Land Use Plans and Wildlife-Inflicted Crop Damage in Zambia's Game Management Areas

A Research Report presented to the Department of Agricultural Economics and Extension Education of the University of Zambia.

BY

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LIST OF ABBREVIATION

CSO	Central Statistical Office
FAO	Food Agricultural Organization
GMA	Game Management Area
IGMAW	Impact of Game Management Areas on Household Welfare
NGO	Non Governmental Organization
NP	National Parks
NPWS	National Parks and Wildlife Services
SEA	Standard Enumeration Area
SPP	Strategic Planning Process
WB	World Bank
WWF	World Wide Fund for Nature
ZAWA	Zambia Wildlife Authority

ABSTRACT

Land Use Plans and Wildlife-Inflicted Crop Damage in Zambia's Game Management Areas

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Previous studies have shown that Game Management Areas (GMAs) are associated with high incidences of wildlife-inflicted crop damage. Although land use plans are hoped to help minimize such damages, their effectiveness is yet to be determined. Often, in Zambia land use planning and evaluation is constrained by data scarcity. On paper, land use plans are supposed to be evaluated every 5 years but this has never happened. Currently only two GMAs have land use plans.

This study aims to determine the impact of land use planning on wildlife-inflicted crop damage in the GMAs using data from the 2006 "Impact of Game Management Areas on Household Welfare (IGMAW)" survey. The IGMAW survey was conducted by the Central Statistical Office (CSO) with financial and technical support from the World Bank (WB). It covered areas adjacent to four national park systems - Bangweulu, Kafue, Lower Zambezi and Luangwa national parks - and involved 2,768 household interviews *and 135 community interviews. A Double Hurdle Model was used to estimate the impact* of land use plans on the probability and extent of wildlife-inflicted crop damage. The results show that crop damage is higher in GMAs (compared to non-GMAs) and that land use plans could be an effective tool to significantly reduce the likelihood of such damage. The probability of crop damage can be reduced by as much as 4.77 percent and 8.74 percent in prime and secondary/specialized GMAs, respectively. The effects are significantly greater and more significant if the community sets aside some land for wildlife habitat as part of the implementation of the plan.

These findings suggest that there is merit in the current drive to develop and implement land use plans as means to minimize human-wildlife conflict such as crop damage. Minimizing this conflict in the agriculture-based livelihood systems found in GMAs is one of the key ingredients for the successful implementation of sustainable wildlife conservation models. This is especially critical as Zambian conservation policies do not have an explicit provision for compensation in the event of damage from wildlife.

CHAPTER ONE
INTRODUCTION

1.1 Background

Basic needs of most rural poor households – such as food, water, fuel, clothing and shelter – almost always have to be met from the land around them. However, population growth means that the capacity of the land to support all these demands has diminished. The way land is used has changed markedly to meet new demands; this change has brought about new conflicts between competing uses of the land and between the interests of individual land users. Development of new farming areas competes with forestry, water supplies and wildlife. This identifies the need to develop land-use plans to guide community allocation of the land resource among the competing, and often conflicting uses. This is especially critical in Game Management Areas (GMAs), where humans are expected to co-exist with wildlife.

GMAs are buffer zones around National Parks (NP), in which licensed safari and subsistence hunting is permitted (Fernandez et al., 2008). They are communal areas in which people live by semi-subsistence agriculture, while also coexisting with wildlife. Many methods have been used to drive away the animals such as building of fence lines, use of fires (e.g. elephants get irritated by the smell of smoke), and growing of chilli e.t.c. However, these techniques are merely effective to drive away wildlife that are not used to these methods while those that are used are not so easily tricked.

In most communities in the Lupande GMA, farmers rely on beating tins and drums to scare elephants from their fields. In the Malama chiefdom, three electric fencing schemes were implemented in 1997 and 1998 but the high repair, maintenance and security demands made this potentially effective method unsustainable. Policing, through use of village scouts, has been shown to enhance wildlife conservation but not necessarily crop damage (Osborn and Parker, 2002). In some cases, such as in the Meru Conservation Area in Kenya, guarding by family members has been tried (Otuoma, 2004). However, this method is not only dangerous and labor-intensive but it was also found not to be fully effective in reducing wildlife-inflicted crop damage.

One of the most effective solutions to wildlife-human conflict in conservation areas is a combination of land use planning and community-based natural resource management. Land use planning is defined as a coherent set of decisions about the use of land and ways to achieve the desired use. It is the systematic assessment of land and water potential, alternatives for land use and eco and social conditions in order to select and adopt the best land use options (Sombroek, 1993; FAO, 1993). In Zambia, land use planning in game management areas has been promoted and facilitated by the Zambia Wildlife Authority (ZAWA) since around 1998. Observed high levels of crop damage by wildlife and wildlife killings by rural households have provided the need to accelerate the implementation of land use plans in the GMAs (Fernandez et al., 2008). The incidence of crop damage in the Lupande GMA, as was reported by Osborn and Parker (2002), is mainly caused by elephants followed by hippos, baboons, bushpigs and bushbucks. Also most farmers reported losses to kudus, monkeys, porcupine and other small mammals (see Figures 2, 3 and 4 in the appendices).

1.2 Problem Statement

Previous studies have shown that GMAs are associated with high incidences of wildlife-inflicted crop damage (Fernandez et al., 2008; Osborn and Parker, 2002; Jonas, 2006; WWF, 2008). Many methods of curbing crop damage have been used and their effectiveness has been documented. ZAWA uses Land use planning as one of the methods to curb crop damage. Often in Zambia, land use planning and evaluation is constrained by data scarcity. On paper, land use plans are supposed to be evaluated every 5 years but this has never happened (ZAWA). Land use planning has been recommended in many studies (Boer and Baquete, 1997; Otuoma, 2004; Pittiglio, undated) but empirical evidence of its effectiveness in reducing crop damage remains very limited.

In some countries like in Nepal (WWF, 2007), communities in an area with reasonably good land-use patterns experienced half the economic damage from human wildlife conflict as two other areas with less effective land-use patterns. Proper Implementation and effective enforcement have to accompany the plans. In Riau, Indonesia, the lack of effective enforcement of the plan did not reduce the levels of wildlife-inflicted crop damage.

1.3 Objective

1.3.1 Overall Objective

The overall objective of the study was to determine the impact of land use planning on wildlife-inflicted crop damage in Zambian GMAs.

1.3.2 Specific Objectives

Specific objectives were to:

i) Identify land use plans and level of their development by various communities in Zambia's GMAs; and
ii) Determine the effectiveness of such land use plans at curbing crop damage caused by wildlife.

1.4 Rationale

Currently there is no compensation for households that suffer losses from crop damage in Zambia's GMAs (Fernandez et al. 2008). Community-developed and community-driven land use plans are an important way to reduce land use conflicts threatening natural resources in GMAs. The driving force in planning has always been either the need to improve management or the need for a different pattern of land use dictated by changing circumstances. Land use planning is useful when the need for change in land use, or action to prevent some unwanted change, is accepted by the people involved.

Therefore this study will provide information on land use planning strategies that will help community members to work together and learn to co-exist with wildlife which will lessen the probability of crop damage thereby enhancing food security.

1.5 Organization of the Report

This report is arranged as follows. Chapter one constituted the introduction, which centers mainly on the background of the study, followed by problem statement then objectives and the rationale of the study. Chapter two focuses on literature review on the benefits of land use planning followed by institutional and policy setting then evidence of crop damage and finally theoretical framework. Chapter three looks at the methods and procedures which look at data collection, study sites and model specification. Study findings are presented and discussed in chapter four and finally chapter five contains the study conclusions and recommendations.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

The literature review will focus on the following; Benefits of land use planning, Institutional and policy setting, evidence of crop damage and finally the theoretical framework.

2.2 Benefits of Land Use Planning

The purpose of land use planning is to select and put into practice those land uses that will best meet the needs of the people while safeguarding resources for the future. Planning provides guidance in cases of conflict between different land uses (FAO, 1993). In this case there is conflict of land use between the rural community in the GMAs and the Government who are trying to conserve wildlife.

Better agricultural practices are adopted with land use planning which can lead to higher crop yields. Also land use planning helps community members have better knowledge of their village boundaries, for example they can identify the boundaries with wildlife protected areas and will also know the extent and status of the natural resources in their village. In addition, community members will know that some species which they were taking for granted are recognized as important internationally and so they will be conscious of taking care of them.

It should be noted that land use planning can be achieved gradually with the participation of the rural community because it is difficult or undesirable to enforce change but very important to stimulate it. Land use, however, does not end at indicating the best use of land but includes putting in place measures to be taken in order to achieve the intended results.

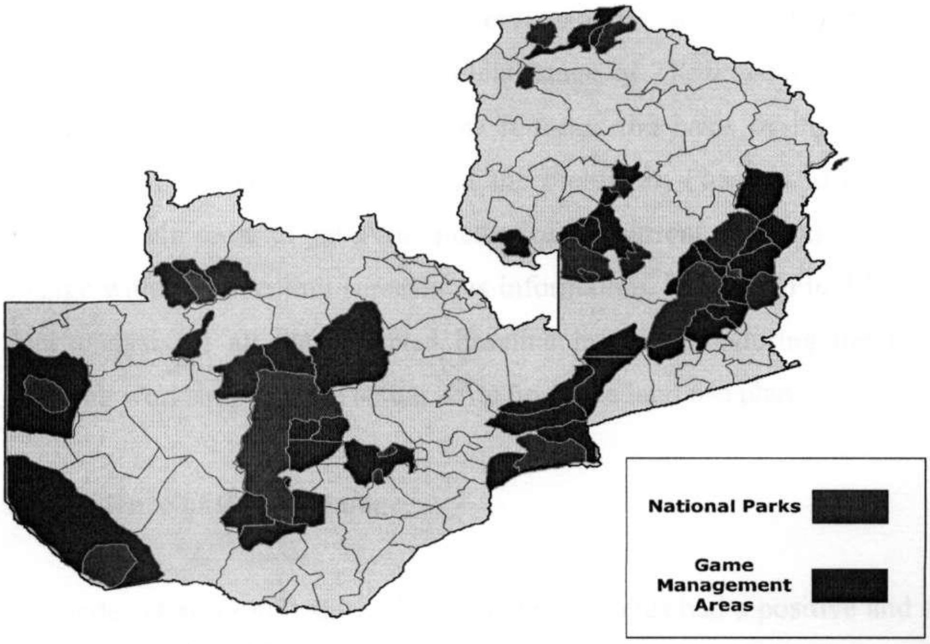
2.3 Institutional and Policy Setting

Studies from a number of societies such as Kenya, Nepal, Java in Indonesia and Thailand suggest that indigenous people do adopt sustainable land use practices when the necessary policy and institutional supports are available. The Government of Zambia accepts responsibility for conserving all wildlife and recognizes the role it plays in sustainable development of the country including those species that may be in conflict with human interests. Wildlife conservation in this country is governed by The National Parks and Wildlife Service (NPWS) Act No. 10 of 1991, which allows the President to declare certain areas of the country as NPs and GMAs.

The role of the Government is to develop a cost effective, adaptive legal and administrative institutional framework for managing NPs and wildlife. It has to draw up plans based on clear policy objectives for the management of the resource, and the development of the industry based on it, for approval by the minister. It has to maintain and enhance Government's commitment to problem driven research and monitoring of the ecological and socio-economic parameters influencing sustainable wildlife management and the growth of a viable industry based on it. ZAWA is responsible for implementing Government policy on wildlife. Preparation of land use plans adopts the standard format determined by ZAWA.

There are currently 35 GMAs in Zambia, distributed around the 19 NPs as shown in figure 1. GMAs are classified as prime, secondary and specialized. Prime GMAs have abundant wildlife and can sustain safari hunting. Secondary GMAs are those in which animals are less abundant but that can still sustain limited hunting. Specialized GMAs are frequently found in wetland areas and are characterized by the presence of only a few species. In under-stocked GMAs, wildlife populations are sparse and hunting is very limited.

Figure 1: Map showing GMAs in Zambia



Source: Fernandez et al (2008)

In these GMAs, ZAWA partners with community organizations to share wildlife management responsibilities and share revenue from licensed hunting. Although some affected rural communities have benefited from such arrangements, often they have not been insulated from negative effects such as crop damage from the wildlife.

ZAWA, with Technical Assistance from the European Development Fund (EDF), in 1996 developed a planning process, for NPs and GMAs, called the Strategic Planning Process (SPP). Land use planning involves wide stakeholder consultations which include traditional leaders, local authorities, government agencies, local communities, civil society and other interest groups. The participatory methods used in all planning promote the technical and organizational capabilities of all participants, thereby extending their capacity to plan and to act. In the medium term, this qualification process leads to an improvement in the capacity of local groups for self determination.

The SPP has 3 phases. (1) The Pre-Field Work Phase (2) The Field Work Phase (3) The Post-Field Work Phase

In The Pre-Field Work Phase all the relevant resource base information of the respective NP is collected in order to get an overview of the situational status and analysis of the GMA. This is an important and crucial stage of The Pre-Field Work Phase and takes significant proportion of the SPP as it forms the basis of initiating the Participatory Planning Process (PPP). The aim of the Fieldwork Phase is to collect all the relevant information in order to get a true picture of the current situation and derive indicators of change without collecting superfluous information. The Post-Field Work Phase involves data analysis of all the collected baseline information during the fieldwork, the first planning workshop and the actual write up of the land use plan.

2.4 Evidence of Crop Damage

Fernandez et al. (2008) showed that the GMA status had a positive and significant effect on the probability of crop damage. This was also the case in the Maputo Elephant Reserve in Mozambique. The crop damage by elephants, hippos or bush pigs led to the construction of an electric fence at the west side of the reserve. This was the area with the highest elephant damage. Land use plans were recommended, (Boer and Baquete, 1997).

In another study that was done by Osborn and Parker (2001), in Muzarabani district, Zimbabwe showed that the majority of elephant crop raiding incidents occurred during the wet season along the edge of the protected wildlife area. Dry season crop damage was also found to be common and occurred along the major rivers of the district. Similar results were also gotten in another study that was done by Pittiglio (undated). He concluded that crop damage by wildlife seriously affected the livelihoods of the farmers around Tarangire National Park in Tanzania. A land use plan was recommended considering the seasonal spatial distribution of the main wildlife species responsible for crop damage such as elephants, zebra, warthog and wild pig.

In the western Terai of Nepal, (WWF, 2008) in the areas Jhapa, Shukla, and Bardia, it was found out that over 90% of the respondents in each area faced and reported problems from wildlife particularly crop damage. Bardia and Jhapa reported over 80%

while Shukla about 50%. The crop area cultivated and the extent of economic loss due to crop damage by elephants was positively and significantly correlated indicating that if the elephant habitat is transformed for other uses such as crop production, increased economic losses from crop damage are likely to occur.

Data that was collected on crop damage in the Sariska Tiger Reserve, India for the period of 1996-1997 showed that annual crop losses varied according to the type of crop grown. For example Mustard accounted for 10-27 percent loss per hectare; Wheat 6-14 percent per hectare; Pearl millet 6-15 percent per hectare and maize 12-24 percent per hectare. The variation was due to the proximity of a household to the reserve (Distefano, undated). The value of crop losses in that period of time was US$91 per household located inside the reserve and US$67 per household located 2.5 km away. In July 1998 and January 2000 in the Tambopata-Candamo Reserve, Peru, it was found that the average value of crop loss per planting season was US$13. In the proximity to Xishuang Banna Nature Reserve, China, it was found out in 2000 that elephant damage accounted for 28 percent to 48 percent of the community's annual income and total economic losses between 1996 and 1999 which amounted to US$ 314, 600.

In all, the studies have shown that wildlife-inflicted crop damage has been and still is an issue in many parts of the world. Many methods of reducing wildlife-inflicted crop damage have been used like the use of weapons, drum beating, fires, shouting, scarecrows, but have been found not to be fully effective against wildlife-inflicted crop damage (Otuoma, 2004). Land use planning has been recommended in most of the studies reviewed but the empirical evidence of its effectiveness in reducing crop damage still remains very limited.

2.5 Theoretical Framework

This study draws from work by Ronald Coase in the 1960. Coase (1960) contends that as long as property rights are clearly defined and transaction costs are low, two individuals involved in the use of any given property can always negotiate a solution that internalizes any externality. The theory of externality examines cases where some of the costs or benefits of activities "spill over" onto third parties. When it is a cost that is imposed on third parties, it is called a negative externality. When third parties benefit from an activity in which they are not directly involved, the benefit is called a positive externality.

In the case of GMAs the two parties involved in the use of property (i.e., the GMA) are human beings on the one hand and wildlife on the other, the latter represented by the Government. Without a property rights system, wildlife will always impose external costs on human activities such as cropping and similarly human communities will impose an externality on wildlife through encroachment. There is clearly a conflict of interests between humans and wildlife in GMAs. Thus, a reliable property rights system is necessary for internalizing these externality, and as argued by Coase (1960), if the property rights are well defined – i.e. if they clearly show whether and to what extent each of the parties has the right to use which pieces of land in the GMAs – negotiation between the human communities and the wildlife (through their representative and custodian, the state authority or government) can lead to optimal land use. Regardless of who owns the property rights, an optimal amount of wildlife can thus be reached.

Suppose the community members in the GMAs were given the property rights, the Government which represents the wildlife would have to negotiate with them in order to increase the wildlife population in the GMAs. Some of the solutions that they may come up with include: i) The Government through ZAWA may have to stop trying to conserve the wildlife, which is damaging the crops, and allow the residents in the GMAs to kill the wildlife; ii) the people in the GMAs might be paid to move; iii) wildlife might have to be relocated; iv) the Government might have to compensate those affected by crop damage; and/or v) the Government might have to put up measures to help control the damage of crops by wildlife through, say, land use plans. Under any of these possible solutions, in theory/principle, an optimal use of land emerges.

CHAPTER THREE
METHODS AND PROCEDURES

3.1 Introduction

This chapter outlines the methods and procedures that were used to achieve the objectives. It gives information on the study sites, data collection and data analysis tools that were used in the study.

3.2 Data Collection and Study Sites

This study uses household and community data from the "Impact of Game Management Areas on Household Welfare (IGMAW)" survey jointly commissioned by the Natural Resources Consultative Forum (NRCF), the World Bank (WB), and Zambia Wildlife Authority (ZAWA) in 2006. IGMAW survey covered areas adjacent to four NP systems: i) Bangweulu (including Isangano, Lavushi and Kasanka National Parks), ii) Kafue (including Kafue, Blue Lagoon and Lochinvar National Parks), iii) Lower Zambezi (Lower Zambezi National Park), and iv) Luangwa (comprising South Luangwa National Park).

Stratified two-stage cluster sampling was used in the survey. About 2,800 households were selected by systematic sampling (second stage) from 139 clusters or standard enumeration areas (SEAs) adjacent to the four NP systems (first stage), with the latter selected by probability proportional to size (PPS). About half of the 139 clusters were GMAs and the rest non-GMAs (the control). Only about 32 (1.1 percent) of the households were non-response. Data were collected at the household and community levels using household and community questionnaires, respectively. For the community questionnaire, key informants were interviewed including the village leaders, chairpersons of Community Resource Boards (CRBs) and Village Action Groups (VAGs), school headmasters, and others.

3.3 Model Specification

This study builds on the work of Fernandez et al. (2008), who used a Double Hurdle Model to test the null hypothesis that a GMA has no effect on the probability and value of crop damage. Their empirical model was represented as:

$$p(CD = 1/x_i) = \beta x_i + \gamma G_i + \mu_i \quad (1a)$$

$$\ln Z = \alpha + \delta x_i + \varphi G_i + \varepsilon_i, \quad (1b)$$

Where *CD* is a crop damage dummy variable which takes a value 1 if the household reported crop losses due to wildlife, Z is the value of the crop losses, x_i (*HC, PC, SA, LC*) is a vector of covariates, and G is a vector of dummy variables representing the various GMA strata.

Within x_i, *HC* is a vector of human capital and socio-demographic variables which include household characteristics such as the age and sex of the household head, the level of education of the most educated household member, and household size. *PC* is a vector of physical capital variables which include total area cropped in hectares (used as a proxy for total land holdings, which was not collected in the survey), productive assets (value of tractors, ploughs, wheel barrows, fishing nets and traction animals), and consumer durables (including radios, refrigerators, cell phones, bicycles, and sewing machines). *SA* is a vector of social and institutional assets which includes community characteristics related to population, remoteness, and access to markets. Infrastructure is an index equal to a simple count of the number of schools, clinics, wells, and dip tanks in the community. Population density variable is included to capture any remaining unobserved aspects of infrastructure. *LC* is a vector of locational dummy variables describing community characteristics in terms of location and availability of facilities.

Our study extends model (1) by adding a dummy variable (or a set of dummy variables) representing the community's status with respect to land use planning. The idea is to not only explain crop damage but to also determine the impact of land use planning on the probability and extent (or value) of crop damage. The new equation was as follows:

$$P(CD = 1/x_i) = \beta x_i + \gamma G_i + \rho L_i + \delta(G * L)_i + \mu_i \quad (2a)$$

$$\ln Z = \alpha + \pi x_i + \varphi G_i + \theta L_i + \tau(G * L)_i + \varepsilon_i \quad (2b)$$

Where L_i takes the value of 1 if the community has a land use plan and zero otherwise.

The hypothesis that land use planning has no effect on the probability and value of crop damage in different GMA strata was tested by testing the null hypotheses that $\delta = 0$ and $\tau = 0$, respectively.

Having a land use plan often is not enough if it is not being implemented. In an alternative specification, three levels of land use planning were identified: i) communities with no land use plans, ii) communities with land use plans, and iii) communities with land use plans and land set aside for wildlife habitat. Thus, three dummy variables were used to represent land use planning of which two were included in the regression models (after dropping the no-plan dummy). Simulations were also done using excel to compute the predicted probability of crop damage.

The model was tested for heteroskedasticity and multicollinearity. Model specification was also checked. Heteroskedasticity was present in the model at 5% and was corrected for using robust estimates.

CHAPTER FOUR
STUDY FINDINGS AND DISCUSSION

4.1 Introduction

This chapter presents the research findings. It gives the descriptive characteristics of the data and its interpretation and goes on to discuss and interpret the findings of the Double Hurdle Model.

4.2 Areas with Land Use Plans in Zambia's GMAs

The following table (Table 1) shows the Game Management Areas status for land use plans in Zambia. As can be seen, only two GMAs with approved land use plans exist in Zambia which includes the Mukungule GMA and the Chikuni/Bangweulu GMA.

Table 1: Game Management Areas Status

GMAs with Approved land use plans	GMAs with finalized land use plans	GMAs whose process of preparing land use plan is on going	GMAs whose process of preparing GMP not yet started
Mukungule GMA	Chifunda Chiefdom – East Musalangu GMA	Lupande GMA	Munyamadzi GMA
Chikuni /Bangweulu GMA	Nkala GMA	Lunga-Luswishi GMA	West Petauke GMA
	Kafinda GMA	Bilili Springs GMA	Rufunsa GMA
	Namwala GMA		Musalangu GMA
	Chiawa GMA		West Zambezi GMA
	Kasonso Busanga GMA		Luano GMA
	Mulobezi GMA		Lumimba GMA
	Sichifulo GMA		Sandwe GMA
	Mumbwa GMA		Kaputa GMA
	Mufunta GMA		Tondwa GMA
	Lukwakwa GMA		Chisomo GMA
	Chibwika-Ntambo GMA		Kalasa Mukoso GMA
			Chizera GMA
			Musele-Matebo GMA
			Luwingu GMA
			Chambeshi GMA
			Mansa GMA
			Machiya Fungulwe GMA

Source: ZAWA

Table 2 shows the distribution of land use plan strata across the GMA Stratum for the 135 communities in the survey data. As can be seen, GMA is represented by five types Stratum which are the prime GMA, Secondary GMA, Specialized GMA, Under Stocked GMA and non GMA. In total 110 communities had no land use plan, 13 had a land use plan but no land was set aside for wildlife habitat while 12 communities had a land use plan and had set aside land for wildlife habitat. As expected, more functional land use plans were found in prime GMAs which have a high density of wildlife. Also, more land use plans did not exist in the Non GMA stratum.

Table 2: Distribution of Land Use Plan Strata across GMA Stratum

Stratum	No land use plan	land use plan exists but no land set aside for wildlife habitat	Land use plan exists and land set aside for wildlife habitat	Total
Prime GMA	13	3	6	22
Secondary GMA	16	0	1	17
Specialized GMA	10	0	1	11
Under Stocked GMA	26	1	1	28
Non GMA	45	9	3	57
Total	110	13	12	135

Source: Own Analysis

4.3 Description of Variables

4.3.1 Description of Variables for Full Sample and Subsets

The description of variables included in the model and the summary statistics are presented in Table 3. For comparison, sample statistics are presented for full Sample, GMAs and Non-GMAs. The table shows that there is a significant difference between households in GMAs and Non-GMAs. Households in GMAs have lower levels of income compared to households in Non-GMAs. Also GMAs have smaller household sizes and lower levels of education. GMAs have fewer assets and are found in more remote areas and are in densely populated areas.

Table 3: Variable means for Full Sample and Subsets

Variable description	Full Sample	GMAs	Non-GMAs
Number of sample households	2,717	1,574	1,143
Total household income (kwacha)	4,235,762	3,591,253	5,123,301*
Human capital			
Household size	5.28	5.08	5.57***
Age of household head (in years)	42.46	41	44.48***
Sex of household head (=1 if male)	0.74	0.73	0.76**
Maximum education of household head (in years)	6.78	6.42	7.27***
Physical capital			
Cropped area (hectares)	0.92	0.93	0.92
Value of consumer assets (ZMK)	401,588	285,362	561,641**
Value of productive assets (ZMK)	618,036	256,729	1,115,584***
Social and institutional assets			
Distance to nearest main road (km)	5.09	6.08	3.8***
Population density (per sq km)	35.2	41.41	26.97***
Infrastructure	3.62	3.64	3.59
GMA-1 classification (=1 if prime)	0.17	0.3	n/a
GMA-2 classification (=1 if secondary or specialized)	0.2	0.35	n/a
Land use plan	0.2	0.18	0.22

n/a = not applicable
Exchange rate as at time of survey: USD 1= ZMK 3676

4.3.2 Description of Variables for Land Use Planning Strata

Table 4 shows that communities differ significantly between those who have no land use plan, those who have a land use plan but have not set aside land for wildlife and those who have a land use plan and land has been set aside for wildlife. As can be seen in Table 4, communities with no land use plans have smaller household sizes, smaller cultivated crop area and lower value of damage. In communities that have not set aside land for wildlife but a land use plan exists have the highest level of education for the most educated household member. Functional land use plans are most prevalent in densely populated areas. This shows us that those communities that have a high population density and are in a GMA use their land well through a land use plan. This can be explained by the fact that land is limiting for agricultural purposes were it is densely populated. Infrastructure (schools, clinics, wells etc) are least prevalent in communities that have land use plans and land has been set aside for wildlife.

Table 4: Variable Means for Land Use Planning Strata

Categorical Variable description	No land use plan	Land use plan exists but no land set aside for wildlife	Land use plan exists and land set aside for wildlife
Number of communities	110	13	12
Number of households	2,082	259	239
Human capital			
Household size	5.28	5.62	5.39*
Age of household head (in years)	42	43	43
Sex of household head (=1 if male)			
Level of education	5.34	5.97	5.01***
Physical capital			
Cropped area (hectares)	0.88	1.07	1.15***
Value of crop damage	1.52	1.87	3.52***
Value of consumer assets (ZMK)	415,3534	429,010	373,633
Value of productive assets (ZMK)	635,661	829,122	390,891
Social and institutional assets			
Distance to nearest main road (km)	5.26	2.84	3.48***
Population density (per sq km)	33.02	31.50	56.54***
Infrastructure[c]	3.64	3.93	2.73**

Exchange rate as at time of survey: USD 1= ZMK 3676

[c] is an index equal to a simple count of number of schools, clinics, wells and dip tanks in the community

4.4 Results and Interpretation of the Estimated Double Hurdle Model

The results of the Double Hurdle Model are shown in Table 5. The first column shows the coefficients of the first Tier (Probit regression) while the second column shows the marginal effects of the first Tier. The third and fourth columns have the coefficients and marginal effects of the second Tier (truncated regression) respectively.

The Average Partial Effects on the probability of crop damage show that distance to the nearest main road by a household has a positive impact on the probability of crop damage. More remote areas are more prone to have greater wildlife population hence higher probability of crop damage. Infrastructure has a negative impact on the probability of crop damage suggesting that the presence of for example, clinics, schools, creates employment opportunities for household members making them prefer off-farm income to on-farm income.

Cropped area and value of harvest has a positive impact on the probability of crop damage showing that the larger the areas under cultivation and the higher the value of crops or higher yields per unit area, increases the chance that crop damage caused by wildlife will occur. For those households that suffered crop damage, value of harvest has a positive impact on value of crop damage. Number of scouts also has a positive impact on the value of crop damage. When scouts are present in the GMAs, it has a negative impact on the value of crop damage. If a household is living in a prime GMA or secondary/specialized GMA, it has a positive impact on the probability of crop damage. These results confirm that households are more likely to be affected by crop damage if they are in a GMA (Fernandez et al., 2008)

For the purpose of this study the Average Partial Effects of the variables measuring the effect of land use planning on the probability and value of crop damage are of particular interest. For households that are in prime GMAs, using a land use plan has a negative and significant effect on the probability of crop damage. Land use plans reduce the probability of crop damage in prime GMAs by 4.77 percent. The results also show that if a household is in a secondary or specialized GMA, land use plans have a negative and significant effect on the probability of crop damage. A land use plan in the secondary/ specialized GMA reduces the probability of crop damage by 8.74 percent. This confirms the hypothesis that land use planning has an effect on the probability of crop damage.

Table 5: Double-Hurdle Estimates and Average Partial Effects for Crop Damage in areas around Zambian National Parks, 2005/06 Agricultural Season

Variables	Tier 1. Probit regression[a]		Tier 2. Truncated regression[b]	
	Parameter estimates	Marginal effects	Parameter Estimates	Marginal effects.
	(1)	(2)	(3)	(4)
Age of household head in years (hage)	0.0062	0.0011	0.0439	0.0433
	(0.0145)	(0.0026)	(0.1020)	(0.1020)
Age of household head squared in years (hage2)	-6.98e-05	-1.25e-05	-0.0001	-0.0001
	(0.0001)	(2.63e-05)	(0.0011)	(0.0011)
Sex of household head, =1 if male (hmale)	-0.0719	-0.0131	-0.3370	-0.3330
	(0.0903)	(0.0168)	(0.7900)	(0.7930)
Level of education (hedu)	0.0036	0.0006	0.1410	0.1390
	(0.0121)	(0.0022)	(0.0932)	(0.0936)
Household size (hhsize)	-0.0268	-0.0048	0.1020	0.1010
	(0.0166)	(0.0030)	(0.1280)	(0.1290)
Distance to nearest main road in km (kroad)	0.0068**	0.0012**	-0.0046	-0.0045
	(0.0027)	(0.0005)	(0.0178)	(0.0179)
Cropped area in hectares (carea)	0.1470***	0.0262***	-0.1370	-0.1350
	(0.0295)	(0.0053)	(0.2230)	(0.2240)
value of consumer assets (vcasset2)	-0.6440	-0.1150	12.2400	12.0600
	(3.2200)	(0.5750)	(22.3400)	(22.4400)
Value of productive assets (vpasset2)	-2.1950	-0.3920	-19.4900	-19.2200
	(2.3570)	(0.4190)	(18.1100)	(18.2000)
Population density (popdens)	0.0020	0.0004	0.0032	0.0032
	(0.0038)	(0.0007)	(0.0160)	(0.0161)
Infrastructure (infras2)	-0.0705***	-0.0126***	-0.1360	-0.1340
	(0.0207)	(0.0037)	(0.1380)	(0.1380)
Number of scouts (nscouts)	0.0253	0.0045	0.8060**	0.7950**
	(0.0392)	(0.0070)	(0.3560)	(0.3570)
Value of harvest (harv2)	1.6740***	0.2990***	9.1430***	9.0140***
	(0.2750)	(0.0480)	(2.3080)	(2.3160)
Prime GMA (gma1)	1.2300***	0.3310***	-0.0101	-0.0099
	(0.2340)	(0.0794)	(1.6800)	(1.6880)
Secondary/specialized GMA (gma2)	0.2840**	0.0562*	0.1410	0.1400
	(0.1380)	(0.0301)	(0.9570)	(0.9610)
Land use plan, 1=Yes (dlandplan)	0.1660	0.0317	1.0240	1.0110
	(0.1530)	(0.0310)	(1.2510)	(1.2550)
dlandplan*gma1	-0.3200	-0.0477*	1.0680	1.0570
	(0.2300)	(0.0279)	(1.8570)	(1.8620)
dplanplan*gma2	-0.8570*	-0.0874***	-1.1120	-1.0900
	(0.5090)	(0.0228)	(2.1860)	(2.2070)
nscouts*gma1	-0.0667	-0.0119	-1.2760**	-1.2560**
	(0.0656)	(0.0117)	(0.5040)	(0.5070)
nscouts*gma2	0.0362	0.0065	-0.7250**	-0.7140*
	(0.0441)	(0.0079)	(0.3680)	(0.3700)
Constant	-0.8450*		5.3940*	
	(0.4700)		(2.8240)	
Sigma			4.2750***	
			(0.3850)	
Number of Observations	2,185		302	
F Test	245.43***		5316.67***	
Log pseudolikelihood	-745.18395		-867.78572	
Cragg & Uhler's R2	0.210			
District dummy variable joint test	88.78***		15.26	

Robust standard errors in parentheses
*10% significance level, **5% significance level, ***1% significance level
[a]Dependent variable: crop damage dummy variable, 1=household reported crop damage
[b]Dependent variable: value of crop damage variable
Exchange rate as at time of survey: USD 1= ZMK 3676

Table 6 shows the results of the alternative specification using two levels of land use planning. If a land use plan exists and land has been set aside for wildlife habitat it has a positive impact on the probability of crop damage. This shows that land use plans are found in places that are in a GMA were the probability of crop damage is significant. This variable also had a positive impact on the value of crop damage. If a land use plan exists and land has been set aside for wildlife habitat, the probability of crop damage reduces both in the prime and secondary/specialized GMAs. This is as expected that if a community sets aside land for wildlife, the probability that wildlife will cause damage to their crops is reduced.

Table 6: Double-Hurdle Estimates and Average Partial Effects for Crop Damage in areas around Zambian National Parks, 2005/06 Agricultural Season

Variable	Tier.1 Probit Regression[a]		Tier.2 Truncated Regression[b]	
	Parameter estimates	Marginal effects	Parameter estimates	Marginal effects
	(1)	(2)	(3)	(4)
Age of household Head In Years (hage)	0.0062	0.0011	0.0546	0.0539
	(0.0145)	(0.0026)	(0.1000)	(0.1010)
Age of household Head Squared In Years (hage2)	-7.42e-05	-1.32e-05	-0.0003	-0.0003
	(0.0001)	(2.61e-05)	(0.0011)	(0.0011)
Level of education of household head (hedu)	0.00356	0.0006	0.1440	0.1420
	(0.0122)	(0.0022)	(0.0944)	(0.0947)
Sex of Household Head, =1 If Male (hmale)	-0.0710	-0.0129	-0.3300	-0.3260
	(0.0901)	(0.0167)	(0.7850)	(0.7880)
Household Size (hhsize)	-0.0245	-0.0043	0.0939	0.0927
	(0.0167)	(0.0030)	(0.1250)	(0.1260)
Distance to nearest main road in km (kroad)	0.0072***	0.0013***	-0.0035	-0.0035
	(0.0027)	(0.0005)	(0.0172)	(0.0172)
Cropped area in hectares (carea)	0.1550***	0.0275***	-0.1640	-0.1620
	(0.0296)	(0.00532)	(0.2190)	(0.2200)
value of consumer assets (vcasset2)	-1.1770	-0.2090	10.6700	10.5300
	(3.2500)	(0.5770)	(21.8900)	(21.9800)
Value of productive assets (vpasset2)	-2.0620	-0.3660	-20.0400	-19.7800
	(2.3760)	(0.4210)	(17.3800)	(17.4500)
Population density (popdens)	0.0026	0.0005	-0.0023	-0.0023
	(0.0037)	(0.0007)	(0.0155)	(0.0156)
Infrastructure (infras2)	-0.0578***	-0.0103***	-0.0029	-0.0029
	(0.0207)	(0.0037)	(0.1370)	(0.1370)
Number of Scouts (nscouts)	0.0153	0.0027	0.7280**	0.7180**
	(0.0399)	(0.0071)	(0.3510)	(0.3520)
Value Of harvest (harv2)	1.6930***	0.3010***	9.5220***	9.4010***
	(0.2800)	(0.0489)	(2.2840)	(2.2910)
Prime GMA (gma1)	1.1800***	0.3130***	-0.0254	-0.0251
	(0.2160)	(0.0723)	(1.4930)	(1.4990)
Secondary/specialized GMA (gma2)	0.2800**	0.0550*	-0.0865	-0.0854
	(0.1390)	(0.0300)	(0.9230)	(0.9270)
Land use plan exist but no land set aside for wildlife, 1=yes (plancat2)	-0.0646	-0.0111	-0.3140	-0.3090
	(0.1840)	(0.0305)	(1.2120)	(1.2180)
Land use plan exist and land set aside for wildlife, 1=yes (plancat4)	0.7250***	0.1810**	3.2510*	3.2290*
	(0.2250)	(0.0720)	(1.839)	(1.8410)
plancat2*gma1	0.2040	0.0409	1.6720	1.6590
	(0.281)	(0.0629)	(2.1650)	(2.1680)
plancat4*gma1	-1.060***	-0.0976***	0.3780	0.3740
	(0.3050)	(0.0118)	(2.2750)	(2.2830)
plancat4*gma2	-1.3880**	-0.1010***	-2.6800	-2.5990
	(0.5390)	(0.0098)	(2.4820)	(2.5370)
nscouts*gma1	-0.03010	-0.0054	-1.2800***	-1.2620**
	(0.0686)	(0.0122)	(0.4950)	(0.4970)
nscouts*gma2	0.0424	0.0075	-0.6910*	-0.6820*
	(0.0447)	(0.0080)	(0.3630)	(0.3650)
Constant	-0.9260**		4.5230	
	(0.4720)		(2.8330)	
Sigma			4.2240***	
			(0.3820)	
Number of Observations	2,185		302	
F Test	237.45***		5171.23***	
Log pseudolikelihood	-737.6614		-859.29024	
Cragg & Uhler's R2	0.218			
District dummy variable joint test	88.78***		15.26	

Robust standard errors in parentheses
*10% significance level, **5% significance level, ***1% significance level
[a]Dependent variable: crop damage dummy variable, 1=household reported crop damage
[b]Dependent variable: value of crop damage variable
plancat2*gma2 dropped because of collinearity
Exchange rate as at time of survey: USD 1 = ZMK 3676

4.5 Simulation Results from Excel

The results from the simulations that were performed in Excel show that on average the probability of crop damage for a household was 10.96 percent. If in a prime GMA and a land use plan does not exist, the probability of crop damage was 10.65 percent. If a land use plan exists, the probability of crop damage was 5.88 percent. If on the other hand a land use plan does not exist in the secondary/specialized GMA, the probability of crop damage on the household was 12.67 percent and if a land use plan exists, the probability of crop damage reduced to 2.28 percent. As can be seen a land use plan reduces the probability of crop damage by about half in the prime GMA and from 12.67 percent to 2.28 percent in the secondary/specialized GMA. These model estimates were generated from the results in table 5.

Using the model estimates from Table 6, the probability of crop damage on average was 11.43 percent. If in a prime GMA and no land use plan exists, the probability of crop damage was 11.50 percent while if a land use plan exists but no land is set aside for wildlife habitat, the probability of crop damage was 15.95 percent. If land has been set aside for wildlife habitat the probability of crop damage was 1.19 percent. If a land use plan does not exist in a secondary/specialized GMA, the probability of crop damage was 12.98 percent while if a land use plan exists but no land has been set aside for wildlife habitat, the probability of crop damage was 12.98 percent. If land has been set aside for wildlife habitat, the probability of crop damage reduces to 0.59 percent. As expected these results show that a land use plan own its own is not that effective compared to the case when land is set aside for wildlife habitat. In the prime GMA the probability of crop damage reduces from 15.95 percent to 1.19 percent while in the secondary GMA probability of crop damage reduces from 12.98 percent to 0.59 percent if land is set aside for wildlife habitat.

CHAPTER FIVE
CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the conclusions and recommendations of the study based on the findings and interpretations of the study.

5.2 Conclusion

The main objective of this study was to determine the impact of land use planning on wildlife-inflicted crop damage in the GMAs. This objective was answered by the use of an econometric model, the Double Hurdle Model. The Double Hurdle Model was used to identify the extent to which the farmers that have crops grown in GMAs are more prone to damage caused by wildlife.

The findings in this study showed that, distance to the nearest road, infrastructure, cropped area, value of harvest and GMA effect are important factors affecting the probability of crop damage. According to the findings, the further away a household is from the nearest main road increases the probability of crop damage. This shows that the more remote an area is, the more prone it is to experience crop damage since the wildlife population is increasing. Increase in the area cultivated and value of harvest increases the probability of crop damage because the wider the area cultivated and the higher the value of crops or the higher the yields per unit area, the higher the chance that crop damage will take place.

The findings also show that the presence of infrastructure in the GMAs reduces the probability of crop damage. Household members will prefer to go work in for example, clinics and schools to earn an income than by earning an income from cultivating crops. Living in a GMA increases the likelihood that crop damage will occur.

The empirical evidence revealed that a land use plan reduces the likelihood of wildlife-inflicted crop damage in the GMAs. The impact is even felt more if a land use plan goes with land been set aside for wildlife habitat. When using the simulations, a land use plan was seen to reduce the likelihood of crop damage in the GMAs, more so in the secondary GMA than the prime GMA. Also, it was seen when the simulation was done that having a land use plan which takes into account the setting aside of land for wildlife habitat reduces the likelihood of crop damage by a greater margin.

5.3 Recommendations

This study has shown the empirical evidence that land use plans are effective in curbing crop damage caused by wildlife. Therefore, the implementation of land use plan should continue in all GMAs which will help farm families have reduced impact of crop damage caused by wildlife thereby sustaining food security. Setting aside land for wildlife habitat reduces the likelihood of crop damage therefore, it should be encouraged for communities in GMAs to not take up all the land for crop cultivation but make sure that when a land use plan is been formulated setting aside of land for wildlife habitat is considered. The lack of policies that compensate the rural community when they suffer from crop damage makes a land use plan a valuable tool. Further work should be done in this area by use of primary data to get up to date information on the actual status on the ground.

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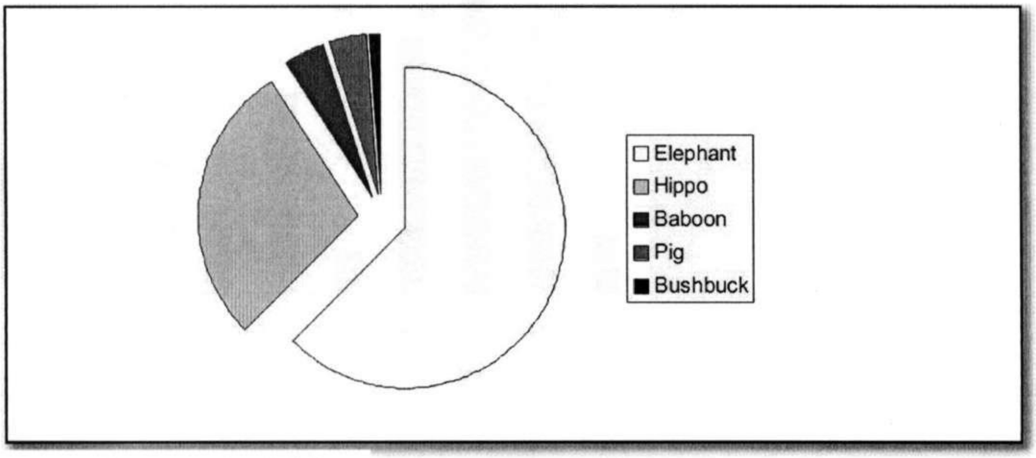
APPENDICES

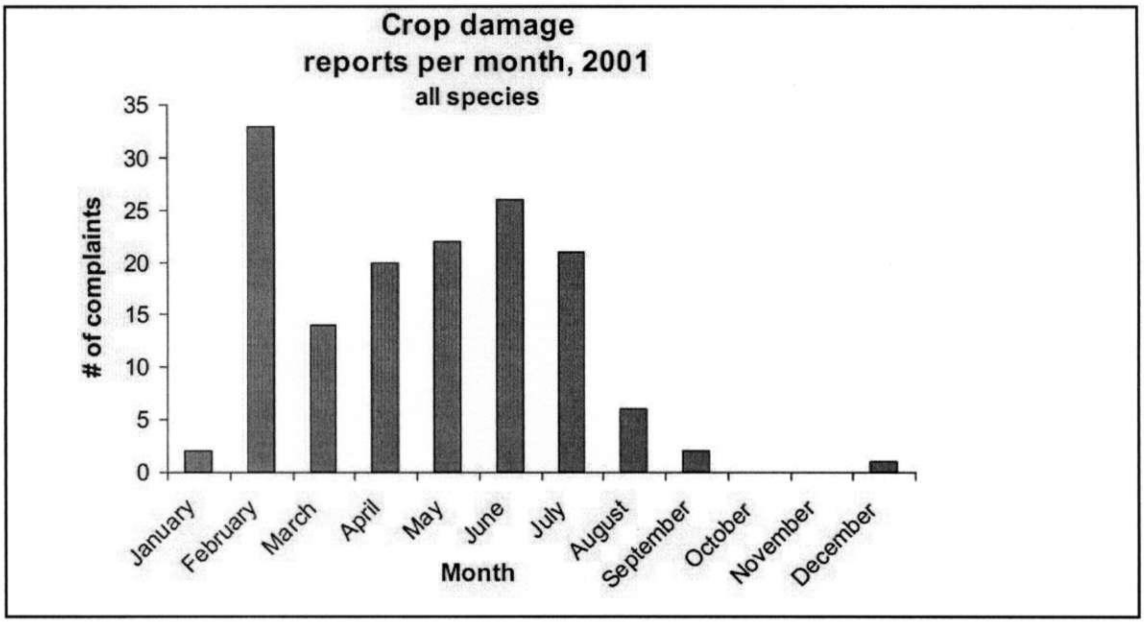
Appendix I: Additional Graphs and Tables

Figure 2: Proportion of Crop Damage Incidents Problem in Lupande GMA



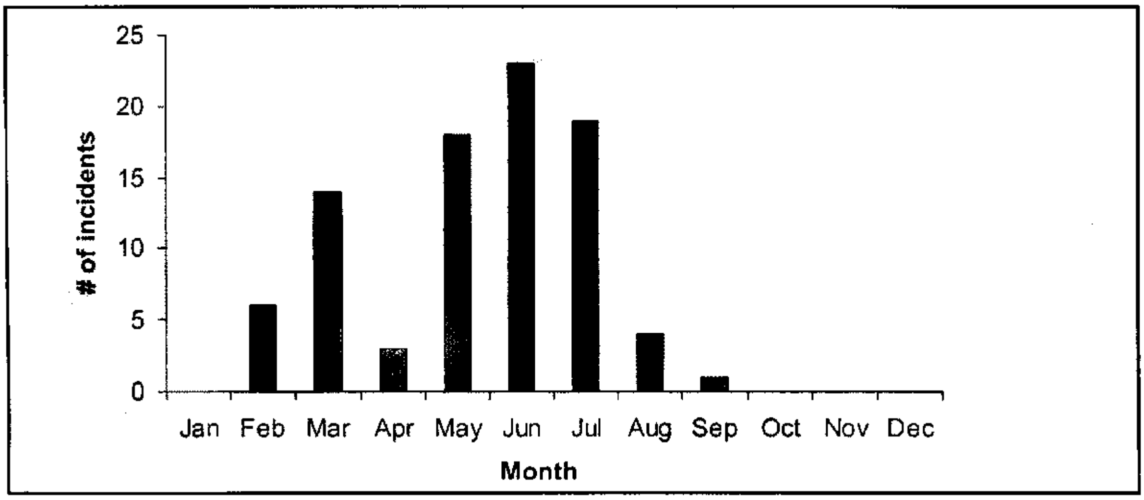
Source: Osborn & Parker (2002)

Figure 3: Crop Damage Reports per Month for Lupande GMA, 2001



Source: Osborn & Parker (2002)

Figure 4: Elephant Crop Damage Incidents for Lupande GMA, 2001



Source: Osborn & Parker (2002)

Appendix II: Steps in Land Use Plan Formulation

A typical planning process involves the following steps (FAO, 1993):

Step 1: Establish goals and terms of reference

Ascertain the present situation; find out the needs of the people and of the government; decide on the land area to be covered; agree on the broad goals and specific objectives of the plan; settle the terms of reference for the plan.

Step 2: Organize the work

Decide what needs to be done; identify the activities needed and select the planning team; draw up a schedule of activities and outputs; ensure that everyone who may be affected by the plan, or will contribute to it, is consulted.

Step 3: Analyze the problems

Study the existing land-use situation, including in the field; talk to the land users and find out their needs and views; identify the problems and analyze their causes; identify constraints to change.

Step 4: Identify opportunities for change

Identify and draft a design for a range of land-use types that might achieve the goals of the plan; present these options for public discussion.

Step 5: Evaluate land suitability

For each promising land-use type, establish the land requirements and match these with the properties of the land to establish physical land suitability.

Step 6: Appraise the alternatives: environmental, economic and social analysis.

For each physically suitable combination of land use and land, assess the environmental, economic and social impacts, for the land users and for the community as a whole. List the consequences, favorable and unfavorable, of alternative courses of action.

Step 7: Choose the best option

Hold public and executive discussions of the viable options and their consequences. Based on these discussions and the above appraisal, decide which changes in land use should be made or worked towards.

Step 8: Prepare the land-use plan

Make allocations or recommendations of the selected land uses for the chosen areas of land; make plans for appropriate land management; plan how the selected improvements are to be brought about and how the plan is to be put into practice; draw up policy guidelines, prepare a budget and draft any necessary legislation; involve decision-makers, sectoral agencies and land users.

Step 9: Implement the plan

Either directly within the planning process or, more likely, as a separate development project, put the plan into action; the planning team should work in conjunction with the implementing agencies

Step 10: Monitor and revise the plan

Monitor the progress of the plan towards its goals; modify or revise the plan in the light of experience

Every land-use planning project is different. Objectives and local circumstances are extremely varied, so each plan will require a different treatment. However, the ten steps above have been found useful as a guide.