Estimating the Economic Value of forest ecosystem services using stated preference methods: the case of Kakamega forest, Kenya

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Abstract

According to the Millennium Ecosystem Assessment, in the next 40 years, tropical forests are among the biomes projected to lose habitat and species most rapidly. Yet these biomes provide numerous ecosystem services that confer local, regional and global economic benefits. One of these forests, and the focus of this study, is Kakamega forest in Kenya. Kakamega Forest is the last remaining rainforest in Kenya and is home to numerous endemic fauna and flora species while it provides crucial ecosystem services to a large number of people. Moreover, the conservation of the forest incurs an opportunity cost on the surrounding communities. Although it could be that Kakamega forest has been degraded due to its low economic value, it is far more likely that the forest holds significant value which cannot be realised due to the public-good nature of many of the services it provides and an ill-enforced set of property rights. This study forms part of a wider research effort to estimate the Total Economic Value of Kakamega Forest in Kenya, with the aim of demonstrating the economic value of the forest's goods and services. It specifically focuses on the estimation of the economic value of a subset of services that are relevant to the local communities.

For the estimation of these values this study employed two different stated preference methods (Contingent Valuation and Choice Experiment) in order to assess the welfare effects to local communities of changes in the provision of forest-related ecosystem services. These services were identified by the respondents and were crucial to their livelihood. The findings of these two studies are presented in the main body of this dissertation, which is comprised by three chapters (chapters 2-4). Both methods demonstrated that there is significant willingness to pay (WTP) for improvement in the provision of the following services: water availability, prevention of soil erosion and future supply of forest products. The highest WTP was expressed for implementing measures that prevent soil erosion, which suggests that any conservation measures should be geared towards addressing this problem. The CV method also assessed the suitability of a non-monetary payment vehicle (labour meals) and found it to be an appropriate means to elicit WTP in the setting of the study.. Finally, the study found that a major determinant of respondents' utility, and thus choices, has been their perception of the severity of the environmental conditions

that they face. This suggests that targeted educational campaigns can play a role in increasing respondents' awareness with regard to the finite nature of the forest resources and thus shift their behaviour into more sustainable ways of interacting with the forest.

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Writing up the Acknowledgements section of a PhD Dissertation can often be an emotional experience. It is certainly the case with this dissertation, the completion of which has been long and arduous, to say the least. It would be no exaggeration to say that I would not be able to write these acknowledgements if it wasn't for the crucial role of certain people.

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To my parents...

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CHAPTER 1 Introduction

1.1 Background: forests, biodiversity and driving forces of deforestation

Human societies stand at a crucial point with regard to the environmental implications of their development choices. Large areas of the world's forests have been converted to other uses or severely degraded. While substantial areas of productive forests remain, there has been widespread recognition that this resource is not infinite and that its wise and sustainable use is needed (CBD, 1996).

Forests generate a substantial number of goods and services that benefit humankind. Some of these benefits accrue locally. Timber, fuelwood, watershed protection and a range of non-timber forest products are examples of products and services whose benefits are realized on a local/national level. On the other hand, forests provide global services as well, whose benefits transcend national boundaries and affect global welfare. The most well-cited global benefits provided by forests are global-climate regulation and biodiversity provision (Pearce and Moran, 1994; MA, 2005).

According to the definition given in Article II of the Convention on Biological Diversity (1992), the term biodiversity denotes "the variability among living organisms from all sources including, inter alias, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems". Biodiversity has several levels: genetic diversity, species diversity, ecosystem diversity, etc. Tropical forests probably contain more than half the world's species (Sandler, 1993). Tropical biodiversity has provided people with important benefits; for example, one quarter of all prescription drugs sold in the U.S. are derived from tropical plants. This biodiversity also provides genetic material useful in genetic engineering for creating, for instance more pest-resistant crops (Sandler, 1993; Ten Kate and Laird, 2002).

The main driving forces behind the present level of forest loss can be divided into: i) proximate causes such as logging, habitat alternation and conversion; and ii) underlying causes such as social and cultural factors that lie behind economic activities (Barbier et al., 1995). These underlying causes of forest depletion include the scale and growth of human population, culture and ethics, poverty, economic incentives, and institutions.

Swanson (1997) attributes the losses in forest biodiversity to, what he calls, *conversion processes*. He offers a very comprehensive account of how this process works and what it entails in terms of biodiversity losses. According to Swanson, conversion of natural environments is just part of society's pursuit to develop by building up a productive asset base. Given that originally the asset base consisted entirely of natural assets, it has been inevitable that some of the natural assets have been replaced by other forms of assets. The extent of this substitution has been determined by the relative productivities of the various types of assets and has led to the formation of a less diverse and more specialised asset portfolio, usually through agricultural expansion.

This explanation hinges on conventional economic analysis, which postulates that the optimal allocation of scarce resources is that which maximises economic value but that does not adequately address non-marketed environmental values. In consequence, conventional economic analysis fails to deal adequately with many natural resources and services. In contrast it focuses almost exclusively on calculating *financial* values: the worth of goods as they are valued in the market (ICEM, 2003). However, many environmental goods and services are not traded in any markets because of their public good nature. In economics jargon, benefits derived from public goods are non-exclusionary, i.e., benefits are not the exclusive property of any individual or group. Though everyone shares the benefits of, say, biodiversity, few people sense a personal stake in its preservation. This is because contributing to the provision of a public good is not in the narrow self-interest of any single individual because of its inability to appropriate the full value of the benefits generated (Kolstad, 2000). Therefore, one of the other major reasons identified for the present level of worldwide loss of tropical forests is the public good nature of the goods and services they provide. Consequently, also many of the economic, social

and environmental benefits associated with forests or other environmental assets have been omitted from consideration in the resource allocation decisions because they do not have a market price nor is their value expressed in monetary terms.

Because of the public good nature of forests and of conservation programs designed to protect them, most of the costs of conservation are imposed on the surrounding local community, society or nation involved. The benefits are shared by the rest of the world. This is one economic key reason for over-exploitation of ecological resources and habitat conversion, for species extinction, ecosystem degradation, and so on (Barbier, et al., 1995).

1.2 Theoretical framework

1.2.1 *The concept of Total Economic Value*

Over the last decades valuation of environmental services – more precisely: to changes of environmental services – has become one of the most important and fastest growing areas of research in the field of environmental economics (Pearce, et al., 2006; Sagoff, 2008). In order to deal with the problem of the valuation of environmental benefits, one needs to properly define the meaning of value. This is a complex and multidimensional matter, however.

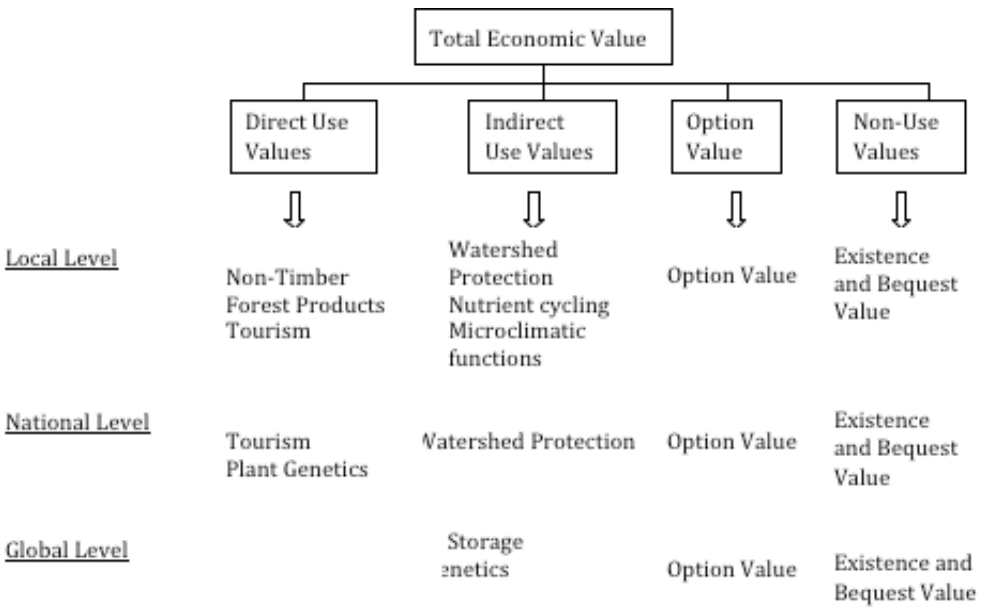
Economists have generally settled for a classification of environmental value, the components of which add up to total economic value (TEV) (Turner, et al., 2003). The key distinction made is between use values (UV) and a remainder called non-use values (NUV). In the case of use values, it is useful to further distinguish between *direct use* values (DUV; e.g. values derived from direct use of the forest's resources and services); *indirect use* values (IUV; e.g. indirect support and protection provided to economic activity and property by forest functions or regulatory services). Non-use values reflect value in addition to that which arises from usage. Thus individuals may make little or no use of a given environmental attribute or asset but would nevertheless feel a 'loss' if the services derived from it was to disappear (Turner, et al., 2003). According to the respective motivations, these values may be classified as

existence (EXV), bequest (BV) or option values (OV). Option value relates to the willingness-to-pay (WTP) to retain an asset in order to keep alive the option to use it at some point in the future. In this respect, it falls under both use and non-use values. While these differentiations are usually accepted even by many non-economists, several authors doubt if it makes sense to also subsume what they consider to be "intrinsic values" in a TEV frame (Bowers 1993; Sagoff, 1988 & 2004). The the main value components by a given ecosystem add up to form the TEV: TEV= UV + NUV= [DUV + IUV] + OV + [EXV + BV].

The usefulness of the TEV classification in practice is debatable. Existing valuation techniques can distinguish use values from non-use values, but attempts to isolate option, bequest and existence value are more problematic (Pearce and Moran, 1994). Therefore, it is convenient to jointly estimate those values for a given resource under the umbrella of non-use values.

As illustrated above, the benefits of tropical forests can be divided into use and non-use values. Together, use and non-use values make up the TEV of rainforests. These values can be further broken down according to whom they accrue. The relevant range of values for tropical forests in general, as well as their geographical distribution is presented in the following figure:

Figure 1. Total Economic Value



Ideally, one would include all types of relevant values in assessing the TEV of the forest. In practice, though, such a task is impossible due to the sheer volume of data necessary. Therefore it is crucial that we identify the most important values as well as the beneficiaries to whom they accrue. After all, evaluation of certain key values may prove to be sufficient to demonstrate the benefit of supporting conservation over alternative land uses. The types of values that appear underlined in Figure 1 are the ones chosen to be estimated in this study. Their inclusion is justified on their significant contribution towards the calculation of TEV, as indicated in the literature (Bulte et al., 2000). Direct values are the object of estimation of another dedicated study within the framework of the BMBF-funded Biota East research program (Guthiga, 2007).

1.2.2 *Valuation Methods*

There are several methods one may employ in order to estimate the TEV of a given resource/service. On the basis of the process through which valuation methods retrieve individuals' preferences, one can distinguish two groups of valuation methods: *revealed preference* and *stated preference* methods. Essentially, the revealed preference approach infers the value of a non-market asset from a market in some well-recognized commodity which is influenced by the non-market asset. Examples of revealed preference techniques are hedonic property pricing, hedonic wage compensation, travel cost method and preventive (or avertive) expenditure models (Freeman, 2003). However, as useful as these methods are, they can be used to value only a small fraction of environmental goods. The demand for many environmental goods cannot be completely estimated using revealed preference methods since they can only measure environmental changes that are accompanied by some sort of behavioral change in the market place (Freeman, 2003).

In order to tackle this problem, the use of the second type of valuation techniques, namely *stated preference* methods, has been advocated. Contingent Valuation (CV) and Choice Modeling (CM) are the most popular stated preference methods. Other stated preference methods are contingent ranking and contingent rating of paired comparisons (see Louviere et al. (2000) or Hanley et al. (2001) for an overall

description of stated preference methods). CV uses surveys to elicit either WTP for a hypothetical change in the availability of an environmental amenity, or willingness to accept compensation (WTA) to forgo the change. In this respect, it involves asking individuals, in survey or experimental settings, to reveal their personal valuations of increments (or decrements) in unpriced goods by using 'contingent markets'. These markets define the good or amenity of interest, the status quo level of provision and the offered change, the institutional structure under which the good is to be provided and the payment vehicle. Simultaneously, these characteristics constitute the "frame" of the valuation exercise (Bateman et al. 2002). The biggest advantage of CV and CM, and of stated preference methods in general, is that we can ask respondents for their WTP regardless of whether they make use of the non-market commodity or not. In other words, we can obtain use as well as non-use values.

1.3 Ecological and socioeconomic overview of Kakamega forest and district.

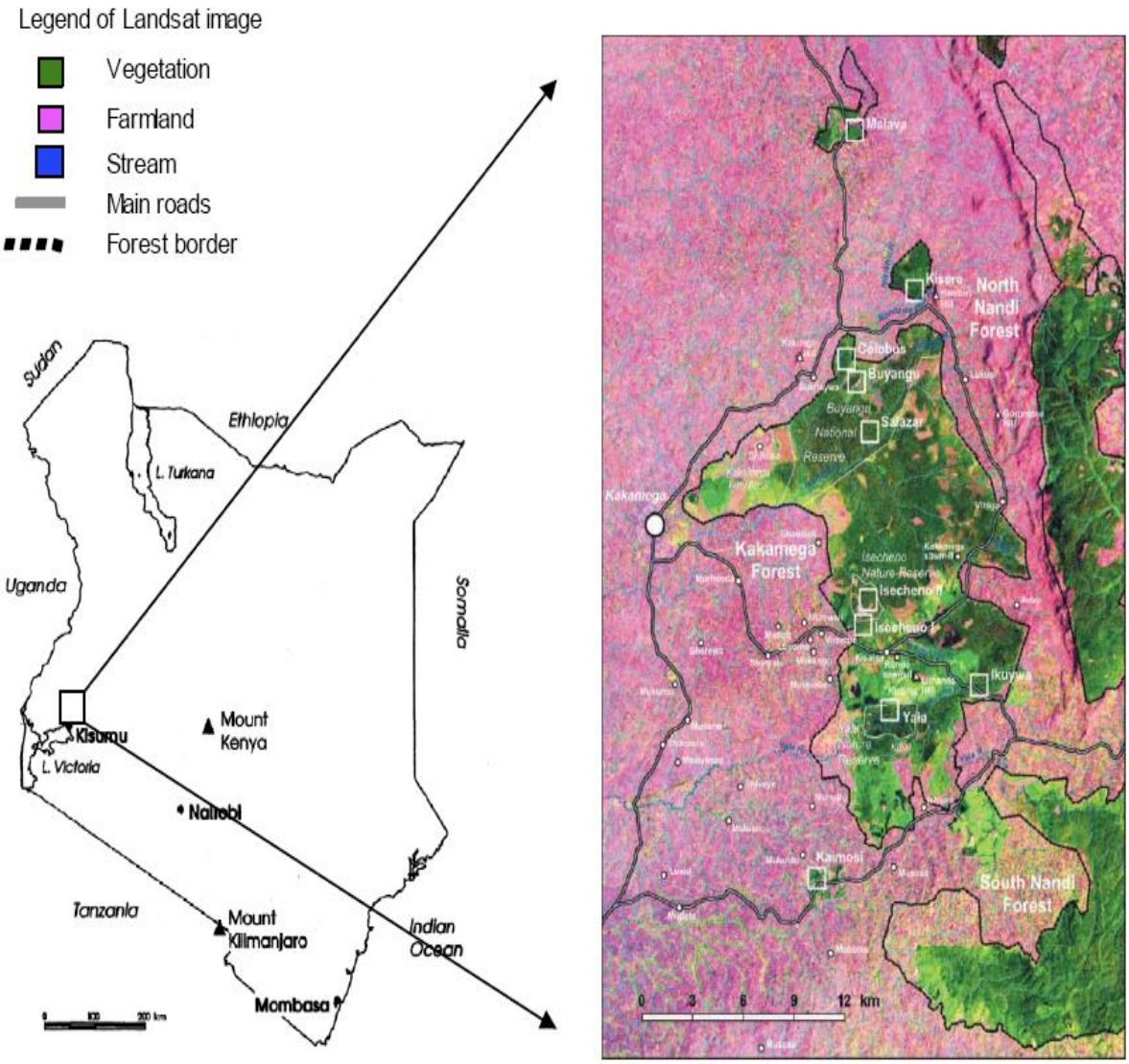
1.3.1 *Ecological status*

Kakamega forest is located in the Kakamega District of the Western Province of Kenya (Fig. 2) It is situated in the Lake Victoria basin on the most eastern edge of the Central African rainforest area about 40 km north of Kisumu and just east of the Nandi Escarpment that forms the edge of the central highlands (Government of Kenya, 2001). Being one of the remnants of the equatorial Guineo-Congolean rainforest in the Eastern fringes of Africa, the forest is known for its diversity of biotic species. It is home to some of the rarest flora and fauna in the East African region including some endemic plant species (Kasina, 2007).

Kakamega forest is not one single continuous forest block. Rather, it consists of one main forest block, which is surrounded by three smaller fragments with distinct names (Figure 3). To the south of the main block, is the Kaimosi fragment. To the north, there are the somewhat larger Malava and Kisere fragments. Over the past decades the forest and its fragments have been subjected to various forms of

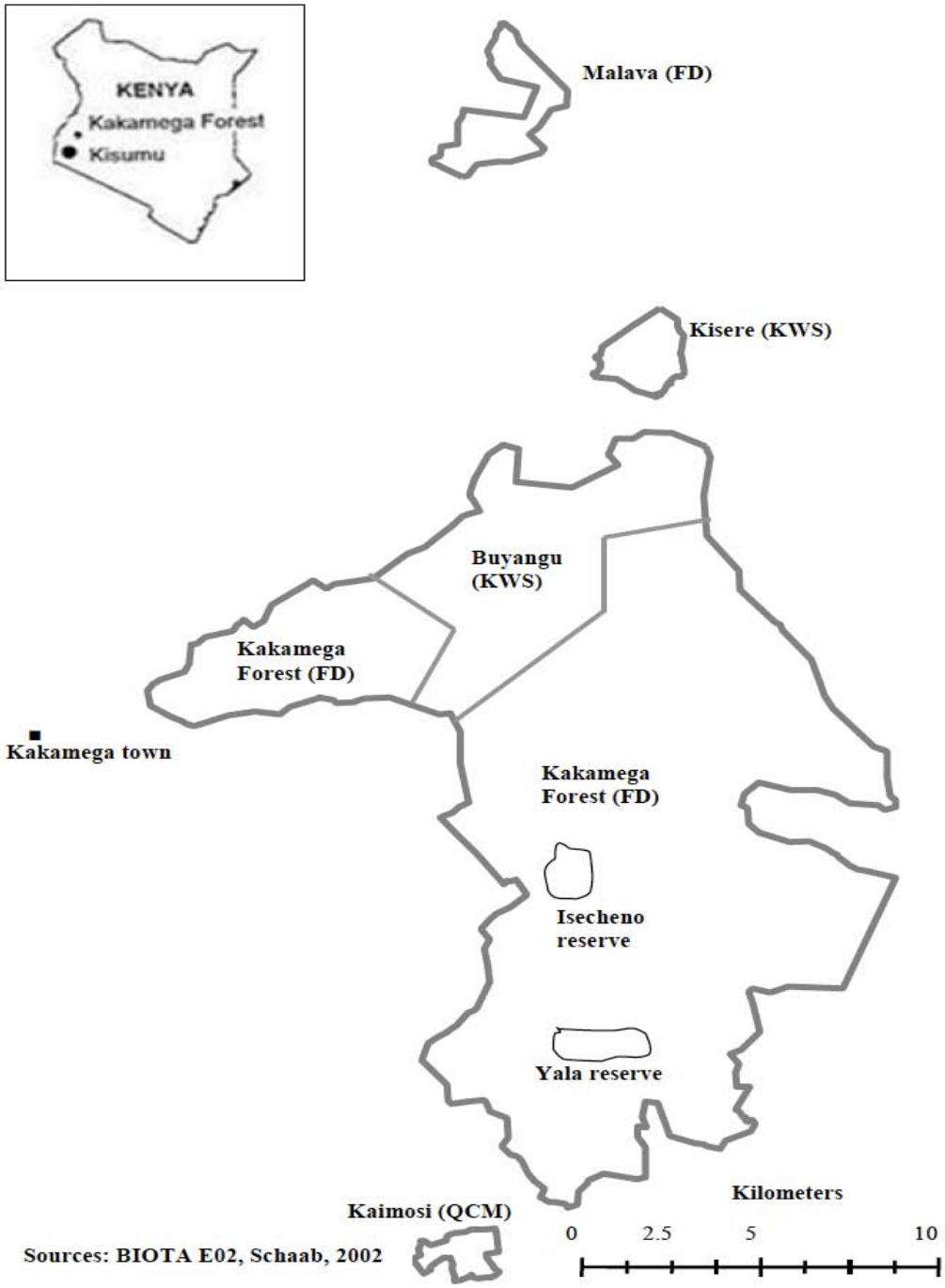
exploitation, such as illegal logging, conversion to farmland and other forms of degradative resource extraction, resulting in varying degrees of disturbance and fragmentation. Generally, a gradient of increasing degradation ranges from Kisere to Malawa, to Kaimosi (Mitchell, 2004). Hence, a disturbance gradient from primary-like forest to secondary forests as well as completely degraded areas can be recorded, while the main part of the Kakamega forest consists of secondary forest (Lung and Schaab, 2004).

Figure 2. Map of Kenya showing Kakamega forest



Source: Lung and Schaab, (2004)

Figure 3. Map of Kakamega forest and its fragments



Adopted by Guthiga, 2007

1.3.2 *Socio-economic situation*

The exploitation of Kakamega forest owes much to the socio-economic profile of the surrounding area. With an average population density of 515 people per km², the Kakamega district belongs to Africa's most densely populated regions. This high figure is coupled with an equally high poverty rate of 54.4% (KIHBS, 2007)[1] Such an alarming picture is exacerbated by a plethora of adverse factors (Government of Kenya, 2001). Among them, highly ranking challenges are the following:

- poor road infrastructure,
- energy supply: Provision of power supply is inadequate as evidenced by the fact that most rural areas do not have electricity;
- high incidences of diseases such as HIV;
- low adoption of new agricultural technologies.

The area surrounding the forest is used intensively for growing sugar cane, maize and tea. The forest itself is used for the collection of a variety of timber and non-timber forest products (Government of Kenya, 2001, Guthiga 2007).

1.4 Problem statement

The forest is a supplier of several products and services. These services range from the provision of timber and non-timber products to local communities, to water regulation, carbon sequestration, nutrient cycling, and microclimatic regulation (KFMP, 1994; Glenday, 2006). Farmers around Kakamega forest deciding whether to encroach on the forest in order to clear it for agriculture focus on the potential crop yields they may obtain. They pay little heed to the ecological services that would cease to exist if they were to do so. Many of the environmental benefits lost are not only lost to them but also lost to a much wider set of people from the local to the regional to the global level. These are negative external effects (Mishan, 1967) as direct negative effects on other economic agents are not appropriately considered in decision-making. On the other hand, the positive environmental services of the forest are, currently, enjoyed by stakeholders from the local to the global level without

[1] This is the percentage of people in rural areas living under the Kenya poverty line of KShs 1562 per month

having to pay for these services. Coupled with high conversion pressure because of a high local population density, this situation is likely to result in high deforestation rates - unless forest usage is not effectively regulated well by formal or informal institutions (Ostrom, 1990).

Some of those ecological services transcend local and even national boundaries, benefiting the global community at large. The global benefits derived from a rain forest include direct-use values from recreation (eco-tourism) and from the provision of genetic material for scientific research; indirect-use value in the form of a carbon storage service mitigating global warming; option values in the form of unknown genetic material which may be used for medical purposes in the future; and an existence value derived from the mere satisfaction of knowing that a place exists where a vast number of fauna and flora species live in their natural environment (Andersen, 1997). Thus, there is a need to incorporate as many of those benefits to whomever they may accrue, in order to demonstrate the true value of the forest.

Moreover, given that a good deal of forest benefits and costs fall upon the local communities (Bawa et al, 2004) and considering the fact that continued forest existence depends on the support of these communities, it is deemed essential that valuing their domestic dimension is given priority. This is not to say that forest conservation can be economically viable solely from a local point of view. Strictly local benefits, especially indirect and non-use values, constitute by default just a fraction of the Total Economic Value of the forest since a very large share of benefits accrues regionally and/or globally (Balmford & Whitten, 2003). Thus, local benefits hardly ever suffice to counterbalance the disproportionate magnitude of costs associated with conservation.

Nevertheless, a few studies have supported the conclusion that local benefits exceed costs of conservation, thus justifying conservation from a local perspective (Andersen, 1997; Bann, 1997). This conclusion has been reached through the use of a range of valuation techniques, each aiming at valuing the different benefits accruing to the local communities. The use of different techniques is necessary because different forest values lend themselves to valuation by different kinds of valuation

techniques. Therefore, one should be wary of any attempts to value the multitude of local forest benefits using only one method.

This is especially the case for Contingent Valuation Method (CV) which has been described as a technique that can be employed to measure virtually all types of environmental values (Turner, 1999). The use of CV, however, is often accompanied by doubts about its reliability because various potential biases (strategic, hypothetical, and information bias, as well as embedding) have been identified (Hausman, 1993). Those biases aside, CV may not be the ideal technique for valuing forests since it does not take fully into account the multi-attribute nature of forest values and the presence of complementary and substitution effects (Rolfe et al., 2000). Furthermore, CV cannot easily distinguish between use and non-use values when applied in a context where respondents interact with the environmental resource, in this case Kakamega forest.

A study by Gregory et al. (1993) examines the use of CV methods for estimating the economic value of environmental changes and argues that a principal constraint on the validity of CV is the imposition of unrealistic cognitive demands on respondents. The authors propose a new CV approach, based on multi-attribute utility theory and decision analysis to better accommodate multidimensionality of value, minimize response refusals, and exclude irrelevancies.

The limitations of CV raise the need to test a different technique for measuring local benefits, namely Choice Modelling (CM). Unlike CV, Choice Modeling does not require survey respondents to place a direct monetary value on a contingently proposed environmental change. Rather, individuals are asked to make comparisons among environmental alternatives, with the environmental good described in terms of its attributes, or characteristics, and the levels that these take. It is the attributes that are important and it is marginal changes in the attributes that are eventually assigned a monetary value. In order to do so, one of the attributes must constitute a monetary amount (Hanley et al., 2001)

The use of both techniques in Kakamega forest constitutes the novelty of this thesis, given that their joint application has, to our knowledge, up to now been restricted on valuing environmental resources almost exclusively in developed countries. Using

both techniques in the context of Kakamega forest enhances our understanding of the values local communities place on the conservation of the forest, especially indirect and non-use values. It can also help test for convergence validity between the values obtained from the two methods and highlight their respective potential for valuing tropical forests in similar contexts.

1.5 Objectives

1.5.1 *Main Objective*

The main objective of this study is to quantitatively assess indirect and non-use benefits of changes in forest-related ecosystem services in the Kakamega forest area.

1.5.2 *Specific objectives*

1. Estimate the economic value of certain indirect use and non-use benefits of a number of environmental services as perceived by local communities.
2. Estimate household willingness to accept compensation for deterioration in specific ecosystem services.
3. Assess the applicability and convergent validity of two different valuation methods
4. Assess the convergence in WTP estimates elicited by a monetary and a non-monetary payment vehicle.
5. Identify the factors that determine the perceived benefits of improved forest benefits

1.6 Structure of the thesis

In addition to this introduction, this thesis is comprised of three manuscript chapters. Chapter two presents the contingent valuation study that was carried out in order to assess the WTP of rural communities around Kakamega forest for an improvement in the provision of a group of selected ecosystem services. Attention is given on survey design issues and the suitability of a non-monetary payment vehicle. Chapter three presents the choice experiment that was carried out in order to estimate household WTP for positive and negative changes in the provision of individual ecosystem

services. Finally, the results from the two valuation methods are compared in chapter four. Besides these chapters, there is a co-authored paper (Cerda et al, 2007)) that has been published as a book chapter. This paper, however, is not included in this dissertation because it was based on preliminary statistical analysis and does not serve the purposes of the current exposition.

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CHAPTER 2 Valuation of forest benefits to local communities using Contingent Valuation with a non-monetary payment vehicle: the case of Kakamega forest, Kenya.

[1]

2.1 Introduction

The lack of markets for many goods and services provided by natural capital underlies many reasons for the degradation of natural capital. This is due to the public-good characteristics that many ecosystem functions and services exhibit (Pearce and Moran, 1994). A pure public good is a good whose consumption has two properties: it is non-rival and non-excludable. Non-rivalry means that consumption of the good by one person does not reduce the availability of the good to others; and non-excludability means that the provider of the good cannot exclude non-payers from consuming it (Heal, 2000). The market mechanism is not good at providing public goods mainly due to their non-excludability, which encourages free-riding on behalf of consumers and discourages providers of the good from investing in something that cannot generate sufficient returns to cover the cost of the investment (Marggraf and Birner, 1998). Many forest goods are rival in consumption while excludability is problematic. This gives rise to open access goods, which are highly prone to degradation if suitable institutions do not protect them (Hardin, 1968; Cornes and Sandler, 1999; Ostrom 1990).

The degradation of natural capital including forests can also be looked at from the perspective of public and private costs and benefits. Sometimes, what is good for society is also good for the individual. However, the costs of conserving a natural resource frequently fall on the user of the resource, whereas conservation benefits accrue to society as a whole (Balmford and Whitten, 2003). Consequently, it pays for the resource appropriator to overexploit and run down the resource. Thus, private choices do not necessarily mirror social values, as the consequences of the choices are not fully born by those making them (Simpson, 2009). The need to correct this imbalance has led to numerous studies that measure the economic value of forest

[1] A modified version of this chapter will be submitted to *Land Degradation and Development*

conservation in order to facilitate the internalization of the full economic value of forest natural capital in decision-making (Bulte, 2000; Torras, 2000; Glenk, 2006).

Economic valuation is an attempt to assign economic value estimates to the goods and services provided by natural resources in the absence of market prices with the aim of informing decision making regarding resource allocation. Improving informed choices on forest conservation though economic valuation fundamentally motivates the present study. This chapter reports on a Contingent Valuation (CV) study to valuate a set of ecosystem services enjoyed by communities adjacent to Kakamega forest, Kenya. Being a CV study, willingness to pay (WTP) for the different forest services cannot be elicited separately. By its very nature, the CV method can only be used to value changes along a single, albeit potentially complex dimension of change.

Although the main focus is on obtaining economic estimates of a bundle of forest benefits as these are perceived by local communities, the study does not shy away from methodological issues, especially as they pertain to the application of CV surveys in developing countries. Specifically, it departs from common practice in the valuation literature (Eom and Larson, 2006); Hung et al., 2007) by employing non-monetary means of expressing WTP. It also assesses the convergence validity of such a payment vehicle by comparing it with a standard, monetary payment vehicle. As there are only very few CV studies employing a non-monetary payment vehicle, this contribution aims at advancing the applicability of economic valuation in the context of subsistence economies where non-monetary, *in kind* contributions are common forms of economic exchange.

2.2 Economic benefits of tropical forests to local communities

Among the various biomes found on Earth, tropical forests are particularly important due to the variety of economic benefits they confer to multiple stakeholders. The benefits include the provision of timber and non-timber forest products, genetic information, the regulation of the quantity and quality of water supplies, enhanced pollination, soil stabilization and erosion control, climate regulation as well as recreational opportunities and cultural services (Field, 2001). Several of these goods

and services are widely dispersed and are enjoyed globally in the form of climate regulation, genetic information and, to a lesser extent, timber. Other forest goods and services are more concentrated and mainly affect communities residing in or nearby tropical forests. At the same time, the costs of conserving the forest, in terms of opportunity costs, are typically incurred by these communities; often they exceed any benefits they derive (Bawa et al. 2004). This effect is exacerbated by a combination of such factors as population growth, poverty and lax property rights, commonly observed in many tropical countries. These factors act together to increase discount rates and, consequently, increase the opportunity costs of preserving the forest (Kahn, 1998).

The strong dependence of local communities on the goods and services of forests has been analysed in the literature extensively. Local communities strongly depend on timber and non-timber forest products (NTFPs) for their subsistence needs as well as for income generation. Forest products are utilized for cooking (firewood), construction, grazing (fodder), medicinal purposes (plants) and food (fruit, bushmeat) (e.g. Motzke et al., 2012). Several studies have calculated the economic value of NTFPs (Yaron, 2001; Guthiga, 2007) with values ranging from $4/ha (Kramer, 1995) to over $100/ha (Grimes et al., 1994). These figures may not seem impressive expressed on a per hectare basis. Still, a substantial fraction of local household income may be derived from NTFPs. Estimates in the literature range from 1%, reaching up to well over half of the household income (Bogahawatte, 1999; Mahapatra, 2005).

At the same time, local communities benefit from the supporting and regulating functions of forests. The dependence on the associated services is aggravated by poverty and lack of vital infrastructure (Field, 2001). For instance, local households depend on the water regulating services of the forest as irrigation schemes or piped water for household consumption is often lacking.

Despite the crucial contribution of supporting and regulating functions to local community welfare, the economic valuation of these functions in low income countries has been somewhat neglected (i) compared to more developed countries, and (ii) to the direct use value of NTFPs. Relatively few studies on valuing these

services from the perspective of local communities exist. A number of them employ revealed preference methods to value hydrological services such as drought mitigation, flood protection and water quality, (Yaron, 2001; Ruitenbeek 1989; Sharachchandra et al. 2009). Alas, there is a great deal of uncertainty and variability in the reported values of such studies, owing to the limited data availability and the assumptions employed. Only more recently, stated preference methods have started being applied to the valuation of ecosystem services from a local community perspective. (Barkmann et al., 2008; Glenk, 2008; Pattanayak & Kramer, 2001).

The current study adds to this growing body of work by employing the contingent valuation method in the measurement of the economic value local communities place on a set of forest ecosystem services. These services are water supply, soil loss prevention and future supply of forest products. The next section turns to a discussion on contingent valuation, the chosen valuation technique in this study.

2.3 Contingent Valuation

2.3.1 Introduction

Contingent valuation is the first stated preference method to be applied in the valuation of non-marketed resources. Its origins can be traced back to 1947 when Ciriacy-Wantrup proposed the use of specially structured public opinion surveys to obtain values for public goods. However, the first one to empirically apply a proper CV study was Davis (1963) who attempted to estimate the value of outdoor recreation in Maine (New England, U.S.A.) woods. For some time, valuing recreation was the most popular application of the CV method. However, the influential nature of this early work gave the impetus for the spread of CV applications in other areas, such as air pollution control, scenery, wetlands and other public goods, not necessarily environmental ones (Smith, 2006).

The CV method uses surveys to elicit either maximum WTP for a hypothetical change in the availability of an environmental amenity, or minimum willingness to accept compensation (WTA) to forgo the change. In this respect, it asks individuals

in survey or experimental settings to reveal their personal valuations of increments (or decrements) in unpriced goods by using contingent markets. In the introduction of a CV survey instrument (its "frame"), the good or amenity of interest is defined, the status quo level of provision and the offered change explained, the institutional structure under which the good is to be provided as well as the payment vehicle described (Carson, 1998). The biggest advantage of CV, and of stated preference methods in general, is that we can ask respondents for their WTP regardless of whether they make use of the hypothetical commodity or not. In TEV terminology, we can obtain valuations for use as well as for non-use values.

2.3.2 Theoretical Model

In a CV survey, the respondent is confronted with the prospect of securing a positive change in the provision of a non-market good/service from Q^o (current level) to Q^1, and asked to express his/her maximum WTP to see the proposed change happen. Standard economic theory defines an individual's indirect utility function, V, as the maximum utility the individual can derive from her/his income, I, given market prices, P, and the level of provision of the non-market good, Q. It is assumed that V also depends on other socio-economic characteristics of the individual, S. Thus, the general form of the indirect utility function can be written as:

$$V(I, P, S, Q) \quad (1)$$

When answering a CV question, respondents are assumed to compare their utility at the two levels of provision of the non-market good, Q^o and Q^1. Since the higher level of provision is regularly associated with greater utility, the respondent is assumed to have a preference for Q^1, and to be willing to pay at maximum an amount, Y, to attain Q^1. Maximum WTP can be described as the amount that ensures that the level of utility before and after the provision of the non-market good is identical. Formally, this can be defined as:

$$V(I, P, S, Q^0) = V(I-Y, P, S, Q^1) \quad (2)$$

Y is called the compensating variation of a change in welfare. By re-arranging (2), Y can be defined as a function of the other parameters in the model without explicit knowledge of the indirect utility function V:

$$Y = Y(Q^0, Q^1, I, P, S) \quad (3)$$

Equations (2) and (3) comprise the basis of the theoretical framework for the analysis of CV data. Equation (3) is also known as the *bid function* and it is the object of estimation of all CV studies. (Bateman et al., 2002). However, although it is assumed to be known to the respondent with certainty, the analyst cannot directly observe it and must make certain assumptions about its structure. Most commonly, the bid function is expressed as:

$$Y = \boldsymbol{\beta}'\boldsymbol{X} + e \qquad (4)$$

Where $\boldsymbol{X}$ is a vector of all the factors that are assumed to influence WTP, $\boldsymbol{\beta}$ is the vector of the associated parameters that need to be estimated, and the error term e is the part of the 'true' indirect utility function that the analyst cannot observe. *The error term* is usually assumed to follow a normal distribution.

2.3.3 Methodological concerns

Although CV is widely used in the economic valuation of environmental resources, its use has been the subject of considerable criticism (Diamond and Hausman, 1994; Diamond et al., 1993). At the heart of such criticism lie concerns about the reliability and validity of CV studies. Reliability concerns the degree of replicability of the measurement over time and over different applications (i.e. generalisability), whereas validity pertains to the degree to which a study measures what it sets out to measure. Validity analyses measure the degree to which *biases* influence the obtained WTP estimates. The validity of a study can be defined as the extent to which it measures the theoretical construct under investigation (Mitchell and Carson, 1989).

There are two types of validity: *content validity* and *construct validity* (Mitchell and Carson, 1989; p190). Content validity refers to the extent to which an estimate takes account of all the issues deemed important for the study. This includes whether the CV survey asks the correct questions in a clear, understandable and appropriate manner so that a valid estimate of WTP is obtained. As such, content validity deals with all aspects of survey design. Content validity is, however, difficult to assess as it depends on the subjective judgment and experience of the person reviewing the study. Focus groups and pilot studies are considered key elements in improving the content validity of a study.

Construct validity is concerned with two sub-issues (Mitchell and Carson, 1989). Convergent validity is the issue of correspondence, or convergence, between measures obtained by different valuation methods. Theoretical validity, refers to the extent to which the findings conform to the theoretical foundation of the study, and to prior expectations. For example, fundamental economic theory requires that statements of *willingness*-to-pay are restricted by an individual's *ability* to pay. Thus, an influence of an indicator of individual income or wealth on stated maximum WTP is expected.

Problems with reliability and validity may arise due to certain biases. The main bias criticism has been centered on the technique's hypothetical nature. CV is a hypothetical method because it relies on mere *statements* of preference that need not reflect future behavior well. This hypothetical nature can result in *hypothetical bias*. A common concern is that without real resources at stake, the response to willingness to pay (WTP) questions is meaningless. What this means is that there is no budget constraint in a hypothetical market; without a budget constraint, WTP statements are regarded as meaningless (Kolstad, 2000).

Depending on their design, CV questions can be categorized as:
Open-ended: Individuals are asked to state their maximum willingness-to-pay without being shown any amounts beforehand. This approach was the first to be used, but has been subject to much criticism, for example, due to the possibility of obtaining unrealistic responses, reflecting mainly an understatement of actual WTP. (Bateman et al. 1999; Hoehn and Randall, 1987).

Bidding game: In this approach, respondents are faced with several rounds of discrete (yes/no) choice questions if they are willing to pay a certain amount for the proposed change or not. The bidding game is continued until the respondent declines to pay the given amount. Though this was one of the most commonly used methods in the early days, it is rarely used today, however, due to considerable evidence for a starting point bias among several issues (Bateman et al., 1999).

Dichotomous choice (also called *close ended* and *referendum*): Here, the respondent is confronted with an amount and has the opportunity to accept or reject to pay the given amount. This elicitation format is thought to simplify the cognitive task faced by respondents as it resembles real market choices. However, due to the limited information that it reveals with regard to an individual's WTP, it requires large samples if efficient estimates of WTP and the bid function are to be obtained (Bateman et al, 1999). The dichotomous choice format results in higher WTP estimates compared to open-ended and payment card approaches (Bateman et al., 1999).

A variant of the dichotomous choice format is the *Double bounded dichotomous choice*: In this format, the first WTP question is followed up by another dichotomous WTP question, depending on whether the prior offer was accepted or rejected. This format has gained ground, as it is more efficient than its using simple dichotomous choice counterpart formals because i.e. more information on individual preferences is gathered from each respondent (Bateman et al., 1999).

Payment card: This approach was developed as an improved alternative to the open-ended and bidding game formats. In a payment card elicitation format, the respondent is presented with a range of values on small cardboard cards, and is asked to choose the highest amount he/she would be willing to pay. Respondent WTP is equal to or greater than the value of the chosen card but smaller than the next higher value. This method has the advantage of being user-friendly because respondents can visually scan a list of value intervals quickly (Cameron and Huppert, 1989). The type of information obtained by this method is less diffuse than with the referendum method. In addition to finding that someone's WTP is higher (or less) than a specific value, we can also determine in which range that WTP lies (Bateman et al., 1999; Mitchell and Carson, 1989). Payment cards have been used extensively in the literature and their main advantage over discrete choice formats is that they allow for more information to be extracted from any given sample. It has been reported that in order to obtain estimates with the same efficiency as the ones from a continuous payment elicitation format, one would have to increase the sample size for a dichotomous-choice CV survey by 157% (Alberini, 1995).

2.3.4 Applying contingent valuation in developing countries

The first CV studies in developing countries were carried out in the mid-1980s and focused on the valuation of recreational amenities (Grandstaff and Dixon 1986; Abala 1987). Today, economic valuation studies in developing countries comprise a substantial fraction of all studies undertaken, and CV studies feature prominently among them. A review by Christie et al. (2008) of biodiversity valuation studies in developing countries identified a total of 195 studies, of which 75 applied the CV method. The experience of applying CV in developing country settings has highlighted certain challenges in addition to the generic methodological issues discussed above. These challenges mainly stem from the socio-economic and political situation in each country and locale, as well as from cultural and ethical norms. The following are some of the methodological and practical challenges involved in applying CV in developing countries, as they are identified in the literature (Christie et al. 2008; Whittington 1998; Whittington 2002):

Literacy, articulacy and language barriers: In many developing countries, literacy levels are considerably lower than in developed countries. As a result, many people – especially in rural areas – are semi-literate or illiterate. This can create significant problems for administering CV studies if they often rely on respondent abilities to read material and sometimes even to complete a questionnaire by writing. Yet, even if literacy is not a problem, there may still be language issues. For example, the need to administer a CV survey in the local language will require the training and use of local research assistants, which could be an issue in some areas with low levels of education. There may also be problems relating to the capacity of some local languages to express certain scientific terms. There are also reported cases where hypothetical terms, such as "imagine" or "suppose", that are commonly used in CV scenarios, are lost in translation due, for example, to the inability of the local language to convey the meaning of the conditional subjunctive (Whittington 2004).

Scientific knowledge and education: Even when basic literacy is assured, it is likely that adequate understanding of the interrelations between ecosystem functioning, ecosystem services and human welfare will be poor in many developing countries when compared to the average CV respondent in a developed country. It is therefore

problematic to apply CV surveys that require respondents to possess a thorough understanding of the environmental change (e.g., Barkmann et al. 2008).

Subsistence economies: In many developing countries with informal or subsistence economies, money transactions are limited and market prices are often absent or poorly defined, thus rendering approaches based on market prices problematic. If local people are not used to dealing with money, employing a monetary payment vehicle in a CV study may make interpretation of WTP hard or even meaningless. A few studies have attempted to address this issue by assessing WTP in terms of other measures of wealth, e.g. bags of rice (Shyamsundar and Kramer, 1996; Rowcroftet al., 2004).

Inappropriate best-practice guidelines: Some of the best-practice guidelines developed by the NOAA panel (Arrow et al., 1993) have been found not to be appropriate in certain developing country contexts. For example, these guidelines recommend that the WTP elicitation question be posed as a dichotomous choice referendum in which payment is made through taxes. This may not be suitable in certain subsistence economies where people often do not pay taxes, and may distrust government policies. Moreover, the use of split samples, necessitated partly by the use of a dichotomous payment format, may spread confusion and misinformation among surveyed households. This can happen if information about the different price levels presented to different respondents leaks in the community while the administering of the CV survey is still underway (Whittington, 1996).

All these issues call for extra caution when applying CV in developing countries. Fortunately the problems they may pose are not insurmountable. As long as care is taken to ensure proper survey design and rigorous training of the enumerators, there is no reason why CV studies in developing countries cannot match, or even exceed, the quality of CV studies in the developed world (Whittington, 1998; Whittington, 2002). Aware of the complications that these challenges can give rise to, this study set out to address them throughout the various stages of the survey.

2.4 Case study: a contingent valuation study of improved forest ecosystem services in Kenya using a non-monetary payment vehicle.

2.4.1 Description of the study area and valuation context

The study was carried out in several locations around Kakamega forest in Kenya. Kakamega forest is situated in the Lake Victoria basin on the easternmost edge of the Central African rainforest area about 40 km north of Kisumu. To the east, it neighbours the Nandi Escarpment that forms the edge of the central highlands (Government of Kenya, 2001). Kakamega forest is one of the remnants of the equatorial Guineo-Congolean rainforest in the Eastern fringes of Africa. It is known for the high levels of biodiversity characterising its plant and animal communities. It is home to some of the most rare flora and fauna in the East African region. Kakamega forest hosts a large number of rare primates, a stark variety of butterfly species and some endemic plant species.

With an average population density of 515 people per km², the Kakamega district belongs to some of Africa's most densely populated rural regions (KIHBS, 2007). The biggest town, in terms of population and economic activity, in the area is the forest's namesake, Kakamega town (population 39,000). According to the most recent available data (KIHBS, 2007), the proportion of people living under the poverty line of KShs 1562/month in the district amounts to around 55% of the total population. The majority of the population is engaged in agriculture, mainly as subsistence farmers. Households frequently keep livestock. In terms of literacy, the official statistics suggest very high rates for the country as whole: 85% of the population. There are no literacy data for Kakamega district but an online source suggests that the literacy rate in Kakamega town is 86% (http://www.rushuk.org.uk/). The area surrounding the forest is used intensively for growing sugar cane, maize and tea. The forest itself is used by local communities for the collection of a variety of timber and non-timber forest products (Kenyan ministry of planning and national development, 2001; Guthiga, 2007). At the same time, people rely on the ecosystem services provided by the forest. For example, the forest ensures a more-or-less stable

water supply, and prevents soil erosion (KFMP, 1994). These benefits are all the more important because irrigation infrastructure and wide-ranging soil conservation schemes are lacking in the area.

Over the years Kakamega forest has been subjected to various disturbances. Bleher et al. (2006) found historical evidence of high-level human impact throughout the forest with logging being most widespread. In pre-colonial times, local people were actively converting the forest into farmland. Natural disasters, diseases and war hindered these efforts (Mitchell, 2004). Under colonial rule, several serious disturbances took place: gold mining and logging, timber extraction by saw millers and fuel wood collection for cooking and charcoal production by the local people. As a result of these extractive activities, compounded by high population growth, the size of the forest has been shrinking rapidly in the last century. Lung and Schaab (2004) indicate that approximately 20% of the forest cover was lost over the past three decades alone.

This study formed part of a broader research project, BIOTA East Africa. This project co-ordinated a series of analyses of biodiversity changes in various East African highland rain forests, one of them being Kakamega forest, which exists in the socio-economic and ecological context described above. Although mostly focusing on assessments of flora and fauna biodiversity degradation, BIOTA project also takes account of socio-economic considerations in order to devise forest plans that promote sustainable utilisation of Kakamega's forest resources. As a first step toward this goal, it was deemed important to recognise and showcase the economic value deriving from the forest and residing with the communities living in the periphery of the forest. Thus, the economic valuation of the goods and services of Kakamega forest can be regarded as partly policy-driven and not exclusively as a research-driven study. In this context, it is remarkable that local people acknowledged and appreciated the importance of the forest during informal interviews and pre-testing prior to the main survey.

2.4.2 Survey design, sampling and data elicitation procedures

The administration of the survey questionnaire was carried out through face-to-face interviews in January and February of 2006. The actual survey was preceded by a period of preparation, whereby the team of research assistants was selected and trained, the sampled households where identified and the ground was laid for engaging with the local communities. The latter was achieved by utilising a network of local contacts developed by other BIOTA researchers who had already carried out research activities in the area.

2.4.2.1 Enumerators

Possible literacy and language problems were anticipated early on In line with the relatively encouraging official literacy figues for Kenya, the average number of years of school attendance in the sample was 6.15. If nothing else, this suggests that most respondents could at least read and write to a certain degree.

In order to avoid language problems, five local enumerators were hired. They had extensive prior experience in administering surveys in the area. Moreover, they came from different parts of the area where different local dialects are spoken[2], so communication issues did not arise. The questionnaire itself, however, was not translated to the local language. This was because respondents did not have to read it or fill it out. This was done for them by the enumerators, who underwent extensive training over a period of two days.

2.4.2.2 Sampling design and survey admisnistration

As a first step in the data collection stage of every survey, the target population needs to be identified. This study was undertaken in the rural area around Kakamega forest.

[2] Kenya's official languages are Kiswahili and English. However, this being a multi-tribal nation, a variety of other languages and idioms are spoken throughout the country. The main language spoken in the Kakamega district is *Luhya* but a few other idioms are spoken as well.

The survey units were households living up to 10 km from the forest edge. An informal census carried out previously by other BIOTA researchers generated a sampling frame of about 20,000 households in 210 villages over the course of the second half of 2005 (Guthiga, 2007).

With this sampling frame in mind, multistage random sampling was used. In the first stage, one village was selected from each of the 23 sub-locations adjacent to the forest. From each village, 14 households were randomly selected for participation in the survey, making the number of chosen households 322. However, as some of these households were not accessible the size of the final sample was somewhat smaller (310 households).

Following the training of the enumerators and before the start of actual data collection, a reconnaissance survey was carried out. This mainly involved informal group and individual interviews with various stakeholders. The aim of these interviews was to obtain the necessary background information about various aspects of local communities' understanding of the forest's condition and perception of environmental issues. Subsequently, the questionnaire was pre-tested by administering it to twenty households in various locations over the course of 4 days. By assessing how well the survey worked overall and how respondents reacted to it, the pre-testing helped to improve the language used in the narrative and to fine-tune the questions. Usually, a village elder was approached in order to introduce the enumerators to the respondents in each village. The interviews were carried out with the household head or the spouse and care was taken to assure the respondents that the information collected on their households' socio-economic condition would not be revealed to any third parties. These measures helped the respondents feel at ease with the enumerators.

2.4.2.3 Questionnaire design

2.4.2.3.1 Data on socio-economic and attitudinal characteristics

In addition to the hypothetical scenario and WTP elicitation, CV questionnaires regularly collect information on the socio-economic characteristics of respondents as

well as on their attitudes towards the valued good. With respect to the latter, we sought to gauge locals' general knowledge about the forest and its condition, as well as their assessments of the severity of problems related to the provision of the forest services at hand. This was done through the inclusion of several 5-point Likert-type questions, asking respondents to indicate their degree of agreement with certain statements and the importance they place on the content of certain questions (Table 1). So, for instance the variable 'yearimp' indicates the extent to which respondents agreed with the following statement: *the forest may not be able to provide my family with the products I need after 20 year*.

Table 1. Perception variables for the severity of environmental problems

The forest may not be able to provide your family with the products that you need after 20 years.	*Evaluated on a 1-5 scale from "completely disagree" to "completely agree"*
The forest has been damaged a lot in the past 20 years	
The protection of the forest is important for the livelihood of your family	
Forest protection issues are important	
The forest is in good condition	
How important do you consider water scarcity to be a problem in your area during the dry season?	*Evaluated on a 1-5 scale from "not at all important" to "very important"*
How important do you consider soil loss to be a problem in your area?	

With regard to socio-economic characteristics of respondent households, data on income was not easy to come by as many respondents were reluctant to reveal their income. In order to overcome this obstacle, a poverty index was constructed instead. This is an index of relative poverty that assigns a specific value to each sampled household representing that household's poverty status relative to all other households in the sample. To construct this index, data on several aspects of household wealth, ranging from household expenditures on several items to dwelling properties and possession of household goods, were collected (Henry et al. (2003).

Principal components analysis (PCA) was employed to extract a single poverty dimension from the data. Following the work by Henry et al. (2003), a large number

of variables were correlated with the variable "household expenditure on clothing per year", chosen as the poverty benchmark indicator. Based on the value of their bivariate Pearson correlation coefficients and other filtering measures (such as the exclusion of closely related variables), fifteen variables were selected for inclusion in the construction of the poverty index. For the component of relative poverty, only variables with component loading values above 0.3 were retained. These variables along with their respective loading values are shown in Table 1. The relative poverty component, having an Eigenvalue of 5.1 explained about 48% of the total variance. The resulting poverty index is in standardized form (mean of zero and a standard deviation of one), with poverty scores ranging from -1.085 (poorest household) to 5.120 (relatively 'wealthiest' household).

Table 2 Poverty Index variables and their component loadings

Variables comprising Relative Poverty component	Loadings
Household annual expenditure on clothing	0.701
Number of appliances and household items	0.745
Quality of residence roofing	0.652
Average household education level (in years of schooling)	0.388
Household monthly expenditure on food	0.450
Value of household land holdings	0.555
Number of cows owned by household	0.315
Household electricity	0.685

2.4.2.3.2 Hypothetical Market

The introduction of the contingent market is one of the most important sections of a CV questionnaire. The success of every CV study largely depends on the way the hypothetical scenario is presented because it determines if people understand the valued good and the setting in which it will be provided. The proposed good to be valued was presented to the respondents within the frame of a village development programme that would bring about certain improvements in a number of ecosystem

services. The services affected by this programme were water availability, soil conservation and the future supply of forest products. All of these services were identified by participants of pre-study focus groups and individual interviews.

The lack of data on values that could be used to describe the current situation as well as the future direction and magnitude of attributes such as soil loss and water availability, led to the use of an approach that conforms to individual perceptions of the prevailing environmental conditions. Thus, the 'soil loss' and 'water availability' attributes in the status quo scenario were not given a specific numerical value but this scenario was framed as a 'no change' situation in the selected attributes, with the attribute levels in the other alternatives defined as percentage changes relative to the current situation. The specific levels of change in the provision of the chosen services were chosen during the piloting of the survey in the way that made most sense to respondents. As not all locales in the studied area may face the exact same environmental problems, this approach also carries the extra benefit of doing away with the need to explicitly address local heterogeneity in environmental conditions (Glenk, 2008).

Regarding the supply of forest products attribute, the choice of the status quo level was not such a straightforward task. The problem was that in order to come up with an estimate for the number of years that the forest will be able to supply local communities with its products, one needs to know what has happened in the past and what conditions may prevail in the future. Unfortunately, there is a lack of adequate information on past deforestation rates and data on historical utilisation of forest resources by local communitites. Moreover, what has happened in the past is not necessarily a good predictor of what will happen in the future. Much like the other two attributes, this problem was tackled by asking the participants in the focus group what their perception of the future was. Specifically, focus group respondents were asked to indicate on a 5-point Likert scale to what extent they agree with the statement: *the forest will not be able to provide me and my family with the products that I need after 20 years*. The average score was 3.88, which shows that a majority of the respondents seemed tended to agree with this statement. Given this high score, it was deemed reasonable that an even higher proportion of people would believe that the supply of forest products would be even less certain after a longer period of time.

Therefore it was considered appropriate to set the status quo to 30 years. Essentially, we chose a slightly optimistic Status Quo level, thus avoiding an 'alarmist' subtext.

2.4.2.3.3 Payment vehicle & elicitation format

The chosen in-kind payment vehicle for the purpose of this study was a weekly contribution in terms of "work meals" offered by the household to a person working for the development programme. The value of such a meal, as valued in the local labour market and confirmed through preliminary enquries was KShs50 (about €0.6). The monetary payment vehicle was simply the value of each meal in money. A binary dummy variable was introduced to test for the potential payment-vehicle effect on the two sub-samples' WTP. In order to minimize hypothetical bias, respondents were instructed to take into account any budget constraints they may face when they make their choice of payment by considering any other goods and services their household may wish to spend their income on.

Given the fieldwork's budget constraints, selection of a sample large enough for accurate WTP estimation using a dichotomous-choice CV was not the ideal option. Thus a payment card was used. Respondents were asked to choose how many meals their household would be willing to contribute on a weekly basis. Initial pre-testing had shown that contributions mentioned spontaneously for the kind and quantity of forest services at stake rarely exceeded four meals a week. Thus, the range of meals was defined from one to five, that is, one meal per working day.

2.4.3 Statistical analysis of payment card data

Payment card data can be analysed in a number of ways. Standard OLS regressions can be used, treating the WTP values chosen by individuals as point estimates of their WTP. Alternatively, the midpoint of the interval between the value chosen and the next value up in the card can be used. This said, the WTP values on a payment card are typically censored at zero, i.e. respondents are offered only positive amounts. Thus, to account for the censored nature of the data, Tobit models can also be used (Halstead et al., 1991).

However, payment card data are most commonly treated as interval data. This is because the respondent maximum WTP lies somewhere in the space between the value chosen on the payment card and the next higher up. For this reason, payment card data can be analysed using parametric, maximum likelihood interval regression methods (Cameron and Huppert, 1989). In this case, the *i*th respondent's true maximum WTP, Y_i, lies between the chosen value (t_{il}, lower bound of WTP interval) and the next higher value (t_{iu}, upper bound). Expressing Y, as in (4), we can estimate the probability that Y_i lies between t_{il} and t_{iu}, $\Pr(t_{il} \leq Y_i < t_{iu})$ as

$\Pr(t_{il} \leq Y_i < t_{iu}) = \phi[(t_{iu} - X_i'\beta)/\sigma] - \phi[(t_{il} - X_i'\beta)/\sigma]$. The log-likelihood is given by:

$$\ln(L) = \sum_{i=1}^{n} \left\{ \ln\left(\phi[z_{iu}] - \phi[z_{il}] \right) \right\}, \text{ where } Z_{iu} = (t_{iu} - x_i\beta)/\sigma \text{ and } Z_{il} = (t_{il} - x_i\beta)/\sigma$$

The choice of a specific model hinges on several properties of the data that may be conflicting (Whitehead et al. 1995). On the one hand, the higher the number of zero responses, the higher the probability of bias if OLS is used instead of a Tobit model. On the other hand, the wider the WTP intervals, the greater the chance of bias if interval regression is not used (Cameron and Huppert 1989). In this study, the WTP responses corresponding to both the monetary and in-kind payment vehicles are analysed using OLS, Tobit and an Interval Data model. The next section presents the results of the statistical analysis.

2.4.4 Results

2.4.4.1 Protest responses

Out of the 310 sampled individuals, 15 were classified as "protest bids" and excluded from the analysis of WTP. This was because they stated either that they did not think they should have to pay for the proposed changes (9 respondents) or because they doubted the proposed services would be provided even if they paid (6 responses). This latter explanation implies that these respondents were probably not convinced by the scenario at hand.

2.4.4.2 Socio-demographic and perception variables

For the respondents that were included in the analysis, Table 2 presents a summary of their socio-demographic characteristics, scores on certain attitudinal and belief items on environmental conditions and services as well as average WTP for the two subsamples, and the overall average. Because of the very small share of protest responses (<5%), no attempt is made to correct WTP estimates for protest responses accepting a very minor overestimation of the true sample mean.

Table 3. Descriptive statistics of respondents and respondent households

Variable	Mean	Standard deviation
Sociodemographic		
Age	47.68	15.09
Education	6.13	4.21
Household size (number of people)	5.81	1.92
Household monthly expenditure[1]	9805	8303
Household poverty index	0.00	1
Perceptions		
Forest condition[3]	2.59	1.28
Forest importance for livelihood[3]	4.60	0.85
Does the forest affect water availability?[2]	0.90	0.28
Forest ability to provide resources in 20 years[3]	3.88	0.94
Severity of water scarcity problems[3]	3.29	1.71
Severity of soil loss problems[3]	3.65	1.42
Willingness to pay		
Mean WTP [**meals** card chosen (n=148)]	2.38	1.43
Mean WTP [**money** card chosen (n=147)]	Kshs 109	Kshs 63.37

[1]Includes cash expenditures on food, clothing, transport, health and schooling
[2]Categorical 0/1 variable; [3] 1-5 Likert type variable (see below for details)

With regard to the perception variables, respondents mostly disagreed with the statement "the forest is in good condition" (average 2.59 on a 1-5 "completely disagree-completely agree" (CD-CA) scale). In contrast, they overwhelmingly agreed (4.6 on a CD-CA scale) with the statement "The protection of the forest is important for the livelihood of your family", whereas 90% of them agreed with the question "Do you think that water availability in your area is affected by the forest?"

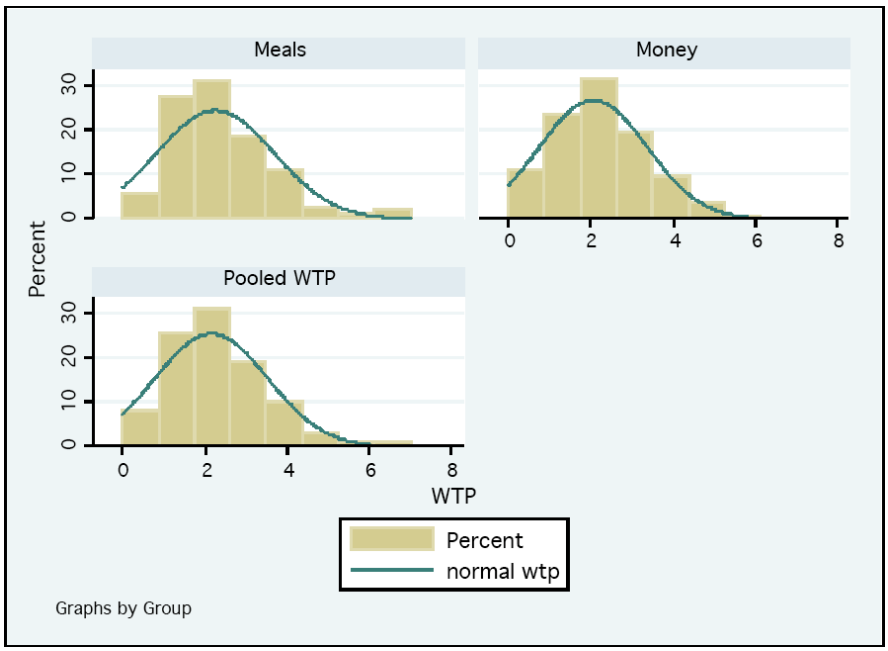
In terms of the severity appraisal of certain environmental problems (Table 1), on average, respondents thought that the forest might not be able to provide their household with forest products after 20 years, and that water shortages and soil problems are relatively important. These attitudes are not very strongly held, though, as the mean scores for the three items of 3.88, 3.29 and 3.65 respectively, indicate all fall between “neither agree nor disagree” and [a flat “agree”]/[agree somewhat]). These findings suggest that respondents think Kakamega forest is important for their livelihood but that they do not regard the assessed environmental issues as particularly acute.

2.4.4.3 Willingness to pay

Regarding average WTP, households in the “meals” subsample were on average willing to contribute 2.38 meals weekly. Households in the "money” subsample were willing to contribute Kshs109; this is the equivalent of about 2.18 meals. For the pooled sample, average WTP expressed in Kenyan Shillings (KShs) was about KShs114, or 2.28 meals. In order to test whether the means from the two subsamples were significantly different, a t-test of means was carried out. The null hypothesis of zero difference could not be rejected (p=0.0219). This was also confirmed by the insignificance of a dummy variable (Group) that was included in the pooled model to distinguish between the two samples (Table 4). As it turns out, there is no significant difference between the WTP values obtained from the two subsamples.

Figure 4 shows the histograms of WTP in the two subsamples and of the WTP in the pooled sample, all converted to meals, and overlaid by a normal distribution. It can be seen that the WTP distributions are very similar indeed. However, even though any differences are statistically insignificant, it may be informative to observe that there are more WTP values towards the high end in the “meals” sample and more zero WTP values in the “money” sample.

Figure 4. WTP distributions with money values converted to meals



2.4.4.4 Model fit & determinants of WTP

The convergence between the WTP values obtained by the two payment vehicles suggests that there is no need to conduct separate analyses for the two subsamples and that a single analysis for the overall sample would suffice. Nevertheless, WTP values for the two subsamples were subjected to separate analyses, as discussed above, and are presented in Table 2 for illustrative purposes. Goodness-of-fit measures for the various models are reported. However, caution should be exercised when comparing the measures obtained by different models, as Tobit and interval regressions do not have an equivalent to the R^2 used in OLS regression. The model estimates from Tobit and interval regressions are maximum likelihood estimates generated through an iterative process and are not calculated to minimize variance, as done in OLS. Thus, the reported R^2 values are not directly comparable, which means that it is not possible to single out any one model as the best-fitting model. Be that as it may, what does matter is the fact that the reported R^2 assume very high values in all three models and for all samples (meals, money, pooled), indicating highly satisfactory model fit.

The variables included in the table are the ones that had a significant effect on WTP in at least one of the models. For all models used, the coefficient parameters are

interpreted in the same way, i.e. as the linear effect of each covariate on WTP. However, due to the different metrics used –meals and money- the scale of the parameters differs accordingly. What matters however are differences in the relative values of the parameters. Table 2 shows that all variables are significant in all samples, and with the expected sign, except for "Education" which is not significant in the "meals" sample and "Age" in the "money" sample. Even in the models with age and education statistically significant, their influence on WTP is minute compared to the other explanatory variables.

Table 4. Model results

	MODELS								
	Meals			Money			Pooled		
Explanatory variables	**Tobit**	**OLS**	**Interval**	**Tobit**	**OLS**	**Interval**	**Tobit**	**OLS**	**Interval**
Constant	-2.807	-2.481	-2.335	-165.333	-132.344	-107.814	-3.130	-2.632	-2.401
Group							$-.1209^{(ns)}$	$-.080^{(ns)}$	$-.0693^{(ns)}$
Sociodemographic									
Poverty Index	4.407	4.186	4.008	334.578	326.036	324.694	5.005	4.632	4.552
Age	-.018*	-.016*	-.017*	$-.203^{(ns)}$	$-.274^{(ns)}$	$-.274^{(ns)}$	-.011*	-.010*	-.010*
Education	$.007^{(ns)}$	$.007^{(ns)}$	$.007^{(ns)}$	2.323*	2.140*	2.172*	.027*	.026*	.028*
Household size	..079*	.074*	.075*	4.679	4.324	4.408	.081	.074	.078*
Perception									
Soil severity	.261	.243	.245	13.021	11.678	11.626	.269	.243	.240
Water severity	.399	.377	.382	16.281	15.187	15.194	.362	.339	.343
Years severity	.283	.253	.251	18.552	16.422	16.456	.346	.312	.321
	Pseudo R^2 = 0.4 ML (Cox-Snell) R^2 = 0.762	R^2= 0.764	ML (Cox-Snell) R^2 =0.793	Pseudo R^2= 0.164 ML (Cox-Snell) R^2=0.819	R^2= 0.835	ML (Cox-Snell) R^2=0.833	Pseudo R^2= 0.4063 ML (Cox-Snell) R^2 =0.763	R^2= 0.77	ML (Cox-Snell) R^2 =0.794

$^{(ns)}$Not significant; *Significant at $p \leq 0.05$; otherwise significant at $p \leq 0.01$

2.5 Discussion & Conclusions

The CV study described here was carried out among rural households around Kakamega forest. Although the main goal of this study was to obtain values of household WTP for improved forest-related services, the study also focused on another issue, namely the use and usefulness of an in-kind payment vehicle.

2.5.1 General Methodological Issues

2.5.1.1 Sampling

In selecting the sample, multistage random sampling was chosen over alternative methods because of the advantages it offered with respect to cost savings and ease of survey administration. Additionally, it facilitated the administration of a split sample of the payment vehicle. Choosing multistage sampling helped to avoid potential problems associated with the leaking of information with regards to the payment vehicle during the survey. This was a real concern for this study as the use of a monetary and a non-monetary payment vehicle called for the use of a split sample, one for each payment vehicle. In the first stage of the multistage sampling, a monetary payment vehicle was assigned to 12 villages, randomly selected out of the original 23, whereas a non-monetary payment vehicle was used for the rest. Thus, the same payment vehicle was used within each village and villages close to each other were surveyed sequentially. This way it was ensured that respondents were not aware that some of them were presented with different payment vehicles, something that could have raised unnecessary suspicion among them.

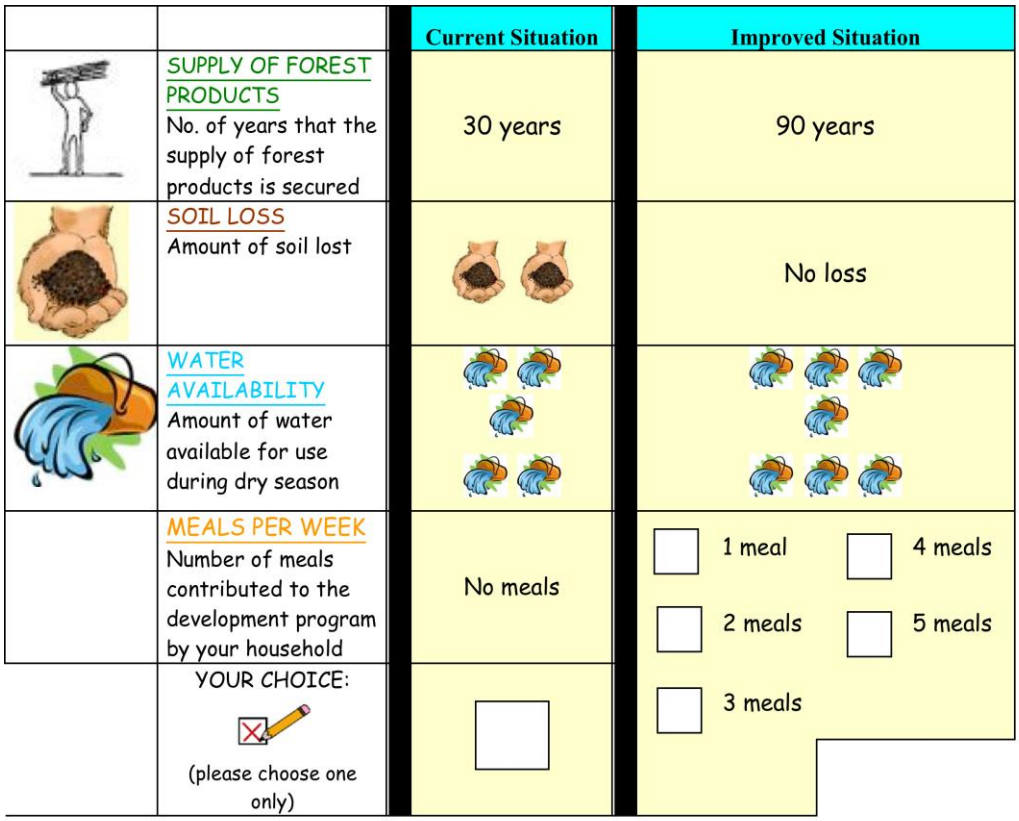
There is another sampling-related issue that could have potentially caused problems. This is the fixed number of households selected from each village. The fact that 14 households were targeted, regardless of the size of each village, could have potentially given rise to sampling bias in the sense that e.g. households from smaller villages could have been oversampled relative to households from larger ones. In retrospect, however, this could have hardly been an issue. The reason is that with an average of 122 households per village and standard deviation of 10.4, the size of the sampled villages is distributed fairly homogeneously. This means that the 14 households selected from each village represent a rather small fraction of the average village and, given that all villages are more or less of similar size, sampling bias should not be a problem. Nevertheless, I addressed the issue by introducing population-proportional sampling weights. This, in essence, assigns to each observation a weight, which is the inverse of the relative oversampling of the household.

2.5.1.2 Respondents' understanding

In our case, even if basic literacy was not a problem, adequate understanding of scientific concepts regarding forest ecosystem functioning could not be taken for granted: The vast majority of respondents had not gone past primary school and, therefore, possessed little formal education on environmental issues. An initial pilot study revealed that people were generally aware of the benefits afforded to them by the forest, but knowledge on how these benefits were generated was incomplete. Therefore, it was necessary to describe the benefits in as simple, yet relevant, a way as possible. The approach to 'translate' aspects of ecosystem functioning as described by the environmental sciences into benefit descriptions in terms of respondents' life worlds follows the explicit *ecosystem service* method described by Barkmann et al. (2008); for a different application, see Rajmis et al. 2009. In order to avoid complicated descriptions of the various hydrological functions of the forest, the study attempted to measure changes in the provision of certain services relative to prevailing conditions as these conditions were perceived by the respondents.

To further enhance respondent understanding, the proposed changes were also presented with the help of visual aids. Figure 1 depicts how these changes were presented. It shows, for instance, how a 40% increase in water availability thanks to the development programme can be described in terms of an increase from five buckets of water to seven, with five buckets representing the current situation as it was perceived by each respondent.

Figure 5. Proposed changes due to village development programme



The specific graphical form of the presentation is very similar to the choice cards used in a concurrent choice experiment with the same sample of respondents conducted directly before presenting the CV card.

2.5.2 Willingness to pay

2.5.2.1 General WTP considerations

The main finding of this study is that, on average, households were willing to contribute about 5,500 KShs/year[3] to a village development program that would halt soil erosion, increase water availability by 40% and secure the supply of forest products for 90 years. What can be said about the obtained magnitude of WTP (either in meals or money) with regard to the convergent validity of this study? For example, we can compare stated preferences with how much households spend on other items such as clothing, food, transport etc. Average monthly household expenditure on such

[3] Yearly figures are obtained using the basic formula: 1 meal x 50 Kshs x 4 weeks (per month) x 12 months.

items was about Kshs10,000. This means that with an average of about KShs465 WTP per month, households were willing to contribute just shy of 5% of their monthly expenditure to the village development program that would enhance a bundle of ecosystem services.

5% of a household's monthly expenditure is not an unrealistic value, especially when one considers the significance of water, soil and forest products for rural households, whose livelihoods depend heavily on the continued provision of these ecosystem services and products. In fact, a number of studies report similar values. For example, Kasina (2007) assessed the value of pollination in the same area, using the same sample frame and similar payment vehicles (meals and labour). The study found the average WTP of households for pollination services to be about KShs125 per week, which is not too far from the value obtained here. Similarly, Barkman et al. (2008) estimate that rural households in Indonesia were willing to pay on the average 1% of their cash income for improved water availability. Day and Mourato (2000) report a share of 1.3% of Chinese urban residents' annual income for WTP for halting the deterioration of river quality in China. Brower et al. (2007) estimated that airplane passengers' willingness to pay (WTP) for a carbon travel tax to offset their GHG emmissions amounted to 2.36% of income. Wang et al. (2000) find that residents of the city of Sofia in Bulgaria would pay 4.2% of their income for air quality improvements. Finally, WTP for deterrents to wildlife attacks in Namibia amount to about 10% of respondent income (Sutton et al., 2002).

2.5.2.2 WTP determinants

By far the biggest effect on WTP is exerted by household wealth as captured by the poverty index. That is, the wealthier a household, the higher its stated willingness to contribute ion toward the proposed village development programme, all other things equal. This finding is in line with theoretical expectations and demonstrates that households did (implicitly or explicitly) take into account their budget constraints. Therefore, our results do not support the claim that CVs are negatively affected by *hypothetical bias* (Loomis, 2011; Hausman, 2012). Instead, stated preferences clearly reflect ability to pay as demanded by theory.

In terms of household size, the positive sign of this variable means that on average, larger households expressed a higher WTP. This is also reasonable as it suggests that larger households stand to benefit more from the improved ecosystem services. The negative sign of the "age" variable, on the other hand means that older respondents were willing to contribute less, though the small magnitude of the coefficient means that this effect is negligible. The same can be said of the education level. Better-educated respondents were more willing to contribute, though again the effect on WTP was small.

What stands out from the analysis is the influence of the perception of the severity of environmental problems on stated WTP. The higher respondents rated the problems associated with soil loss, water availability and the forest's ability to provide their household with products, the higher were respondents WTP bids on average. Although the effect of these variables is smaller than the effect of household wealth, it is larger than the effect of socio-demographic variables. The positive sign of the three variables is a clear indication that perceptions matter, in this case even more so than socio-demographic characteristics.

2.5.2.3 Monetary vs. in-kind WTP

WTP in this study was elicited using both monetary and non-monetary payment forms Although the rural economy around Kakamega forest is of a semi-subsistence nature, money is commonplace and used on a daily basis. At the same time, in-kind payment for services and goods, though not the rule, is relatively common. Specifically as a 'payment' for people participating in community activities, in-kind payments are often observed. Thus, conditions were right to assess the convergent validity of such a payment mode when compared to a monetary payment vehicle.

There is a small but growing number of CV studies that have elicited WTP in non-monetary forms. The justification for this is usually the subsistence nature of the surveyed setting coupled with an absence of an organized market economy. Eom and Larson (2006) argued that economic theory would suggest that when, choices are constrained by time and money, welfare values can be elicited using either monetary or in-kind forms. Some of the studies using in-kind payment vehicles have used

tangible goods as payment methods, such as bags of rice (Shyamsundar and Kramer, 1996; Akter, et al., 2007) and maize (Sutton et al, 2002). However, the most commonly-used, non-monetary payment vehicle has been *time* contributed to various activities aiming at the delivery of certain goods and services. (Khorshed and Marinova, 2003; Mekonnen, 2000; Swallow and Woudyalew, 1994; Echessah et al., 1997; Hung et al., 2007).

Results from many of these studies (Swallow and Woudyalew, 1994; Echessah et al., 1997; Hung et al., 2007) indicate that a *labour* payment vehicle is often associated with higher WTP among respondents compared to a monetary payment. For example, using the wage rate of a casual worker, Echessah et al. (1997) found that the mean WTP is higher under the labour payment vehicle than under the monetary payment vehicle. Eom and Larson (2006), suggested that the higher mean WTP for labour could be linked to a low valuation of time and/or hypothetical bias. Ahlheim et al. (2010) even argue that labour as a payment vehicle is flawed altogether because it "is not as easily and straightforwardly convertible into utility as money" (p22). However, in their study of farmers' WTP for maintenance of irrigation canals in Ghana, Vondolia et al. (2011) showed that familiarity with monetary and labour payment vehicles attenuates differences in WTP.

The current study intended to assess the suitability of a hitherto untested payment vehicle, namely labour-meals and found no significant difference in WTP between the two sub-samples. This is a key finding as it suggests that respondents did not perceive any difference between the "meals" and the "money" payment vehicle. It therefore is a confirmation of the convergent validity of the CV survey with regard to the use of two different payment vehicles, one monetary and one in-kind.

2.5.3 Looking at the bigger picture

By multiplying household WTP with the number of households in the sampling frame (20,000), one arrives at the total economic benefit accrued to the rural population around Kakamega forest. This amounts to KShs110 million/year and is predicated on the assumption that the valuation scenario changes would manifest themselves

without further positive or negative side-effects. Stated differently, this number is the aggregated maximum ex ante WTP to bring about the scenario changes.

Dividing this amount by the forest size (24,000ha) we obtain an estimate of KShs4,580/ha/year (about $50/ha/year). One way to appreciate this figure would be to compare it with estimates from other studies in the literature. Comparable estimates in the literature, however, are hard to find. This is mainly because there are few studies that explicitly value forest ecosystem services in developing countries from a local communities' perspective. Despite the limited number and varying scope and methodologies of studies on the economic value of forest ecosystem services to local communities, certain figures reported in the literature compare favourably with the findings in this study. For instance, Yaron (2001) valued flood protection by tropical forests in Cameroon at US$24/ha/year, while Kumar et al. (2006), in their study of the economic value of forest ecosystem services in India, estimate a value of about 30/ha/year for soil erosion prevention.

One way to make sense of this kind of figures would be to try to compare them with some of the costs associated with bringing forth the proposed changes, as well as the opportunity cost of conservation, i.e. the foregone benefits of utilizing the forest for agricultural purposes. Unfortunately, such a comparison can only be a crude approximation at best, for practical as well as methodological reasons. First of all, dividing the total economic benefit by the number of forest hectares in order to arrive to a "per hectare" economic value, though commonly done, is potentially misleading because it may suggest the notion of a linear relationship between forest cover and economic value of ecosystem services.

It should be obvious that this would be a gross oversimplification. For example, it overlooks non-linearities and threshold effects that often characterize ecosystems. The potential for thresholds, beyond which ecosystem services might more rapidly decline or even collapse, is significant and needs to be recognised (Brouwer et al., 2013). According to Morse-Jones et al. (2011), "at the level of individual service provision one cannot always make the assumption that marginal benefit values are equally distributed" (p5). For example, the storm protection benefit of a unit increase in mangrove habitat area may not be constant for mangroves of all sizes due to non-

linearities in the wave attenuation service (Barbier et al., 2008). Closer to home, much was made in recent years of the water crisis faced by Nairobi residents and largely attributed to the severe degradation of Mau forest, which is considered one of Kenya's main water towers and which has lost a fourth of its original cover since the 1980's (Baldyga et al., 2008).

Another problem is that the cost of implementing a village development programme that brings about the changes specified in the valuation exercise is not known. In absence of detailed locally applicable and sufficiently applied ecosystem models – or very detailed actual planning material – already the economic quantification of such a scenario is guesswork (Barkmann et al., 2008).

The conservation of Kakamega forest carries an opportunity cost in the form of income that could have been generated through the conversion of the forest to farmland. The net returns from agriculture in the study area have been estimated to average 100-500 euros/ha/year depending on the choice of cash crop (Boerner et al., 2009), a figure that is comparable with the opportunity cost estimated by Norton-Griffiths and Southey, (1995) for high potential agricultural land in Kenya at US $ 150/ha/year. It should thus be obvious that the village development programme is not economically viable when judged on the economic benefits that it confers to the local communities alone. However, this opportunity cost does not reflect the potentially adverse impact of agricultural land use on the deterioration or collapse of some of the ecosystem services associated with the presence of Kakamega forest. Although there is no data suggesting that such an eventuality is imminent, the possibility of something like this happening has been highlighted elsewhere in the literature. For instance, in his study of the economic and ecological benefits of mangrove ecosystems in Thailand, Barbier (2012, p77) concludes that "although the critical landscape size that leads to the demise of the ecosystem is unknown, the risk of collapse is likely to increase with a fall in the ecosystem area". Thus, in the case of Kakamega forest, if advanced deforestation were to lead to significant decline in agricultural productivity, it could be that the opportunity costs of conservation are negligible and hence the development programme would be economically viable.

Finally, in order to properly evaluate the conservation of Kakamega forest economically, all elements of the TEV framework as well as other consituents (national or global) ought to be taken into account. Guthiga (2007), based on an estimated carbon density of 330tC/ha (Glenday, 2006) estimated that for a carbon price of US$10 per tonne of CO2, the value of the carbon storage potential of Kakamega forest is approximately US $ 1060/ha/year. Thus, the inclusion of just the climate change mitigation potential of the forest would suffice to tilt the balance toward conservation. Still, even from a financial point of view, these economic benefits would have to be captured at least in part and appropriately distributed to the local communities in order to change their forest utilization patterns.

Although the main goal of this study was to obtain values of household WTP for improved forest-related services, the study also focused on another issue, namely the use and usefulness of an in-kind payment vehicle. Through the use of a split-sample, two payment vehicles were employed: a monetary and an in-kind one. The findings confirm that both payment vehicles were equally appropriate, as the WTP values obtained from the two subsamples were not significantly different. Although this is a confirmation of the convergent validity of values obtained from different payment vehicles, too wide-ranging a generalization of this conclusion may not be warranted. This is because different countries and areas in the developing world face different socio-economic and cultural conditions and the use of any particular payment vehicle is very much context specific. Still, it appears appropriate to interpret the results of this study as an indication that an outright rejection of monetary payment vehicles is not indicated under semi-subsistence conditions as widespread in rural areas of developing countries.

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CHAPTER 3 Estimating the Economic Value of changes in forest-related ecological services using a choice experiment: the case of Kakamega forest, Kenya

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[1] A modified version of this chapter will be submitted to the *Journal of Choice Modeling*

3.1 Introduction

Tropical forests generate a substantial number of goods and services that benefit society at large. On the one hand, they provide global services whose benefits transgress national boundaries and affect global welfare (Swanson, 1997). The most common examples are carbon sequestration and biodiversity preservation (Swanson 2007). Many of the benefits, however, accrue locally. Timber, fuel wood, water supply, soil protection and a range of non-timber forest products are examples of products and services whose benefits are felt on a local/regional level (Pearce, 2007). Yet, tropical forests have been and are being destroyed around the world at an alarming rate (MA, 2003). The most common explanation put forward by economists is that, since there are no markets for most forest services, their benefits go unpriced and are thus undervalued in economic decision-making (Barbier, 2007).

This study is part of an organized attempt by BIOTA East Africa to estimate the Total Economic Value (TEV) of the forest to the communities residing around Kakamega forest. Its main purpose is to measure the magnitude, in monetary terms, of certain indirect and non-use benefits afforded by the forest locally. It does so by adopting an ecosystem services approach, whereby the objects of valuation are ecosystem services that conform to the views and perceptions of local communities living in the vicinity of Kakamega forest (Barkmann et al., 2008) Specifically, "prevention of soil erosion", "water availability" and "supply of forest products" are investigated.

Kakamega forest is one of the remnants of the equatorial Guineo-Congolean rainforest in the Eastern fringes of Africa (Kasina, 2007). As such, the forest is known for its diversity of biotic species, and it is home to some of the most rare flora and fauna in the East African region. It hosts a large number of rare animals and even some endemic plant species. Local communities adjacent to Kakamega forest rely heavily on its existence for their survival (Guthiga, 2007).

Despite the extensive research that has been conducted on various levels of biodiversity in Kakamega forest, there is a paucity of data on regulatory functions of

the forest. However, the existing data suggest that the disturbance that the local ecosystems have been subjected to over the past decades has led to deterioration in the environmental quality on which local communities rely. For instance, Waswa (2012), in his assessment of land degradation at various sites around Kakamega forest, found that at least 70% of sampled farms experienced sheet erosion. At the same time, "major soil chemical properties were found to be below the critical thresholds needed to support meaningful crop production" (p4). Waswa identifies agricultural expansion as the activity most responsible for these problems. In addition, the conversion of Kakamega forest to agriculture has been associated with increased water discharge and storm runoff (Recha et a., 2012)

The lack of more detailed data on the relationship between Kakamega forest and the various ecosystem services that flow from it is unfortunate, since the estimation of the benefits from regulatory functions would help demonstrate the true economic value of the forest. What is more, it also renders the use of revealed preference methods for the estimation of the relevant indirect values problematic. For example, little is known on how forest cover affects the regional supply of water. Without such information, production function methods that relate water supply to agricultural income cannot be used in order to valuate the hydrological functions of Kakamega forest. In the absence of data that facilitate the use of revealed preference methods, one has to resort to the second-best solution. Thus, in order to estimate indirect use values, as well as non-use values, the use of stated preference techniques was deemed appropriate (Freeman, 2003). One such technique, a Choice Experiment, was adopted for this study. By its design, the choice experiment interview allows for the independent calculation of WTA- and WTP-format stated preferences. As this issue has already be investigated in Cerda et al. (2007), respective calculations and results will not be repeated here.

The rest of the paper is organised in the following way. Section 2 makes a case for the use of an ecosystem services approach to assess the economic value of Kakamega forest functions. Section 3 briefly describes the study area. Section 4 describes the choice experiment used in this study, mainly focusing on issues of attribute selection and experimental design. In section, 5 two econometric models, a Nested Logit and a

Random Parameter Logit model, are presented and the results are discussed. Section 6 offers some conclusions.

3.2 Adopting an Ecosystem Services approach for the valuation of forest benefits.

Studies measuring the various economic benefits of forest ecosystem functions and services abound in the literature (Costanza et al., 1997; Barkmann et al. 2008, Glenk, 2008; Kasina, 2007). In valuing environmental goods and services economists typically employ the Total Economic Value (TEV) framework (Pearce and Moran, 1994). According to this framework, the TEV can be divided into *use value* and *non-use value*. Use values arise from an actual use made of a given resource. This might be the use of a forest for timber and non-timber products, or for recreational purposes. Use values are further broken down to *direct use values*, which refer to actual uses such as those just mentioned; *indirect use values*, which refer to the benefits deriving from ecosystem functions such as the soil's nutrient cycling function, water regulation and pollination; and *option values*, which are expressed as individuals' willingness to pay to preserve an asset for the option of using it at a future date. Finally, non-use values are those held by individuals who value a resource's mere existence without intending to make use of it either now or in the future.

With respect to the indirect use values –and of particular importance to any sound economic valuation study– the distinction between ecosystem functions and ecosystem services is crucial. Costanza et al. (1997) define ecosystem functions as "the habitat, biological or system properties or processes of ecosystems" (p. 4). De Groot et al. (2002) define them as "the capacity of natural processes and components to provide goods and services that satisfy human needs" (p. 394). Ecosystem services, on the other hand, are the beneficial outcomes for people that result from ecosystem functions. According to Scott et al. (1998) ecosystem services are "attributes of ecological functions that are valued by humans" (p. 50). The most cited definition of ecosystem services is provided by the Millennium Ecosystems Assessment (2005). Specifically, ecosystem services are the benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such

as regulation of floods, drought, land degradation, and disease; supporting services such as soil formation and nutrient cycling; and cultural services such as recreational, spiritual, religious, and other nonmaterial benefits. According to Hawkins (2003), essentially the distinction boils down to this: "Functions are what biologically and chemically occur in ecosystems, and would occur regardless of human presence. Services, however, are based on human needs, uses, and preferences" (p2). Similar to this, Barkmann et al. (2008), define ecosystem services as "immaterial economic goods provided by ecological systems including their elements, structures, processes, states, dynamics etc" (p50).

The distinction between ecosystem functions and services matters because from an economic point of view what is valued by people are the end products of the various ecological processes and functions, namely the ecosystem services directly affecting peoples' welfare. In most cases it is quite difficult to value ecosystem functions, such as nutrient cycling and water purification. Such functions become pertinent and amenable to economic valuation when, through specific benefits they confer, they enter the economic system via production functions and/or people's preferences as expressed by their willingness to pay (Glenk, 2008).

The economic valuation literature distinguishes between direct (or stated preference) and indirect (or revealed preference) approaches (Pearce and Moran, 2004). The direct approach employs methods that attempt to elicit values directly by the use of surveys and experimental techniques such as contingent valuation and choice experiments. The indirect approach makes use of the notion of weak complementarity, which allows us to infer the value of a non-market good or service from the influence it exerts on the utilisation of a well-recognised market commodity (Bockstael and Kling, 2007). For instance, we know that people spend money to travel to natural parks and reserves. Consequently, we can look at those expenditures to see if we can infer the recreational value of such sites ("travel cost method"). We also know that watershed protection afforded by forests mitigates the risks of flooding and, thus, the probability and magnitude of damages.

Assuming that data availability and accessibility are of no concern and that sufficiently clear weak complementarity is in operation, revealed preference methods

are well suited to estimate the economic value of ecosystem functions because of the links between these functions and market prices. Unfortunately, establishing linkages between market goods and ecosystem functions is quite complicated as, more often than not, reliable ecological and market data are hard to come across (Carson, 1998; Barkmann et al., 2008). When these requirements are not easily met, the use of stated preference methods is necessitated. The main benefits of such methods are that, in theory, they can be used to value any goods and services, and that their data requirements are relatively low.

Stated preference methods have been criticized for not performing as well as revealed preference methods when it comes to the valuation of complex ecosystem processes. This is mainly due to the general public's lack of awareness and understanding of ecosystem processes and functions (Nunes and Bergh, 2001). A common claim (e.g., Desvousges et al. 1993) is that *familiarity* with a good is a necessary precondition to providing meaningful responses to CV valuation questions.

The rationale for the non-familiarity critique is the assumption that respondents cannot have well-defined preferences in an economic sense for goods and services which they have no direct experience with. This assumption has not gone uncontested. For instance, Carson et al. (2001) claim that personal experience or familiarity is only one factor in the decision-making process. In today's fast-changing market conditions, consumers regularly make purchase decisions involving goods for which they have no prior experience. This, however, is only partly true, as it still pertains to market goods and services. In the case of ecosystem functions however the degree of unfamiliarity is often greater. There is evidence that the general population in many countries lacks basic environmental knowledge and awareness. This evidence supports the conclusion that attempts to explain the complex background of ecosystem functions to non-expert respondents within the frame of a stated preference survey will most likely overwhelm their cognitive processing capacity (Barkmann, et al. 2008). As an immediate result, lay respondents of such a survey can usually not be made sufficiently aware of the practical consequences of the hypothetical changes in the level of provisioning of ecosystem functions proposed in the study (Barkmann, et al. 2008).

This shortcoming can be overcome, or at least minimized, by the use of an ecosystem services approach formulated in Barkmann et al. (2008). The approach focuses on the end products of ecosystem functioning by translating ecosystem structures, states and processes without intuitive meaning to survey respondents into “value-laden entities”, i.e. ecosystem benefits (Glenk, 2008, p126). This approach has been adopted in the present study of the economic valuation of forest services, as they are perceived by communities living in the vicinity of Kakamega rainforest

3.3 The research area

The economic valuation exercise was carried out in the farmland area in the immediate vicinity of Kakamega Forest. The forest is located in the Kakamega District of the Western Province of Kenya. It is situated in the Lake Victoria basin on the most eastern edge of the Central African rainforest area about 40 km north of Kisumu and just east of the Nandi Escarpment that forms the edge of the central highlands.

The Kakamega Forest is a rainforest with an average of 2080 mm of rain per year. Rainfall is heaviest in April and May ("long rains"). After a slightly drier phase, a second peak is reached roughly in August and September ("short rains"). January and February are the driest months (Althof, 2005).

The area surrounding the forest is used intensively for growing sugar cane, maize and tea, and the forest itself used for the collection of a variety of timber and non-timber forest products (Kenyan ministry of planning and national development, 2001)

Over the past decades the forest has been subjected to varying degrees of exploitation and disturbance. Hence, a disturbance gradient from primary-like forest to secondary forests as well as completely degraded areas can be recorded, while the main part of the Kakamega Forest consists of secondary forest (Lung and Schaab, 2004). The forest has some fragments in its vicinity, which differ in distance, size and age.

3.4 Choice Modelling

In Choice Modelling (CM), respondents are presented with a hypothetical setting and asked to choose their preferred alternative among several alternatives (also called *options* or *scenarios*) in a *choice set* (Hanley et al., 2001). Each alternative is described in terms of a set of characteristics, or attributes. A monetary value, usually in the form of "price" or "cost" is included as one of the attributes, along with other attributes of relevance, when describing each alternative presented. Individuals are commonly asked to perform a sequence of such choices (Bateman et al., 2002). Thus, when individuals make their choices, they implicitly make trade-offs between the levels of the attributes in the different alternatives presented in each choice set. It is through the tradeoffs between these attributes, that allows monetary values to be assessed for each of the attributes in the alternatives. It is common practice to include in each choice set a constant 'opt-out' alternative, whose attribute levels do not change over the choice sets (Bateman et al., 2002). This alternative does not imply an additional cost to the respondent. By choosing this alternative, respondents are able to express dissatisfaction with the other alternatives in the choice set. Their choice thus resembles a real market situation where people can choose to opt out from participating in any specific transaction. In the environmental economics literature, the opt-out alternative is usually called the 'status quo' or the 'no change' alternative as it typically describes the current situation, or the situation at some future point in the absence of any intervention (Glenk, 2008)

CM is not immune to some of the problems facing also other stated preference methods such as contingent valution (CV). However, as Adamowicz et al. (1998) demonstrated, CM has considerable merit over CV for the following reasons:

i. CM provides a richer description of the attribute trade offs that individuals are willing to make.
ii. CM avoids compliance bias or "yeah saying" problem of dichotomous choice surveys as respondents are not faced with the same "all or nothing" choice (Hanley et al., 2001)
iii. CM helps avoid the potential "embedding problem" present in CV when WTP for a good varies depending on whether it is evaluated on its own or as part of a more inclusive category (Rolfe and Bennett, 2000).

iv. By allowing some attributes to take on levels both above and below the status quo level, it is possible to estimate both WTP and WTA.

For some time, the use of CM was almost universally restricted to a developed-country context, with a special focus on market research and transportation (Bateman et al. 2002). It is only during the past decade that the focus has shifted to the valuation of environmental resources and amenities, including those in low-income countries. Examples are the valuation of renewable energy projects (Bergmann et al., 2004), forests (Rolfe et al., 2000; Mogas et al, 2002), climate change mitigation and adaptation options (Rajmis et al. 2009) endangered species (Adamowicz, et al. 1998), or genetic resources (Drucker et al., 2001). Even so, there are still relatively few CM or CV studies on the values of tropical forests. Moreover, the majority of these studies estimate economic values from the perspective of people in developed countries (Menzel & Scarpa, 2004; Rolfe et al., 2000). As a result, they do not attempt to measure the local economic benefits stemming from the regulatory and supporting services of the forests, which is the focus of this study (for a recent exception, see Barkmann et al. 2013).

3.5 Survey design

The main survey, which was carried out in the first months of 2006, was preceded by a series of focus group discussions. These mainly involved informal group and individual interviews with various stakeholders, the aim of which was to obtain the necessary background information about various aspects of local communities' understanding of the forest's condition and perception of environmental issues. Subsequently, the questionnaire was drafted and pre-tested by administering it to twenty households in various locations over the course of 4 days. Other than the choice experiment, the final questionnaire contained sections pertaining to the socio-economic characteristics of the relevant population and questions exploring respondents' attitudes and perceptions on the prevailing environmental conditions (see Annex at the end of this Thesis). Due to the big size of the sampling population, the respondents were picked using a multistage random sample (see chapter 2 of this Thesis for a more detailed explanation).

3.5.1 Attribute selection

According to Blamey et al. (2002), the attributes selected for a choice experiment should fulfill the following requirements: Attributes should be a) demand-relevant, b) policy-relevant and c) measurable. Demand-relevance is clearly of great importance when it comes to adopting an ecosystem services approach in economic valuation as it ensures that the estimated values correspond to respondent experiences and perceptions of what the valued services are and how they affect their well being.

Prior to the pre-testing of the questionnaire, a reconnaissance survey was undertaken aimed at identifying the attributes of the forest that local people attach most importance to. Almost invariably, the most commonly identified services of the forest were the following

1. Harvested forest products. As was to be expected, people considered products collected from the forest a major benefit. A study by Guthiga (2007) indeed confirms that people crucially rely on the forest for the provision of timber and non-timber products;
2. Attraction of rainfall. It appeared to be a commonly held belief among respondents that the presence of the forest has beneficial effect on the amount of rainfall they receive;
3. Water and soil conservation;
4. Tourism-generated employment;
5. Use of the forest by future generations.

Since the aforementioned benefits were identified by the people themselves, they were clearly demand-relevant. Nevertheless, certain modifications had to be made if they were to be included in the choice experiment. The reason for this is that they had to be presented in a way that was clear to all respondents and that minimised any negative implications of unfamiliarity with the valued services. Tourism was not included as the recreational benefits of the forest were the topic of another study (Mugambi and Mburu, 2013) using the travel cost method.

The included attributes were: (1) Water availability. This was described as the water necessary to meet household needs and being available during the dry season. (2) Soil loss. This attribute relates to the amount of soil loss that farmers experience every year. (3) Supply of forest products. This was expressed as the number of years that the supply of forest products will be secured.

The little information that exists on the state and trends in the relevant attributes comes from studies that were carried out long after the completion of the current study (Waswa, 2012; Recha et al., 2012). Thus, the lack of data on values that could be used to describe the current situation as well as the future direction and magnitude of attributes such as soil loss and water availability, led to the use of an approach that conforms to individual perceptions of the prevailing environmental conditions.

In particular, the 'soil loss' and 'water availability' attributes in the status quo scenario were not given a specific numerical value but this scenario was framed as a 'no change' situation in the selected attributes, with the attribute levels in the other alternatives defined as percentage changes relative to the current situation. As not all locales in the studied area face the exact same environmental problems, this approach also carries the extra benefit of doing away with the need to explicitly address local heterogeneity in environmental conditions (Glenk, 2008; Hynes et al. 2011)

Regarding the *supply of forest products* attribute, the choice of the status quo level was not an easy task. The problem was that in order to come up with an estimate for the number of years that the forest will be able to supply local communities with its products, one needs to know what has happened in the past and what conditions may prevail in the future. According to Mitchel (2004), as a result of a host of extractive activities, dating from pre-colonial times and compounded by high population growth, the size of the forest has been shrinking rapidly in the last century. Lung and Schaab (2004) indicate that approximately 20% of the forest cover was lost over the past three decades alone. With regard to the future, Müller and Mburu (2009) parameterised a neural network model to predict deforestation hotspots estimated that 34% of the remaining natural forests of Kakamega Forest have a high risk of being cleared in the near future. However, they do not offer a time frame over which their prediction may materialise. What is more, their model is based on the assumption of

a constant rate of change i.e. a continuation of past trends into the future. Yet, as they acknowledge, "in reality, the changes are likely to exhibit temporal variation depending on external forces and on the subsequent endogenous reactions of forest-using agents" (p976). Therefore the direction of future changes is a matter of speculation.

Owing to the lack of more adequate data, as well as the fact that what has happened in the past is not necessarily a precise predictor of what will happen in the future, the characterization of the *supply of forest products* attribute was done similarly to the other two attributes. The problem was tackled by asking the participants in the pre-test study what their perception of the future was. Specifically, respondents were asked to indicate on a 5-point Likert scale to what extent they agree with the statement: *the forest will not be able to provide me and my family with the products that I need after 20 years*. The average score was 3.88 which shows that, on average, the respondents tended to agree with this statement. Given this high score, it was deemed reasonable that an even higher proportion of people would believe that the supply of forest products would be even less certain after a longer period of time. Therefore it was considered appropriate to set the status quo to 30 years. Essentially, we chose a slightly optimistic Status Quo level, thus avoiding an 'alarmist' subtext.

Particular attention deserves the choice of the payment vehicle. Eom and Larson (2006) argued that, according to economic theory, when choices are constrained by time and money, welfare values can be elicited using either monetary or in-kind forms. Owing to the fact that the majority of stated preferences studies have been carried out in the developed world, money is the predominant payment vehicle of choice. To the best of our knowledge, non-monetary payment vehicles have not been employed in Choice Experiment studies. All of the studies using in-kind payment vehicles are Contingent Valuation studies and have elicited WTP using tangible goods, such as bags of rice (Shyamsundar and Kramer, 1996; Akter, et al., 2007) and maize (Sutton et al, 2002). However, the most commonly-used, non-monetary payment vehicle has been *time* contributed to various activities aiming at the delivery of certain goods and services. (Khorshed and Marinova, 2003; Mekonnen, 2000; Swallow and Woudyalew, 1994; Echessah et al., 1997; Hung et al., 2007).

The current study also employed a non-monetary vehicle. Unlike other studies, however, this decision was not due to the absence of money in the local economy (Shyamsundar and Kramer, 1996; Rowcroft et al., 2004). Though a subsistence economy to a large extent (Kasina, 2007), the local economy does make use of money even though not exclusively. The subsistence nature of the local economy means that monetary transactions are not very widespread among local people. In many cases, locals are too poor and/or too cash constrained to express meaningful WTP values in monetary terms. With a low level of market integration, the ability to pay in money is no suitable expression of the actual ability of the local population to engage in (hypothetical) exchange transactions.

For this study a hitherto untested payment vehicle was employed, namely labour-meals. The payment vehicle was framed as "meals per week" contributed to a village development program. These meals were to be provided by households to people working in the development programs that would bring about the improvements in the selected environmental attributes. The cost of a meal to respondents was estimated to be 50 KShs (Kenyan Shillings). This reflects the local labour market situation, where a day's wage for a casual worker is 100 Kshs without food, or 50 KShs with food. During a pretest study it was ascertained that the overwhelming majority of respondents was aware of this fact. This information was communicated to the respondents also during the main survey. The attributes of the choice experiment and the levels they assumed are described in Table 1.

Table 5. Attributes and levels

Attribute	Levels	Valuation dimension
Water availability	No change in water availability* 20% increase in water availability 40% increase in water availability	Indirect use value
Amount of soil loss per year	No change in the amount of soil loss* Amount of soil loss decreases by 50% Amount of soil loss stops (No soil loss)	Indirect use value
Supply of forest products (years)	30 more years*, 60 more years, 90 more years	Option/bequest value
Meals per week	No meals*, 1 meal, 2 meals, 3 meals, 4 meals, 5 meals	Payment vehicle

* Status quo level

3.5.2 *Choice set construction*

The attributes and levels in each format were combined using an orthogonal main effects design. This generated a fractional factorial design of 16 combinations (profiles). The second profile in each of the 16 choice sets was created from the first profile using a "shifted" design (Chrzan and Orme, 2000). The choice sets thus created were assigned in four blocks of four choice sets. Each respondent was randomly assigned to one of the four blocks. Figure 1 depicts a typical choice set presented to respondents.

3.5.3 *Visual aids*

During the pre-testing of the survey it became apparent that several respondents did not cope well with respect to the changes in the attributes *water* and *soil* being presented to them in arithmetic form (percentage changes). As elsewhere in the literature, (Glenk, 2008; Jae and Delvecchio, 2004; Abou-Ali and Carlsson, 2004; Bateman, et al., 2008) we decided to employ visual aids with the aim of simplifying the cognitive demands on respondent's choice tasks. After toying with various formats, we chose to depict the attributes and their levels in the form of stylised drawings that were clear enough to understand but did not convey too much information so as to potentially distract respondents. Figure 1 shows one of the choice sets that were used in the main survey.

Figure 6. Choice set

		Current Situation	Improved Situation A	Improved Situation B
	SUPPLY OF FOREST PRODUCTS No. of years that the supply of forest products is secured	30 years	60 years	90 years
	SOIL LOSS Amount of soil lost			No loss
	WATER AVAILABILITY Amount of water available for use during dry season			
	MEALS PER WEEK Number of meals contributed to the development program by your household	No meals	1 meal per week	2 meals per week
	YOUR CHOICE:  (please choose one only)			

3.5.4 *Models*

3.5.4.1 Multinomial Logit

Choice experiments are an application of the characteristics theory of value (Lancaster 1966), combined with random utility theory (Train, 2003). Thus, they share strong ties with the random utility approach to modeling recreational demand using revealed preference data (Bockstaell et al. 1991). According to this approach, the indirect utility function for each respondent i, (U_i), can be decomposed into two parts: a deterministic element, V_i, which is usually specified as a linear function of the attributes (X_j) of the j different alternatives in the choice set, a number of socioeconomic characteristics of the respondent (S_i); and a stochastic element (e) which represents unobservable influences on individual choices:

$$U_{ij} = V_{ij}(X_j, S_i) + e_{ij}(X_j, S_i) \quad (1)$$

Where the indirect utility function generally takes the linear form:

$$V_{ij} = \beta_{j0} + \beta_{j1} \quad x_{j1} + \beta_{j2}x_{j2} + \cdots + \beta_{jn}x_{jn} + \delta_1 s_1 + \delta_2 s_2 + \cdots + \delta_m s_m \quad (2)$$

with β_{j0} taking on the role of an alternative specific constant which captures the average effects on utility of any factors not included in V_i. Since socio-economic and attitudinal characteristics do not vary across choices for any given respondent *i*, they only enter the utility function as interaction terms with the *X* attributes, or with the Status Quo. Thus, the probability that a particular respondent prefers option *h* in the choice set to any alternative option *g*, can be expressed as the probability that the utility associated with option *h* exceeds the probability associated with all other options:

$$P[U_{ij} > U_{ig}, \forall g \neq h] = P[(V_{ih} - V_{ig}) > (e_{ig} - e_{ih})] \quad (3)$$

To empirically estimate the parameters of this expression, assumptions are made about the random component of the model. A typical assumption is that these stochastic components are independently and identically distributed (IID) with a Gumbel or Weibull distribution. This leads to the use of multinomial logit (MNL) models to determine the probabilities of choosing *h* over *g* options (Hanley et al., 2001)

$$P(U_{ih} > U_{ig}) = \frac{e^{\mu V_h}}{\sum_g e^{\mu V_g}}, \forall g \neq h \quad (4)$$

Here, μ is a scale parameter, inversely related to the standard deviation of the error term and commonly normalised to 1 for any dataset. The estimated coefficients of the attributes are linear parameters, and therefore can be used to estimate the tradeoffs between the attributes that respondents would be willing to make.

The IID assumption of the error terms leads to the behaviorally comparable independence of irrelevant alternatives (IIA) assumption. Simply put, this assumption states that the relative odds of choosing alternative *i* over alternative *j* are not affected by the availability of other alternatives in the choice set. That is, the ratio of the probabilities of any two alternatives stays the same regardless of the presence or absence of other alternatives. In turn, this assumption implies a certain pattern of substitution among alternatives, which is proportional, i.e. an improvement in the attributes of one alternative reduces the choice probability for all the other alternatives in the choice set by the same percentage (Train, 2003).

To overcome the asssumption of IIA, which may not always hold, a number of alternative models lend themselves for estimation. The two most prominent among these are the Nested Logit and the Random Parameter Logit models, which are the ones chosen for the analysis of the choice experiment data.

3.5.4.2 Nested Logit

The Nested Logit is a less restrictive model than the MNL in that it partially relaxes the IID assumption of the latter "such that the random components are correlated within a partition of a choice set but not across partitions" (Louviere et all. 2000; p144). It allows for the possibility that subsets of alternatives share unobserved utility components. In such a setting, the set of alternatives are partitioned into subsets, called *nests*, and IIA is assumed to hold within nests but not necessarily across nests. Nesting therefore is introduced in order to accommodate violations of IIA. Formally, nested logit models split the decision process in a marginal choice between nests m and a conditional choice between alternatives i, given choice of nest m. The probability of choosing alternative i in nest m is the product of the probability of choosing nest m, P_m, and the probability of choosing alternative i, $P_{i/m}$, within nest m.

$$P_{im} = P_m P_{i|m} = \frac{exp\left(\lambda_m V_m + \frac{\lambda_m}{\mu_m} IV_m\right)}{\sum_n exp\left(\lambda_n V_n + \frac{\lambda_n}{\mu_n} IV_n\right)} \cdot \frac{exp(\mu_m V_{\iota|m})}{\sum_{j \in m} exp(\mu_m V_{j|m})} \quad (5)$$

where $IV_m = ln \sum_{j \in m} exp\left(\mu_m V_{j|m}\right)$ is called the *inclusive value*. V_m (V_n) is the indirect utility associated with nest m (n), λ_m (λ_n) is the scale parameter describing the variance of the unobservable effects associated with utility V_m (V_n), and μ_m (μ_n) is the scale parameter of the elemental alternatives in nest $m(n)$. The ratio λ_m / μ_m, associated with the inclusive value, is a scale parameter, which contains information about whether or not the "nested logit" aspect arises. If it is equal to 1.0, then the choice model as described reduces to the simple multinomial logit model as in (4). This would imply that there is no nested aspect in the model, or in other words, the IIA property simply holds.

3.5.4.3 Random Parameter Logit

Compared with the standard MNL model, the random parameter model (RPL) has the distinct advantages that it does not exhibit the IIA property and that it can explicitly model unobserved heterogeneity by allowing for a distribution of preferences within the population. Like in the MNL model, the utility that respondent *n* obtains from alternative *j* in choice situation *t* is:

$$U_{njt} = \boldsymbol{\beta}_n \boldsymbol{x}_{njt} + \varepsilon_{njt} \quad (6)$$

where $\boldsymbol{x}_{njt}$ is a vector of observed variables with coefficient vector $\boldsymbol{\beta}_n$, representing respondents' tastes. $\boldsymbol{\beta}_n$ is unobserved for each person and varies in the population with density $f(\beta_n|\theta)$, where θ are the (true) parameters of this distribution. e_{njt} is an unobserved random component that, similarly to the MNL model, is distributed iid extreme value, independent of $\boldsymbol{\beta}_n$ and $\boldsymbol{x}_{njt}$. This is a standard logit specification except that the coefficients are not fixed but vary across the population. Note there is no *t* subscript on the $\boldsymbol{\beta}_n$ term: tastes vary across those making choices in the survey, but not across the choices made by the same person.

The variation in $\boldsymbol{\beta}_n$ introduces correlation in utility across choices. The vector of coefficients $\boldsymbol{\beta}_n$ can be expressed as the population mean ($\boldsymbol{b}$) and the individual specific deviation from that mean $\boldsymbol{\eta}_n$. Hence the utility that respondent *n* obtains from alternative *j* in choice situation *t* (equation 4) can be re-written as:

$$U_{njt} = \boldsymbol{\beta}_n \boldsymbol{x}_{njt} + \boldsymbol{\eta}_n \boldsymbol{x}_{njt} + \varepsilon_{njt} \quad (7)$$

The RPL model estimates $\boldsymbol{\beta}$ but $\boldsymbol{\eta}_n$ is not observed and hence there is correlation in unobserved utility ($\boldsymbol{\eta}_n \boldsymbol{x}_{njt} + \varepsilon_{njt}$) across options and choice situations via the presence of the $\boldsymbol{\eta}_n$ term. If $\boldsymbol{\beta}_n$ were known to take the value $\boldsymbol{\beta}$, the probability of a particular option being chosen would be given by a standard logit. That is, conditional on $\boldsymbol{\beta}_n$, the probability that person *n* chooses alternative *i* in choice situation t is given by

$$L_{nit}(\beta_n) = \frac{e^{\beta_n x_{nit}}}{\sum_j e^{\beta_n x_{njt}}} \quad (8)$$

which is essentially equation (4). Given that the values of $\boldsymbol{\beta}_n$ are not known, the unconditional probability of choosing option *i* in choice *t* is the integral of the conditional probability in (8) over all possible values of $\boldsymbol{\beta}_n$ which depends on the parameters of the distribution of $\boldsymbol{\beta}_n$. This integral is expressed as:

$$Q_{nit}(\theta) = \int L_{nit}\,(\beta_n|\theta) f(\beta_n|\theta) d\beta \quad (9)$$

The conditional probability of obtaining the observed sequence of choices, denoted y_h, from the choice sets an individual n faces is the product of the conditional probabilities:

$$P_n(y_n|\beta_n) = \prod_i L_{nit}\,(y_n|\beta_n) \quad (10)$$

Given that $\boldsymbol{\beta}_n$ is unobserved, the unconditional probability for the sequence of choices is the integral of (10) over all possible values of β:

$$P_n(y_h|\vartheta) = \int P(y_h|\beta_n)\; f(\beta_n|\theta) d\beta \quad (11)$$

In this form, the coefficients vary over individuals but are fixed over the choice sets of each individual. This reflects a common assumption of stable preference structures for all individuals; an assumption that is quite plausible. The parameters in the coefficient vector $\boldsymbol{\beta}_n$ represent person's n tastes. These tastes vary over people, following a density with parameters θ. The goal of the estimation procedure is to estimate θ, that is, the population parameters that describe the distribution of individual parameters. The log-likelihood function is $LL(\vartheta) = \sum lnP_n(y_h|\vartheta)$ and is maximized via simulation by summing over values of $\boldsymbol{\beta}_n$. These values can be generated by various methods, the most common being Halton draws (Train, 1999). For a given value of the parameters θ, a value of $\boldsymbol{\beta}_n$ is drawn from its distribution and on the basis of this draw of $\boldsymbol{\beta}_n$, $P_n(y_h|\vartheta)$ is calculated. This process is repeated for many draws, and the mean of the resulting values of $P_n(y_h|\vartheta)$ is taken as the estimated choice probability:

$$SP_n(y_h|\theta) = \left({}^{1}/_{R}\right) \sum P_n\left(y_h|\beta^{r|\vartheta}\right) \quad (12)$$

where R is the number of draws of $\boldsymbol{\beta}_n$, $\beta^{r|\vartheta}$ is the r-th draw from $f(\beta_n|\theta)$ and $SP_n(y_h|\theta)$ is the simulated probability of person n's sequence of choices. The simulated log-likelihood function is constructed as $SLL(\vartheta) = \sum lnSP_n(y_h|\vartheta)$ and the estimated parameters are those that maximize SLL.

3.5.5 *Model estimation*

In order to test for violations of the IIA assumption, the Hausman-test was performed. The test was highly significant, which indicated that the IIA assumption was violated. Hence, a Nested Logit model was first performed whereby the best fitted tree structures with an inclusive value (IV) between 0 and 1 were selected. The best fitting model consists of a nesting structure with the status quo alternative in one branch and the two other alternatives in the other. An alternative-specific constant (ASC) is also included, whose role is to pick up the average influence on utility of unobserved factors that are correlated with the choices A, B or the SQ. Given the generic nature of the alternatives, the ASC is set equal to one for alternatives A and B and zero for the status quo alternative.

In addition to the design attributes, certain perceptional and socio-economic characteristics of respondents are included. Three perception variables were interacted with their matching attributes as follows: the first such variable is called 'yearimp' and is a Likert-scale variable, indicating the extend to which respondents agreed with the following statement: *the forest may not be able to provide my family with the products I need after 20 year*. This variable is interacted with the 'years' attribute to create the 'impyear' interaction variable. The two other variables are 'soilimp' and 'waterimp' (also Likert-scale); they gauge respondents' perceptions of how important (severe) soil loss and water availability are. These variables are interacted with the 'soil' and 'water' attributes respectively, to create 'impsoil' and 'impwater' (the 'imp' prefix stands for 'importance').

In addition to the perception variables, a number of socio-economic variables were hypothesized to have an effect on utility and are included by interacting them with the ASC and some of the attributes. Specifically, respondent *Age* is interacted with both the ASC and the *years* attribute, while the *Education* level of the respondent and the *Household Size* are included via interactions with the ASC. Moreover, the *Poverty Index* is interacted with both the ASC and the *meals* attribute.

The poverty index was constructed in the absence of readily available and easily obtainable data on respondent income. Its purpose was to measure relative poverty by

assigning a poverty 'score' to each sampled household representing that household's poverty status relative to all other households in the sample. For the construction of this index, data on several categories of household wealth, ranging from household expenditures on several items to dwelling properties and possession of household goods, were collected and combined (Henry et al., 2003; Barkmann et al. 2008). Using *Principal components analysis* (PCA), the "poverty component", used to compute the poverty index, was extracted. This component, having an eigenvalue of 5.112 explained about 48% of the total variance in people's responses to the questionnaire's questions on wealth. The resulting poverty index is in standardised form (mean of zero and a standard deviation of one), with poverty values ranging from -1.085 (poorest household) to 5.120 (wealthiest household).

Respondents' understanding was gauged by asking them to indicate on a 5-point Likert scale the extent to which they agreed or disagreed with this statement: *The task that I just completed was easy for me to understand.* This statement followed immediately after the choice experiment and the values ranged from *strongly disagree* to *strongly agree.* If the interviewer deemed that a respondent with values one or two had indeed trouble understanding the process, then the respondent was not included in the analysis. This was to ensure that the final sample consisted only of respondents confident enough about their choices.

The RPL model is estimated using the same socio-economic and attitudinal variables. What makes this model stand out relative to the NL and the MNL models, is its ability to explicitly model otherwise unobserved preference variation among respondents. As discussed above, this is achieved by assuming that the taste parameters are not fixed in the population but they vary according to certain probability distributions. The probability densities most commonly used to describe the variation in the taste parameters are the normal, the log-normal, the triangular and the uniform densities. The log-normal form is usually employed when there is a-priori expectation with respect to the sign of the relevant parameters, i.e., when there is good reason to believe that a specific attribute has either positive or negative effect on the utilities over all respondents. The other densities allow for the possibility that a parameter takes on both negative and positive values. For the models estimated here, it is quite plausible to assume that the attributes be of a single sign as they refer

to an improvement in the provision of ecosystem services. More specifically the environmental attributes are expected to have a positive sign while the payment attribute is expected to be negative.

Originally, in search of the optimal model, all attributes, including the ASC, were allowed to be random. The use of the log-normal density, however, proved quite problematic, as its use often resulted in the model not being able to converge. Exhaustive search for the best-fitting model and experimentation with all possible combinations of probability densities helped arrive at a WTP model whereby the *meals* attribute follows a normal density. The rest of the attributes did not exhibit significant variances so they are held constant. The simulated maximum likelihood function for the two models was estimated by taking 250 Halton draws.

3.5.6 *WTP Calculation*

In choice experiments, the price attribute can be used in conjunction with the other attributes to determine the willingness to pay of respondents for gains or losses of attribute levels. This WTP is called the "implicit price" or part-worth of the attribute and is calculated as follows:

$$WTP_c = -\frac{\beta_c}{\beta_y} \tag{13}$$

where β_c is the coefficient of any of the attributes and β_y gives the marginal utility of income and is the coefficient of the cost attribute. This is the standard way of calculating WTP (or WTA) in any MNL and NL models where the parameters are fixed. The same approach can be employed in the RPL model. The common practice is to keep the cost parameter fixed while allowing the other ones to be random and using the point estimate of its mean. Fixing the cost coefficient is done for two main reasons. First, when all coefficients are allowed to vary, the distribution of WTP is the ratio of two distributions, which is inconvenient to evaluate and often results in unstable RPL models (Ruud, 1996). Second, as the price coefficient is supposed to be negative, distributions other than the log-normal are considered inappropriate as they take on both negative and positive values (Revelt and Train, 2000).

In the RPL model at hand, instead of keeping the price coefficient fixed it is allowed to vary, while the rest of the coefficients are kept fixed. As discussed above, this is not an intentional choice but rather came about as a result of the search for the best-fitting model. Moreover, the range of the estimated values of these two random parameters is such that the probability of either switching signs is zero.

For the calculation of the WTP, the indirect utility function is adjusted in order to take account of the interaction effects (Rajmis et al., 2009). For instance, the utility of the *meals* parameter can be expressed as follows:

$$V_m = \beta_m M + \beta_{pm} MP \quad (14)$$

where V_m stands for the indirect utility of meals, β_{m} is the parameter of meals and β_{pm} is the parameter of the interaction of meals (M) with the poverty index (P). Further, in order to reduce collinearity between the attributes and the interaction terms, the socio-economic variables that are interacted with the choice attributes are Z-transformed (standardised) before they are included in equation 14. Since the value of a standardized variable is zero, the calculation of WTP values for the polulation mean becomes much more simple as the interaction term essentialy drops out (Rajmis et al., 2009).

The part-worths of equation 13 are not estimates of compensating surplus. The change in economic surplus from possible alternative projects can be expressed as the so-called log-sum formula (Hanemann, 1999):

$$CS = \frac{ln \sum_j e^{V_{j0}} - \sum_j e^{V_{j1}}}{\beta_y} \quad (15)$$

where V_{j0} and V_{j1} are the utilities before and after the change for each of the j alternatives in a choice set and β_y is the utility of income. This formula is based on the assumption of branded alternatives. However, in this case the choice experiment consists of generic alternatives and there is a more straightforward way of obtaining the welfare measure of compensating surplus, which is derived by solving the following equation:

$$CS = \frac{-(V_0 - V_1)}{\beta_y} \quad (16)$$

Where, again, β_y is the utility of income; V_o is the utility of the current situation and V_1 is the utility of a proposed alternative.

3.6 Results

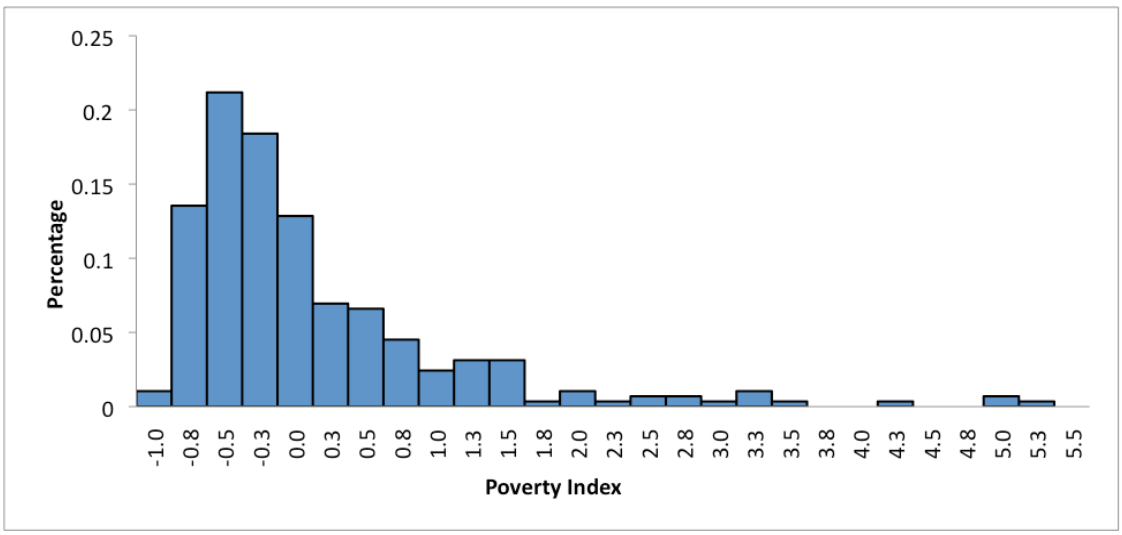
3.6.1 *Survey administration*

Following the pre-testing stage, the CE was administered to 322 respondents in face-to-face interviews. In total, 22 respondents were excluded from the analysis because they either protested or showed a poor understanding of the choice experiment. Protests bids were expressed either in the form of incredulity towards the programme's ability to deliver the promised benefits or as an outright rejection of the implied property rights (e.g, "I shouldn't have to pay for these services"). The socio-demographic characteristics of the respondents who successfully completed the choice experiment are summarized in Table 2. In terms of the poverty index, since it has been standardised its mean value is effectively zero so it is not shown in Table 2. However, the distribution of the poverty index values among the sampled households is presented in Figure 2.

Table 6. Socio-demographics of respondents

Variable	Value (mean)
Gender (% female)	66%
Position in the household: (% household head or spouse)	95%
Age (>18)	47.68
Education (average years of schooling)	6.13

Figure 7. Poverty Index distribution



3.6.2 *Econometric results*

The results presented in this section include the variables that contributed to an increase in the fit of the model, as this is expressed by the adjusted R^2. That is, even if a variable was found not be statistically significant, it was still included as long as it contributed to a higher *adj.* R^2. This is the case for both the NL and the RPL models. As such, some of the variables that appear in one model do not necessarily show up in another.

Table 3 shows results from two NL models.. Model 1 is the *non-interacted attributes* model and includes only the non-interacted attributes. Model 2 is the *interacted attributes* model, which includes interactions with certain attitudinal and socio-economic variables. All the attribute parameters in model 1 are significant at $p \leq 0.05$. Moreover, they have the expected sign: the three environmental attributes are positive, suggesting that increases in their levels correspond to increases in the probability of choosing a non-status quo alternative. The meals attribute is, as expected, negative, i.e. the probability of choosing a non-status quo option decreases as this attribute takes on higher levels. The only parameter that comes out insignificant is the ASC, which means that the specific set of attribute levels that are labeled as Status Quo is not evaluated any different from alternatives A and B after the effects of the attributes themselves are taken into account.

The inclusion of interaction terms in Model 2 paints a different picture. The *adj.* R^2 used as a goodness-of-fit measure is one that is based on comparing the estimated model with a constants-only model. This is a better measure (compared to a *adj.* R^2 from a no-coefficents base-model) to use for evaluating models because it "controls for the choice proportions in the estimation sample and is therefore a better measure to use for evaluating models" (Koppleman & Bhat, 2006; p81). As the *adj.* R^2 suggests, Model 2 makes for a better model than Model 1. It should be noted that the magnitude of the *adj.* R^2 in both models is particularly large, indicating a very good fit to the data. According to Hensher et al., the interpretation of the *adj.* R^2 value of a choice model differs form the interpretation in linear regressions. In particular, Hensher et al. (2005, p339) point out that in a choice model, values of *adj.* R^2 in the range of 0.3 to 0.4 are equivalent to an R^2 of about 0.6 to 0.8 for the linear model.

Table 7. Results for the NL model

Variable	Coefficients	
	Non-interacted model	**Interacted model**
Water availability		
Non-interacted variable	0.3709***	0.3198**`
Impwater	---	0.5644***
Reduction in Soil loss per year		
Non-interacted variable	1.3602***	1.7906***
Impsoil	---	0.5847***
Supply of forest products (years)		
Non-interacted variable	0.8690***	1.2201***
Impyears	---	ns
Meals	-1.4569***	-1.8131***
ASC	ns	ns
Meals*Poverty Index		0.1123*
ASC*Education		0.4154**
Log-likelihood	-421.3179	-354.3875
Restricted Log-likelihood	-691.76	-691.76
P(Chi²); DF	<0.0001; 5	<0.0001; 9
Inclusive value (IV)	0.7480***	0.7478***
Adj. R^2 (constants only)	0.3234	0.4289

***: significant at p≤0.01; **: significant at p ≤ 0.05; *: significant at p ≤ 0.1; ns: not significant;

With regards to the attribute coefficients, the non-interacted *water* coefficient in Model 2 appears to decrease in magnitude compared to Model 1. This effect, however, is inversed in the case of the *soil* attribute, whereby the non-interacted coefficient gains in value compared to Model 1. On the other hand, the interaction of the *years* (supply of forest products) attribute (*impyears*) with the *yearimp* variable does not seem to have a significant influence on choice. Yet, the non-interacted *years* parameter remains highly significant and takes on an even bigger value than before. Finally, the *meals* coefficient assumes a negative sign again and has a value greater than in the non-interacted model.

In terms of the effect of socio-economic variables on utility and thus on respondent choices, the picture is as follows. Out of all of the socio-economic variables that were

interacted with the choice experiment's attributes and the ASC, only the interaction of education with the ASC and the interaction of the poverty index with the *meals* attribute came out significant.

Table 5 presents the results from the RPL model. Compared with the corresponding NL model, one can observe broadly similar patterns in terms of which variables are significant. The main departure of the RPL model is its ability to detect preference heterogeneity, as this is evident by the significant standard deviations of the *meals* attribute.

Table 8. Results for the RPL model

Variable	Coefficient	Coeff. Std.
Water availability	0,8352***	Fixed
Soil loss	2.312***	Fixed
Supply of forest products (years)	1.4481***	Fixed
Meals	-3.42906***	1.6211***
ASC	2.0139**	Fixed
Impyears **Impwater** **Impsoil**	ns 0.8355*** 0.9808***	
Meals*Poverty Index	0.2722*	
Compens*Poverty Index		
Age*years	ns	
ASC*Education	0.5229**	
Log-likelihood	-339.8235	
Restricted Log-likelihood	-625.870	
P(Chi²); DF	<0.0000; 10	
Adj. R^2 (Pseudo-R^2)	0.4503	

***: significant at p≤0.01; **: significant at p ≤ 0.05; *: significant at p ≤ 0.1;
ns: not significant

3.6.3 *Welfare Estimates*

Based on the random specification of the *meals* parameter, and equation 13, Figure 3 shows the WTP distribution of the *years* attribute, where, owing to the large spread

of the *meals* parameter, there is a correspondingly large spread in the estimated WTP values.

Figure 8. WTP distribution of the *years* attribute

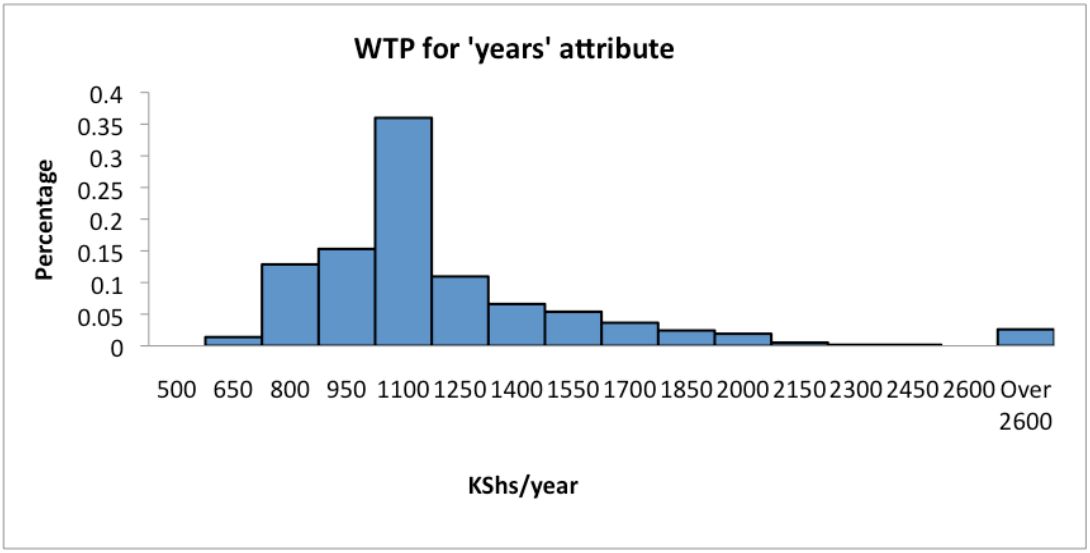


Table 6 reports marginal WTP, for a change in one of the choice attributes, obtained from the estimates of the best-fitting models with the highest value of the *Adj.* R^2. This means that the WTP values presented are calculated based on the parameter estimates of the RPL model as this model produced the highest *Adj.* R^2 values.

Table 6. Marginal WTP in KShs for 1 year

Attribute	WTP
Water availability	662 (20% increase)
Amount of soil loss	1835 (50% decrease)
Supply of forest products (years)	1150 (30 more years)

Table 7 presents average compensating surplus, with and without the ASC. The theoretically correct approach is to include the ASC parameter, whereas exclusion of the ASC can be considered as a measure of respondent's WTP given that they are willing to choose one of the non-status quo alternatives.

Table 7. Compensating surplus for alternative scenarios

	KShs per household per year (with ASC)	KShs per household per year (without ASC)
Status Quo Scenario: The supply of forest products is secured for 30 more years, soil erosion and water availability remain at the current levels	0 KShs	0 KShs
Improved Services Scenario: The supply of forest products is secured for 90 more years, soil loss is halted and water availability increases by 40%	8890 KShs	7290 KShs

3.7 Conclusions & Discussion

This paper presents research findings from a choice experiment exploring how households around Kakamega forest valuate some of its most important services: future supply of forest products, water provision, and prevention of soil erosion. Following Barkmann et al. (2008), an *ecosystem services* approach was adopted. The aim of this approach was to avoid potential familiarity problems by focusing on end products that are easily perceived and thus valued by people with little knowledge of the complex underlying ecological processes.The case study presented here was carried out in a fairly early, ill-defined planning situation with open environmental outcome (Cerda et al., 2007), the novelty of which lies in its use of a non-monetary payment vehicle.

3.7.1 *Data analysis and interpretation*

Due to violation of the IIA assumption, the data were analysed using a Nested Logit (NL) and a Random Parameter Logit (RPL) model. The various welfare estimates are based on the obtained parameters from the best-fitting models, as they were broadly similar. The high *Adj.* R^2 values indicate particularly well fitting models. Both NL and RPL models show that households were willing to contribute positive amounts of resources to a village development program that would secure increased levels in the provision of the valued services. The RPL models revealed significant heterogeneity in respondent preferences with regard to the payment attribute. It could be that

variation in tastes exists for the rest of the attributes but this was not picked up by the model, as the standard deviation parameters were not found to be significant.

With respect to the various interaction terms, we observe that the more severe water scarcity was perceived by respondents, the more likely they were to choose an alternative that offers greater water availability. As evident by the positive sign of the interaction of the poverty index with the *meals* attribute, the wealth of a household appears to have a diminishing effect on the disutility associated with the payment attribute. In other words, wealthier households are less affected negatively by the prospect of contributing to the village development programme. This finding is in line with expectations. Another interesting finding is the effect of the respondent education on the probability of choosing a non-status quo alternative. The positive sign of the interaction of the education level, measured in years, with the Non-Status Quo ASC means that better educated respondents were more likely to choose to contribute an alternative to the SQ. This implies that they are more willing to invest in the proposed programme. In fact, this could indicate a small remaining familiarity issue as more educated households feel more confident with the explanations given, and with the entire CE exercise. Having said this, the interaction of the "understanding" variable with the ASC did not come out significant.

With respect to actual WTP, the average household was willing to make a contribution of approximately 8890 KShs/year for the improved scenario described in Table 7. In terms of WTP for the individual aspects of the village development programme, average WTP for a 20% increase in water availability during the dry season was 662KShs. Turning to the future supply of forest products (Fig. 6b), households were willing to pay for 30 more years of secure supply of forest products 1150 KShs. This suggests that people consider securing the supply of forest product to be more important an invest than increasing water availability. The relatively low WTP for water may reflect the fact that severe water scarcity has not been such a big problem in this part of the country, unlike elsewhere in Kenya. Indeed, this is confirmed by the fact that respondents gave the lowest score to the perception question *"How important do you consider water scarcity to be a problem in your area during the dry season?"* The service most valued by households is prevention of soil erosion, as evidenced by a WTP of 1835KShs for a 50% reduction in soil loss.

This suggests that any future investment in rural development, forest management and conservation in the area around Kakamega forest should include actions mainly geared toward containing soil and securing the supply of forest products.

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CHAPTER 4 A comparison of Choice Experiment and Contingent Valuation in valuing local ecological services of an African rainforest.

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4.1 Introduction

Tropical forests play crucial roles in the lives of communities and nations the world over. Apart from the supply of vital timber and non-timber products, forests are credited with the provision or maintenance of crucial ecosystem services. Such essential services include soil formation, nutrient cycling, watershed protection, pollination, genetic information and carbon sequestration (MA, 2003) While some of these services provide benefits on a global scale, a substantial portion of them affects the livelihoods of communities that live in close proximity to the forests (Bawa et al., 2004). This is the case especially for rural communities in Africa and other parts of the developing world that reside close to forests and depend on them for their livelihood directly and/or indirectly. However, due to several adverse socio-economic reasons and to the public-good nature of these services, tropical forest cover has been losing out to other forms of land use through conversion or overexploitation. (Barbier, 2007). It has been suggested in the literature that the first step to reversing this trend is to first demonstrate the true value of forests by measuring the economic value of the many benefits stemming from the various forest services (Pearce, 2007).

With regard to African tropical forests, there have been a number of attempts at estimating economic values, using a number of established valuation techniques. However, most of these studies focus on estimating the value of direct benefits, such as timber and non-timber products, or the value of protecting forest areas that have high levels of actual or potential recreational demand. Thus, the measurement of the economic value of forest ecosystem services to local communities in Africa has not been particularly prominent in the literature. Yaron (2001) and Ruitenberg (1989) use revealed preference techniques to attach an economic value to the benefits of flood and sedimentation prevention from forests in Cameroon and Kasina (2007) uses a

[1] This chapter will be submitted to *Forest Policy and Economics*

stated preference method to value pollination services in Kenya. With the possible only exception of these three studies there has been no other research on the local value of forest ecosystem services in Africa.

The current study differs in its approach to valuing local forest services by concurrently employing two stated preference techniques to value more than one ecosystem service. Specifically, the Contingent Valuation (CV) and Choice Experiment (CE) methods are applied in order to estimate the willingness to pay (WTP) of local communities for the improvement of services related to Kakamega rainforest in Kenya. This is the first concurrent use of these two methods in the valuation of local forest ecosystem services in a developing country context. The rest of this paper elaborates on and compares the results obtained from the application of these methods. First, a brief introduction of the study area is given.

4.2 Study area

In Kenya, the gazetted forests cover about 1.24 million hectares, representing a mere 2.8% of the total land cover (Wass, 1995). Outside the gazetted forests, there are other large tracks of forests in trustlands (national parks, national reserves) and in privately owned land covering about 0.5 million hectares. The types of Kenyan forests can be grouped into four categories, according to the climatic conditions of the regions they are found: dry zone forests, coastal forests, montane forests and the western rain forests. The montane forests form the bulk of the forest cover in Kenya, followed by dry zone forests, coastal forests and western rain forests. Kakamega Forest, the area for this case study, is located in the western rain forest region.

Over the years the forest has been subjected to disturbances of various kinds, ranging from conversion into farmland, gold mining, logging for commercial purposes and fuel wood collection and charcoal burning by the local people (Bleher et al., 2006). As a result of these activities, the forest size has been shrinking rapidly throughout the past decades, with the forest losing 20% of its mass in the last three decades alone (Lung and Schaab, 2004).According to the 1999 population census, the area within a 5km radius around the forest edge held a total population of about 376,169 people,

with 90% of them relying heavily on agriculture. Owing to high population growth rates, the land holdings tend to be small and they are intensively used for crop cultivation, often without a fallow period, which would allow the soil to regain its fertility. This practice, coupled with low use of other inputs, such as fertilizers, and accompanied by serious forest disturbance has contributed to a decline in productivity, soil erosion and falling farm incomes (Ogutu, 1997). Moreover, farmers rely exclusively on rainfall for growing their crops, as there are no irrigation schemes in the area. As such, local communities are dependent to a large degree on the forest, which has been shown to influence precipitation through its dense mass of forest vegetation (Althof, 2005). The forest itself is a big watershed system with several small rivers and streams crossing the forest and the surrounding farmlands.

Despite the paucity of detailed data on the status and trends of Kakamega Forest's various ecosystem services, there is strong evidence of their decline. For instance, Waswa (2012) assessed land degradation at various sites around Kakamega forest and found that at least 70% of sampled farms experienced sheet erosion. At the same time, he identified agricultural expansion as the activity most responsible for soil degradation. With regard to water availability, Recha et a. (2012) associated the conversion of Kakamega forest to agriculture with increased water discharge and storm runoff.

The reliance of the local population on the services provided by Kakamega forest, along with the precarious future supply of these services, motivated the valuation exercise of this study. The choice of the stated preference techniques was necessitated by a lack of reliable and extensive data on the hydrological properties and soil enhancing services of the forest ecosystem, as well as a desire to give local communities centre stage by allowing them to directly express their views and preferences.

4.3 Contingent Valuation vs. Choice Experiments

Although the CV and CE methods have been employed extensively in many different fields (refs), their simultaneous use has been considerably less common. Examples include Ryan and Watson (2008), Adamowicz et al. (1998) and Hynes et al. (2011). To the best of our knowledge, there are no studies featuring both these techniques to estimate economic benefits of forest ecosystem services in developing countries. In developed countries, a number of studies have compared welfare estimates derived from the application of CV and CE in the valuation of many environmental resources as well as health benefits. The results of some of these studies are summarised in Table 1. One can see that these studies provide mixed evidence of the convergent validity of the estimated welfare measures (i.e. whether the two methods yield the same welfare estimates). The results are sensitive to assumptions made, such as the specification of the form taken by individuals' preferences and the inclusion of the intercept in the specification of the utility function. For instance, in Adamowicz et al. (1998) a linear functional form for the indirect utility function produced lower welfare measures for CE than for CV.. In contrast, a quadratic model generated measures that were higher for CE than those generated by CV. In another study of forest services valuation, Mogas et al. (2002) obtain higher welfare estimates from the CE when excluding the intercept of the utility function.

Note that in most comparisons of the two methods, WTP in the CV is elicited by making use of the dichotomous choice (DC) format, whereby the respondent is asked to either accept or reject the proposed good at a given price/cost. This is due to the common theoretical underpinning of the CE and the (DC) CV methods, namely the random utility theory, which stipulates that choices are based on utility comparisons between the available alternatives, and the alternative providing the highest utility will be the preferred choice (Train, 2003). The discrete choice nature of these two techniques makes comparing welfare estimates from them relatively straightforward. Yet, as reported in Table 1, the use of these two methods does not by itself guarantee convergence in the welfare estimates, so the use of other elicitation formats in CV studies has been also employed.

The present study makes use of a payment card (PC) elicitation format for the CV part of the valuation exercise. The PC format was proposed by Mitchell and Carson (1981) It presents respondents with a range of values and asks them to choose the amount that comes closest to their maximum willingness to pay. The PC is argued to reproduce real life conditions by allowing individuals to 'shop around' for the bid amount closest to their maximum value, thus facilitating those mental processes that result in meaningful preference statements (Donaldson et al., 1997; Ready et al., 1996). Recent application featuring a payment card-type format of the payment vehicle in the field of natural resources and environmental valuation include Farr et al. (2014), Hynes and Hanley (2009), Huenchuleo et al. (2012) and Afroz et al. (2005).

Although the DC format is the method of choice for the majority of CV studies, there is considerable, yet not conclusive evidence indicating that this format leads to higher values than other CV elicitation formats (Boyle et al., 1996; Ready et al., 1996). Moreover, the PC format is less data demanding, i.e. it requires smaller samples in order to achieve a desired level of standard errors. Finally, at the time the research for this study was carried out, there was no other study in the literature comparing PC CV with CE welfare estimates to our knowledge. It was, therefore, thought helpful to expand the knowledge base and start the debate on the potential of other elicitation formats. In the meanwhile, there have been just two more studies that make use of PC CV and CE (Ryan & Watson, 2008; Hynes, et al., 2011).

Table 9. Comparison of welfare estimates from the CV and CE methods

Study	Application &units valuated	Contingent Valuation	Choice Experiment
Adamowicz et al. (1998)a	Caribou habitat preservation: number of caribou	US$142.82, median CS, DC, linear US$140.86, median CS, DC, quadratic	US$91.84 Median CS linear, no intercept -US$116.29 Median CS. Linear model, intercept US$217.83 Median CS, quadratic, no intercept US$76.70, median CS, quadratic, intercept
Hanley et al. (1998a)b	Conservation of environmentally sensitive areas: presence of specific features	£31.43, mean OE £98, mean DC	£182.84, Mean CS, linear £107.55, mean CS, quadratic
Hanley et al. (1998b)a	Alternative forest Landscapes: Shape of trees, scale of felling, species mix	£29.16, mean OE	£38.15, sum of the marginal WTP of the forest attributes
Mogas et al. (2002)a	Alternative afforestation scenarios: carbon sequestered, soil productivity	Eur20.4, mean CS, DC, no intercept and ASC, scenario A Eur20.55, mean CS, DC, no intercept and ASC, scenario B Eur37.5, mean CS, DC, no interactive variables, scenario A Eur61.53, mean CS, DC, no interactive variables, scenario B Eur17.22, mean CS, DC, no interactive and socioeconomic variables, scenario A Eur45.03, mean CS, DC, no interactive and socioeconomic variables, scenario B	Eur52.67, mean CS, no intercept and ASC, scenario A Eur59.17, mean CS, no intercept and ASC, scenario B Eur76.38, mean CS, no interactive variables, scenario A Eur89.65, mean CS, no interactive variables, scenario B Eur37.5, mean CS, no interactive and socioeconomic variables, scenario A Eur58.73, mean CS, no interactive and socioeconomic variables, scenario B
Ryan and Watson (2008)b	Health screening: presence of specific features	£23.71, mean CS, PC	£34.18, means CS
Hynes et al. (2011)a	Alternative agri-environmental schemes: change in number of cattle, land dedicated to bio-fuel crops, presence of flora and faun	Eur45.5, Mean CS, PC	Eur59.5, mean CS

a: the CV and CE were administered to the same sample
b: the CV and CE were administered to different samples; CS: compensating surplus; DC: dichotomous choice; OE: open ended; PC: payment card

4.4 Research design

In order to estimate the local economic benefits resulting from conserving Kakamega forest, a survey of 310 households was conducted between January and February of 2006. Pilot testing of the survey instrument was carried out prior to the main survey. This consisted of preliminary, informal talks with various stakeholders followed by focus group discussions and, finally, of pretesting the survey to a small sample of households. Results from the pilot were used to refine the questions asked in the main survey.

Rather than employing a split sample, we presented both the CV question and the choice experiment to the same group of respondents. The proposed good to be valued was described to the respondents within the frame of a village development programme that would bring about certain improvements in a number of ecosystem services. This was meant to be a one-year programme, implemented by a non-governmental organisation. It would employ local people who would engage in certain conservation activities that would bring about certain improvements in a number of ecosystem services. Although the nature of these measures was not elaborated, it was made explicit that they would not impose any restrictions on the households' utilisation of the forest resources. This was done in order to alleviate any suspicion on behalf of the respondents with regard to possible negative effects of implementing the programme.

Based on the findings of the pretesting, the ecosystem services chosen for valuation in the CV and CE were: water availability, prevention of soil loss, and supply of forest products. Following a round of pre-testing of the questionnaire, the attributes were refined and expressed as: (1) Water availability, defined as the water necessary to meet household needs during the dry season; (2) Soil loss, being the amount of soil loss that farmers experience every year, and (3) Supply of forest products. This was expressed as the number of years that the supply of forest products will be secured for, and was included with the aim of expressing an element of households' bequest value.

The lack of appropriate data that could be used to reflect the levels of water availability and soil loss faced by each household at the time of the survey

necessitated the use of an approach that makes use of individual perceptions with regard to the prevailing environmental conditions. Thus, the status quo level of soil loss and water availability attribute was not given a specific numerical value but was expressed as a "no change" situation, with the levels of these two attributes in the other alternatives defined as percentage changes relative to the current situation. With regard to the supply of forest products attribute, the status quo level was set to 30 years, meaning that - if current trends were to continue - the forest may not be able to provide adequate supplies after 30 years. The figure of 30 years was chosen after a majority of respondents in the pilot stage expressed concern that the forest might not be able to supply their household with products after 20 years, thus making it very likely that most of them would agree with the 30 years figure.

In terms of the payment vehicle, we used a non-monetary format whereby payment was framed as a "meals per week" contributed by the household for one year to people working for the village development program that would would be tasked with bringing about the improvements in the selected environmental attributes. Reflecting the local labour market situation, where a day's wage for a casual worker is 100Kshs (Kenyan Shillings) without food, or 50KShs with food, the cost of a meal to the households was estimated to be 50KShs. Unlike other studies in the literature, the decision to use an in-kind payment vehicle was not due to a complete absence of money in the local economy. Although a subsistence economy to a large extent (Kasina, 2007), money is used, even though not exclusively. However, the subsistence nature of the local economy means that monetary transactions are not particularly prevalent among local people. In many cases, locals are too poor and/or too cash constrained to express meaningful WTP values in monetary terms.

For the CE, an orthogonal main effects fractional factorial design was generated. Based on this design, each respondent was presented with two choice sets, each comprising a status quo alternative and two other generic alternatives describing the improvements brought upon by the village development programme. The attributes of the choice experiment and their levels are shown in Table 2. The CV question was framed using the same attributes as in the CE and described a situation with the maximum improvements in the attributes. Moreover, half of the respondents were asked to choose their maximum willingness to contribute from a range of one to five

meals per week. The other half were asked to express their WTP in money, thus allowing for the possibility to assess the convergence validity of the two payment formats.

Apart from the main attributes, a number of socio-economic and perception variables were assumed to impact upon household welfare and were therefore included in the utility function as interactions either with some of the choice attributes or with the alternative specific constant (ASC). Regarding the wealth profile of respondent households, data on income was not particularly easy to come by, as many respondents were reluctant to reveal their income. In order to circumvent this obstacle, a poverty index was constructed instead, following Henry et al. (2003). In addition, we sought to gauge general knowledge about the forest and its condition, as well as respondents' assessments of the severity of problems related to the provision of the forest services at hand. To do this, a number of perception variables were introduced. These represent the strength of respondents' opinions (measured on a 1-5 Likert scale) with regard to the importance they place on certain environmental aspects and problems. Since these variables do not vary over the choices sets they are entered as interaction terms with the design attributes[2].

Table 10. Attributes and levels

Attributes	Levels
Water availability	No change in water availability*
	20% increase in water availability
	40% increase in water availability
Amount of soil loss per year	No change in the amount of soil loss*
	Amount of soil loss decreases by 50%
	Amount of soil loss stops (No soil loss)
Supply of forest products (years)	30 more years*, 60 more years, 90 more years
Meals per week	No meals*, 1 meal, 2 meals, 3 meals,
	4 meals, 5 meals

*Status Quo

Owing to the non-continuous nature of the WTP in the PC format, the CV data were analysed using OLS and the Tobit model. The CE data were analysed within the

[2] For a detailed discussion on the construction of the poverty index, the perception variables and how they were interacted, see chapters 2 & 3 of this Thesis.

framework of random utility (RU) models (McFadden, 1974). Depending on the assumptions about the distribution of the error term of the utility function, there are a number of different specifications of the RU model. In this study we analysed the data using a Random Parameter Logit model, which, unlike the standard Conditional Logit, can accommodate correlations across alternatives and reveal preference heterogeneity.

4.5 Results

In total, 22 respondents were excluded from the analysis of the CE data because they either protested or showed a poor understanding of the technique. With regard to the CV task, 15 were classified as "protest bids" and excluded from the analysis of WTP. The results presented below are based on the analysis carried out for the 288 and 295 respondents that successfully completed the CE and CV tasks respectively.

4.5.1 Socioeconomic and perception variables

Table 3 provides a summary of the basic socio-economic and attitudinal variables included in the survey.

Table 11. Descriptive statistics

Variables	Mean	Standard deviation
Socio-economic		
Respondent's age	47.68	15.09
Respondent's education	6.13	4.21
Household size (number of people)	5.81	1.92
Household's monthly expenditure[1]	9805	8303
Perception		
Forest is in bad shape*	2.59	1.28
Forest's importance for livelihood*	4.60	0.85
Does the forest affect water availability?[2]	0.90	0.28
Forest's inability to provide after 20 years*	3.88	0.94
Severity of water scarcity problems*	3.29	1.71
Severity of soil loss problems*	3.65	1.42

[1]Includes expenditures on food, clothing, transport, health and schooling
[2]Categorigall 0/1 variable; *1-5 Likert type variable

In terms of the perception variables, they represent the strength of respondents' opinions (measured on a 1-5 Likert scale) with regard to the importance of certain

environmental aspects. The findings show, for instance, that a significant majority of the respondents agrees that the forest may not be able to provide their households with forest products after 20 years (3.88) and that soil loss problems are quite severe (3.65).

4.5.2 Econometric Results

The CE results are presented in Table 4 and include the variables that contributed to an increase in the fit of the model, as this is expressed by the adjusted R^2. That is, even if a variable was found not be statistically significant, it was still included as long as it contributed to a higher *adj.* R^2.

Table 12. Choice experiment results

Variable	Coefficients	
	Coefficient	**Coeff. Std.**
Water availability	0. 8352***	Fixed
Soil loss	2. 312***	Fixed
Supply of forest products (years)	1. 4481***	Fixed
Meals	-3. 4291***	1. 6211***
ASC	2. 0139**	Fixed
Impyears	ns	
Impwater	0. 8355***	
Impsoil	0. 9808***	
Meals*Poverty Index	0. 2722*	
Age*years	ns	
ASC*Education	0. 5229**	
Log-likelihood	-339.8235	
Restricted Log-likelihood	-625.870	
P(Chi²); DF	<0.0000; 10	
Adj. R^2 (Pseudo-R^2)	0. 4503	

***: significant at p≤0.01; **: significant at p ≤ 0.05; *: significant at p ≤ 0.1;
ns: not significant; #: coefficients multiplied with the sample means

As a first observation, it is worth noticing that all of the attributes coefficients are significant have the expected sign. In addition, respondents' perception of the severity of environmental problems also affected their utility. With regard to socio-economic characteristics, two of them have impacted household utility significantly. The

poverty index, representing household wealth, has a positive sign, thus reducing the negative impact of the payment attribute on the utility function. This suggests a diminishing marginal utility of income (or in this case wealth), conforming to expectations. Finally, the interaction of the educational level with the ASC comes up positive, suggesting that better educated respondents were more likely to choose to contribute to one of the two village development programmes.

The analysis of the CV responses is presented in Table 5. The results reported are based on pooling the observations from the two sub-samples of respondents facing different payment vehicles (meals vs. money). This is allowed as a t-test of means revealed that there was no significant difference in the average WTP of the two samples, thus confirming the convergent validity of the CV survey in terms of the use of two different payment vehicles. The pooled data were analysed in the meals format (i.e.WTP in money was converted in WTP in meals) and two different types of regression were carried out, namely Tobit and OLS regressions. The table paints a picture similar to the one obtained from the CE analysis in terms of the factors affecting WTP and their expected sign. Here, again, peoples' perception of the environmental problems has a positive influence on their WTP for improved forest services. Moreover, household wealth and respondents' education level also affect WTP positively. The only differences compared to the CE results pertain to the effect on WTP of household size and respondents' age. The positive sign of the household size variable implies that bigger households exhibit slightly higher WTP. On the other hand, the negative sign of the age variable suggests that older respondents' WTP was slightly smaller

Table 13. Contingent Valuation results

Variables	Tobit	OLS
Constant	-3.130	-2.632
Sociodemographic		
Poverty Index	5.005	4.632
Age	-.011	-.014
Education	.027	.026
Household size	.081	.074
Attitudinal		
Soil severity	.269	.243
Water severity	.362	.339
Years severity	.346	.312
	Pseudo R^2= 0.406 ML (Cox-Snell) R^2 =0.763	R^2= 0.769

All coefficients are significant at the 0.01 level

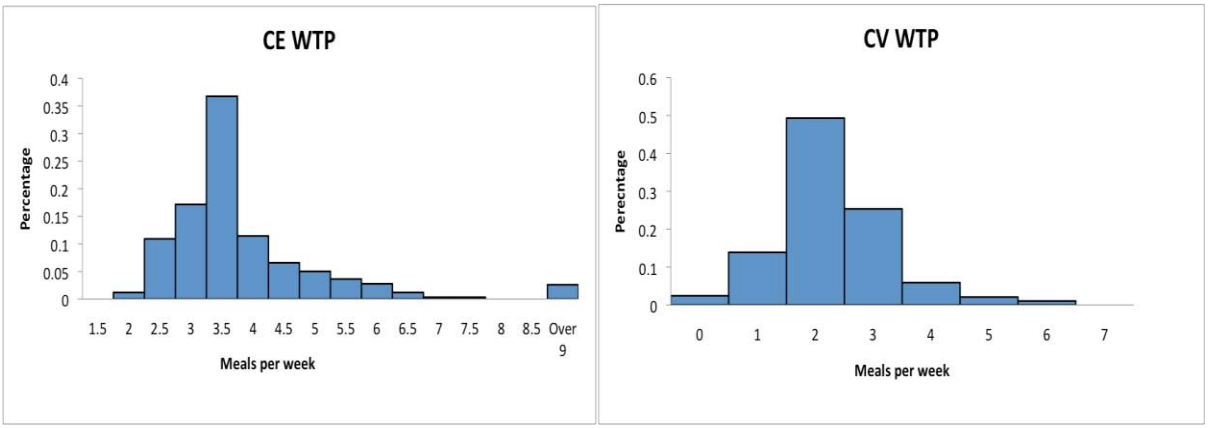
4.5.3 WTP comparison

WTP from the PC CV data is estimated by simply taking the mean of the given responses from the pooled sample. This amounts to a mean WTP of 2.28 meals/week. In the case of the CE, mean WTP, or Compensating Surplus, for a change from the status quo to the situation described in the CV, is estimated with the help of the following equation:

$$CS = \frac{-(V_0 - V_1)}{\beta_y}$$

Where β_y is the utility of income; V_0 is the utility of the current situation and V_1 is the utility of the proposed alternative. Thus calculated, mean WTP is estimated to be 3.5 meals/week. The payment attribute in the RPL was found to vary across respondents, which reveals a significant heterogeneity in terms of respondents' sensitivity to this attribute. This variability in tastes consequently translates into variability in WTP, which can be measured by inserting each respondent's β_y in the above equation and estimating the individual CS. Figure 1 shows graphically the distribution of WTP amongst households from the CE and the CV question. The estimated CE WTP is for an improvement in forest services of the same magnitude as in the CV question.

Figure 9. Variability in individual WTP



4.6 Conclusions and discussion

This study has presented the first comparison of the Contingent Valuation and Choice experiment methods applied in the valuation of local forest ecosystem services in Africa. The two methods were applied on the same sample of households living around Kakamega forest, eliciting the households' WTP for improvements in three ecosystem services associated with the forest: water availability, soil loss prevention and future supply of forest products. For the CV task, a Payment Card type of elicitation format was used. Moreover, a non-monetary payment vehicle, expressed in the form of meals contributed to a village development programme, was employed. The comparison of the WTP estimates obtained from the two methods shows that the CE resulted in higher WTP estimates than the PC CV did.

As the PC CV and CE methods do not share the same random utility, we cannot treat the CE and open-ended CV results to be theoretically equivalent and therefore the WTP estimates are not directly comparable. The different assumptions by these two methods might be one cause of the reported divergence in WTP values. However, using the dichotomous choice (DC) elicitation format, which is based on random utility theory, does not guarantee convergence of WTP values with values obtained from CE, as evident by the majority of comparisons where the DC format is used instead. The results of the present study are broadly in line with Ryan and Watson (2009) and with Hynes et al. (2011), who also use PC CV in their comparison. In both

these studies the WTP values obtained from CE are higher than the ones obtained from CV. Thus, these results are in agreement with the general finding in the literature that direct estimates of WTP, obtained from CV studies, result in lower welfare estimates than indirect approaches to valuation, such as the CE. The most common explanation for this is that in CE the cost attribute is not as prominent as in CV, thereby diverting respondents' attention away from it. This is reinforced in the Ryan and Watson study in which a simulated dichotomous choice CV task is generated, yielding higher WTP estimates than the PC format, though still lower than the actual CE employed.

Notwithstanding the difference between the WTP estimates in the present study, it is encouraging to notice that the two methods show theoretical consistency in that certain factors influence respondents' choices in a consistent and expected way. For instance, in both the CV and CE tasks, respondents' choices were influenced by their wealth levels and their perceptions of environmental problems in ways that conform to theoretical expectations. This means that respondents did not just make random, arbitrary choices but that they took to the survey seriously and they engaged with it.

Finally, although estimates of the mean WTP across people are very helpful, it is also interesting to know that there is variability of preferences in the population. By fitting a RPL model to the data, this study has revealed considerable heterogeneity with respect to household WTP, ranging from about 1 meal per week to more than 10 meals per week. However, the data has not shown the source of this heterogeneity and this is something that lends itself to further research in the future.

4.7 References

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CHAPTER 5 Summary and limitations

This study has used two stated preference methods to estimate the economic value that households place on certain ecosystem services of Kakamega forest. Both menhods were applied to the sample of respondents, which consisted of 310 rural households living around the forest; the survey was carried out in the first two months of 2006. This dissertation provided empirical evidence on the effects on households' welfare of changes in water availability, soil loss and future supply of forest products.

Chapter Two presented the first stated preference method, namely the Contingent Valuation. It showed that the average household expressed significant willingness to pay (WTP) for a development programme that would bring about specific improvements in the provision of the measured services. This work departed from common practice in the valuation literature by employing a non-monetary means of expressing WTP. Using a split sample, it also tested the convergence validity of such a payment vehicle by comparing it with a standard, monetary payment vehicle. By demonstrating equivalence between the two WTP measures, it demonstrated the suitability of the use of a non-monetary payment means that respondents were well familiar with.

Chapter Three elaborated on the use of a Choice Experiment (CE) for the elicitation of households' WTP for the improvement in the aforementioned ecosystem services. This was the first instance in the literature of a CE that elicited WTP using a non-monetary payment vehicle. The observed very high goodness-of-fit measures, as well as the significance of the main hypothesised determinants of choice establish that the CE was successfully applied. The chapter further delineates respondents' preferences with respect to the specific ecosystem services and shows that prevention of soil loss was the highest valued amongst the three ecosystem services.

Chapter Four compared the two stated preference methods. At the time of the application of these methods, it was the first instance of a concurrent use of a CE with a CV that used a payment card elicitation format. Shortly after the completion of this study, two more studies came out that compared these two instruments. Our findings are in line with the general consensus in the literature that WTP elicited by CEs is larger than when elicited in a CV context. Beyond the estimation of respondents' WTP, an interesting finding that was common to CV and CE, was that, after households' wealth, the strongest factors influencing choice and therefore WTP was

respondents' perceptions with respect to the gravity of the environmental conditions and forest services. This implies that next to income-improving policies, raising awareness through targeted information campaigns could prove to be an effective way to modify people's behaviour.

Despite the important findings presented here, this work is not without its shortcomings. Other than the comparison of the two payment vehicles, this study did not embark on exploring other methodological issues. For instance, a limitation is the inability to test for non-linear utility effects in the Choice Experiment. Doing so would have produced a more realistic and precise representation of respondents' preferences. However, the way the various attributes were coded in the CE design rendered this possibility void. Be that as it may, these limitations do not detract from the fact that this work produced theoretically robust estimates of WTP that are based on excellent-fitting models. As such, it offered clear insights into the economic benefits of Kakamega forest's ecosystem services, as perceived and valued by local communities.

APPENDIX

APPENDIX

Survey Questionnaire

Date ……/……/……
(Day, Month, Year)

Enumerator's Name……..

Respondent's Name……..

District……..…. Division…….. Location……...

Sub-Location……..... Village……

Hello, I am a researcher from the Center for Development Research in Bonn, Germany, carrying out a study on the management and economic importance of Kakamega forest. I would like to ask you some questions about your views on the forest and the advantages that you obtain from it. Some of the topics may involve issues that you may not be familiar with. So please ask me, if I have not explained them well. Take your time; if you are unsure do not hesitate to say so. Your answers will help me understand your interests in the forest which will be used to design forest-management programmes in the interests of the local communities. The forest-management programs for Kakamega will be undertaken by BIOTA which is a non-governmental organization based in Germany and has experience in managing forests for the benefits of local communities.

The questionnaire is divided into three parts: First, I will ask you about your relationship with Kakamega forest and your attitudes towards forest management in general. In the second part I will show you different cards. Each card describes three different forest-management programmes, and I will ask you which you like best. The third part focuses on your household situation, for example about how many people your household holds, occupation, etc.

Thanks a lot for your participation. We really appreciate your help!

PART ONE: DATA ON ATTITUDES TOWARDS FOREST CONSERVATION AND ON FOREST UTILISATION

To what extent do you agree, or disagree, with the following statements? (Circle the answer)

Q1. Forest protection issues are important

1	2	3	4	5
Completely Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Completely Agree

Q2. The protection of the forest is important for the livelihood of your family

1	2	3	4	5
Completely Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Completely Agree

Q3. The forest is in good condition

1	2	3	4	5
Completely Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Completely Agree

Q4. The forest has been damaged a lot in the past 20 years

1	2	3	4	5
Completely Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Completely Agree

Q5. The forest may not be able to provide your family with the products that you need after 20 years

1	2	3	4	5
Completely Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Completely Agree

Q6. The current management of the forest reflects the interests of local communities.

1	2	3	4	5
Completely Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Completely Agree

Q7. On average, how many times *per month* do you, or other members of your household, go to the forest?

0-5 times per month	6-10 times per month	11-15 times per month	Almost every day
1	**2**	**3**	**4**

Q8. Please fill in the following details concerning the distance between your homestead and the nearest forest edge

	Name	Distance (in Km)	Transport type you usually use [Walking=1, Bike=2, Car/Bus/Motorbik Company Transport Service=4]	Time spen (hours)
Nearest forest ed				

Q9. When you go to the forest, do you go only to the nearest forest edge or do you go to other parts of the forest that are further away?

Nearest forest edge	Other parts of the forest
1	**2**

Q10. What are the main reasons for going to the forest? (Circle more than one if necessary)

Collection of Wood	Collection of Medicinal plants	Collection of Thatch grass	Grazing	Educational reasons	Spiritual reasons
1	**2**	**3**	**4**	**5**	**6**

Q11. Other than providing forest products, do you feel that the forest has any value to you?

…….. [*yes=1/no=0*]

If the answer was "No", go to **Question 13**

Q12. What other services of the forest do you value?

…….

Q13. Do you think that water availability in your area is affected by the forest?

…….. [*yes=1/no=0*]

If the answer was "No", go to **Question 15**

Q14. In what ways, do you think, the forest affects water availability?

……

Q15. How important do you consider water scarcity to be a problem in your area during the dry season?

1	**2**	**3**	**4**	**5**
Completely Unimportant	Fairly unimportant	Neither important nor unimportant	Fairly important	Very important

If the answer was **1** go to **Question 17**

Q16. How many months during the dry season do you think you have a water-scarcity problem?

…….. [*Number of months*]

Q17. Do you think that the existence of the forest prevents the loss of soil?

…….. [*yes=1/no=0*]

Q18. How important do you consider soil loss to be a problem in your area?

1	**2**	**3**	**4**	**5**
Completely Unimportant	Fairly unimportant	Neither important nor unimportant	Fairly important	Very important

PART TWO: CHOICE EXPERIMENT

This part of the questionnaire analyzes your preferences for different village development programs that will manage the forest and the services you obtain from it. Your preferences are very important to us. This is because any future management program should be based on the opinions and designed according to the preferences of the communities living around the forest.

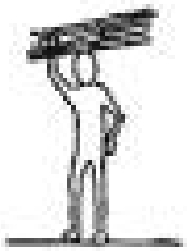
As you probably know, there is a lot of change to nature here in recent years. Some of the changes refer to the forest and your land. Many people think that the changes were negative. If a negative trend continues, the quality and/or amount of the services that you obtain from the forest will decline over time. We want to help the government to find out what you people here in the region really think that has to be done. You can help us find out in a very simple way: You will play a game, whereby I show you different situations, and you tell us which situation you like best.

In some situations the environmental conditions get better, but you have to contribute to a village development program that brings about the positive changes. The contribution will be in the form of meals that you will be asked to provide in order to support the people working in these programs.

In other situations the environmental conditions get worse, and then you will receive a compensation in the form of meals per week.

The different programs under consideration will affect certain services of the forest (such as prevention of soil erosion, availability of fuel wood and availability of water) and they are described in terms of the effect they will have on these services.

The village development programs that you will be asked to choose from will focus on the following characteristics/services of the forest.

Characteristics	*Description*
Water availability 	The forest regulates the flow of water in the streams and rivers in your area and it is also thought to attract rain. Depending on the way the forest and the land are managed, the amount of water available for use could increase approximately by 20% or 40% during the dry season.
Supply of wood and medicinal plants 	Currently, most households get the wood and medicinal plants from the forest either by collecting them themselves, or by buying them. Given the current situation, the forest will continue to provide the wood and medicinal plants that your household needs for 30 more years, some scientists estimate. According to how the forest is managed, the supply of these forest products can be secured for more years to come. In particular, the proposed management programs can secure the supply of forest products for 60 or 90 years.
Soil loss 	It is known that the forest prevents soil erosion by retaining the soil and by acting as a wind breaker. However, it has been observed that many farmers in your area experience some soil loss. If the current situation persists, the current rate of soil loss will continue. This rate of soil loss can be slowed down by half, or stopped, depending on the way the forest and the land is managed.
Number of meals contributed per week	In order for the proposed village-development programs to go ahead, you will be asked to contribute some meals every week in order to support the people working in those programs. Please note that any meals you may decide to contribute to help with the programs represent resources that you might want to spend on other things, such as clothing, or feeding your own family. This means that you should agree to contribute the required meals only if you are absolutely sure you can afford to do so.

(To be filled in by the enumerator)
Choice Experiment

	Contribution			
	Card 1	Card 2	Card 1	Card 2
S.Q.				
Altern. 1				
Altern. 2				

APPENDIX

Contingent Valuation

	Contribution
S.Q. (Tick)	
Meals (Number)	

END of Choice Experiment
If the respondent has chosen the *Current Situation* in the "contribution" cards ask:

Q19. Why did you choose the current situation in these two cards?
I could not afford to contribute any meals……
I don't think that I should have to pay for these changes in the forest services…….
I don't think these services will be provided even if I pay……
If the respondent has chosen the *Current Situation* in the "compensation" cards ask:

Q20. Why did you choose the current situation in these two cards?
a) My minimum required compensation is bigger than the amounts indicated on the cards…….
b)
Other…….
.

To what extent do you agree, or disagree, with the following statement? (Circle the answer)

Q21. The game that I just played was easy to understand

1	2	3	4	5
Strongly Disagree	Partly disagree	Neither agree nor disagree	Partly agree	Strongly Agree

Q22. How certain do you feel about the last two choices you made? (Circle one)

1	2	3	4	5
Completely uncertain	Quite uncertain	Neither certain nor Uncertain	Quite certain	Completely certain

Q23. How did you make your choices in all the cards that you were shown?
a) I compared **all** the characteristics of each situation and chose the situation that I preferred most in each card that I was shown.
Yes ☐
Or:
b) I considered only **one** characteristic as the most important one and chose

in all the cards that I was shown, the situations that gave me the best value for that characteristic.
Yes ☐

If you answered **b)**, which characteristic was it? _____

PART THREE: SOCIO-ECONOMIC DATA

24. Please list all household members in the first column according to their relation to the head of household. Include also respondent in the first row!

Household member (e.g. wife, son)	Sex 1=F 2=M	Age (years)	Formal Education (Years)	Main occupation
1)				
2)				
3)				
4)				
5)				
6)				
7)				
8)				
9)				

Codes
Main occupation: 1= Self employed in agriculture; 2= Self employed in non-farm enterprises; 3= Salaried worker; 4= Daily wage laborer; 5= Pupil/student; 6= Unemployed, looking for a job; 7= Retired, 8= not able to work.
Relation to HH head: 1=HH head, 2=Father/Mother, 3=Daughter/Son, 4=Other relative, 5=Non relative

25. Did you receive any kind of education on forest conservation during your school days?

…….. [yes=1/no=0]
26. Currently, are you actively involved in any kind of forest conservation programmes?

…….. [yes=1/no=0]
27. Size of residence building: ……. Unit: ..…….
28. Building material: ……. [Wood = 1, Bricks (clay) = 2, Stones = 3, Mud = 4, Other = describe]
29. Roof: …… [Tiles=1, Iron sheet=2, Thatching grass=3, Other = describe]
30. Could you estimate the value of your pieces of land today? …… (Kshs)
31. How much does your family usually spend on food **per month**? ……..

32. How much does your family usually spend on clothing **per year**? …….
33. How much does your family usually spend on transport **per month**? .....
34. How much does your family usually spend on health care **per year?** ……..
35. How much money did your family spend for schooling (Fees, books, uniforms) during the last school year? …….
36. Does you household own or have access to the following items?

	Item	Yes=1/No=0
1.	Electricity	
2.	Piped Water	
3.	Radio	
4.	Bike	
5.	Car	
6.	Motorbike	
7.	Gas Stove	
8.	Charcoal Stove (jiko)	
9.	Fridge	
10.	T.V. set	
11.	Solar Panel	
12.	Phone	
13.	Water Storage Tank	

37. Does your household own the following animals?

	Animal	How many?
1.	Cow	
2.	Ox	
3.	Donkey	
4.	Pig	
5.	Chicken	
6.	Sheep/Goats	

Eidesstattliche Erklärung

Ich versichere an Eides statt, dass ich die eingereichte Dissertation “Estimating the Economic Value of forest ecosystem services using stated preference methods: the case of Kakamega forest, Kenya” selbstständig und ohne unerlaubte Hilfsmittel verfasst habe. Anderer als der von mir angegebenen Hilfsmittel und Schriften habe ich mich nicht bedient. Alle wörtlich oder sinngemäß den Schriften anderer Autoren entnommenen Stellen habe ich kenntlich gemacht.