order of magnitude greater than the median stems at least partly from the influence of other factors. In this case, analysis of the socio-cultural characteristics of harvesting sites indicates that the majority of households traveling 15 or more kilometres from Maun collected fuelwood at their own cattleposts (allocated communal land) rather than in the "bush" (unallocated communal land) due to both social and economic advantages conferred by this behaviour. On one hand, as cattleposts are both more distant from Maun and less open to competition than unallocated bush, not only is fuelwood more abundant and easy to collect, but the semi-formally recognized access rights of households to these areas reduces the likelihood of resource conflicts with other citizens or government. Conversely, as trips to the cattlepost for social and other purposes are a regular feature of the lifestyles of many households, time and transport costs are not just dissociated

from fuelwood collection, but it is in fact arguably cheaper to obtain fuelwood supplies during biweekly-bimonthly trips to the cattleposts than to make additional trips to the bush for wood collection alone.

While both bush and cattlepost fuelwood collection occur over relatively wide ranges of distance, sites nearer to Maun are predominantly located in unallocated bush, whereas the dominance of cattleposts increases with distance up to the 50 km mark beyond which no more bush harvesting was observed (Map 5.2; Figure 5.27). Due to this pattern, the benefits which accrue to harvesters with increased distance from Maun are predominantly associated with cattlepost locations. While 35 percent of bush harvesting sites were associated with either no difficulties or only the availability of transport, respondents indicated that 65 percent posed other challenges (Figure 5.28). By contrast, at over 80 percent of the cattleposts used for fuelwood collection no difficulties were encountered other than transportation. Similarly, 92 percent of responses indicated that cattlepost sites were currently characterized by an abundance of fuelwood, and while at 50 percent of these locations harvesters encountered local competition, at only 27 percent did they feel that the total harvesting pressure was out of balance with the existing stock and rate of replenishment.

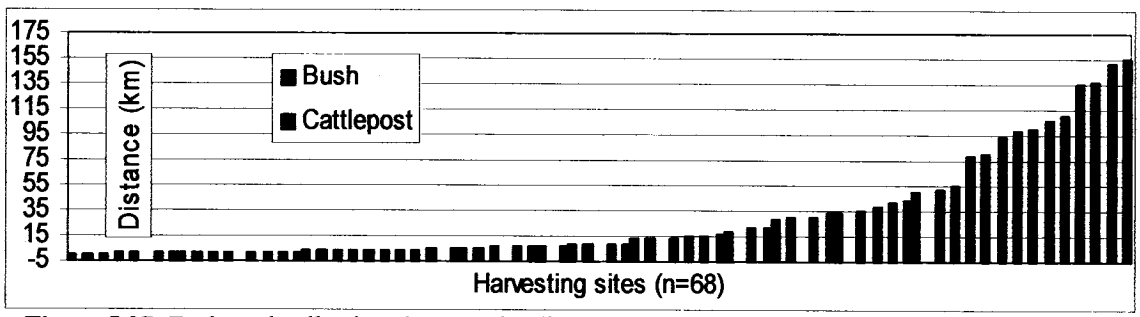
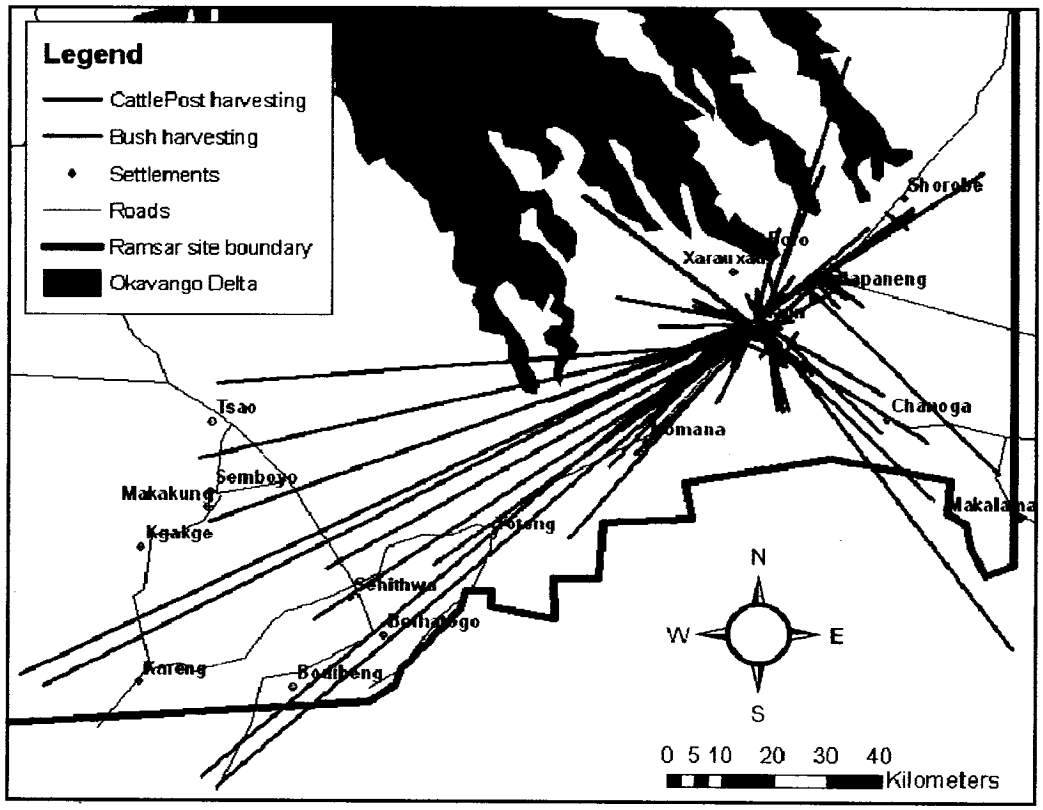


Figure 5.27: Fuelwood collection site types by distance from residence to harvesting site



Map 5.2: Bush and cattlepost harvesting patterns of respondents

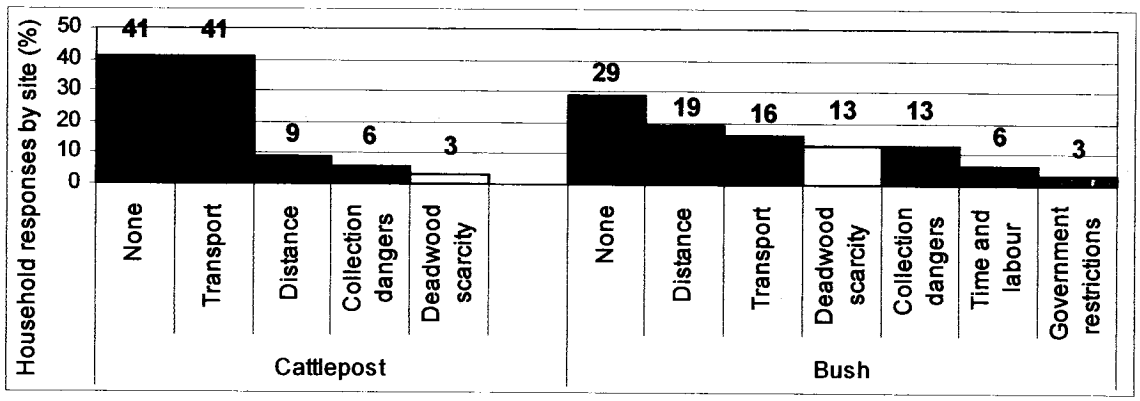


Figure 5.28: Proportions of responses regarding difficulties experienced in fuelwood collection

Moreover, as users have recognized resource use rights at their cattleposts, conflicts with local residents and/or government officials over even live tree cutting is significantly less likely than for those harvesting in open access bush areas. While there is no formal process in place for the allocation or registry of cattleposts, the land boards recognize their existence and the usufruct rights of resident families in practice and the possibility of tenure formalization has been discussed. In addition, the likelihood of conflict with local residents at

the cattleposts is reduced by three factors. First, cattleposts are obtained on a consensual basis whereby the "applicant" approaches prospective neighbours in order to establish the boundaries of the areas they are using and negotiate the location of the new residence. Second, as these land use "parcels" are hereditary many, if not most, cattlepost harvesters will likely have had long familiarity with families occupying neighbouring areas, particularly if they are closely spaced. Finally, cattleposts are rarely unoccupied as in most cases at least some family members (often the elderly and young children) are present to look after livestock etc. such that urban residents collecting at their rural cattleposts are also to some extent rural residents collecting resources near to their own homes.

In addition to factors such as abundance and the recognition of access rights, however, the harvesting of fuelwood at far away cattleposts is not only essentially "cost free", but to some extent more economical than other options in the context of many of Maun households' lifestyles. As Figures 5.29 and 5.30 illustrate, while abundance and proximity emerged as the most important criteria for the selection of bush harvesting sites, the most frequently cited reason for collection at the cattleposts was the fact that household members were going anyways for other reasons, often on a monthly basis. Moreover, this response was most common in the highest distance range. In this context, cattlepost harvesting is a relatively quick, easy and cost-free method of procuring energy supplies. In contrast, any harvesting in bush areas nearer to the Maun residence, aside from potentially increased difficulties would represent an additional expenditure of time and/or fuel for transport.

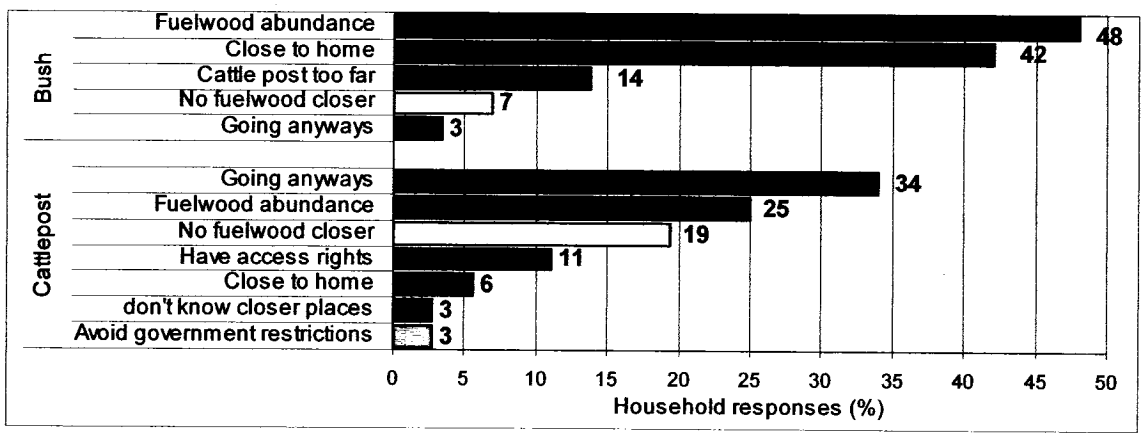


Figure 5.29: Proportions of responses regarding reasons for harvesting at particular sites

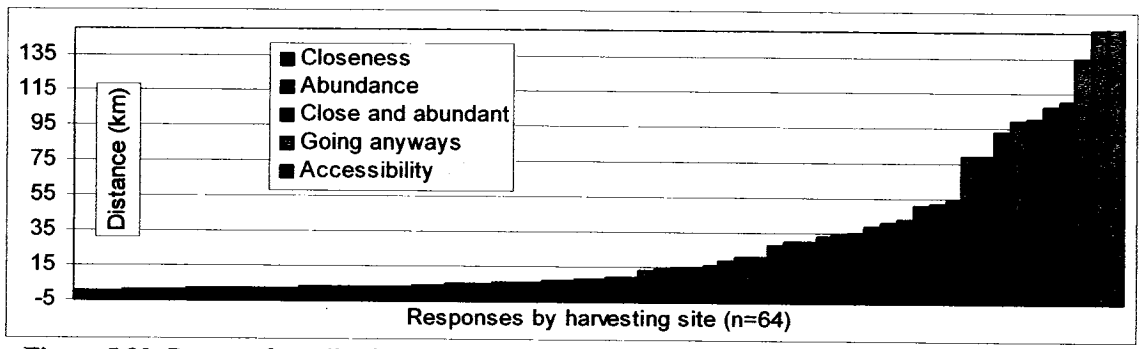


Figure 5.30: Reasons for collecting at specific sites by distance from residence to harvesting site

5.3 Urban energy and hinterland opportunities: positive aspects of the fuelwood market

In the context of both academic and, particularly, government concerns over the ecological, urban socioeconomic and rural livelihood impacts of urban fuelwood dependence, the commercialization of this resource is often cited as one of the key causes of environmental damage and the deprivation of both low income urban and peri-urban/rural households while positive aspects are given either little or no attention. This has been due to the perception that vendors typically harvest large amounts of (particularly) live wood from communal lands shared with household collectors and hence are major contributors to woodland degradation and the displacement of these "traditional" woodfuel consumers.

The results of the Maun vendor and household surveys, however, indicate that while the environmental impacts of the rapidly emerging fuelwood market in this area appear to have been modest to date, it has provided both a critical service for low income urbanites and an important opportunity for rural households with few cash-earning opportunities. First,

while some live tree cutting from bush locations was observed, the majority of vendors harvested only dead wood, many from their own (widely spread) cattleposts, in relatively small quantities. Second, rather than inducing deprivation, households indicated that vendors provided a critical source of wood when time and or transport constraints prevented self-collection. Finally, while the potential exists for conflict between vendors and the needs of peri-urban and rural residents, most vendors lived in these areas rather than in town, and, particularly in the rural areas, harvested from their own cattleposts. As cash earning opportunities are scarce in these areas, vendors revealed that fuelwood sales provided an important income supplement for the maintenance of their households.

5.3.1 Many vendors, small quantities: evidence for modest impacts

The results of the vendor survey clearly indicate rapid growth of Maun's fuelwood market in recent years largely in response to urban household energy demand. However, while the potential for future ecological damage is certainly present, the sourcing patterns observed suggest that up to the present the exponential growth in the numbers of vendors in the Maun area has not resulted in significant environmental impacts due to both the nature of vendor participation and the harvesting strategies of many vendors.

As Figure 5.31 illustrates, the rate of market entrance of vendors in the sample population exhibits a strong exponential trend with a more than five-fold increase over the last six years such that nearly 40 percent of those interviewed had been selling for 1 year or less. While sales to customers associated with the growing tourist trade were responsible for some of these sales particularly in Matlapaneng along the road to Moremi game reserve and a few vendors made some sales to businesses and government institutions, roughly 65 percent made half or more of their sales to residential customers and only 4 percent did not have any local household business (Figure 5.32). In the context of the cessation of fuelwood use by previously major customers such as public schools and some other government institutions in

the Maun are over the past 5 years these trends clearly indicate that, along with the tourist trade, residential consumption has been significantly responsible for market growth.

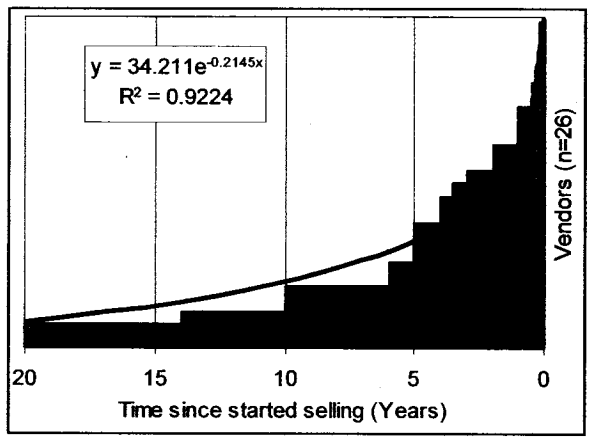


Figure 5.31: Rate of fuelwood market entrance

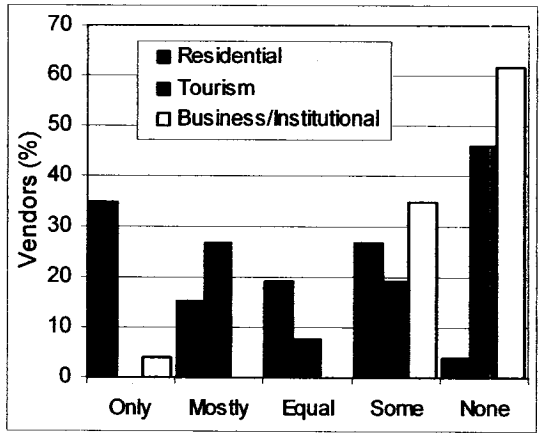


Figure 5.32: Proportions of client types

While on the surface this growth rate suggests a massive increase in harvesting pressure and attendant ecological change, a number of factors indicate the contrary. The first is that roughly a third of the vendors indicated that they sourced fuelwood from bush or cattlepost locations 15 to 50 km from Maun such that their harvesting impact appears to be relatively diffuse despite some pockets of higher concentration. Another is that most new market participants are, at present, selling only modest amounts compared to longer active vendors (Figure 5.33). It is unclear whether this is due to current market circumstances, vendors' other livelihood activities or the recency of market entrance as, with two exceptions, monthly sale volumes exhibited a fairly strong correlation to the length of time vendors have been selling suggesting that monthly sales may increase over time (Figure 5.33; 5.34). Thus far, however, it is clear that the rapid rate of market entrance has not been matched by equivalent growth in sales volumes. In addition, nearly 70 percent of the vendors interviewed indicated that they only or nearly always harvested deadwood for their sale stocks. This trend is most likely made possible by, first, the small quantities harvested by most vendors and, second, the fact that nearly 40 percent, including some of the highest volume traders, collected at their own cattleposts a number of which were quite distant from the town.

Overall, the mainly low sale volumes, relatively diffuse pattern of harvesting sites, prevalence of dry wood use and the fact that many vendors harvest from their own cattleposts where their harvesting activities compete primarily with their own fuelwood needs suggest that, up to the present, commercialization has had only modest environmental impacts.

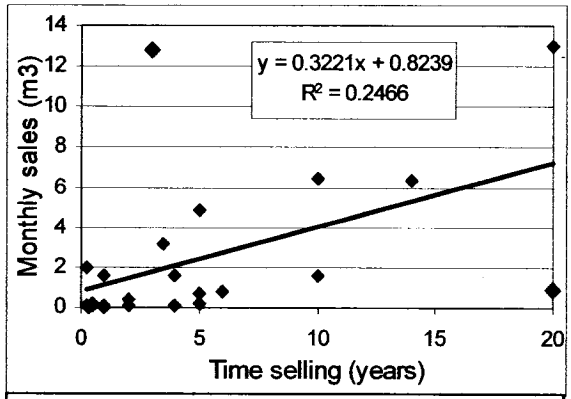


Figure 5.33: Fuelwood sales volume vs. length of market participation history

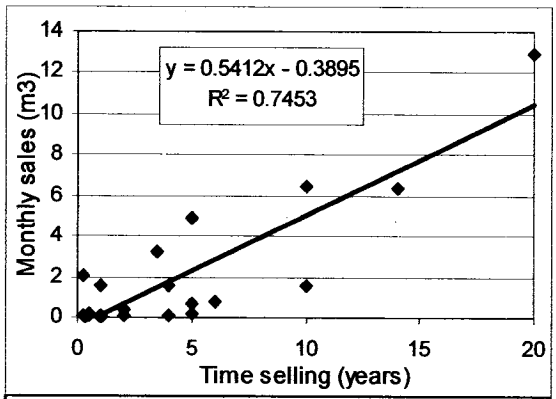


Figure 5.34: Sales volume vs. length of market participation history (outliers removed)

5.3.2 Daily needs and drudgery: essential services for the less affluent

Although it is possible that some competition does exist between vendors and self-collecting households harvesting near to Maun, the results indicate that the predominant impact of the emergent fuelwood market was a significant positive contribution to the quality of life of many of Maun's households, particularly in the lower income ranges. While not in the majority, respondents who purchased at least some of their fuelwood supplies were found to include 43 percent of fuelwood using households while 18 percent relied solely on vendors for this resource. Although purchasing was observed across the income spectrum it was slightly more frequent among lower income households (Figure 5.35). The pattern of reasons given for this behaviour clearly indicates that fuelwood vendors, particularly the mobile variety using donkey carts to deliver fuelwood house to house, provided a valuable service to Maun residents who, due to various circumstances, are at least some of the time unable to collect energy supplies themselves. The most frequently cited reason for fuelwood purchasing, for instance, was an either temporary or ongoing lack of transportation to access

fuelwood outside the urban centre (Figure 5.36). While many households even in the lower income ranges either owned or were able to borrow or informally rent a vehicle to collect fuelwood on their own behalf, such vehicles were periodically unavailable for various reasons, and some simply did not have such access. Another difficulty, similarly observed across the income range (Figure 5.37) was that respondents often simply did not have the time to collect fuelwood due to the time demands of other aspects of their lives such as formal employment, businesses, or caring for young children. For households in such circumstances the availability of fuelwood, particularly that available from donkey cart vendors passing next to residents' homes, offers a convenient solution to important difficulties experienced in the daily management of essential domestic affairs. Moreover, a number of households specifically noted that when household financial resources were inadequate for the refilling of gas cylinders or purchasing fuel for motor-vehicle based fuelwood collection, they were nonetheless able to meet their energy needs due to the flexibility of vendors with respect to sale quantities. While the filling of an LPG cylinder may require 180-200 BWP, vendors selling fuelwood speculatively[39] were typically willing to sell individual pieces of wood for 10-15 BWP. It is important to note that, in the context of the monthly payment system commonly used in Maun, even those with formal employment frequently experienced cash shortages near month's end. Respondents explained, however, that such small amounts can usually be easily obtained, even if by borrowing from relatives or neighbours. As such, the day to day meeting of many low income households' needs was at least sometimes predicated on the presence of neighbourhood and mobile fuelwood vendors without whom energy would sometimes be unavailable or difficult to obtain.

[39] as opposed to on a full-load commission basis, which is also commonly practiced at households' request

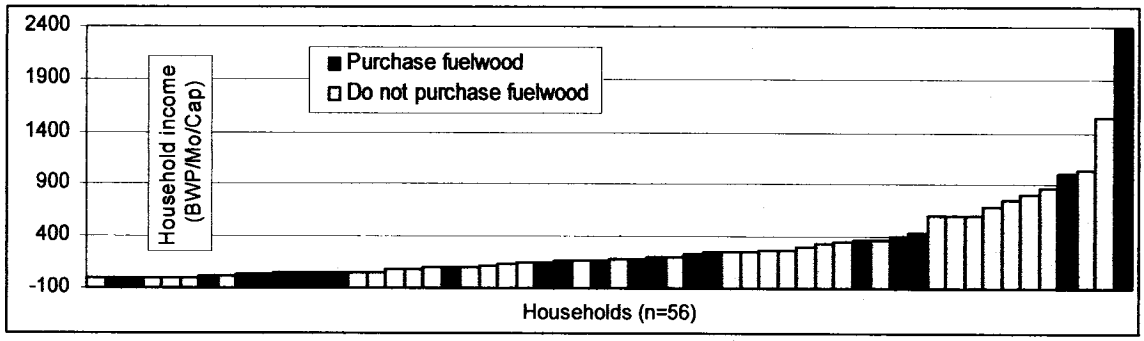


Figure 5.35: Distribution of fuelwood purchasers across the range of fuelwood users' incomes

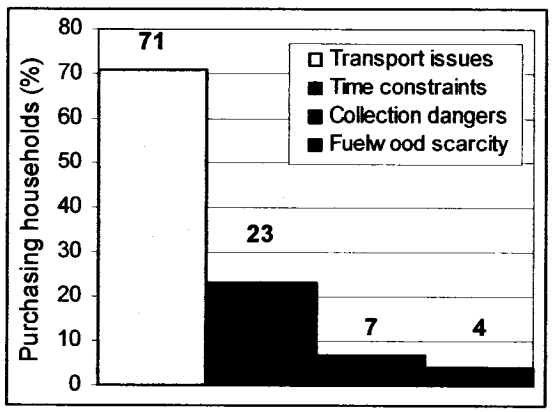


Figure 5.36: Proportions of reasons for buying fuelwood rather than collecting

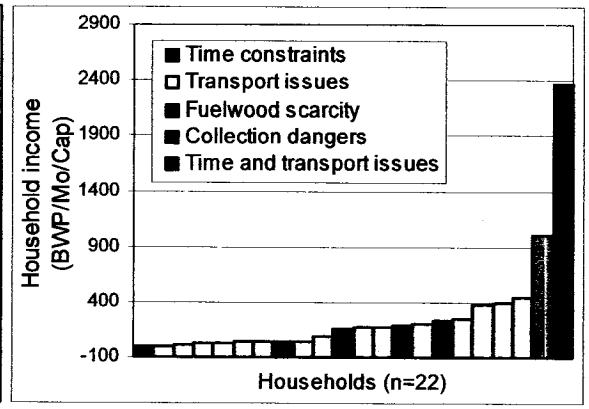


Figure 5.37: Reasons for buying fuelwood rather than collecting by income

5.3.3 Selling fuelwood, buying sugar: new opportunities in the hinterlands

Finally, although potential ultimately exists for conflict between vendors and the needs of non-vending households, the results of the vendor survey indicate that urban fuelwood dependence in Maun is responsible for the generation of important cash-earning opportunities in the hinterland. As most vendors lived in peri-urban and rural areas few had significant alternative sources of cash income; nearly 80 percent obtained half or more of their earnings from fuelwood selling and 60 percent relied on it for all cash income (Figure 5.38). While 20 percent were engaged in either steady formal employment or small business enterprises (Figure 5.39), even these respondents indicated that incomes from these sources were insufficient and all affirmed that income from fuelwood sales was critical to their households. As well, many vendors, particularly those coming to Maun by donkey cart from rural cattlepost residences, did not sell on a continuous basis, but indicated that they bring fuelwood to town only when they need to buy household supplies such as sugar and coffee.

For these vendors in particular, the fuelwood market in Maun represents an important means of improving the welfare of their households. Finally, as noted above, since nearly 40 percent of the vendors surveyed harvested at their own cattleposts, the additional harvesting pressure caused by their vending activities impacts first on their own fuelwood needs, both reducing impacts on neighbours and increasing incentives to manage the resource sustainably.

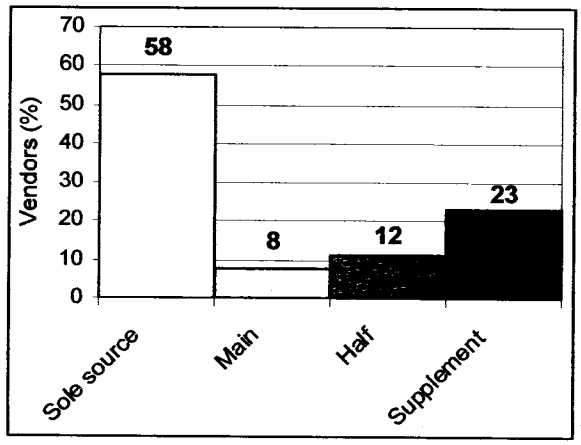


Figure 5.38: Proportional contribution of fuelwood sales to vendors' incomes

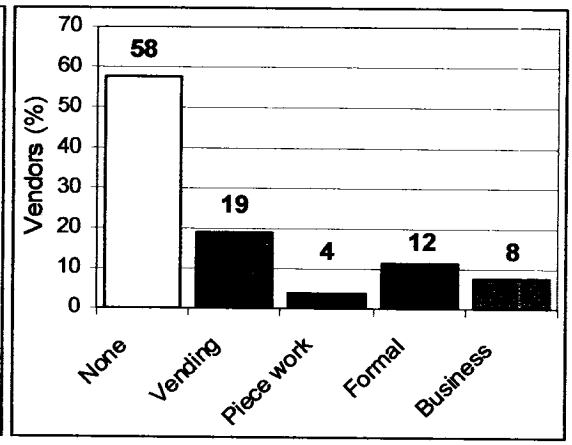


Figure 5.39: Proportions of other income sources among vendors

5.4 Overview

In summary, the results of the household energy, fuelwood collection and vendor surveys of the current research paint a distinctly different, and noticeably more complex picture of fuelwood use and sourcing dynamics than previous models, articulated in academic and government literature, have suggested. In these understandings, poverty-driven urban fuelwood use drives hinterland deforestation causing undesirable ecological change, urban socio-economic stress due to reduced low income energy security and degradation of rural livelihoods dependent on direct use of wood resources. Commercialization of the resource is seen as key factor worsening these impacts as vendors are assumed to harvest predominantly live trees in large amounts, hastening the process of land cover loss and its attendant effects. However, the results of the current study illustrate that, in Maun, use of fuelwood by households of all incomes in response to the relative prices of commercial fuels is associated with modest impacts as harvesters' responses to patterns of abundance, resource access and

household activities, in combination with creativity and flexibility in social and economic arrangements minimise negative ecological, urban socio-economic and rural livelihood effects. Moreover, the minimal ecological impacts of the emerging fuelwood market are thus far significantly outweighed by its positive contributions to urban low-income energy security and rural income opportunities.

In the dominant narrative, fuelwood use is considered to be essentially a function of poverty as low income households rely on this low cost fuel to meet their daily needs by necessity rather than choice, switching to more convenient energy sources as income increases permit such that increases in commercial energy uptake are taken as evidence of reduced fuelwood use. However, the present study finds that while most low income households are able to use commercial fuels as well as fuelwood, its use is remarkably resilient in the face of increasing incomes as exponential increases in household earnings are associated with only incremental reductions in wood energy consumption which, overall, exhibits net stability rather than significant change over time. This persistence is found to be largely due to fuelwood's unique role within the strategic fuel combinations used by households for specific applications, which are determined more by high commercial energy prices than earnings as, in the interest of energy cost reduction, household "ability to pay" is not fully translated into "willingness to pay" below the highest income level.

The continued fuelwood use of low income urbanites has perpetuated traditional concerns over wood harvesting patterns as urban collectors, perceived to be mainly of low-income status with little access to transportation, are assumed to place a premium on the proximity of resources to the relative exclusion of other concerns. Peri-urban dry wood depletion due to the concentration of harvesting pressure due to growth of poor urban populations is therefore expected to lead to live tree harvesting resulting in the outwardly mobile "wave of deforestation" of fuelwood orthodoxy. This dynamic is seen to involve

negative consequences for ecological dynamics (and conservation efforts), the energy security of poor urbanites (and hence equitable urban development) and wood-dependent rural lifestyles (and therefore rural livelihood sustainability). In contrast, however, the results of the current research indicate that, in Maun, a combination of most households' high preferences for deadwood in abundance over proximity and the dispersal of harvesting pressure associated with the range of distances traveled to collect fuelwood results in both moderate and highly dispersed environmental impacts. The potential for negative urban socioeconomic effects, moreover, is significantly mitigated by the resulting increase in peri-urban fuelwood availability along with low income households' creativity in arranging access to motor vehicle transportation such that serious threats to their energy security are generally avoided. Furthermore, as the majority of fuelwood collection in rural areas is conducted at urban households' often far-flung cattleposts where they have recognized rights of access to specific resources and ongoing relationships with neighbouring residents, the potential for negative rural livelihood impacts and urban-rural resource conflict is significantly mitigated.

Finally, traditional narratives of urban growth and fuelwood use have tended to emphasize commercialization of this resource as a key concern as vendors are assumed to harvest generally large quantities of (frequently) live wood with little or no regard to ecological consequences exacerbating negative environmental, socio-economic and livelihood impacts. However, the present study finds that environmental damage caused by Maun's fuelwood market has thus far been modest due to the predominance of dead wood harvesting, the relatively small quantities collected by individual vendors and the relatively diffuse pattern of harvesting sites, many of which are vendors' own cattleposts. Conversely, rather than inducing urban and rural deprivation the market makes significant positive contributions to regional welfare by ensuring urban households' energy security on the one hand and providing important cash-earning opportunities for households in rural areas where

these are extremely scarce.

Overall, while the confluence of fuelwood use and urban growth is typically viewed as a problematic local issue stemming from poverty and mismanagement, this study finds that many local actors are responsive to the patterns of landscape change which have resulted from urban wood consumption (driven by structural factors beyond local control such as commercial fuel prices) and respond with creativity and flexibility in ways which not only mitigate negative effects, but create positive opportunities, particularly for less affluent households.

Chapter 6

6.0 Discussion and conclusions

In this final chapter of the thesis the relationships between the major themes of Chapters 2, 4 and 5 are detailed. The first section presents the discussion which is framed by the key theoretical conclusions of the study which are examined with reference to the significance of the Maun study in the context of state perceptions and policies at the national level. Following the discussion, the contributions and limitations of the current study are presented in the second and third sections and the chapter concludes with a brief discussion of future research opportunities.

6.1 The political ecology of urbanization

Whereas the urban use of rural resources is generally portrayed as a scenario in which locally driven urban demands for materials generate negative effects for hinterland residents, this study finds that resource consumption patterns can be driven by political-economic structural forces emanating from national, regional and international scales as much as, or more than, by household characteristics and other local factors. Furthermore, creativity in urban responses to local social and ecological dynamics can both moderate negative impacts and generate important positive hinterland opportunities.

In Swyngedouw's assessment, the growth of urban centres is predicated on capital "generated through the political-ecological transformation of the city's hinterland" such that urbanization "is closely associated with successive waves of ecological conquest and the pushing outwards of the urban socio-ecological frontier" (1996 p.79). As such, the expansion of urban settlements and attendant growth in their demands for local resources are implicated in the generation of both undesirable ecological change and injustices in the distribution of environmental costs and benefits as urban, sub-urban, peri-urban and ex-urban or rural landuse requirements eventually come into conflict. It is perceived that rapidly changing land

and resource use patterns are likely to create displacement or co-optation of land-users, appropriation of ecological goods and services and marginalization of the less powerful.

Despite some important differences, the stories which emerge from the works of Swyngedouw and others share some fundamental commonalities with the traditional narratives of fuelwood use and sourcing in urbanizing African landscapes. While the former's research, for instance, focuses on the activities of the wealthy and powerful in the context of developed world cities, it also assumes that the resource demands of urbanites more generally place them in an essentially exploitative relationship to hinterlands and their residents wherein the needs of less powerful rural lobbies are not equally recognized. Although dominant fuelwood narratives differ in their focus on the impacts of growing urban poor populations, they too see urban consumption and procurement of this resource essentially as a locally bounded dynamic by means of which urban growth is directly implicated in the degradation of hinterland resources, rural livelihoods and low income urban energy security.

As illustrated by the discussion of the case of fuelwood use and sourcing in Maun elaborated in the preceding chapters, however, the results of the present study indicate that urban households' decision-making around resource consumption and sourcing are, in some cases, significantly influenced by both structural and local factors, which elicit responses that both moderate negative effects and generate new opportunities for rural residents. The three key findings underpinning this conclusion are that, first, as evidenced by the influence of commercial fuel prices on urban fuelwood consumption, rural-urban flows of even the most local and traditional resources can be significantly driven by political and economic factors of external origin. Second, as illustrated by household responses regarding fuelwood collection, urban resource seekers' sensitivities to urban-rural socioecological gradients of

abundance and opportunity generated by past patterns of settlement growth in urbanizing landscapes can result in resource harvesting patterns which reduce rather than promote conflict. Finally, as both household and vendor responses demonstrate, emphasis on the implicit potential of urban resource abstraction to threaten peri-urban and rural needs can obscure the emergence of important livelihood opportunities for hinterland residents in providing for urban household requirements.

6.1.1 Local energy, national policies: fuelwood use in a broader context

While the study focused on one resource in a particular context, the patterns observed in Maun clearly indicate that even in relatively small and remote secondary African towns, consumption of the most traditional and indigenous materials can be significantly influenced, if not primarily determined, by factors originating at national or broader scales. As the example of fuelwood use amply illustrates, local characteristics, such as household incomes or cultural preferences, may in some cases be less important drivers of urban consumption of hinterland resources than other elements like the prices of alternatives determined by regional and global markets and (un)influenced by the decisions of national policy makers. As such, effective and complete understanding of issues and conflicts pertaining to ostensibly "local" and "traditional" resources may be precluded by a failure to recognize that actors, particularly in urban settlements, are both affected by and responsive to political and economic realities far beyond the immediate spheres in which collection and consumption occur.

Although such an observation is far from revolutionary in the context of past political ecological research, it is a message of some importance with respect to academic and government understandings of household energy use decision-making. While some broadening and refocusing of theoretical perspectives has occurred since the heydays of the "fuelwood crisis" in the 1970s and 80s, recent urban as well as rural research has continued to focus almost exclusively on quantitative modeling of fuelwood consumption as a function

of household characteristics such as size, dwelling type and location and income (e.g. Biran et al 2004; Brouwer and Falcao 2004; Dovie et al 2004). In addition, significant attention has also been paid to other local factors such as the adequacy and reliability of commercial energy supply chains. The focus on differences between local households and settlement-level patterns of accessibility as primary determinants of fuel use dynamics, however, has tended to obscure commonalities between households in terms of both micro-level ways in which individual fuels are put to strategic uses, and the macro-scale factors influencing these decisions.

As chapter 4 details, the effects of these trends in the majority of fuelwood research to date on state actors' understandings of and approaches to fuelwood use issues is readily apparent. In Botswana, government has largely operated on the persistent theoretical assumption that individual households will switch from cheaper to more expensive fuels which offer increased convenience more or less as soon as they are: 1) able to afford to switch from fuelwood; 2) have convenient and reliable access to commercial energy sources; and 3) are aware of their benefits. As prior policy commitments have prevented serious consideration of price moderation in aid of the first, government has focused on the improvement of energy distribution networks and, through public "education" on the uses and cost-efficiency of commercial fuels, sought to "promote rational least-cost choices" (MFDP 2003, p.168). Due to the prevalent use of aggregated statistics and the lingering influence of the "energy ladder" model of urban fuel switching (FAO 1993), indications of increased gas and electricity use over the past 15 years have been taken as signs of an overall transition away from fuelwood in the residential energy sector.

The patterns observed in Maun, however, describe a notably different scenario. Not only were households found to be aware of fuelwood alternatives, the majority used more than one on a daily basis demonstrating ability to both afford and access commercial fuels.

Despite the popularity of electricity and gas, however, fuelwood remained the most widely used energy source across a wide range of incomes, and was most often employed in combination with these others. Moreover, most households had used modern energy sources for a significant period of time, and both past and planned energy use patterns indicated a tendency toward stability rather than change for all fuels. Ultimately, the results illustrate that fuelwood use in Maun persists mainly due to the high (and in the case of gas, erratic) unit prices of commercial fuels determined by international and regional markets. Across the majority of the income spectrum, household efforts to economise on expenditure rather than optimize convenience resulted in strategic use of multiple fuels for specific purposes and under particular conditions such that "ability to pay" was not directly or completely translated into "willingness to pay" high energy prices except among the most affluent households.

It is evident from these results that state actors will likely continue to find urban fuelwood consumption an intractable issue if attempts to influence household energy use remain exclusively focused on the local level. While clearly adequate distribution networks for, and household familiarity with, commercial fuels are critical to their uptake, the current evidence indicates that, even in remote Maun, these are no longer key drivers of fuelwood use. Although the evidence suggests that fuelwood will likely remain an important energy source for many households in at least the near future, the extent to which households are sensitive to fuel prices suggests that their moderation may ultimately be key to any efforts toward prevention or resolution of perceived or real conflicts between urban energy needs and national socioeconomic and ecological conservation goals.

6.1.2 Changing landscapes and household responses

While urban ecologists have explored the effects of urban growth on ecological dynamics across the urban-rural continuum, less attention has been paid to the ways in which

the resultant environmental gradients impact subsequent human-environmental interaction in urbanizing landscapes. As well, the influence of socio-cultural unevenness on the decision-making patterns of urban resource seekers has been frequently underemphasized and often ignored. In this context, oversimplification of urban sourcing dynamics and underestimation of urbanites' sensitivities to hinterland patterns of socioecological characteristics have resulted in models of resource abstraction in urbanizing landscapes which tend to (over)emphasize socioeconomic and environmental conflict and degradation. In contrast, the results of the Maun study reveal that urbanization processes generate changes in hinterland landscapes which have both environmental and sociocultural components. Moreover, these forces do not act in a uni-directional fashion, as the results of urban-driven ecological modification of peri-urban and rural landscapes, as well as evolutions in urban-rural socio-cultural relationships also recursively exert significant influence upon the resource-seeking behaviours of urbanites. Moreover, creativity and flexibility in these responses to socioecological change can be responsible for considerable reductions in both the socioeconomic and environmental impacts of urban resource consumption.

As discussed in chapters 4 and 5, "traditional" articulations of urban fuelwood harvesting dynamics have relied upon relatively simplistic models of urban resource abstraction which, while recognizing the impacts of harvesting on environmental patterns of wood abundance, assume sociocultural homogeneity across the landscape of possible harvesting sites on one hand and ignore the potential for creativity in local responses on the other. While current government understandings of the issue allow for greater nuance than the most "orthodox" model of the fuelwood crisis which predicted a more or less linear relationship between the growth of poor urban populations and levels of peri-urban deforestation, they nonetheless remain implicitly reliant on the general tenets of the dominant, proximity-driven narrative. In particular, the perceived threat posed by urban

fuelwood dependence to the key national development goals of ecological conservation, equitable urban socioeconomic development and the improvement and security of rural livelihoods is ultimately predicated on the assumption that, in the eyes of urban harvesters, "wood is wood" as long as it is close to home. As distance is assumed to be the ultimate determinant of collection site choices, little room is left for consideration of other possible concerns such as ease of collection, wood quality and conflict avoidance.

The results of the Maun household fuelwood sourcing survey presented in chapter 5, however, paint a distinctly different picture. First, as expected, the processes of urban growth in this area, such as residential, commercial and agricultural development along with fuelwood and other resource collection, have generated a gradient of increasing deadwood abundance with distance from the urban core area. This environmental pattern, however, is not simply being amplified to the point of deforestation by a poor, desperate population of wood consumers, but rather, at quite an early stage in its development[40] already exerts a significant influence on decision-making around some of the very activities by which it was created. The distances to which urban fuelwood seekers were willing to travel to access abundant stocks long before deadwood, much less tree cover, resources of urban fringe areas have been exhausted reveals that urban households are highly sensitive to hinterland environmental change. As such, the relationship between urban fuelwood collectors and the hinterland environment is revealed as an interactive process rather than a uni-directional trend of human impacts on the urbanizing landscape.

Second, creativity and flexibility in the responses of urban, particularly low income, households to environmental patterns of fuelwood abundance resulted in harvesting arrangements which reduced the potential for deprivation and conflict both among Maun

[40] The majority of Maun and its immediate and peri-urban environs, in wet and dry areas alike, retain landcover similar in type and density to that observed in ecologically similar rural areas of Maun's hinterland

harvesters and between urban and hinterland residents. On one hand, in addition to the reduced pressure on peri-urban stocks associated with many households' avoidance of these areas, innovative social arrangements alleviated either problems with access to transportation or their effects, ensuring fuelwood availability for many households with low cash earnings. On the other, urbanites' sensitivities to socio-cultural patterns of resource accessibility and usufruct rights served to minimize negative impacts on the livelihoods of rural residents. In this context, the results indicate that urbanization processes in this case are implicated in the creation of not only ecological, but also sociocultural patterns of landscape heterogeneity of relevance to urban resource seekers. In essence, due to the prevalent practice of maintaining cattle posts[41] and the primarily rural-urban migration driven nature of settlement growth in Botswana, urbanization has resulted in increased sociocultural connectivity between urban and rural areas as many, if not most, urbanites retain simultaneous identities as rural residents. As responses to peri-urban competition and scarcity induce household collectors to travel further from town for fuelwood supplies, these considerations come to exert significant influence on harvesting site choices. Urbanites seeking to avoid competition near Maun, largely avoided conflict in the rural areas as well, and hence combined fuelwood collection with trips to the cattleposts, reducing the costs of collection, decreasing competition with rural resource claims and diffusing harvesting pressure across wide areas.

Ultimately, it is evident that potential for conflict remains as the growth of both urban and rural populations result in overall increases in harvesting pressure. However, it is clear that, despite a near total vacuum in fuelwood-related resource management in Botswana, residents have developed local solutions which, for the time being at least, moderate this problem. Policy makers looking to address fuelwood harvesting issues with respect to future growth-related problems would be well advised to recognize the contextual nature of

[41] 82 percent of household respondents indicated their families had one or more cattle posts

collection patterns and build on the solutions and relationships already in existence. This should be done in ways which focus on enhancing the capacities of peri-urban and rural residents to voice their concerns and influence resource management patterns at the local level rather than threatening urban access to affordable energy which, in the first place, may not be problematic.

6.1.3 Deprivation or opportunity? Urban needs and rural livelihoods

While many studies have explored the negative impacts and conflicts associated with patterns of urban resource abstraction the results of the present work highlight the significant potential for the generation of increased peri-urban and rural household welfare opportunities in providing for urban needs. Particularly in secondary African towns, where hinterland cash income prospects are generally far and few between, the meeting of urban demands for local resources can offer important chances for residents of these areas to obtain the means to purchase important household supplies not otherwise available. Naturally, the potential for conflict between urban consumption and rural livelihoods cannot be dismissed, but as the Maun example illustrates, a misguided focus by state and other actors on solely or mainly negative aspects can not only obscure but endanger positive trends, simultaneously leading to conflict between locals and the very government bodies ostensibly attempting to protect their interests.

Government assessments of fuelwood trading in Botswana have rarely mentioned its potential to make positive contributions to the welfare of low income peri-urban and rural populations whose welfare it has been attempting to beneficiate for more than 30 years. On the contrary, it is assumed (perhaps with some truth in certain areas) that as vendors harvest live trees in large quantities, their activities ultimately exacerbate existing fuelwood scarcities around growing settlements. Fuelwood commercialization is therefore held responsible for worsening undesirable ecological change increasing threats to the energy security of low

income urbanites and the viability of rural livelihoods. It is for this reason that discussions of urban fuelwood concerns in state publications and government offices frequently focus predominantly on potential "solutions" to the emergence of fuelwood markets which are generally viewed as problematic *per se*.

In contrast to this view, however, the situation observed in Maun suggests that, at least at certain levels of urbanization and fuelwood commercialization, positive impacts may outweigh negative effects, and a curtailing or reduction of fuelwood selling may, ironically, imperil the welfare of many of the very households which vendors' activities are seen to threaten. Whereas the ecological impact of the vending community was found to be minimized by the nature of most vendors' origins, levels of participation and methods of fuelwood procurement, the service they rendered to many Maun households provides a critical means of meeting daily basic needs at these residences when various constraints prevent access to affordable energy. Moreover, the vendors primarily originated from the peri-urban and rural areas themselves and were frequently only occasionally engaged in this activity as dictated by the needs of their households for purchased supplies. At the same time, revenue obtained from fuelwood sales represented a critical, and often unique, source of cash revenue for all vendors encountered. In the absence of the fuelwood market, many vendors' households would find it difficult to purchase locally unavailable supplies such as sugar, tea, or manufactured clothing items.

In this context, as in the case of household self-collection of fuelwood, it is apparent that potential for conflict will grow with increases in both household and vendor harvesting pressure. Nonetheless, the existence and effectiveness of local solutions offer an opportunity to build on positive trends rather than merely attempting to avoid negative impacts. Such an approach is likely to be necessary if future urban growth is not to result in some loss of the sustainability in the use of fuelwood resources and both urban and rural welfare.

6.2 Research contributions

The significance of this study of the dynamics of fuelwood use and sourcing in a rapidly growing secondary African town has both theoretical and practical aspects. In theoretical terms, the study contributes to the ongoing efforts of urban and political ecologists to develop a more nuanced understanding of the socioecological development of urbanizing landscapes by illustrating the application of an ecological theoretical model and its relevance to understanding human environmental behaviour in such contexts. In particular, the study illustrates both the potential and the relevance of increased dialogue between these two subfields, offering urban ecologists a means of integrating human dynamics into this successful ecological model, and political ecologists a model which both increases the *ecological* content of urban political ecology and integrates knowledge gained from the valuable rural, urban and peri-urban works to date.

In the African context, the work contributes to the understanding of the processes of urbanization, the socio-ecological aspects of which are poorly understood particularly with respect to the development and growth dynamics of secondary towns which have been under-explored as yet. In particular, the study offers an important contribution to theoretical understandings of fuelwood use and harvesting dynamics in urbanizing African landscapes. First, the study broadens the literature beyond the focus on rural villages and larger cities which has predominated, offering a view into the articulation of these dynamics at an intermediate stage of settlement growth. Second, the exploration of macro-level variables offers a consideration of broader scale influences on household resource use decision-making which have rarely been considered in the fuelwood context. Finally, through greater attention to empirical geographic patterns of fuelwood sourcing and the role of landscape characteristics in directing decision-making in this area, the study offers an insight into the importance of place-based characteristics of harvesting sites where simple spatial dynamics

have received the majority of attention to date.

In practical terms, the study's focus on household decision making parameters, the history of policies related to the fuelwood issue and their effects in urban centers and their hinterlands offer policy makers in Botswana as well as elsewhere an increased ability to critically assess the ground level effects and likely future impacts of current policy trajectories. In this sense, the research contributes also to enhancing the ability of African policy makers and planners to guide urban and rural development in ecologically desirable and socially equitable directions and avoid negative policy externalities and state-local conflict.

6.3 Research limitations

The key limitations of this study are related to the limited linguistic and cultural fluency of the primary field researcher, the political nature of the issue under study, logistical constraints and the paucity of other research on related issues in the study area. First, although the assistance of a local research assistant made it possible to overcome the barriers posed by the multi-lingual nature of the area, the necessity of interpretation by a third party made it difficult at times to obtain clarification of a response or additional information on particular points of interest. As such, a fair amount of detail was lost from some of the interviews conducted which may have allowed for greater nuance in the analysis.

Second, due largely to recent local and central government actions, natural resources management issues in the Maun area are currently quite contentious. For this reason, despite attempts to ensure triangulation by various means, some responses may have been biased, reflecting respondents' perceptions of social and/or official acceptability rather than actual actions or opinions.

Third, due to time constraints and the widespread nature of fuelwood harvesting sites it was not possible to directly obtain information on conditions at these sites themselves

except in the immediate environs of the town. While it was initially hoped that such information could be obtained by participant observation and local interviews in these areas, in practice the research was, by necessity, limited to direct and interview based exploration of peri-urban conditions. As it was necessary to rely on urban respondents for characterization of more distant sites, triangulation of information relating to scarcity and conflict in these areas was not possible.

Fourth, again due primarily to time and logistical constraints, direct measurement of ecological characteristics of Maun's urbanizing landscape was not practicable. While it was initially hoped that such data might be collected in the course of the study, the time consumptive nature of the document analysis, key informant interviews and the conduct of the surveys prevented field measurement on the one hand, while, conversely, it was established that in the Botswana context, estimation of biomass from remotely sensed data is unreliable.

Finally, as little related research has been conducted in this area, it was not possible to compare the results of the current study with previous findings. As such, findings with respect to temporal trends are limited to the relatively small number of households sampled during the field work such that the conclusions drawn with respect to these trends are not as robust as they would be were it possible to compare the current results to baseline information.

6.4 Opportunities for further research

Finally, the findings of the study suggest a number of opportunities for future research into the socioecological development of urbanizing landscapes. First, it would be useful to capture the rural experience of the dynamics explored in this thesis in greater detail. Due to the limitations of the study, it was not possible to pursue an in-depth investigation of perceptions of urban fuelwood harvesting dynamics among (particularly non-vending) rural

households. However, such information is necessary to the achievement of a more nuanced understanding of where, and for which actors urban wood consumption trends are most problematic and most beneficial.

Second, greater attention to ground-level ecological patterns generated by fuelwood harvesting across the urban-rural continuum would allow for a more detailed and robust and detailed analysis of the relative influences of social versus environmental factors in the decision-making patterns of individual harvesting households. Similarly, a more nuanced focus on household day-to-day decision-making around energy use would shed significant light on the ways in which individual fuels are used in different ways at different times and under different conditions by households in various circumstances. In essence, the full complexity of fluctuations in energy use and sourcing decisions will not be understood without in-depth exploration of the ways in which these dynamics are influenced by ongoing shifts in internal household dynamics such as who is cooking a particular meal, when are paychecks received, what other activities necessitate trips to the cattlepost (or other rural areas) etc.

Finally, it is evident from the results that dynamics of the kind observed with respect to fuelwood may well occur in the context of the use and sourcing of other urban resources as well. Just as urban-rural gradients have been observed with respect to many and diverse ecological characteristics, so the harvesting of other resources may also be influenced by (socio)ecological patterns of abundance and other landscape characteristics generated by urbanization processes. As such, the theoretical approach taken in this study may shed additional light on other urban-rural resource dynamics where conflict is experienced or anticipated. In the same sense, the potential broader scale drivers of urban consumption of other locally-derived resources might also be explored. Just as urban fuelwood use may often be driven by exogenous factors, so also other urban consumption patterns may be

misunderstood due to over-emphasis of household or other local determinants.

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APPENDIX A: SUMMARY OF KEY INFORMANT INTERVIEWS

Location	Organization	Date (2006)
Gaborone	DTRP	June 1
Gaborone	UB	June 1
Gaborone	DFRR	June 5
Gaborone	FAB	June 5
Gaborone	EAD	June 6, August 21
Gaborone	AQCT	June 6
Gaborone	UNDP	June 6
Gaborone	MEWT	June 7
Maun	TLB	July 5
Maun	TLB	July 5
Maun	DFRR	July 6
Matlapaneng	HOORC	July 6
Matlapaneng	HOORC	July 6
Maun	HOORC	July 7
Maun	TLB	July 20
Maun	TLB	July 21
Maun	DFRR	August 15
Maun	BPC	August 16
Maun	TLB	August 16
Gaborone	BPC	August 22
Gaborone	EAD	August 22

APPENDIX B: HOUSEHOLD SURVEY QUESTIONNAIRE

Residence type

1) Traditional hut Cement block Brick

Household structure

2) What is your name?

3) What is your postal address?

4) What is your position in this household?
Male: female:

5) How old are you?

6) Who is the head of the household?
Male: female:

7) How many adults and children normally eat dinner together in the household?
adults: children:

8) Who usually does the cooking?

Residence history

9) What do you consider to be the edge of Maun?

10) How long has your household lived here?

11) Where did your household live before this place?

12) Do you have additional residences? Where?

home: cattle post:

b) How often do you bring firewood back to this residence from there?

c) How much do you bring and what do you use for transport?

Energy use

13) Do you use electricity?

b) what for?

14) Would you ever use an electric stove for cooking? Why/why not?

15) Do you use gas?

b) how often for cooking? how often for heating?

c) how often to heat water?

16) Do you use firewood?

b) how often for cooking? how often for heating?

c) How often to heat water?

d) Do you use gas and wood to cook different things?

17) Have you always used the same kind of energy for cooking?

b) Why did you change?

18) What do you think is the best fuel for cooking and why?

19) What do you think you will use for cooking in the future and why?

20) Who usually decides which type of fuel to use?

Fuelwood consumption and sourcing

21) How many weeks would a donkey cart load of wood last for your household?

22) What kind of wood do you use, why?

23) How often do you buy wood from someone else?

b) Who/where do you buy it from?

c) Why do you buy it instead of collecting it yourself?

d) Who normally goes to buy the wood?

e) How much do you spend on wood in a month?

24) How often do you collect wood yourself?

b) Who normally collects the wood?

c) Can you draw on this map where you go to collect the wood?

d) Why do you go there?

e) Is it easy to find wood there?

f) Do you always go to the same place? (why/why not?)

g) What do you use for transport?

h) Can you get dead wood or do you have to cut it?

i) Do many other people get firewood from the same place?

j) where do they come from?

k) is there enough for everyone?

l) What are the main difficulties with firewood collection?

m) Do you think that you will have problems getting firewood in the future? Why/Why not?

n) How often do you sell wood to other people?

Socio-economic status

25) How much cash income does the household have per month?

26) What are the main sources of this income?

27) Which of the following assets does your household own?

a) cattle (Dikgoma) ? goats? donkeys?

horses?

chickens?

b) arable fields (tshimo)

c) borehole (sediba)

d) pick-up (koloi)

e) donkey cart

f) gas stove

g) radio

h) TV

28) May I take a picture of you with your home?

-GPS log:

APPENDIX C: VENDOR SURVEY QUESTIONNAIRE

1) Where do you live in Maun?

2) Do you have another residence outside of Maun (cattle post, etc.)?

3) Which one do you stay at most often?

4) Where do you sell the firewood usually?

5) Who are your main customers? (people from where?)

6) How long have you been selling firewood?

7) How much do you sell (per week?) (units?)

8) What other kinds of work do you do?

9) Has the demand for firewood changed since you have been selling? How?

10) Has the price changed?

12) Where do you get the firewood come from? (please draw on map)

13) How long have you been getting it from there?

14) Is firewood still easy to get there?

15) Is the wood available of good quality?

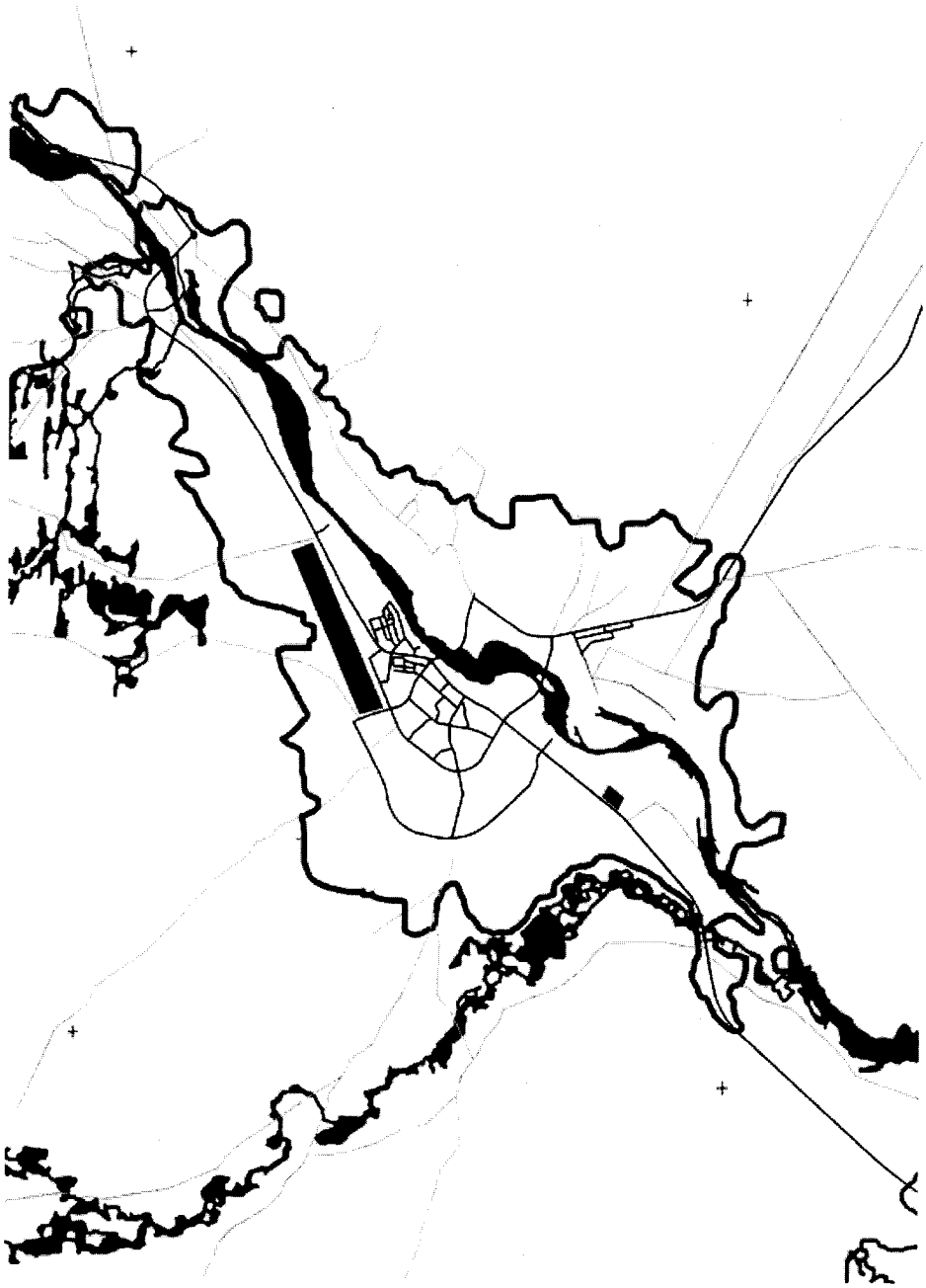
16) What kind of wood do you harvest?

17) Why this/these kinds?

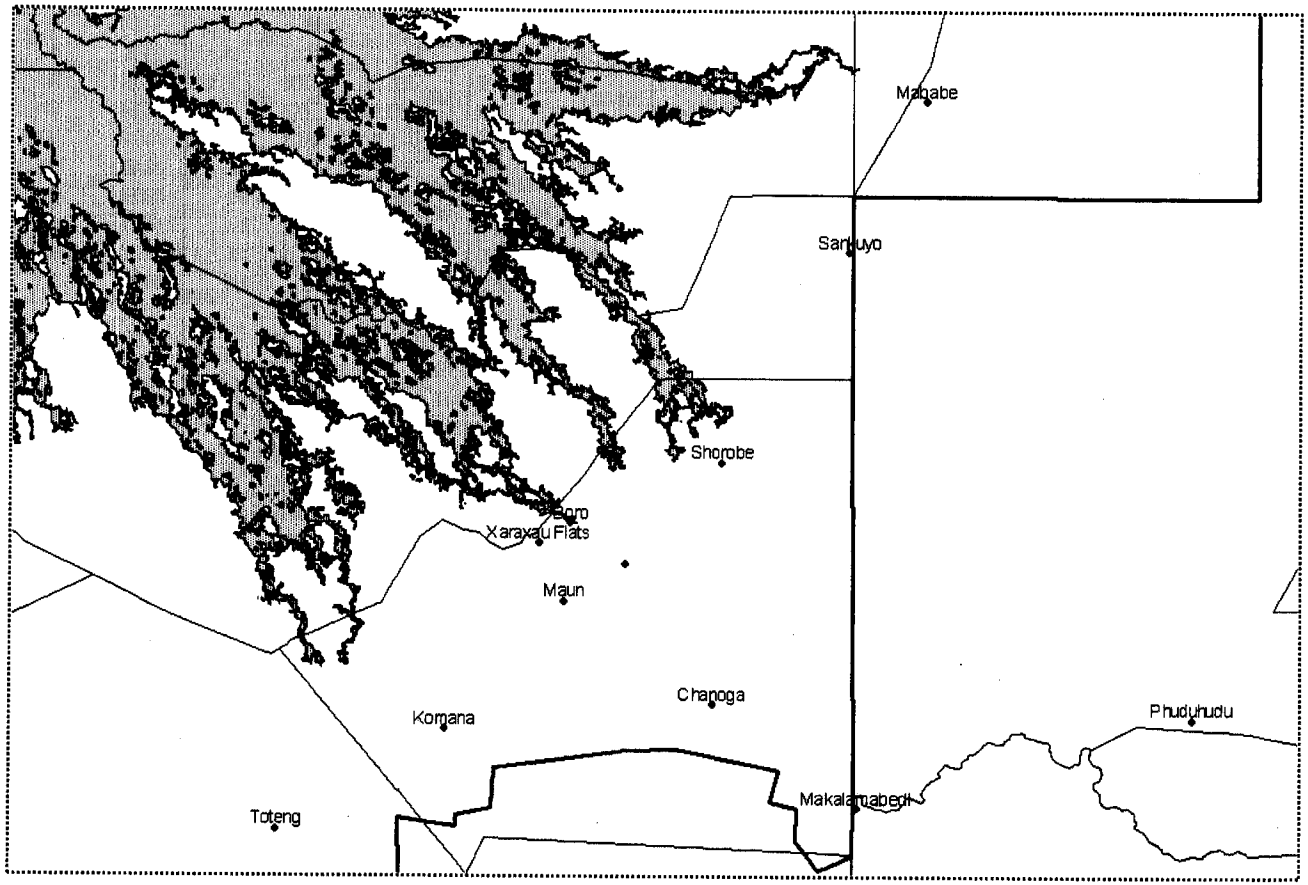
18) Is there anything that makes it difficult for you to get firewood?

GPS LOG:

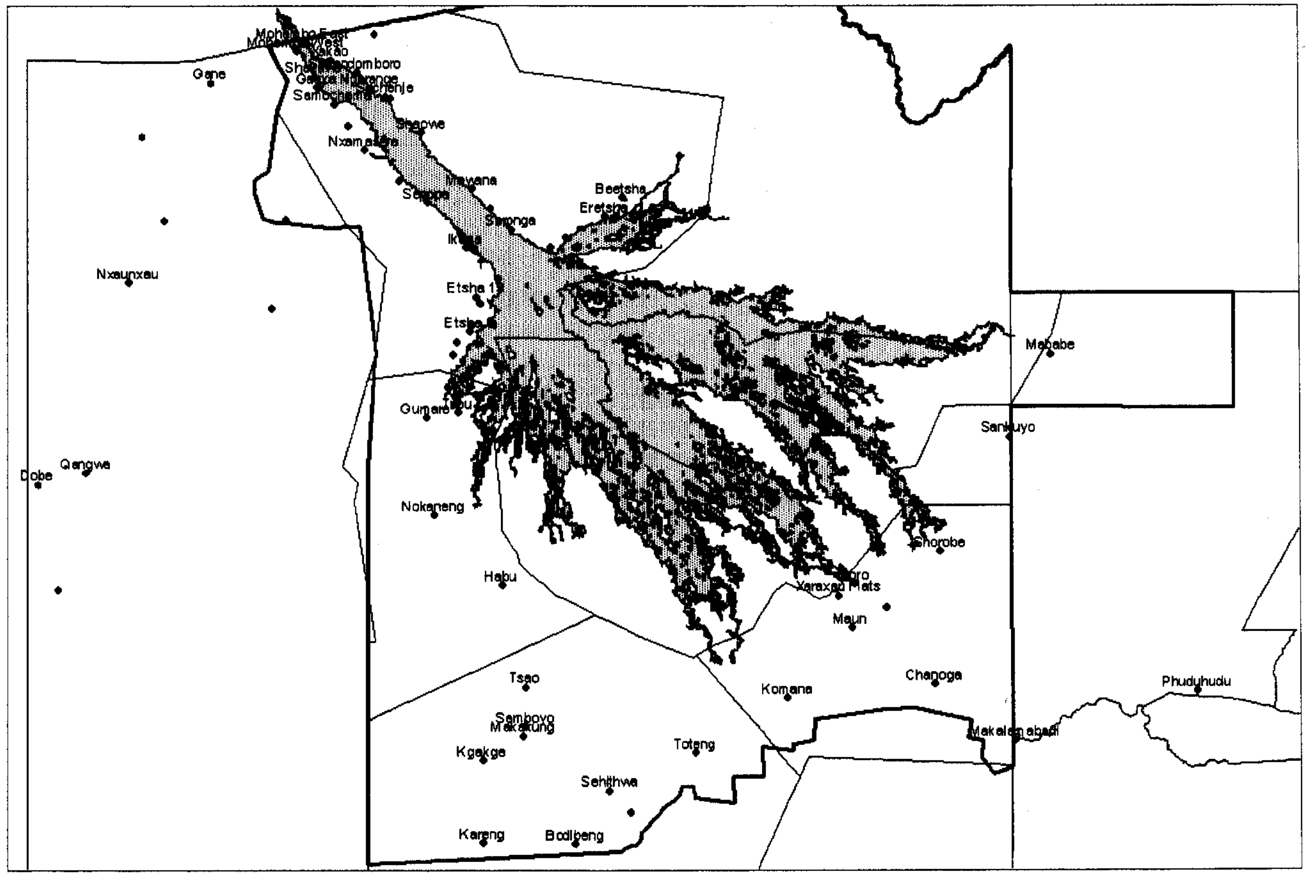
APPENDIX D: PARTICIPATORY RAPID APPRAISAL MAPS



PRA map 1: Urban Maun and immediate environs



PRA map 2: Maun in southern Ngamiland context



PRA map 3: Maun in Ngamiland context